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33^{rd} ANNUAL SCIENTIFIC MEETING

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Keynote Address for the 33rd Annual Scientific Meeting of the National Academy of Science and Technology, Philippines (NAST PHL)

MEETING THE CHALLENGES OF AGRICULTURAL PRODUCTIVITY, SUSTAINABILITY, AND COMPETITIVENESS

Senator Francis N. Pangilinan

Good morning.

We wish to thank Dr. Javier for inviting us to today's event, as the scientific community comes together to discuss how science and technology could be used to address some of our key social, environmental, and economic issues and help lift the country out of poverty. We have seen from recent events the urgency of meeting our agricultural challenges: massive amounts of fish kill in Batangas and Pangasinan have left our fishermen out of livelihood and are threatening our food supply; extreme weather caused by climate change is causing us billions of pesos worth of damage—not to mention hundreds of lives—yearly; the series of crises in the Middle East is sending millions of our people home with no viable alternatives for livelihood and security; and our ballooning population, coupled with unsustainable use of resources, is threatening our already substandard quality of life. While we look to high-technology and 21st century models to inspire us in our work, we also know that we need to go back to basics and resolve our challenges in agriculture if we are to move our nation forward.

The agriculture sector accounts for roughly 70% of our labor force, including those indirectly involved in agriculture, and it also accounts for around 70% of our GDP. However, if you look at the total budget allocated for agriculture, as well as science and technology, you will see that not enough resources are directed toward this crucial sector. We see more money being pumped into ―intelligence funds rather than urgent investments in agricultural infrastructure and R&D. Add to that, our farmers are getting older and poorer, and there are no attractive options or incentives for the next generation to step up in this field. We will be facing a looming crisis, as well as a breakdown in our domestic economy, if things don't shape up soon. As Chair of the Senate Committee on Agriculture and Food, it is our priority to address key issues in the following areas:

- **Access to credit for farmers, fishermen, agricultural workers, and budding "farmpreneurs";**
- **Access to markets, both domestic and overseas;**
- **Roll-out of critical infrastructure—such as farm-to-market roads, post-harvest facilities, cold storage facilities, and the like;**
- **Increased investments in Research & Development, as well as the transfer of knowledge and technology from our researchers and scientists onto the field; and;**
- **Helping agricultural workers get organized to be able to benefit from the cooperative and micro-finance models, which we have seen works in many parts of the country.**

Of these five priorities, we are counting on the scientific community to help us address our clear gaps in R&D—especially in translating scientific knowledge into practical, applicable information that will help boost the agricultural sector's profitability, productivity, and sustainability. We know that we have some of the best minds in this room today, and if we could all work together to bring the latest of your research and scientific breakthroughs out to the field to be tested or rolled out, then we could make great headway in finding solutions that work. Remember: we were the country that once taught Japan, Vietnam, and other countries in the region a lot of what they know about agriculture. If we could harness all that energy, knowledge, and potential today, then we can make a big difference for our people, for our children.

I have always said that for us to achieve different results, we need to do things differently. Einstein himself said that **—** "***We can't solve problems by using the same kind of thinking we used when we created them".*** We cannot have more of the same poverty, more of the same hunger, more of the same vulnerability, more of the same injustice. We therefore need to look at the challenges of agriculture from new lenses, with new mindsets and perspectives, with a new vision in mind. We must be willing to dare. We must be willing to tackle risks. To do things differently.

On a personal note, when I was faced with the decision of whether or not to take the Agriculture and Food Committee some months ago, I initially hesitated knowing that I know very little about the Agriculture and Fisheries sector in that it most definitely wasn't my forte. Yet, my nearly ten years in the Senate has taught me that poverty and backwardness will not go away unless we modernize our Agriculture and Fisheries sector–that in order to reach developed-nation status in a decade and a half, we must resolve the decades-old problems facing Agriculture and Fisheries Modernization. Hence, I told myself, I had to walk the talk. I had to move away from my comfort zone if I was to make a real difference. I had to risk. I had to dare. I had to have the courage to do things differently and see change through. It was Gandhi who said **—** "***We must be the change we seek to see".*** And so my own personal journey to help secure our farmers and fisherfolk began.

So let us map out a new future for our country starting today—right here in this very hall. Let us open our minds, reach out and collaborate, and create solutions that will make life better for all of us. Your government is here to listen, to participate, and to act, and we hope that, with you, we can change the lives of millions of our countrymen and forever change our nation's path toward one of genuine change, progress, and prosperity.

Thank you and good morning.

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PHILIPPINE AGRICULTURE 2020: A STRATEGY FOR POVERTY REDUCTION, FOOD SECURITY, COMPETITIVENESS, SUSTAINABILITY, AND JUSTICE AND PEACE

Emil Q. Javier

Philippine Agriculture (PA) 2020 is a medium term strategic plan for the agriculture and natural resources sector articulated by scientists, farmers, entrepreneurs, non-government workers, people in the bureaucracy and other stakeholders in a series of consultations and workshops convened by the National Academy of Science and Technology, Philippines (NAST PHL).

The plan envisions a sector that shall have major role in reducing poverty, achieving food security, global competitiveness, sustainability and justice and peace. It looks forward ten years hence to a vision of robust and vibrant agricultural and natural resources production systems and ecosystems services that improve and sustain well being in the Philippines.

PA 2020 adopted as its conceptual framework the UN Millennium Ecosystems Assessment which posits a strong linkage between ecosystems and human well being. Using this ecosystem framework, agriculture is seen as embedded in three overlapping and interacting systems- 1) agricultural systems, 2) natural resources systems, and 3) social systems.

Agricultural systems involve the production of crop livestock, fisheries and trees for food, feed, clothing and shelter. Their productivity and sustainability are driven by changes in climate, technologies, tenurial arrangements, in the country’s resource endowments and on the ecological services provided by environment and natural resource systems. The social systems, characterized by population size and quality, culture, peace and order, tenurial systems and governance integrate the manner how the two physical systems are utilized for human well being for now, and for the generations to come.

Moreover, PA 2020 embraced the social philosophy that agriculture is a way of life and that it has multiple functions: That agriculture beyond its economic and material contributions is connected to the distribution of social and political power and to the culture and values that animate it and enrich society as a whole. That the multiple goals of poverty reduction, attainment of food security, competitiveness, sustainability, and of justice and peace cannot be achieved without a holistic view that expands production and broadens markets, hand in hand with empowering people to move out of poverty and preserving the sources of pride in Filipino culture.

Thus PA 2020 rests on three pillars: 1) organizing and managing agriculture as a business, 2) changing the social structure through asset reform, and 3) nurturing values respecting nature and community.

To make the social philosophy and pillars of PA 2020 operational, three broad enabling strategies are required, namely, 1) technology development, 2) investments, and 3) governance reforms.

Technology innovations raise yields, improve product quality, reduce losses and conserve the environment resulting in enhanced productivity, profitability, competitiveness and sustainability. These technology modernization requirements and opportunities are treated at length in the fifteen agro-industrial clusters into which the whole of agriculture and natural resources were divided.

The modernization of agriculture calls for massive public investments in physical infrastructure, in rural credit and finance, in human capital and institutions. These public investments make agriculture more productive and less risky and therefore more competitive for private investments.

Governance is the “binding force” for the enabling strategies. In the first place the public sector has a major role in initiating development interventions. Appropriate laws, policies, rules and regulations need to be in place to make the public institutions work and to define the space within which the private sector has to operate and most importantly development in order to be sustainable and equitable require the broad participation of stakeholders.

PA 2020 essentially is a blueprint for the modernization of Philippine agriculture not so much from the perspective of macro planners and legislators but from the point of view of sector stakeholders, technical people and the implementers. Thus it basically reinforces the Agriculture and Fisheries Modernization Act of 1997 (AFMA) and the NEDA MTPDP but richer in organization and technical details and ideas on project planning and implementation. Much of the added value of the PA 2020 exercise come from the attached Industry Cluster Strategic Plans (ISPs) and the extra effort to translate the broad sector objectives and strategies into Indicative Action Plans unique for each industry cluster. These suggested Indicative Action Plans are described at length in the fifteen Industry Cluster Strategic Plans (ISPs) in the annexes.

PA 2020 proceeds from the premise that the anemic performance of Philippine agriculture in the last three decades has not been for lack of appropriate laws, policies, institutions, programs and human resources. Most of the features of a modern agriculture sector are in place but what had been lacking for the most part are 1) the political will to fully invest in its requirements; 2) concentration and sustained efforts, 3) coordination and convergence of public and private investments and interventions, and 4) greater transparency and accountability in the use of public funds.

Up to 2006 the annual appropriations to the Department of Agriculture, its attached corporations and for the implementation of AFMA together was only about P18-20 billion. Thus the lack of funds has ceased to be a real constraint and hence the guarded optimism for the 7% projected growth rate of agriculture consistent with the NEDA medium term plan. The big challenge now is to allocate the resources properly and in a balanced and carefully calibrated manner to those programs and activities which will contribute the most to the national goals of poverty reduction, food security, productivity, competitiveness, sustainability, and justice and peace.

An annual public expenditure of around P50-60 billion should be adequate to meet the modernization needs of agriculture and fisheries in the coming decade. Thus the first and foremost requirement is to sustain this level of public expenditure for agriculture in the General Appropriations Acts.

What needs and can be done in the near term most of which can be implemented with the human, financial and institutional resources at hand include the following:

For Near-Term Implementation

1. Updating of Industry Cluster Road Maps
2. Translating the Updated Industry Road Maps into Operational National Commodity Programs
3. Strengthening of the LGU ANR Extension Offices
4. Strengthening of DA Regional Offices
5. Establishment of Dedicated Extension Units in Selected SUCs
6. Emancipation of the DA Bureaus
7. Strengthening of Statistics Gathering and Analysis Capability of BAS including Utilization of GIS and Remote Sensing Technology
8. Organizing All-Philippine Farming Systems RDE Networks for Rice, Corn and Coconut
9. Professional Management and Institutional Support to Farmers Organizations
10. Review and Oversight of NIA Operations
11. Completion of Agrarian Reform
12. Resurrection of the Bureau of Agricultural Extension
13. Resolution of the Fisheries Governance Issue
14. Review of Priority Setting and Resource Allocation Among Programs and Activities
15. Phase out of Procurement and Distribution of Farm Inputs

Those which require additional legislation, policy reform, major restructuring as well as programs and projects which have longer gestation period include the following:

For Medium-to-Long Term Implementation

1. Enactment of a National Land Use Policy
2. Unified Lands Administration and Public Lands Management; Creation of a Lands Administration Authority under DENR
3. Further Extension of AFMA till 2020
4. Reform of the National Food Authority
5. Creation of a Special Small Farmers Fund, with Subsidized Interest Rates
6. Irrigators Associations to Collect and Retain Water Users Fees; Amendment of NIA Charter from a Corporation to a Bureau

7. Conversion of Production Forestlands Covered by CBFMAs, CLOAs and CADCs/ CATCs into Large Forest and Industrial Tree Crop Plantations.
8. Devolution of Natural Resources Extension Services from DENR to the LGUs and their Rationalization into Merged Agriculture and National Resources Extension Offices.

The Philippine population will continue to grow unabated to 2020 and beyond as the population debate remains unresolved. The low per capita availability of arable land and freshwater will further decline. Thus the country, like most of the rest of the developing world, faces the dauntless task of producing more and more food from less and less arable land and irrigation water.

A net food importer even now, the Philippines cannot, even if it wished, be fully food self-sufficient. Nevertheless with strong measures to preserve prime arable lands, the full harvest, storage and careful utilization of surface waters and aquifers, and with modern production and postharvest technologies, the country can produce a big part of what it imports now and still produce some niche products for export.

Among the hierarchy of national purposes, elimination of poverty is most pressing and problematic. Poverty is pervasive in the country, more so in the countryside. The problem of poverty cannot be adequately addressed without resolving the challenges of productivity and equitable access to productive assets by farmers and fisher folks.

PA 2020 has embraced the social philosophy that agriculture beyond its economic and material contributions is connected to the distribution of social and political power and to the culture and values that animate it and enrich society as a whole.

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MANAGING OUR MARINE FRONTIER: CHALLENGES AND OPPORTUNITIES

Rafael D. Guerrero III

Introduction

Planet Earth, the world we live in, is known as the "Blue Planet" (as seen from outer space) with more than 70% of its surface covered by oceans. The waters of our world are 97% salty (marine) and 3% fresh. A cross-section of the ocean shows the different zones at various depths from the shallowest and most productive (Light Zone) to the deepest and most unknown (Dark Zone). Aside from their biological (e.g., fisheries) mineral and energy resources, the oceans are also important for producing oxygen and absorbing carbon dioxide through the plants in them, for regulating climates, as a major means of transport of goods and people with ocean-plying vessels, and for their aesthetic value and recreation.

In the context of "Meeting the Challenges of Agriculture Productivity, Sustainability and Competitiveness," only the fisheries of our marine frontier (oceans) shall be discussed in this paper. Marine fisheries involve the capture, culture, processing, marketing and utilization of marine plants and animals.

World Fisheries Scenario

Globally, the total fisheries production in 2009 was 145.1 million metric tons with a value of US$199.9 billion. Marine fisheries (capture and culture) contributed 69% to such production while inland fisheries (capture and culture) contributed 31%. Fish (65%) constituted the bulk of production followed by invertebrates (25%) and aquatic plants (10%). Humans consumed 81% of the production which supplied 15.7% of the global population's annual protein intake. Fisheries provided income and livelihood directly and indirectly to 54 million people worldwide. The majority (85.5%) of fishers and fish farmers are in Asia (FAO, 2010).

With overfishing, only 15% of the marine fish stocks of the world are believed to be underexploited or moderately exploited. Most of the stocks have been fully exploited or overexploited. Worldwide, 99% of the annual commercial ocean catch comes from coastal waters within 200 nautical miles of the coastline. Marine fish catching is expected to grow only by 0.7% annually until 2020.

Aquaculture, the farming of aquatic organisms, is seen as the hope of the future for fisheries. It is the fastest growing animal producing sector with an annual growth rate of 6.6%. In 2009, the sector provided 38 % of the total global fisheries production (**Table 1**) and is expected to contribute two-thirds of the world's fish supply in 2020 with an annual growth rate of more than 2.8%.

Table 1. World Fisheries Production in 2009

SOURCE	PRODUCTION (million tons)	%
Inland		
Capture	10.1	7
Culture	35.0	24
Subtotal	45.1	31
Marine		
Capture	79.9	54
Culture	20.1	15
Subtotal	100.00	69
Total	**145.1**	**100**

Source: (FAO, 2010)

Asia accounted for 52 % of global capture fisheries production and 89% of culture fisheries production. According to ecosystem, the fish production of selected Southeast Asian countries showed that the Philippines was the third largest in fish production after Indonesia and Thailand (**Table 2**).

Table 2. Fish Production (million tons) of Selected Southeast Asian Countries by Ecosystem

Country	Marine Capture	Culture	Brackishwater Culture	Freshwater Capture	Culture
Indonesia	3.8	0.20	0.43	0.30	0.99
Thailand	2.7	-	0.44	0.21	0.25
Philippines	2.03	0.92	0.25	0.19a	0.15
Malaysia	1.29	0.92	0.12	-	0.15
Vietnam	-	0.08	-	0.88	-

Source: Dey et al., 2008 aBFAR.2010

The Importance of Philippine Fisheries

In 2009, the Philippine fisheries industry produced 5,079,977 million metric tons of products with a value of PhP 215.58 billion (BFAR, 2010). Of this volume, 53% of the production was from capture fishing (inland and marine) and 47% from culture fisheries or aquaculture (inland and marine). The production from marine waters was 84% of the total compared to 16% from inland waters (**Table 3**).

Table 3. Fisheries Production of Philippine Inland and Marine Waters (2009)

Source	Production (mt)	% of Total Production
Inland		
Capture	188,722	4
Culture	616,777	12
Subtotal	805,499	16
Marine		
Capture	2,413,863	48
Culture	1,779,862	36
	4,193,725	84
Total	**5,079,977**	**100**

Source: BFAR, 2010

The fisheries industry contributed 2.2% to the country's Gross Domestic Product amounting to PhP170.3 billion at current prices and 24.4% of the Gross Value Added in the Agriculture Sector, the second largest to agricultural crops. It also provided direct employment to more than 1.6 million fishers and fish farmers who are mostly small-scale and poor. The fisheries exports of the country (mainly tuna and seaweeds) had a value of US$674,861. Filipinos consume about 38 kg/cap/yr of fish and fish products that comprise 42% of their animal protein supply (BFAR. 2010)

The Philippine Marine Frontier and Its Fisheries

As an archipelagic country, the Philippines has a marine frontier (oceans) consisting of 2,200,000 km^2 territorial waters that are 12% coastal or inshore and 88% oceanic or offshore. It also has a continental shelf area of 184,600 km^2 (from the shoreline to a depth of 200 m) and a coastline of 36,289 km which is the third longest in the world next to Canada and Indonesia (BFAR, 2010).

The marine fisheries of the country include both the capture or catching and culture or farming of plants and animals in the oceans. Marine fisheries capture involves the catching of pelagic species (dwelling near the sea surface) and demersal species (dwelling near the sea bottom). The pelagic fishes consisting of the small pelagics (e.g., roundscad and sardine) and large pelagics (e.g., tuna and billfish) contribute 56% and l5%, respectively, to the total marine catch. Demersal fishes that contribute about 18% to the total catch are caught in hard bottoms (e.g., snapper and grouper) and soft bottoms (e.g., slipmouth and catfish). Aside from fishes, invertebrates like squids, shrimps and crabs are also caught in marine waters. Marine fishers are categorized into municipal fishers (without or with boats of 3 gross tons or less) fishing within municipal waters (up to 15 km from the shoreline) and commercial fishers (with boats more than 3 gross tons) fishing outside of municipal waters. Commercial fishers using active types of fishing gear such as ring nets, bag nets and purse seines land about 53% of the total marine catch while municipal fishers using passive types of fishing gear such as hand lines, gill nets and fish traps land 47% of the catch. In 2002, there were an estimated 1,371,676 municipal fishers and 16,497 commercial fishers in addition to 226,195 fish farmers (BFAR, 2010).

For marine culture fisheries or mariculture, the dominant production was for seaweeds (94.6%) with *Kappaphycus alvarerzi* and *Eucheuma cottoni* as the main species which are utilized for industrial products. Marine fishes (mainly milkfish) cultured in cages and pens contribute 3.1% to production followed by mollusks (oysters and mussels) with 2.2% and crustaceans (crabs, lobsters and shrimps) contributing the least.

Challenges of Philippine Marine Fisheries

In the Comprehensive National Fisheries Industry Development Plan (CNFIDP) of the Bureau of Fisheries and Aquatic Resources (2008), the problems/issues (challenges) confronting the Philippine marine fisheries industry are: (1) depleted fisheries resources due to excessive fishing effort and open access regimes; (2) degraded fisheries habitats due to destructive fishing methods, conversion of fisheries habitats into economic uses and negative impacts from land-based activities; (3) intensified resource use competition and conflict among fisher groups and other economic sectors; (4) unrealized full potential of aquaculture and commercial fisheries as there are still underutilized areas for industry development; (5) uncompetitive products due to inferior quality and safety standards; (6) post-harvest losses in terms of physical, nutritional and value losses; (7) limited institutional capabilities from the local up to the national levels of governance; (8) inadequate/inconsistent fisheries policies that promote conducive environment for sustainable development; and (9) weak institutional partnership among government agencies, civil society organizations and the private sector.

The CNFIDP projected that by 2025 with a population growth rate of 2.31% and per capita fish consumption of 31.4 kg/yr, the country will have a fish supply deficit of 585,538 metric tons. In addition, the negative impacts of climate change on fisheries resources also need to be considered.

Overfishing has resulted in the depletion of most of the marine fisheries stocks of the country. The demersal stocks are estimated to be only 10-30% of the levels in the late 1940s with an annual rent dissipation of US$130 million (Silvestre et al., 1986). The maximum sustainable yield (MSY), the biomass of fish that can be harvested from a fishing ground in a year without compromising its ability to replenish itself, for small pelagics was reached in the mid-1970s and the biomass of stocks today is only 17% compared to that in the 1950s with an annual rent dissipation estimated at US$290 million (Silvestre et al., 1986). The large pelagics have also been overfished with the catching of juveniles and the use of “payaos” (Babaran, 2004).

The critical marine ecosystems (habitats) namely, mangroves, sea grass beds and coral reefs that sustain marine life have extensively been degraded due to heavy human pressures. Only less than one-third of the 450,000 hectares of the mangroves that we had in 1918 are still available (Israel, 2004). Losses of extensive sea grass beds in the country due to pollution and other human impacts have been reported (Fortes and Santos, 2004). More than 70% of the coral reefs in the country are in poor condition and only 5% is in excellent condition (Gomez et al., 1994). Aside from supporting marine fisheries, such ecosystems also render vital ecological services such as conserving biodiversity, trapping sediments from land, protecting coastal areas from storm surges and providing eco-tourism opportunities.

Despite the enactment of the Fisheries Code of 1998 (R.A. 8550) that provides for the development, management, conservation and protection of fisheries and aquatic resources for food security, poverty alleviation of small-scale fishers and optimal utilization of offshore and deep sea resources, the intense competition and conflict among the municipal fishers and commercial fishers in coastal waters still persists. Up to now, commercial fishers continue to intrude into the municipal waters that are exclusively allotted to municipal fishers because of poor law enforcement by local government units which have jurisdiction over such waters. The definition of the extent of municipal waters in certain areas of the country has still to be resolved juridically.

Aquaculture, the fastest growing food-producing sector in the world today, is considered the main driver of growth for the country's fisheries industry provided that it is applied on a sustainable basis (within ecological limits). The potential for expanding mariculture or sea farming of fin fishes (e.g., milkfish and grouper), seaweeds and invertebrates in our extensive coastal waters is enormous. The fisheries resources in our EEZ have barely been assessed and exploited.

For improving the competitiveness of our fisheries industry, there is need for ensuring the quality and safety of its products that are traded locally and internationally in accordance with accepted standards. The problems of the industry for fish processing are poor quality products, inconsistent quality of products, lack of appropriate standards for traditional products, insufficient capital to improve the enterprise and the lack of infrastructure for chilling and cold storage facilities. The needs for upgrading the technology and quality standards for value-added products including hygiene and sanitation in processing plants are imperative (Espejo-Hermes, 2004).

It is estimated that 25-30% of the total marine catch is lost due to improper handling (Camu, 1991). Aside from physical losses, economic and nutritional losses are also incurred with the lack of icing, appropriate containers, processing, packaging and storage (Espejo-Hermes, 2004).

The Bureau of Fisheries and Aquatic Resources (BFAR) of the Department of Agriculture is tasked with the functions of policy and enforcement, fisheries industry development, regulation of commercial fishing and research. Aside from formulating and implementing the

CNFIDP, it is also expected to formulate and implement a Comprehensive Fisheries Research and Development Program and establish/maintain a Comprehensive Fisheries Information System, among others. With the lack of sufficient human and capital resources, the BFAR is unable to fully implement its role as "premier fisheries management agency" of the country. At the national level, the Department of Agriculture takes charge of the overall planning and policy-making for agriculture and fisheries. The Fisheries Code of 1998 provided for the position of Undersecretary for Fisheries in the Department of Agriculture to fully attend to the needs of the fisheries industry. While the position was filled for a while, it was relegated to the position of Undersecretary for Livestock and Fisheries and then unfilled until the present subject to the rationalization plan of the Department of Agriculture (Tabios, pers. comm.). There is low priority given to fisheries relative to other concerns of the government particularly under the Department of Agriculture (Luna et al., 2004).

The national and local institutions concerned with fisheries governance have inadequate capabilities to manage and effectively control the amount of fishing with the lack of a system to monitor fish stocks and determine sustainable catch levels on an annual basis. Such institutions lack sufficient manpower, funds and equipment to carry out their operations efficiently (Luna et al., 2004).

The inadequate/inconsistent fisheries policies in the Fisheries Code of 1998 and the lack of clear policies on capture fisheries make implementation impractical and confusing (Santos, 2004). For instance, while municipal waters are supposedly reserved for fishing by municipal fishers, small and medium-scale commercial fishers are allowed to fish in the same waters with certain conditions. Moreover, while the use of active fishing gear is banned in municipal waters, the use of the same gear is allowed for use by medium-scale commercial fishers in municipal waters.

The weak institutional partnership among government agencies, civil society organizations and private sector is brought about by the lack of effective coordination and participation of the said groups in the policy-making and implementation processes. While the Department of Agriculture through the BFAR is responsible for the overall policy and programs pertaining to fisheries, the Department of Environment and Natural Resources is responsible for the protection and conservation of natural ecosystems including marine ecosystems, and the Philippine Coast Guard under the Department of Transportation and Communication is responsible for enforcement of maritime laws including those for illegal fishing. Frequent consultations and close coordination with concerned stakeholders such as local government units, civil society organizations and the private sector are needed for ensuring awareness, participation and cooperation of such groups.

Climate change will bring about extreme weather events as protracted droughts and strong typhoons in the country. Sea level rise and ocean acidification are also among the expected negative impacts. In the ENSO (El Nino Southern Oscillation) episode of 1997-98 losses of more than PhP 6 billion and PhP 1 billion were incurred by the country's aquaculture and capture fisheries industries, respectively (PCARRD, 2001). Coral "bleaching" caused by abnormally high sea surface temperature that kills the symbiotic dinoflagellates which live within the living coral polyps was observed in Bolinao, Pangasinan in 1998 (San Diego-McGlone et al., 2005).

Opportunities for Marine Fisheries

In meeting the challenges of our marine fisheries, there are opportunities that should be considered and acted on. These opportunities are: (1) reducing the fishing effort so as not to exceed the MSY of 1.9 million metric tons, (2) rehabilitating and conserving marine ecosystems, (3) improving post-harvest methods and practices, (4) providing alternative and supplemental livelihood to municipal fishers, (5) enhancing investment opportunities in mariculture and commercial fishing overseas, (6) strengthening the capacity and capability of institutions for science-based fisheries policy formulation and effective fisheries resources management, and (7) formulating a long-term response and action plan for cushioning the impacts of climate change.

To address the key issue of overfishing, the number of fishers in depleted fishing grounds should be reduced to sustainable levels (MSY). For small pelagics, for instance, the fishing effort needs to be decreased by 50-65% (Dalzell et al., 1987). Other means of reducing the pressure on natural stocks include fishing gear restrictions and seasonal closures of depleted areas (Trudeau, 2004).

The rehabilitation and conservation of marine ecosystems such as mangroves and coral reefs can be done through the establishment of marine fisheries reserves and protected areas. In Section 81 of the Fisheries Code of 1998, the designation of at least 15% of municipal waters for fish refuges or sanctuaries is provided and 25-40% of fishing grounds for mangrove reserves is allowed. For coral reefs, at least 10-15% of the area should be managed for intensive protection (Alino et al., 2004). Marine reserves are the best option for protecting and managing marine fisheries and biodiversity. The protection of at least 20% of marine habitats is the minimum to avoid ecosystem failure (Alcala, 2001).

Post-harvest losses can be reduced by improving handling and processing methods such as the use of sufficient ice, appropriate containers for chilling and the application of improved packaging and storage methods (Espejo-Hermes, 2004)

Mariculture or sea farming can be an alternative and/or supplemental livelihood for impoverished small fishers. There are now more than 100,000 coastal fishing families engaged in seaweed farming throughout the country. With only 60% of the available coastal water area identified to be suitable for such enterprise being utilized, there is still a lot of room for expansion. However, there is need for more seaweed nurseries and credit support to the fisherfolk (Pagdilao, 2011).

Aside from seaweeds, the culture of high-value invertebrates such as abalones and sea cucumbers and finfishes (e.g., milkfish, grouper, siganid and salt-tolerant tilapia) in pens and cages can now be done commercially in designated mariculture parks. Likened to agricultural estates and industrial parks, mariculture parks are set up with infrastructure and other incentives provided by the government to attract private investors. There are now more than 50 mariculture parks in 13 regions of the country established by the BFAR in collaboration with local government units with an area of over 50,000 has and a total investment of PhP950 million, 84% of which was from the private sector (Adora, 2011). Considering the country's extensive coastal waters, tropical climate, strong technological base and the increasing demand for fish here and abroad, the deficit for fish in the coming years can be met by sustainable aquaculture.

There are also opportunities for commercial fishers to catch tunas and other large pelagics in the EEZ and overseas. Some Filipino fishing companies have already engaged in joint ventures with tuna-rich countries like Papua New Guinea in the West Pacific and Indonesia in the Indian Ocean (Barut, 2011).

Capacity building at the national and local levels for fisheries resources assessment, management and law enforcement is imperative. The capability of national agencies such as the BFAR and local government units are limited by inadequate funds because low priority is given to fisheries by the national government through the Department of Agriculture (Luna et al., 2004). There is also need to improve fisheries statistical information systems and for more biological studies on the country's marine stocks (Barut, 2011).

To strengthen the national institution for more effective policy implementation and management of fisheries resources, the establishment of a Department of Fisheries and Aquatic Resources to replace the present BFAR has been proposed. There are now seven bills in the House of Representatives and two parallel bills in the Senate being deliberated on to this effect. Revision of the Fisheries Code of 1998 to thresh out inconsistencies and deficiencies is also on-going (Tabios, pers. comm.).

In cushioning the impacts of climate change on the country's marine fisheries, risk and vulnerability assessment studies need to be done. Such studies on coral reefs are now being conducted by researchers of the Marine Science Institute of the University of the Philippines in collaboration with other institutions. The Philippine Climate Change Commission is preparing an action plan for adaptive and mitigating responses to the phenomenon. An awareness and information drive for all stakeholders of the fisheries sector is essential.

Conclusion

The marine resources (e.g., fisheries) of the Philippines contribute significantly to its people and economy in terms of food security, livelihoods, exports and ecological services. Despite the challenges (problems/issues) confronting the sector, there are opportunities (appropriate actions) that should be considered and done for addressing them.

For the sustainable development of our marine frontier, high priority should be given it by the government considering that it can provide valuable social, economic and environmental benefits to the present and future generations of Filipinos if it is rationally and efficiently managed.

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FURTHER INTENSIFICATION OF AGRICULTURE: A MUST TO MEET THE CHALLENGES OF AGRICULTURAL PRODUCTIVITY, SUSTAINABILITY AND COMPETITIVENESS

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Introduction

The Philippines faces the dauntless task of producing more and more food from less and less arable land and irrigation water. Like most of the rest of the developing world, the burgeoning population in the Philippines results in low per capita availability of arable land and fresh water for irrigation. Moreover, Philippine agriculture is faced with multifaceted challenges such as low land and labor productivity, high production cost, post production and distribution losses, high environmental and market risks to producers, low private sector interest in agriculture and degradation of ecological services. All of these contribute to low income and poverty of farmers, high food costs to consumers, deterioration of environment, and lack of competitiveness of Philippine agricultural products in the world market.

Indeed, challenges to Philippine agriculture are complex and thus require multidisciplinary, innovative strategies. All possible means to increase agricultural productivity in a sustainable manner should be utilized. This paper analyzed some key factors and issues to further intensify agriculture for productivity, sustainability and competitiveness. Specifically, we looked into land use and administration, raising cropping index, varietal improvement and agricultural biotechnology, water use efficiency, integrated nutrient management, integrated pest management and labor productivity and mechanization.

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Land Use and Administration

Land use planning is the practice of accounting and allocation of land resources in order to meet national requirement for food, feed and energy including sites for the needed infrastructure of the community as well as additional space to accommodate wildlife habitat. Critical to the planning process is the evaluation of land resource potential towards sustainable land utilization. With identified major soil constraints to food production such as water availability, low CEC, aluminum toxicity, vertic properties, high P fixation, shallowness and erosion risk, Philippines has barely 9.323 M hectares of arable land with a potential of supporting only the grain requirements of a population of 22.909 M, 41.559 M and 76.295 M under low, medium, and high technology input levels, respectively (Beinroth, Eswaran and Reich, 2001). The estimate does not even take into account the negative impact of climate change, extent of land degradation due to mismanagement and neglect, which can exacerbate the productivity of available arable lands for particular agricultural crops (Badayos, 2011). This available arable land translates to current land availability of only 1080 square meters for every Filipino. This very narrow land: people ratio can only get worse as Congress continues its debate on the reproductive health bill (PA 2020, 2011).

Thus, the second order of business, after finally arriving at a national consensus on family planning/population management, is appropriate governance and strong political will to halt the conversion of prime, irreplaceable farm lands into settlements, industry and other non-agricultural uses. The Comprehensive National Land Use Policy and Plan legislation is long overdue. Cadastral mapping and delineation of forestlands, protected areas and ancestral domains should be completed soonest. All LGUs must complete their local land use plans consistent with national guidelines and implement the same with rigor and firmness.

Moreover, land administration is lodged in several departments and bureaus and is therefore very fragmented, very confusing and inefficient. It is imperative therefore, to consolidate all government lands management activities under DENR. Hence, the participants of the Annual Scientific Meeting (NAST, 2011) proposed the following resolution addressed to the Office of the President and Legislative Bodies:

> "Enactment of a Comprehensive National Land Use Plan Law, Lands Administration Reform Law and the establishment of the Lands Administration Authority (LAA) under the Department of Environment and Natural Resources for an integrated, unified, synchronized system of land use planning at all levels. LAA will integrate the functions of Lands Registration Authority, Registry of Deeds, Lands Management Bureaus, Lands Management Services and National Mapping Resources Information Authority (NAMRIA)*...*"

In addition, the following resolution was proposed to the Department of Environment and Natural Resources (DENR) and the Department of Interior and Local Government (DILG):

> "Immediate completion of cadastral maps to delineate forestlands, protected areas and ancestral domains; and facilitating and expediting the completion by LGUs of their respective comprehensive land use plan (CLUPs) to serve as an integrating framework in the management of resources…"

Hand in hand with the governance and implementation issues, it is also imperative to train more experts in land planning, accounting and allocation of land resources in the university and in government, the LGUs/stakeholders in order to prepare them for teaching, research and practical application, respectively. Thus, this capacity building should be supported by both local and national governments.

Raising Cropping Index

Land productivity could be further improved by raising crop yields per cropping and on per unit area-basis by raising the cropping index (CI). Total annual harvested area is about 12.4 million hectares, which with a physical area of 10.3 million hectares, translates to a cropping index of 1.20. With our favorable year-round growing conditions, cropping intensity could be raised to 2 to 3 or a potential harvested area of 20.6 to 30.9 million hectares.

As a starting point, we have to look at the current CI in our crop production areas. However, current information on cropping index is limited to our agriculture data sets of crop production information such as area planted, yield per hectare and production volume per crop. In most cases (except for the monoculture cropping), these do not reflect the contribution of CI in attaining the present crop production level. Hence, increasing the CI in our agricultural lands should be done on area-basis, i. e., on properly delineated areas that will allow accounting of the various interventions directed towards increasing crop productivity.

Rice-based Cropping

Raising the CI of a rice-based cropping system from 1 to 2 can be achieved through rice double cropping ($Rice_1$-$Rice_2$) or Rice-Upland Crop (UC) cropping. Increasing CI from 2 to 3 can be achieved through Rice-UC_1-UC_2, $Rice_1$-UC-$Rice_2$ or triple rice cropping ($Rice_1$-$Rice_2$-$Rice_3$) (**Figure 1**).

Raising CI from 1 to 2. With wet season rice as the base crop, sequential planting of dry season rice ($Rice_{ws}$ - $Rice_{ds}$), or relay/sequential planting of short-duration upland crop ($Rice_{ws}$ - UC_{ds}) can be done. Raising CI from 2 to 3. With $Rice_{ws}$ - $Rice_{ds}$ as the base crops, planting of the 3rd rice crop during the transition period between dry and wet seasons can be done such as $Rice_{ws}$ - $Rice_{ws\text{-}ds\ transition}$ - $Rice_{ds}$. Sequential or relay planting of short duration upland crop can also be a potential option for $Rice_{ws}$ - $Rice_{ds}$ and for $Rice_{ws}$ - UC_{ds} as base crops, thus a cropping system of $Rice_{ws}$ - $UC_{ws\text{-}ds\ transition}$ - $Rice_{ds}$, or $Rice_{ws}$ - $UC_{ws\text{-}ds\ transition}$ - UC_{ds}.

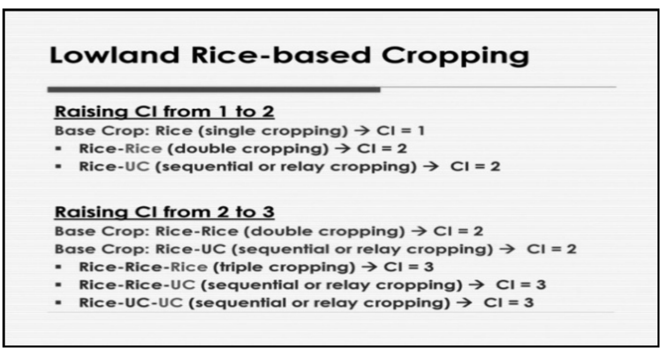


Figure 1. Raising cropping index for lowland rice-based cropping system from CI 1-2 and CI 2-3 (Sta. Cruz, 2011)

Annual Upland Crop-based Cropping

Annual upland cropping may include monoculture (e. g. corn) or multiple cropping of long-duration (6–12 mo) annuals (e. g. sugarcane, cassava) and short-duration (3 mo) annuals (grain crops, grain legumes, vegetables, etc.)

<u>Raising the CI from 1 to 2</u> in annual upland crop-based cropping can be achieved through intercropping of a long-duration annual with short-duration annual ($UC_{1(LD)}$ + $UC_{2(SD)}$) or sequential cropping of two short-duration annuals ($UC_{1(SD)}$ – $UC_{2(SD)}$). With the long-duration annual as the main crop, a short duration crop can be intercropped ($UC_{1\ (LD)}$ + $UC_{2\ (SD)}$) (**Figure 2**). The short-duration crop is usually harvested before the canopy of the main crop closes. <u>Increasing the CI from 2 to 3</u> can be achieved through sequential cropping of 1 crop or 3 fast-maturing upland annuals ($UC_{1(SD)}$ – $UC_{2(SD)}$ – $UC_{3(SD)}$).

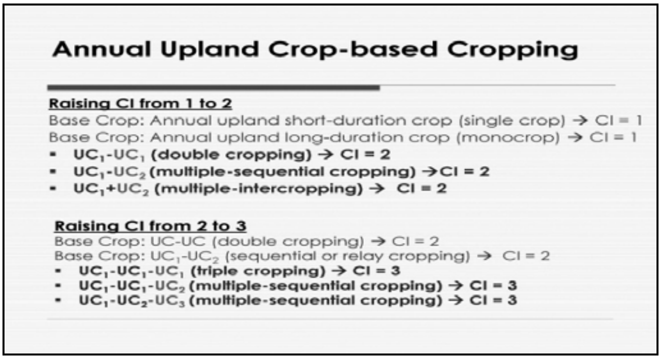


Figure 2. Raising crop index for annual upland crop-based cropping from CI 1-2 and CI 2-3 (Sta. Cruz, 2011)

Coconut- and Perennial Crop-based Cropping

Existing coconut and perennial crop-based cropping offers great potential in <u>raising the CI from 1 to 3 or more</u>. The multi-storey cropping has been proven to be productive in a lot of farms across the country. In coconut-based or perennial crop- based cropping, short-duration field/horticultural crops can be intercropped during the earlier stage of the main crop, while shade-loving fruit trees, vines and/or low-growing field/horticultural crops can be intercropped when the main crop is about to reach its maximum leaf area or canopy size, i.e., near canopy closure at optimum plant spacing (**Figure 3**).

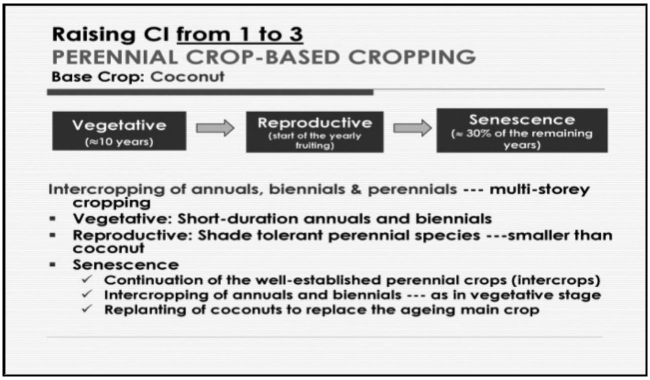


Figure 3. Raising crop index for perennial crop-based cropping from CI from 1 – 3 (Sta. Cruz, 2011)

Both research and experience show that a cropping index in all cases would require the following: synchronization of cropping schedules with the rainfall pattern, provision of supplemental irrigation, use of early maturing crop varieties/species, use of protective structures especially for high value crops, and provision of good pest and disease control. In the case of rice-based cropping, shortening of fallow period is also imperative. Only the coconut and perennial crop-based cropping requires the use of shade-loving crop species.

Villareal (1976) reported his practical observations on the interlinked factors which contributed to the success of multiple cropping synonymous to high CI in Taiwan: favorable climatic condition, excellent irrigation facilities, extensive application of organic and inorganic fertilizers, small farm size, and well-organized marketing systems. Except for favorable climatic conditions and small farm size, the importance of irrigation and use of fertilizers are already adequately covered in this paper.

Villareal (1976) considered the influence of favorable climatic conditions on both the farmers who practice multiple cropping and on the crops that follow after rice. With excellent irrigation, raising of the more intensively grown crops is only from October to March because at that time, temperatures are milder and very conducive to work. Farmers in thick sweaters working on their farms do not seem to get tired unlike in the tropical countries i.e. Philippines and Thailand where temperatures are much higher causing them to be less active. Most farmers crawl to weed their rice fields in winter planting than in summer planting. Temperatures in Taiwan from October to March are also more suitable for growing a variety of crops. Cool season vegetables such as cabbage, Chinese cabbage, onion and potato are specially favored in early winter through spring, Also, the warm days and cool nights are optimum for melon and tomato production. Still, more suitable varieties of crops for the climatic conditions of tropical Asia have to be discovered or developed.

The bottom line is beyond science, farmers should be industrious and willing to work hard and spend long hours in attending to their crops despite the harsh weather.

On small farm size, Villareal (1976) noted that, "Taiwan agriculture is that of gardening and not farming. Intensive and continuous cropping of farms, irrigation, and efficient protection against crop pests, characterize a typical market garden. Noteworthy are the very intensive operations such as: crawling to weed rice fields, training sweet potato vines, watering individual vegetable crop with liquid manure, cutting individual corn stalks above the ear, topping and pollination tomato, etc. One reason the massive intensive cropping systems in Taiwan are carried out successfully is their small farm. Average farm size in Taiwan was 0.84 in 1972 (Wang and Yu, 1973). Farmers are anxious to improve the productivity level of their farms and explore any possibility of obtaining extra income through the very intensive use of their limited land resources. Small farm size permits Taiwanese farmers to intensively crop their areas, which would have been difficult if their farms are bigger since farm family members are the main source of farm labor.

However, intensive monocropping and succession cropping of same crop year in and year out on the same piece of land will raise productivity but will ultimately result in soil fertility problems and build up of pests and diseases. Crop rotation and diversification to high value crops should be promoted to avoid these ecological problems and to enable farmers to take advantage of market opportunities and thereby achieve higher returns. The necessary agronomic technologies which are highly location- and market- specific can be systematically developed through the **All Philippine Farming Systems**

R&D Networks built around rice, corn and coconut, which together account for three-fourths of farm lands and small farmers. And this effort requires sustained financial support from both the government and the private sector.

Sta. Cruz (2011) summarized the issues and recommendations in raising cropping index:

Issue	**Recommendation**
Delineation of agricultural areas based on cropping system — an entry point for crop intensification	Development of land use plan at the municipal level delineating the areas (location and hectarage) for crop intensification based on dominant cropping systems
Crop intensification and municipal agricultural program	Integration of crop intensification program as a long-term component of the municipal agricultural program
Planning, development and implementation of the crop intensification program: • Setting of direction • Stakeholders • Extension	• Program goals and direction to be set at the national level— top down • Participatory planning, development and implementation by SCUs, LGUs and NGOs • Extension support program to address the technical and extension needs
• Irrigation water requirement • Capital/input requirement • Postharvest handling and marketing requirement	Support programs to address the key issues: • Water availability for crop production • Increased capital/input requirement • Increased production volume that may disrupt usual postharvest handling and marketing schemes

• Climate change on crop adaptation and pest shift • Pest management under intensified cropping • Energy problem and conventional agriculture • Sustainable agriculture • Introduction of 'new crops' in various cropping systems	Strategic RD support program to proactively address the key issues: • Impact of climate change on crops grown under multiple cropping scheme • Reduction of fossil-based inputs • Sustainable farming practices • Fitting of 'new crops' in the intensified farming scheme

Varietal Improvement and Agricultural Biotechnology

Crop agriculture starts with good seeds. The major improvement objectives include high yield, earlier maturity, adaptation to drought and water logging, tolerance to soil infertility, acidity and salinity; resistance to pests and diseases, and enhanced nutritive value and quality including storage and shipping traits. Much had been achieved and many more are yet to come with conventional breeding technologies by public and private plant breeding organizations. In addition, the new tools from modern biotechnology, e.g., DNA marker-assisted breeding and transgenics will greatly facilitate crop improvement and should be promoted.

The Philippines is the first Asian country to commercialize a genetically modified food crop. In 2002 during the first year of commercialization of Bt corn in the Philippines, 10,000 ha were planted to this product of modern biotechnology. Substantial yield increases of up to 37% were realized during the first year of planting, which translated to PhP10,000 additional profit for the farmer (Yorobe and Quicoy, 2006). A study of Bt corn ROI for cropping seasons from 2003–2004 to 2007–2008 showed consistently higher % ROI with performance ratio ranging from 1.1 to 1.9, in spite of the higher cost of Bt corn seeds (Gonzales, 2009). According to Gonzales, the use of Bt technology is more cost efficient, resulting in higher net income for farms which could lead to higher subsistence level carrying capacity. As of 2010, genetically modified corn (Bt corn, HT corn and stacked Bt and HT corn) was planted to 500,000 ha in the country (James, 2011), a 50-fold increase in 7 years.

With the impressive yield gains obtained using GM corn, the promise of modern biotechnology to contribute significantly to further improving agricultural productivity is underscored. Doubling the corn yield over the next twenty years from 10–20 tons per ha has been projected using combinations of biotechnology traits, marker-assisted breeding and advances in agronomic practices (Edgerton, 2009).

Although the target is to deliver twice as much food in 2050 as is produced today and deliver economic benefits to small and large farmers alike, these must be done with reduction of impacts to environment, while getting more food per unit land, water, and energy, and adapting to climate change by improving yield stability even under stress (Sachs, 2009).

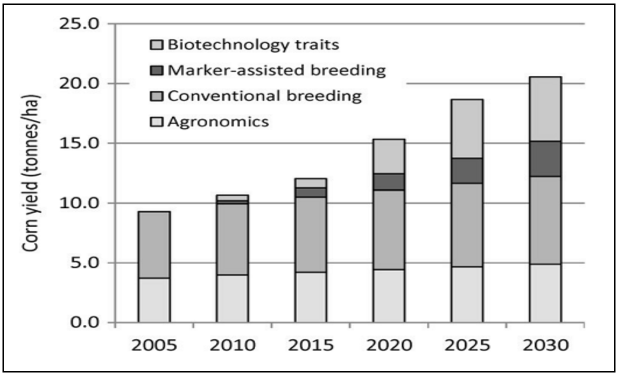


Figure 4. Projected impact of improvements in agronomics, breeding and biotechnology on corn yields in the United States. From Edgerton, 2009

The presently available biotech agricultural products corn, soybean, cotton and canola have desirable agronomic traits of insect protection and/or herbicide tolerance. In 2010, the GM crops were planted to 148 M ha in 29 countries (James, 2011). Herbicide tolerance trait accounted for 61% of the total global area planted to GM crops, followed by 22% for stacked traits of herbicide tolerance and insect protection, and 17% for insect protection. These GM products belong to the first wave or generation of biotech products which directly benefit the farmers. These traits will remain important but development of other important traits is being strengthened to help increase the yield of crops under various conditions. The different traits of biotech agricultural products which are at different stages of development include: (1) better pest resistance and weed control, (2) water usage efficiency, (3) nitrogen use efficiency, (4) intrinsic yield, and (5) quality traits.

Pest Resistance and Weed Control

From the present two stacked traits of corn borer resistance and herbicide tolerance, new corn varieties will exhibit multi-stacked traits which controls as many as 12 above and below ground insect pests that include corn borer, rootworm and multipest complex, and herbicide tolerance flexibility which can allow the use of either glyphosate or glufosinate applications (Syngenta, 2010). Corn varieties with third generation corn borer- and rootworm-resistance and tolerance to more than one herbicide are expected to provide more durable protection against a wider spectrum of insect pests and greater flexibility for use by farmers (Monsanto, 2011). Soybean which has herbicide tolerance to two types of herbicides and insect protection is now in the late stage of development. Monsanto is also developing soybean varieties with cyst nematode resistance using modern biotechnology and Asian rust resistance by advanced breeding using markers.

Bt eggplant has insect protection against fruit and shoot borer. It yields twice that of other varieties and will need 30% less pesticide. The Bt eggplant in India was approved for commercialization in October 2009 by the Genetic Engineering Approval Committee of the Indian government. However, its commercialization was put on hold in February 2010 due to safety concerns after protests from various groups against the technology. In the Philippines, the field testing of Bt eggplant continues although this was marred by uprooting of experimental plants at the University of the Philippines Mindanao in December 2010 and then at UP Los Baños in February 2011.

China’s Ministry of Agriculture approved the commercial planting of Bt rice and GM phytase rice in November 2009 and it is expected that large scale cultivation of Bt rice will start in 2011. Huazhong Agricultural University developed the Bt rice while the Chinese Academy of Agricultural Sciences developed the phytase rice. India is conducting open field trials of Bt rice and commercialization is not expected in the next six years.

The development of sugarcane with insect resistance and herbicide tolerance is being conducted in India, Brazil, US, and South Africa.

Monsanto is using its Bt and Roundup Ready technologies in developing GM sugarcane which is at an early stage. South Africa is field testing GM sugarcane which include lines with the Bt gene. However, several groups have posed objection to further testing of GM sugarcane in South Africa due to biosafety concerns.

Water Usage Efficiency

Water is becoming a precious commodity and with increasing global food, feed and fuel demand, developing crops which are efficient in their use of water has become very important. The strategy in developing maize with superior water usage efficiency includes the use of the global maize germplasm, use of markers to aid in selection and genetic engineering tools to introduce drought tolerance traits. Syngenta released in 2010 its Agrisure Artesian™ technology of maize hybrids which are able to utilize moisture more efficiently on drought stressed areas. This technology was created through molecular breeding, mining genes from the corn genome which are responsible for efficient water utilization. Syngenta is also developing drought tolerant maize varieties using GM trait and these hybrids are expected to be available after 2015 (Syngenta, 2010).

Monsanto and BASF introduced a gene from *Bacillus subtilis* called *cspB*, which helps the bacteria cope with cold temperature, into corn which confers it drought tolerance and provides 7–16% yield advantage over control (Sachs, 2009; Gilbert, 2010). Pioneer-Dupont has a second generation combination of native and transgenic maize with improved 16% yield advantage in limited water conditions (Gilbert, 2010). In January 2011, Pioneer Dupont announced the release of its drought tolerant maize hybrid developed using marker-assisted breeding which followed the announcement of Syngenta on its own maize hybrid of similar trait in July 2010.

Performance Plants Inc. of Canada has developed the WET™ technology which allows plants to grow normally and produce excellent seed yields with significantly less water. Greenhouse experiments have shown that WET® plants produce 22% more growth with limited water. The effectiveness of the technology has been demonstrated in canola and is being developed for maize, soybean, cotton, ornamentals and turf grass (Performance Plants Inc., 2011).

Nitrogen Use Efficiency

Nitrogen fertilizer accounts for about 20% of corn production cost. Thus, increasing the efficiency of nitrogen use by corn (and other crops) will improve the crop's profitability. It is estimated that only 30–50% of applied nitrogen fertilizer is actually taken up by crops. This nitrogen use efficiency (NUE) trait will help plants to use nitrogen more efficiently by increasing yield under normal nitrogen conditions or stabilize yields under low nitrogen conditions. The big agricultural biotech companies (Monsanto, Syngenta and Pioneer) and small start-ups (Arcadia, Evogene, Performance Plants Inc.), as well as several research institutes and universities are developing nitrogen-use efficient plants but all initiatives are at proof-of-concept stage. Strategies to improve nitrogen use efficiency by genetic engineering include (a) increasing uptake efficiency by overexpressing transporters and (b) increasing physiological use efficiency by overexpression of key enzymes in nitrogen metabolism such as nitrate reductase, glutamine synthetase, and alanine amino transferase.

Monsanto started collaboration with Evogene in 2007 to use the genes discovered by the latter which help plants maintain yield even with lower applications of nitrogen. Yield gains of 23% for NUE transgenic corn plants at 0 level of nitrogen and 8% at 60 pounds applied nitrogen were observed for experiments in 2007–2008 for up to 16 locations. The main targets for the NUE improvement by genetic engineering are corn, wheat, rice and rapeseed. However, it is believed that improved agronomic practices could further increase nitrogen use efficiency. For the past 21 years, nitrogen-fertilizer efficiency of maize in the United States increased by 36% due to large investments in public sector research and extension education, investments by farmers in soil testing and proper timing of applying fertilizer (Tilman et al., 2002).

Intrinsic Yield

Two major approaches to increase the yield ceiling are improving photosynthetic efficiency and increasing biomass yield. Christou and Twyman (2004) discussed various strategies of genetic engineering which could potentially increase agricultural productivity.

Majority of plant species including rice utilize C3 type of photosynthesis which is much less efficient than C4. For example, for the same amount of fertilizer and water, maize, a C4 plant, will produce twice the biomass and yield twice of rice. The International C4 Rice Consortium led by the International Rice Research Institute and funded by the Bill and Melinda Gates Foundation aims to double rice yields through understanding the genes which are responsible for the different photosynthesis mechanisms in plants and ultimately finding ways to convert the photosynthetic mechanism in rice from C3 to C4 for more efficient photosynthesis (http://irri.org/c4rice). The consortium estimates 15–20 years of collaborative work to attain its goal of developing C4 rice.

Increasing biomass yield is a primary goal of companies and researchers working on biofuels. This involves understanding the molecular mechanism of biomass improvement. Some of the studies being undertaken towards this are: (a) analyzing gene expression involved in biomass accumulation; (b) identifying key microRNAs important for biomass accumulation and stress tolerance; and (c) constructing and DNA marker genetic map and identifying key QTLs for biomass accumulation (http://www.okepscor.org/research/cellulosic-bioenergy-research). Performance Plants Inc. is introducing its Biomass Enhancement Technology™ into crops and results in the screenhouse showed significant biomass increases. Model plants with this technology produce twice the biomass by enhancing vegetative plant growth (http://www.performanceplants.com/).

Quality Traits

Among the quality traits that have been targeted for improvement using modern biotechnology tools are:

(a) Enhanced nutritional quality, e.g., higher vitamin and Fe content. In Golden Rice, two genes were introduced to produce the β-carotene, the precursor of Vitamin A, in the grain endosperm. The second generation Golden Rice has 31 µg of β-carotene, 23 times greater than the original Golden rice (Golden Rice Project, 2011). Various national rice research institutes in different countries including the Philippines have introgressed the Golden Rice into their elite lines and are in the process of field testing it. PhilRice plans to conduct a confined field test which will be followed by multilocation field trials for several seasons. PhilRice is also developing Golden Rice with two other important traits, tungro and bacterial blight resistance.

(b) Improved nutritional profile, e.g., improved amino acid or fatty acid profile. Monsanto is developing high oleic and omega-3 soybeans. Vistive® Gold has mono-unsaturated oil like olive oil and low saturated fat like canola. SDA omega-3 soybean will produce oil with the omega-3 fatty acids which have heart health benefits. Both technologies are nearing completion and release.

(c) Improved processing qualities. Syngenta recently obtained full deregulation for its Enogen™ corn which has α-amylase trait. This trait will allow dry grind ethanol production which can generate higher ethanol yield (Syngenta, 2011).

(d) Improved postharvest qualities. Postharvest losses account for up to 30-40% of production. We have developed papaya with long shelf life or delayed ripening trait. For control nontransgenic papaya, it takes 5–7 days from color break to ripe stage, compared with 11–14 days for long shelf-life papaya (Tecson-Mendoza et al, 2011). Plans for the field testing of this technology under biosafety regime are now being made.

Water Use Efficiency

Water has long been recognized as one of the most critical inputs to agricultural production systems. For rice production alone, irrigation water management constitutes close to 30% of the yield gap (Ferguson, 1987). Furthermore, crop yield and cropping intensity are both increased with irrigation. For rice cropping systems alone, recorded data in the Philippines show that crop yield is generally higher under irrigated than under rainfed conditions. At the same time cropping intensity is increased with irrigation particularly under Type I climatic conditions. Instead of one cropping under rainfed agriculture, the number of cropping can be doubled or even tripled with irrigation. Consequently, the land area available for agriculture is virtually doubled or tripled. Currently, irrigation development in the Philippines is less than 50%, with potential irrigable area estimated at 3,126,340 has and actual irrigated area as of 2009 was reported to be 1,539,377 has (BAS, 2011). With irrigation, this land area available for cropping can be doubled or tripled. All these point toward the fact that water plays a major role in agriculture especially when intensification that would enhance agricultural productivity, sustainability and competitiveness is targeted.

However, water resources dependability in the Philippines, both surface and groundwater, has become an issue not only because of the potential consequences of climate change but of the seemingly inadequate measures to protect watersheds and aquifer systems in the country. As a result, the issue of water use efficiency has come into play. And this has become even more critical for the agriculture sector as it consumes about 88% of the total water resources in the country (FAO, 2011).

The term water use efficiency is a loosely defined term. From a purely hydraulic or technical standpoint, water use efficiency refers to the ratio of the amount of water beneficially used to the amount of water delivered or withdrawn. From other points of view, it may refer to the mass or value of agricultural produce per unit amount of water withdrawn. For practical purposes, water use efficiency will be defined in this paper as simply the degree by which the use of water withdrawn from a given source for whatever purpose is maximized. This implies minimization of unnecessary losses and wastage during conveyance and during water application. Applied to crop production systems, this means maximizing the amount of water withdrawn from any source for irrigation purposes and eliminating irrigation conveyance and application losses.

Therefore, it is imperative that agriculture must do with less water. Fortunately, we have a number of technologies and practices which have been developed over the years to address water scarcity and adequacy problems. Although they require further research to generate new knowledge and information to maximize the benefits under local conditions they can address the issue of water efficiency.

Drip irrigation

Drip or trickle irrigation involves the use of flexible pipe and emitters to deliver just the right amount of water to crops to be irrigated at relatively low pressure. This technology can be used to irrigate almost any crop and can be adapted to any soil, climatic and topographic conditions. It offers special agronomical, agrotechnical, and economical advantages for efficient use of water and labor (Keller, 2002). Drip irrigation can also be used under limited water supply conditions. In the recent years, low-cost drip irrigation technologies have evolved and have been tested and applied in the Philippines (e.g. Ella et al., 2010 and 2009). But regardless of the cost, drip irrigation maximizes water use efficiency since the amount of water delivered is just sufficient to supply the evapotranspiration requirement of the crops to be irrigated. Hence, runoff and percolation losses are avoided and irrigation efficiency is maximized. Drip irrigation has also been proven to increase crop yield (Ella et al., 2009).

Alternate Wetting and Drying

Alternate wetting and drying technology involves the application irrigation water (wetting) several days after the infiltration of ponded water or when the saturated zone has lowered to a specified level in the rootzone (drying). This is particularly applicable for irrigating lowland rice. This technology has been widely applied in other countries like China. It is being promoted in the Philippines by the International Rice Research Institute (IRRI) (Bouman and Lampayan, 2009). This technology is subject to further refinement to continued research (e.g. Samoy, 2010).

Alternate wetting and drying technology obviously increases water use efficiency in that irrigation water is used intermittently and evaporation losses are minimized.

Conservation Agriculture—a Biological Engineering Approach

Conservation agriculture is a biological engineering approach to farming based on the principles of minimum soil disturbance, continuous mulch cover and diversified crop rotation. Indirectly, this technology improves soil quality including soil moisture retention due to increased organic matter. This technology has been widely adopted in many parts of the world. In the Philippines, this technology in its truest sense of the word, is relatively new and is the subject of ongoing research (Reyes, 2010; Ella, 2010).

This biological engineering approach to agriculture can increase water use efficiency indirectly through increased soil moisture retention.

Consequently, percolation and runoff losses during water application from either irrigation or rainfall are minimized.

Proper irrigation water management at the farm and system level

Proper irrigation management at the farm level involves proper application rate, irrigation period and irrigation interval. Whether irrigation is accomplished by surface methods (basin, border, furrow, corrugation, wild flooding), overhead (sprinkler, drip or trickle) or subsurface methods, the minimization of application losses depends on the application rate, duration of application and irrigation interval. The calculation of these irrigation parameters requires basic knowledge of soil-plant-water relations and soil water dynamics. For surface irrigation methods alone, the variability of the net opportunity time for infiltration along the strip to be irrigated could be greatly minimized with proper choice of irrigation application rates and duration. At the same time, percolation and surface runoff losses could be greatly minimized with proper irrigation water management.

At the system level, proper irrigation water management involves proper amount and timing of water releases to avoid conveyance losses. Again by minimizing water losses, irrigation efficiency is maximized.

Irrigation by demand or by rotation

One of the major reasons why irrigation water use efficiency is relatively low in rice-based cropping systems in the Philippines is the fact that irrigation is allowed to flow continuously in irrigation canals even if irrigation application has already been accomplished. This obviously results to so much water wastage as unused water discharge is continuously lost to the drainage canals. An alternative approach that would dramatically increase water use efficiency is through irrigation by demand, i.e. delivering irrigation water to the farm or group of farms only when it is needed. After irrigation has been accomplished the flow of water into the irrigation canals is shut down using appropriate water control structures.

The other alternative is irrigation by rotation. In this approach, water is delivered to a farm or group of farms by rotation. That is, for any given period, only a farm or group of farms is served by the irrigation system. Irrigation service is then moved to the next set of farms and so on until the entire service area has been irrigated. In this way, conveyance and application losses are minimized and hence water use efficiency is maximized. With optimal water allocation and distribution, the water use efficiency using irrigation by demand or by rotation can be further increased.

Improvement of conveyance and water delivery system

During conveyance of water from the source to where it will be used beneficially, water losses are incurred due to seepage and percolation and other conveyance losses. The maximization of conveyance efficiency is therefore dependent on the minimization of these conveyance losses. Conversely, the water use efficiency at the system level could be increased through the improvement of the conveyance system. For irrigation canals, the provision of lining material for the channel bed could greatly minimize seepage and percolation losses. Illegal diversion and other conveyance losses could also be prevented with a properly designed and maintained canal network.

Development of minor irrigation systems

Minor irrigation systems refer to farmer-controlled and small-scale irrigation systems (David, 2003). This includes shallow tubewells, deep tubewells, low-lift pumps, small farm reservoirs among others. Minor irrigation systems obviously eliminate excessive conveyance losses as water withdrawn is within or close to the farms to be irrigated. Moreover, being farmer-controlled irrigation application losses can be greatly minimized. Consequently, the water use efficiency can be greatly increased with minor irrigation systems.

Optimal water resources allocation

In view of competing water uses for various purposes such as agriculture, domestic, industrial, power generation, aquaculture, recreation, etc., available water resources in the country should be allocated in an optimal fashion. This may require the use of optimization models with maximum benefits as the target objective function and dependability as one of the constraints. In this way, water losses due to arbitrary allocation of water resources can be minimized and hence the water use efficiency can be maximized.

Water recycling and reuse

When excess irrigation water, which would otherwise go down the drain, is reused or recycled to irrigate the same farm or nearby farms, then losses are minimized and hence water use efficiency is increased. This old concept of water recycling or reuse can even be extended to wastewater, which when properly treated could be used for irrigation purposes.

Water conservation and sustainable water resources management

Water conservation can be done at the system level or at the farm of field level. This involves not only the traditional concept of saving water during the rain season for use during the dry season but also the minimization of water losses due to seepage and evaporation. Again, by reducing the water losses the water use efficiency can be greatly increased.

All technologies and practices would, however, be useless if there is no sustainable water resources management to start with. This involves proper protection of watersheds and aquifer systems. After all, without sustainable supply of water there is no water use efficiency to talk about. Equally important is the issue on prioritization and management of irrigation projects. For instance, the current area under irrigation is 1.5 million hectares out of the potentially easily irrigable area of 3.1 million hectares. The bulk of the existing irrigation areas are under the National Irrigation System (NIS) and Communal Irrigation System (CIS). However, the reported cropping intensities for NIS and CIS are 1.49 and 1.11 respectively indicating that they are grossly underperforming. Thus, priority should be given to the rehabilitation and better management and maintenance of existing irrigation over the construction of new systems which require billions and a long term development (PA 2020).

Dr. Emil Q. Javier (2011) made the following statement on this issue during the NAST annual scientific meeting.

> "…the NIA indicative plan calling for P20 billion annually for irrigation is unlikely to be met. An annual allocation of P10 billion p.a. is more realizable, thus leaving P6 billion p.a. after deducting the mandatory payments for San Roque and Casecnan. These amounts will be supplemented by the water users fees from current

> irrigation systems if collected properly in the order of P2-3 billion p. a. These amounts should be judiciously divided between restoration and rehabilitation of NIS and CIS systems and complimentary investments in small irrigation systems i.e. farm and village level ponds and reservoirs, shallow tube wells and low lift pumps. Likewise, improvement in management of irrigation projects through staff training and development and application of new operating procedures are needed to ensure greater water use efficiency, equity of water distribution across areas and timeliness of water delivery. "

Moreover, the participants of the Annual Scientific Meeting (NAST PHL, 2011) presented the following resolution to the Department of Agriculture (DA) to address the above mentioned concern,

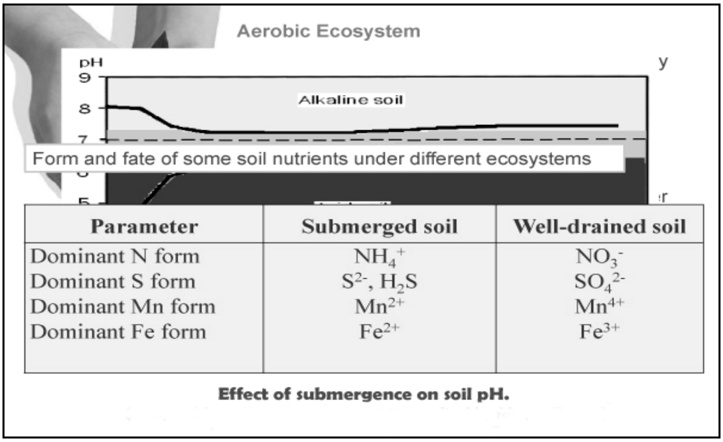
> "Comprehensive external review of the National Irrigation Authority (NIA), its mandate, functions, performance, future plans and programs; Exploring the possibility of allowing Irrigators Associations to keep the majority of irrigation fees, of providing incentives for them to organize their associations, pay and collect water fees and properly maintain and manage irrigation systems…"

Integrated Nutrient Management (INM)

The unabated population growth demands constant increase of food supply and to meet this demand require increase in yields or expansion of production area, use of high yielding crops and increase in inputs use. These could cause pressure on the soil resources and the quality of the environment as evident from the survey conducted nationwide on the nutrient status of rice soils, thus the importance of INM. It is defined as the judicious application of inorganic and organic fertilizers in proper proportion, rate, time and method of application based on the nutrient requirement of crops, nutrient levels in soils plus sound cultural management practices in crop production.

INM has a number of benefits: maintains and/or enhances soil fertility and plant nutrition at an optimum level to sustain desired crop productivity; utilizes both inorganic and organic fertilizers resulting in the increase of nutrient use efficiency from other sources; and is an effective strategy in attaining sustainable agriculture (Mamaril, 2011).

For efficient application of INM, it is imperative to consider the ecosystems where crops will be grown: aerobic vs anaerobic since the form and rate of nutrients will vary under different ecosystems (**Figure 5**), and yield potentials, maturity and resistance/susceptibility to physiologic stresses of crop species/varieties. For instance, under anaerobic condition the dominant N form is NH_4^+ while it is NO_3^- under aerobic condition (Ponamperuma, 1985, as cited by Mamaril, 2011).



Parameter	Submerged soil	Well-drained soil
Dominant N form	NH_4^+	NO_3^-
Dominant S form	S^{2-}, H_2S	SO_4^{2-}
Dominant Mn form	Mn^{2+}	Mn^{4+}
Dominant Fe form	Fe^{2+}	Fe^{3+}

Figure 5. Aerobic Ecosystem (Ponamperuma 1985, as cited by Mamaril, 2011)

High crop yields and higher cropping intensities will ultimately exhaust the ability of the soil to supply the nutrient requirements of crops grown on them. Exogenous nutrients must be applied judiciously as chemical fertilizer and as organic manures to replace those taken up by plants and those lost to the environment.

Soils supply essential mineral nutrients, harbor microorganisms beneficial to root and plant growth and provide anchorage to plants and conduit for water. Nitrogen, one of the three major nutrients is plentiful in the atmosphere. A substantial part of the nitrogen requirements of crops can be sourced from the air through the free-living nitrogen-fixing soil microorganisms and those which symbiotically reside in the root hairs of some legume plants. Leguminous crops should be included in crop rotations to fix nitrogen from the air and build up organic matter content of the soil. Phosphorus and other minerals are often locked in unavailable forms among the soil clay particles. Similarly, soil microorganisms can be deployed to accelerate mineralization into compounds available for plant use. The National Molecular Biology and Biotechnology Institute at UP Los Baños has isolated and popularized soil microorganisms which fix nitrogen from the atmosphere, mineralize nutrients, promote root growth and control soil-borne pathogens. A good example is Bio-N, a microbial-based fertilizer mainly composed of microorganisms (bacteria) isolated from the roots of *talahib* (*Saccharum spontaneum*). These bacteria can convert atmospheric nitrogen (N_2) into a form usable by rice, corn and vegetables and can enhance short growth and root development (Biotech UPLB, 2008). The search for more efficient cocktails of soil microorganisms as biofertilizers and bioinoculants should continue. Moreover, additional efforts are needed to facilitate their commercialization.

Farm residues contain a lot of mineral nutrients. They should not be burned but recycled as organic manure. Commercial microorganism preparations must be developed to hasten their degradation. Organic materials are generally low and variable in nutrient contents but may contain not only macro but also micronutrients. They vary in carbon:nitrogen ratio, thus rate of mineralization also varies. Commercial organic fertilizers may contain heavy metals and pathogens which may end up in food chains. While green manuring may contribute in sustaining soil fertility, small farmers are hesitant to adopt due to low financial return. Based on nationwide experiments on lowland and rainfed rice, certain biofertilizers were found not effective. Foliar fertilizers are not consistently effective. Inoculants do not show consistent effect. However, the emphasis should be on producing organic manure on farm rather than on commercial production of organic manure sold in bags like chemical fertilizers to offset the high cost of transport.

Chemical fertilizers are costly but very often the gain in yield offset the additional cost of fertilizer. The use of commercial chemical fertilizers should be made more efficient and effective with slow, controlled release formulations, precise timing and placement. The necessary agronomic measures to minimize soil erosion such as zero tillage, cover crops, mulching, terracing, hedgerows and grass strips for slope lands, should be popularized.

In conclusion, INM will contribute significantly in sustaining soil productivity provided that the appropriate technologies are adopted for the proper conditions. No one technology is appropriate for all conditions (Mamaril, et al, 2009; Cosico, 2010; Mamaril, 2011). The complementary benefits of organic and inorganic fertilizers are good examples. While inorganic fertilizers provide adequate nutrients, the organics can improve and condition the physical, chemical and microbiological properties of the soil.

Integrated Pest Management (IPM)

Pest and diseases are permanent features in crop agriculture. The struggle to control pests and diseases is a never-ending challenge as these biological entities continually evolve relative to their hosts and preys. A good example is in the case of the 1999 breakdown of resistance to wheat stem rust. In the 1950s, the late Norman E. Borlaug, Nobel Peace Prize winner and renowned plant breeder, led a team of scientists to develop high yielding wheat varieties which were resistant to wheat stem rust. This stem rust had ruined 40 per cent of spring wheat crop in Northern America. These high yielding and rust resistant wheat varieties helped launch the Green Revolution and protected wheat for more than 50 years. However, in 1999, a new virulent strain of wheat rust called Ug99 was discovered in Uganda. Worldwide, wheat varieties rely on only a few resistance genes and majority of these genes do not give adequate protection against Ug99 (Singh et. al., 2008). In addition to being pollutive and costly, control measures with pesticides are often ephemeral measures as the pest organisms develop resistance and/or other pests succeed them (Bernardo, 2011).

Integrated pests management (IPM), the judicious combination of biological, cultural and mechanical methods, and in the dearth of such measures, chemical control agents, is proving to be a safer, cleaner, more cost effective and sustainable manner of crop protection. This trend is being reinforced by the increasingly stringent pesticide residue standards imposed by food importing countries and local environment and health authorities.

IPM is a continuing delicate balancing act, quite location specific and relatively knowledge intensive. In general, much research has yet to be done before IPM can be an integral part of agricultural production practices in the country. These include a better understanding of the ecological balance among host pests and diseases, breeding for stable, horizontal pest and disease resistance, and use of more benign biodegradable pesticides as well as deployment of predators and natural enemies. In other words, wide acceptance can be achieved with better science and informed policies as demonstrated by the diminishing use of pesticides in rice fields in much of Asia (Bernardo, 2011). Institutionally, this would require strengthening of R&D units like the National Crop Protection Center at UPLB, the Bureau of Plant Industry network of regional crop protection centers and the DA-RIARCs. Also required are disciplinary research groups in the state universities and colleges (SUCs) studying basic systematics, morphology, physiology, reproductive biology and ecology of pests and disease organisms, predators and hosts.

It is equally important to train more experts who will actively pursue the science of IPM and extension specialists who will deliver the technology to farmers. All of these require solid financial support from both the public and private sector.

Labor Productivity and Mechanization

Unit labor costs in the Philippines are higher than those in our ASEAN competitors, Thailand, Indonesia and Vietnam, except Malaysia. But Philippine value added per agricultural worker of US$103 has a long way to go to match Malaysia's labor productivity at US$877 per agricultural worker (**Table 1**).

Table 1. Labor productivity in agriculture in the region

Analytical Grouping/Country	**Arable land (hectare/capita)**		**Agricultural value added/unit of labour ($)**	
	1979-81	1994-96	1979-81	1995-97
Malaysia	0.07	0.09	3,279	6,267
Philippines	0.09	0.07	1,347	1,379
Thailand	0.35	0.29	630	928
Indonesia	0.12	0.09	610	745
Lao, PDR	0.21	0.17	---	526
Cambodia	0.30	0.37	---	407
Vietnam	0.11	0.07	---	---
Bangladesh	0.10	0.07	181	221

(Adapted from ILO, 2001)

The level of agricultural mechanization must be raised to raise labor productivity and justify high wages. A suggested practical solution is to mechanize most farm operations as successfully done in Taiwan, Korea and Japan. For example, in the case of rice farming, mechanization has been practiced from land preparation, seedling production, transplanting, spraying, harvesting, and drying. The extent of mechanization in Taiwan is 98% (Din-Sue Fon, 2005). In the Philippines, 80% of farm power is provided by human beings (Paras and Amongo, 2005).

Table 2. Mechanization System vs. Productivity

	Mechanization System	Productivity
1	Manual farming	1,000
2	Irrig 1, light animal cultivation	2.000
3	Irrig 1, heavy animal cultivation	3,500
4	Irrig 2, heavy animal cultivation	5,000
5	Irrig 2, mechanized cultivation, animal traction	10,000
6	Irrig 2, motorized mechanization	30,000

Source: FAO, 2000

Table 2 shows productivity under various mechanization systems compared to manual farming (FAO, 2000). Benefits from mechanization are clear cut. Experts however, claim that although mechanization has distinct superior efficiency and enhanced labor productivity, there are barriers that impede the growth, sustainability and adoption of farm mechanization. Such impediments include: technological constraints, socio-cultural and behavioral barriers, financial and economic problems, and environmental issues.

In the international workshop on small-farm mechanization (FFTC, 2005), it was concluded that the extent and choice of agricultural mechanization directly affects land and labor productivity, farm income, environment, and the quality of life of small-scale farmers. Hence, the requirements for basic farm mechanization to cater to small-farm needs must be met. These requirements include: suitability to small farms; simple design and technology; versatility for use in different farm operations; affordability in terms of cost to farmers; and most importantly, the provision of support services from the government and the private sectors/manufacturers.

Political will is cited as a common factor for successful farm mechanization programs in highly mechanized countries. Therefore, efforts on small-farm mechanization must be based on a holistic and integrated strategy that considers the actual needs and priorities of the small-scale farmers.

The need to consolidate small farms to efficiently mechanize small farms was also emphasized. Such innovation allows for the entry and travel of tractors and other implements, provision of efficient irrigation and drainage, road access systems, and establishment of on-farm post harvest facilities and other infrastructures. Land consolidation as practiced by BMD Cornworld in Isabela includes custom hiring services and clustering of services and shows that it is workable and feasible (Lantin, et al, 2003). According to Mr. B.M. Domingo, he resorted to this scheme for three major reasons: lack of hired laborers during the peak labor seasons; farmers save time; do not have to wait for hired laborers; and avoid postharvest losses and with pre-arranged custom provider, farmers could have time for other jobs.

Summary and Conclusion

This paper analyzed some key factors and issues to further intensify agriculture for productivity, sustainability and competitiveness, specifically: land use and administration, raising cropping index, varietal improvement and agricultural biotechnology, water use efficiency, integrated nutrient management, integrated pest management and labor productivity and mechanization.

To integrate, unify and synchronize the system of land use planning at all levels in the country, the enactment of enabling laws such as Comprehensive National Land Use Plan Law, Lands Administration Reform Law, and the Lands Administration Authority was proposed. The completion of cadastral maps to define forestlands, protected areas and ancestral domains was also deemed essential. LGUs also have to complete their respective comprehensive land use plan to serve as an integrating framework in the management of resources. Finally, more experts in land planning, accounting and allocation of land resources in the university, in government, in the LGUs and stakeholders, are needed for better planning and implementation of the land use projects.

To further improve land productivity, the cropping index (CI), i.e., crop yields per cropping, has to be raised. Increasing the CI in the country's agricultural lands has to be done on area-basis, i.e., on properly delineated areas that will allow accounting of various interventions directed towards increasing crop productivity. Raising the CI would require the following: synchronization of cropping schedules with the rainfall pattern, provision of supplemental irrigation, use of early maturing crop varieties/species, use of protective structures and provision of good pest and disease control.

Crop agricultural productivity depends to a large extent on the use of good varieties. While conventional breeding and advanced agronomic practices can bring about 30% higher yield, doubling of yield can be brought about by the combination of present biotech traits of yield protection and new traits being developed such as drought tolerance, nutrient use, drought and flood tolerance, and other yield-enhancing traits. Various biotech crops with said traits are now at different stages of development. Further, biotech crops with enhanced nutritional value and quality are being developed. In the Philippines, corn with insect pest resistance and herbicide tolerance is planted to half million hectares. On the other hand, Bt eggplant with insect pest resistance is now being tested in several locations in the country while Golden Rice with pro-Vitamin A and papaya with long shelf life are awaiting field testing.

Water plays a major role in agriculture especially when intensification to enhance agricultural productivity, sustainability and competitiveness is targeted. Applied to crop production systems, water use efficiency means maximizing the amount of water withdrawn from any source for irrigation purposes and eliminating irrigation conveyance and application losses. Further, technologies and practices in agriculture should make use of less water to address water scarcity and adequacy problems. Some of these technologies and practices are drip irrigation, alternate wetting and drying technology, conservation agriculture, proper irrigation water management at the farm and system level, irrigation by demand or rotation, improvement of conveyance and water delivery systems, minor irrigation systems, and water recycling and reuse.

Integrated nutrient management is the judicious application of inorganic and organic fertilizers in proper proportion, rate, time and method of application based on the nutrient requirement of crops, nutrient levels in soils plus sound cultural management practices in crop production. For efficient use of INM, the ecosystems where crops are grown have to be considered since the form and rate of nutrients use will vary under different ecosystems. Nutrients such chemical fertilizer and organic manures must be applied on soil to replace those taken up by plants and those lost to the environment. Other requirements of plants can be sourced from soil microorganisms, leguminous plants and other sources. The complementary use of inorganic fertilizers which provide adequate nutrients and organics which can improve and condition the physical, chemical and microbiological properties of the soil can significantly contribute to sustaining soil productivity.

Integrated pests management (IPM) is the judicious combination of biological, cultural, mechanical methods, and chemical control agents and provides a safer, cleaner, more cost effective and sustainable manner of crop protection. However, the need for a better understanding of the ecological balance among host pests and diseases, breeding for stable, horizontal pest and disease resistance, and use of more benign biodegradable pesticides as well as deployment of predators and natural enemies was emphasized before IPM can really become more widely adopted in the country. The need for more highly trained IPM experts and extension specialists to transfer the technology to farmers was underscored.

To raise the country's low level of agricultural labor productivity, it is recommended that the level of farm mechanization be raised. Farm mechanization in the Philippines is estimated at 20% compared with 98% in Taiwan. Barriers that impede the growth, sustainability and adoption of farm mechanization are technological constraints, socio-cultural and behavioral barriers, financial and economic problems, and environmental issues. Consolidation of small farms as in the case of Cornworld in Isabela to efficiently mechanize them was emphasized. Such innovation allows for the entry and travel of tractors and other implements, provision of efficient irrigation and drainage, road access systems, and establishment of on-farm post harvest facilities and other infrastructures.

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HOW SUSTAINABLE IS ORGANIC AGRICULTURE IN THE PHILIPPINES?

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Abstract

Organic agriculture has continued to grow substantially despite the world economic crisis. It is now being viewed as an additional option to conventional or 'chemical' agriculture and not just for the niche market. But uncertainties remain that it can be an alternative option that could feed the world. The reported organic area in the Philippines is just 52,500 hectares but the government support for organic agriculture became more emphatic and accelerated in 2010 with the passing of the "Organic Agriculture Act of 2010" or RA 10068 which provides for its development and promotion in the country. Being an advisory body for science and technology policies and issues, the National Academy of Science and Technology has subsequently conducted discussions addressing the assessment of the status of organic agriculture in the Philippines. Organic pioneers and leaders in their respective fields presented papers related to the issue of 'How Sustainable is Organic Agriculture'. The organic practitioners provided relevant data on the advantages of organic agriculture on income in the case of rice and sugarcane with yields comparable to conventional farming. The need for more research and the help of the scientific community in improving the technologies in organic agriculture were also highlighted specially on livestock and poultry. The paper on health took a different route of dealing on food safety concerns rather than directly on organic produce. But organic agriculture in its present state is still far from its full potential. Given the meager formal support throughout its supply chain including input supply, production and Research and Development on seeds, nutrient and pest management. Thus direct comparison of organic agriculture with conventional agriculture does not appear to be valid. Overall it is well accepted that organic agriculture is sustainable on the ecological aspect but sustainability on the financial and the social/cultural aspects *are still being questioned. There is optimistic prognosis for organic agriculture, but the numerous challenges of agronomic, economic and cultural nature must be addressed more substantially. This would require long term support from research institutions, a strong extension system and a committed public in sharing with the costs of organic agriculture given its multi-functionality benefiting everyone.*

Introduction

Global production and sale of organically grown food and fiber continue to increase exponentially. The 2009 tally from 160 countries reporting organic production data finds 37.2 million hectares under organic management involving 1.8 million farmers (Willer and Kilcher 2011). Global sales of food and drinks have expanded, with the 2009 market estimated at 54.9 billion US dollars and a vast majority of products consumed in North America and Europe. Regions with the largest areas of organic agriculture are Oceania, followed by Europe and Latin America. Asia's total organic agricultural area is nearly 3.6 m ha.

The Philippines' organic production area reported in 2009 is 52,546 ha, employing around 70,000 producers/farmers scattered all over the country. The organic industry has been primarily in the hands of the private sector, non-governmental organizations (NGOs), and people organizations or cooperatives. Among the organic crops grown for domestic use are rice, maize, vegetables, fruits and root crops. These are generally produced by small-scale farmers under more diversified farming systems and are integrated with a few heads of livestock (pigs, goats, carabaos, cows, chickens or ducks). Organic farming inputs such as fertilizers, foliar sprays and microbial soil preparations are sourced and made from local indigenous materials. Organic products are sold in special outlets in Metro Manila and major urban centers such as Rustans', Shoe Mart, Landmark, Shopwise, etc. On the other hand, the organic crops produced for export are bananas (Bungulan and Cavendish), banana chips, fresh pineapple, muscovado sugar, coconut palm sugar, virgin coconut oil, coconut vinegar, coffee, asparagus, yellow corn for feeds, Banaba leaves and miscellaneous herbs. These are largely produced through grower arrangements among community-based organizations, agricultural cooperatives and development NGOs or private corporations. Producers usually employ single crop cultivation in the case of sugarcane, asparagus and pineapple but more diversified in the other crops. Inputs are usually produced by the cooperative or company including initial research on efficacy and production efficiency.

Organic agriculture is one of the livelihood options being offered to farmers in the Philippine Agriculture 2020. Hence it is imperative to take a closer look at it. There have been issues in the past for and against it and we want to clarify these issues to shed light on the controversy. In particular, we want to expound on how organic agriculture is practiced and to evaluate the science behind the practice. With that, the role and place of organic agriculture in the total scheme of agriculture in the country can be pinpointed. The objective of this paper is to highlight some organic agriculture experience of various local and successful practitioners and to address some challenging issues confronting its sustainability.

Variations of Farming

For countless generations, farmers have inherited and managed different farming systems adapted to their local conditions. A common desire to all of them is to produce what they have a demand for. Most of the existing variations on agricultural production system are illustrated in **Figure 1**. In global areas of cultivation, the two most prevailing agricultural systems are conventional farming and sustainable agriculture. In reality though, many farmers practice combinations of the different production systems to augment production and income under local conditions. Conventional farming, variously called "modern agriculture," or "industrial farming", has delivered tremendous gains in productivity and efficiency. Conventional farming systems vary from farm to farm and from country to country. However, they share many characteristics such as rapid technological innovation, alteration of the natural environment, large capital investments for production and management, large-scale farms, mono-cropping over many seasons, uniform high-yield hybrid crops, extensive use of chemical pesticides, fertilizers, and external energy inputs, high labor efficiency and dependency on agribusiness. Traditional agriculture systems on the other hand, has emerged over centuries of cultural and biological evolution and represent accumulated experiences of indigenous farmers interacting with the environment without access to external inputs, capital, or modern scientific knowledge. Traditional farmers have often developed farming systems with sustained yields using intensive experiential knowledge and natural resources, including the management of agro-biodiversity in the form of diversified agricultural systems.

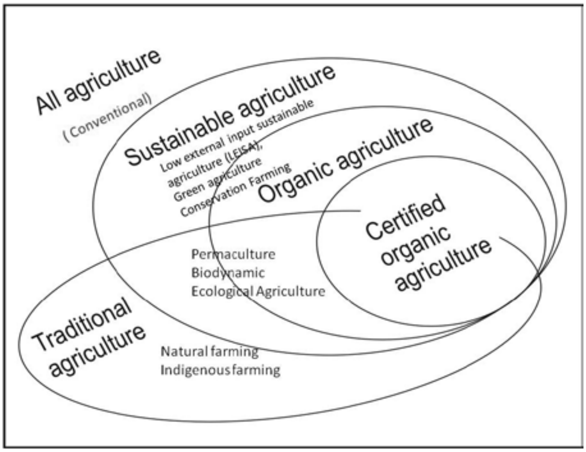

Figure 1. Variations of Farming

As of today, sustainable agriculture appears to be the most popular, government-supported farming programs. It is an integrated system of plant and animal production practices having a site-specific application that will, over the long term satisfy human food and fiber needs, enhance environmental quality and the natural resource based upon which the agricultural economy depends, make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls, sustain the economic viability of farm operations, and enhance the quality of life for farmers and society as a whole. Common practices under this system include crop rotations, integrated pest management, more soil and water conservation practices and strategic use of animal and green manures and use of natural or synthetic inputs that are not harmful to natural systems, farmers, their neighbors, or consumers. Sustainable agriculture encompasses many different production methods, systems, and approaches such as organic farming, green agriculture, conservation farming, natural farming, ecological farming, etc. that aim to meet the goals of profitability, stewardship, and quality of life.

The philosophy of organic food production systems maintains certain principles such as biodiversity, ecological balance, sustainability, natural plant fertilization, natural pest management, and soil integrity. Organic farming excludes or strictly limits the use of manufactured fertilizers, pesticides, herbicides, insecticides and fungicides, plant growth regulators such as hormones, livestock antibiotics, food additives, and genetically modified organisms. Since farms vary in product and practice, there is also a wide variety in how these principles are applied. Organic farming has its roots in traditional practices that evolved in villages and farming communities over the past many years. Organic agriculture is generally considered to be under the “umbrella” of sustainable agriculture. But it is not exactly a subset, since organic practices may conflict with sustainability goals in certain situations. Organic products can also be unsustainably produced on large industrial farms, and farms that are not certified organic can produce food using methods that will sustain the farm's productivity for generations. Sustainable farms do not follow organic standards; they incorporate ways that will not deplete or permanently damage resources. When the production system is managed in accordance with the standards set by the International Federation of Organic Agriculture Movements (IFOAM) or Philippine National Standards of Organic Agriculture (PNSOA) and to meet the set requirements for national organic certification process involving a substantial fee and extensive record keeping, this type of farming came to be known as certified organic.

Lastly, to ensure food security and to combat crop failures in the country, people should be encouraged to cultivate and use crops that are appropriate for the climatic conditions prevailing in their areas, especially the traditional ones. Farmers should be given the choice on how to farm, make appropriate choices for their land, their animals, and their local situation in general. Education and improving the way food is produced can make a big difference.

Highlights of RTD on Organic Agriculture

The National Academy of Science and Technology (NAST) Philippines, the country’s lead advisory body on science and technology issues and policies, conducted a round table discussion on March 14, 2011 where the following objectives were addressed: i. Assess the status of organic agriculture of the country; ii. Identify issues related to productivity, sustainability and competitiveness, and iii. Recommend actions on policy related to organic agriculture. Speakers were Dr. Charito O. Medina, National Coordinator of Magsasaka at Siyentista Tungo sa Pag-unlad ng Agrikultura (MASIPAG); Edgardo S. Uychiat, President of the Negros Island Sustainable Agriculture and Rural Development Foundation, Inc. (NISARD);

Dr. Angel L. Lambio, Professor of the College of Agriculture, University of the Philippines Los Baños (UPLB); Andry K. Lim, Founder/Consultant of Tribal Mission Foundation International, Inc.; Dr. Oscar Gutierrez Jr. of the Food and Drugs Administration (FDA); Lara G. Vivas of Bureau of Agriculture and Fisheries Product Standards (BAFPS); and Antonio de Castro, Vice-President of the Organic Producers and Traders Association (OPTA). Participants included traders and producers, academe, local government units (LGUs), nongovernment organizations (NGOs) and other people who have a stake of the organic agriculture industry. The main provocative question raised is how sustainable is organic agriculture? Making a comparison between sustainable agriculture and the legally protected organic agriculture was the focal issue.

Sustainable Agriculture vs. Organic Agriculture

Sustainable agriculture is ecologically sound, economically viable, socially just and humane. Organic agriculture on the other hand is an agricultural production system that promotes environmentally, socially and economically sound production of food and fibers and excludes the use of synthetically compounded fertilizers, pesticides, growth regulators, livestock feed additives and genetically modified organisms. These definitions show that both share the broad goals of ecological soundness, economic viability, social justice and humaneness but they are not identical. The divergence begins with the banning of certain practices in organic agriculture whose justifications are being disputed, rightly or wrongly, as not entirely supported by science. The non-use of the banned inputs can lead to lower initial yields usually during the transition period *(and even thereafter)*. Thus it appears that to become economically viable and competitive, there must be a premium for organically produced food that results in higher food prices to consumers and thereby more food insecurity to the poor. However it has been shown repeatedly that if done properly organic products can be produced cheaper and with a better overall quality than conventional foods. To protect organic producers from spurious labeling and unfair competition, and to assure consumers of the integrity of their food, a need for systems of organic certification had to be in place thus adding to the cost. Hence while organic farming passes the test of ecological soundness, there are still serious reservations, mostly from policy makers, on its economic viability without the premiums, and its ability to meet the equity goal of sustainability. Other most commonly disputed differences between organic agriculture and sustainable agriculture are on issues of certification, farm size and producers and use of fossil fuels. Organic farms must be independently certified every year and approved by certifying agency while a farm using sustainable practices is more of a way of life and does not require any official certificate. On organic farming, food can be produced by large corporations and there is no limitation on how many hectares can be used to grow the crops. With sustainable farming, food production is carried out by small farmers and their families who live on the land where they farm. They plant crops in relatively small, mixed plots as a form of pest control and to enhance soil and conserve land resources. Supply chain of organically produced can travel thousands of kilometers before reaching your food plate and certification does not take into consideration the use of petroleum to truck food. Sustainable food, however, is distributed and sold close to the farm as possible.

Organic Crops

In the Philippines, development-oriented organizations have long been championing organic agriculture for rural development. For instance, MASIPAG has initiated a range of activities as alternative to the Green Revolution, such as rice and corn programs, diversified integrated systems, and farmer-developed and adapted technologies. Results of their project assessment in 2007 was presented and summarized by Medina (2011) in **Tables 1** and **2**.

Table 1. Comparison of mean yield of rice (kg/ha) involving 840 MASIPAG farmers in the Philippines in 2007

	Masipag Organic	Masipag in Conversion	Chemical Farming
Luzon	3,743ns	3,436ns	3,851ns
Visayas	2,683ns	2,470ns	2,626ns
Mindanao (Maximum)	3,767ns (8,710)	3,864ns (10,400)	4,131ns (8,070)

Source: Medina (2011)

The total number of respondents was 840: 100 farmers in each category except for Visayas where 80 were involved. MASIPAG means that they are planting their own rice varieties and not spraying pesticides but are still adding some chemical fertilizers. So in this case, the yield comparison was between the three categories of farming: MASIPAG Organic, MASIPAG in Conversion and Chemical Farming.

Maximum average yield of 8,710 kg/ha (M-organic), 10,400 kg/ha (M-conversion) and 8,070 kg/ha (Chemical Farming) were obtained in Mindanao. No significant difference on grain yield among farming categories across Philippine regions was observed.

On the contrary, results showed highly significant difference on average annual net income comparison across the regions (Table 2). MASIPAG's corn program are still in its infancy and not as successful as in rice. Most of their cooperators are rice farmers and have less experience in corn farming and more so, their corn yields are still 20% lower than the commercial hybrid seeds. The important thing is to be able to compete with the hybrids to be adapted by the farmers. At present, there is no successful corn varieties developed for MASIPAG farming.

Table 2. Net agricultural income per hectare among MASIPAG farmers in 2007 (Pesos)

	Masipag Organic	**Masipag in Conversion**	**Chemical Farming**
Luzon	24,412**	18,991**	13,403**
Visayas	22,868**	16,039**	13,728**
Mindanao	23,715ns	17,362ns	19,588ns
Average	23,599***	17,457***	15,643***

Negros Island Sustainable Agriculture and Rural Development Foundation, Inc., better known as NISARD, founded in 2005, is the prime mover of promoting organic agriculture development in Negros Island. Its mission is to make Negros Island the organic food island of Asia by advocating and promoting organic agriculture across the island, evolved out of the serious socio-economic and environmental problems faced by Negrenses. NISARD embarks on organic agriculture as a strategy towards poverty alleviation and food security. Setting these objectives off the ground, NISARD forges alliances with various organic agriculture advocates and practitioners and tapping public, private partnership wherein the provincial government provides funding and policy support for organic agriculture programs and projects. Various organic farming strategies are being practiced and promoted (Uychiat 2011). Formation of various commodity clusters, particularly small scale farmers is vital element where each cluster collectively addresses diverse issues and concerns affecting them. This resulted to the creation of various associations such as the Negros Island Organic Fertilizer Producers Association (NIOFRA), Organic Coffee Producers Association, Negros Organic Muscovado Industry Association (NOMIA), Negros Organic Rice Industry Association (NORIA), etc. As organic farmers and practicioners in Negros Island gain knowledge and experiences, various significant breakthroughs have already been achieved that shows significant results. A certified organic producer based in Sagay City, Negros Occidental who runs 194 ha of certified organic sugarcane, obtained an average yield of 60 t/ha canes (**Table 3**).

Table 3. Organic and conventional gross sales comparison under rice and vegetable systems

Farming System	**Crops Grown**	**Gross Sales (annual)**
Diversified Organic Farming System[1]	Rice (0.7 ha) + Vegetables (0.6 ha.)	P332,000.00[3]
Conventional[2]	Rice monocrop (1.3 has.)	P72,000.00

[1]*Based on NICERT list of certified organic farm products (rice, pechay, baguio beans, carrots, ampalaya, bananas, okra, tomatoes, papaya.*
[2]*Mode of farming before shifted to diversified organic farming system in 2007.*
[3]*Sales with premium price for organic products.*

This is almost the same yield level obtained when using the chemical based sugarcane production but, the company saves a lot in terms of expenses in purchasing expensive chemical inputs. The same story hold true with a certified organic rice-vegetable farmer whose income more than doubled from sales of organic vegetables such as carrots, onion leaf, pechay, Baguio beans, potatoes, etc. using diversified organic farming system as compared to conventional farming (**Table 4**).

Table 4. Yield and cost comparison on organic and non-organic sugarcane at Sagay City, Philippines

Comparison	Average Yield/Ha (in ton)	Production Cost/Ha (newly planted)	Lkg/TC
Organic (Kent Javelosa)	60 (2008-2009)	P30,000.00	1.70
Non-Organic[1] (neighboring sugarcane farm)	65 (2008-2009)	P45,000.00	1.65

[1]Based on the prevailing practices in sugarcane production in Sagay City.

NISARD's intervention with the certified small scale organic producers in Mt. Kanlaon increased yield from 0.8 to 1.2 kg/ha from coffee trees in the rainforest. Aside from improving productivity using the modern organic farming technologies, farm income increased and most importantly help protect the remaining flora and fauna in Mt. Kanlaon, the highest peak and home to various endemic species in Negros Island. Along with the growing number of certified producers and practitioners coupled by the growing consumer awareness and increasing income, developing local market for organic products become more imperative.

Organic Livestock

The academe has also been doing its share in developing organic agriculture. UPLB is on the track to fully develop the organic chicken meat and egg production in the country amidst problems like source of stock for breeding, flock health care, management system, and source of organic feeds (Lambio 2011). However, here are still no stocks that are specifically developed for organic production. The two breed-groups of free-range colored chickens namely Sasso and Kabir being considered for organic production are imported hence; supply is not reliable and not sustainable. The present constraint on stocks could be partly addressed if we consider the native chickens as option (Figure 2).

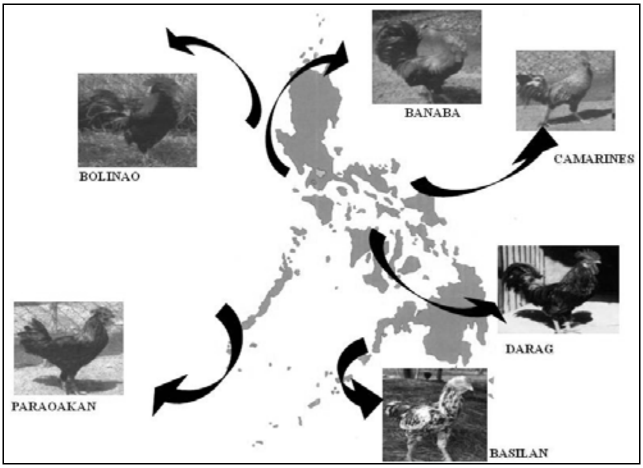

Figure 2. Genetic groups of Philippine native chickens.

Almost 50 % of the total chicken inventory in the country is of the native-type. These chickens however, are raised by smallholders primarily for their own consumption and additional source of income. Their productive and reproductive performances are variable indicating high potential for genetic improvement through the application of appropriate selection methods and mating systems. It is noteworthy that some genetic groups of native chickens have already been identified, though there are still shortfalls in leveling up with the poultry production of developed countries like France. A possible solution to this is the breeding of a native chicken such as Banaba or Paraoakan and a commercial broiler that produces offspring with better performance (**Table 5**).

Table 5. Growth potential of native chickens and their hybrids

GENETIC GROUP	BW 6wks,g	BW 8wks,g	BW 12wks,g
BANABA(BB)	358	549	879
PARAOAKAN (PN)	319	514	880
COMMERCIAL BROILER(CB)	1528	2159	3298
F1 of BB x CB	772	1162	1721
F1 of PN x CB	731	1137	1849

However, breeding should not oppose the natural behavior of animals so that they can adjust easier and reproduce under prevailing environmental and management conditions. Protocols for new breeding strategies are now being undertaken to meet these shortfalls. The local supply of organic feeds is a major constraint. Some organic poultry producers could have easily passed organic certification if only they have consistent supply of organic corn and organic soybean or other legume substitutes. Organic feeds are still being imported by commercial producers of organic chickens. In the traditional way of raising native-type chickens in the Philippines, feeds that are given include rice and rice by-products, corn and corn by-products, legumes, chopped root crops banana and coconut meat. On the range they are also able to find fallen grains, insects, small fishes, succulent leaves and flowers. Many of these feedstuffs are produced with none or just minimal use of harmful chemicals and other synthetic substances. Farmers practicing organic crop production and at the same time raising chickens could feed them with their own organically-produced feedstuffs. The climate in the Philippines is conducive to the growth of harmful microorganism that causes diseases to chickens and other poultry species. As a consequence, high morbidity and mortality rates are incurred making the production of meat and eggs unnecessarily high.

Herbal medicines have shown potential but constant supply is a problem. Management system should be aimed to develop harmonious relationship between land and the animals, and respect for their behavioral needs. Housing and equipment should permit natural behavior including outdoor access; protect the birds from the elements, maintain a comfortable temperature, provide ventilation and clean bedding and allow birds to exercise and conduct natural behavior. Manures produced should be disposed properly. This would be essential not only on the aspect of food safety but also on Nitrogen balance/accounting (MINAS).

The Philippines has a great prospect of developing an organic production system for chicken meat and eggs. We have our very own Philippine native-type chickens as stocks that we could further develop to suit the requirements of organic production systems. We have large tract of fertile lands which could be used for the organic production of feeds needed by the chickens could be locally produced. Medicinal plants can be used in maintaining good flock health of the birds. Production could be year-round with minimal expense on housing and facilities.

Lim (2011) focused discussion on livestock “sustainability and productivity” in connection to climate change, pollution in production and food security guided by Natural Farming concepts on “respect for life”. For instance, housing for livestocks should be according to “original” living conditions of the animals thereby reducing stress during their growing period. For example, in the conventional way, pigs stays on concrete, steel or plastic facilities. Concrete floorings tend to be slippery hence limit the animals from running and enjoying life. While under natural farming, beddings are 1-meter deep mixture of sawdust, soil, salt and indigenous microorganism is used. Coco dusts and rice hulls are other locally available materials that can be used as substitutes in the mixture. This type of beddings could serve for 10 years by just maintaining the depth of the beds. Farmers can also change the beddings after two years and use this as farm fertilizers. More so, on the housing facilities, split type of roofing is utilized for better aeration and ventilation. Sunlight that goes into the pens served as disinfectants eliminating odors and other undesirable microbial activities. There is significant savings on water-use since there is no bathing and cleaning involved just the water consumed by the animals.

Another way of doing natural pig farming is the free-range system. It eliminates the high cost of housing facilities and feeds but bigger land area is required. Hybrid pigs have been identified that fit into the production system. One critical point is to establish a dynamic farm plant population that can sustain the supply of nutritious-safe food for the herd, a semi-closed organic crop-livestock integration.

Standards and Certification

Ms. Lara G. Vivas (2011), Senior Scientist and Specialist in the Bureau of Agriculture and Fisheries Product Standards (BAFPS), discussed and presented standards that are basically technical specifications that are made available to public as private standards or national standards, for use of the producers, farmers, as well as the consumers of the country. These are drawn up with the cooperation and consensus or general approval of all interests affected by it based on the consolidated results of science, technology and experience. Standards are aimed to promote optimum community benefits and approved by a body recognized by national, regional, and international levels. Minimum requirements for safety are also defined in the standards, the freedom from unacceptable risk of harm and also some standards define the preservation and protection of environment from unacceptable damages from the effects and operations of producers. Standards promote cooperation among concerned agencies and organizations and it facilitates easy implementation. It defines the specific purpose and conditions that prevents or eliminates technical barriers to trade. There is at present no regulation on organic products applicable worldwide, however the 3 main organic standard types can be summarized as follow: a. International Private or inter-governmental frame standards, such IFOAM Standards that seeks to clarify the practices and procedures approved in organic agriculture; those that may be accepted, and those that are to be prohibited or the Codex Alimentarius, b. Baseline Regulatory Standards and Regulation regulates certain organic markets contributing a legal basis for the minimum requirement that a product and its production process have to fulfill in order to label and market it as “Organic”. Most organic regulatory standards define the requirements for organic production and labeling within the applicable market but also define certain import requirements, c. Private Organic Label Standards.

The Philippine National Standards Specification for Organic Agriculture was initially prepared by the Organic Certification Center of the Philippines (OCCP) and was adopted by the Department of Agriculture through the Bureau of Agriculture and Fisheries Product Standards (BAFPS). The BAFPS’ Technical Committee on Crops and Livestock subjected these organic agriculture standards to a series of Technical Reviews and Public Consultations. These Standards for Organic Agriculture have been prepared for the purpose of providing a uniform approach to the requirements, which is the basis of the following: conversion period, crop production, livestock, processing, special products, labeling and consumer information.

Certification is the procedure by which official certification bodies or recognized official certification bodies provide a written or equivalent assurance that the foods or food control systems conform to requirements. At first, organic certification was privately organized to build trust between producers and consumers; to improve and standardize quality, protect organic producers from fraudulent producer and to “brand” organic certified products. There are 3 types of certification: a. First Party Certification where verification criteria and rules are set and monitored/enforced by the company itself, b. Second Party Certification, verification criteria and rules are set by buyers or industry organizations, and c. Third Party Certification also called Independent Certification. But the main objective of certification is actually to assess the farm or company and assures in writing that specified standards are met. Certification always has a cost regardless of the type of system (private or public). There are costs for compliance and inspection, registration, etc. These costs should be shared among those stakeholders that benefit from certification, but this is not often the case; producers often bear the bulk of the costs. There are group certification schemes where the group of farmers shares the certificate and certification fee among themselves.

Health Concerns on Organic Food: Food Safety Assurance

The paper on Health Concerns on Organic Food: Food Safety Assurance was prepared by S.H. Lazo and O. Gutierrez, Jr. (2011) of the Food and Drug Regulation but the presentation and open forum was handled by the latter. Food safety assures that food will not cause harm to the consumers when it is prepared and eaten according to its intended use. All the necessary conditions and measures must be followed strictly during production, processing, storage, distribution and preparation of food to ensure that it is safe, sound, wholesome and fit for human consumption. The Philippine food regulatory system instills confidence in the safety of food supply regardless of the method of technology used to produce them. It assures safe levels of contaminants, adulterants, naturally occurring toxins or any other substance that may render food injurious to health. Food safety assurance is ensured across all the stages of food chain from farm to table. The FDA recognizes that there are hazards whether chronic or acute that may make food injurious to the health of the consumers. Assurance of the safety of food products whether organic, conventional or agrobiotech, does not begin or end after the harvest, certification or labeling. There are standards, guidelines, measures and practices that help avoid, control or prevent food contamination hence manage possible health risks. As applicable, all food products should be produced, harvested, handled, packed, transported, distributed, stored, retailed, offered for consumption or sale, and even processed into pre-packed food products under good agricultural practices, sanitary and hygienic conditions, good post-harvest practices, and good storage and distribution, as well as good manufacturing practices and hazard analysis critical control points. Exposure to hazardous contaminants and hazardous level of farm inputs should be prevented during the entire food chain. There are processes in the government that approve chemicals from pharmaceuticals as farm inputs based on international standards like the Codex. Poor harvesting and handling practices of fruits, vegetables and meat can render food unsafe for consumption.

There are instances when farm animal manures and excretes can contaminate food products. Farm animals are good reservoir of infectious agents. Food whether organic or non-organic still needs adequate washing, proper storage and preparation (cooking) at home and in food establishments. Food safety is "common sense". Organic farms are not absolutely free from contamination and exposure to harmful chemicals. For livestock and poultry products, any chemical inputs whether organic or inorganic should undergo withdrawal or wash-out period before slaughtering. Some plant foods contain toxins such as alkaloids, cyanogenic glucocides, antinutrients, neurotoxins and allergens. Some fruits and vegetables when challenged by increased pressures from insects, weeds and other plant diseases are simulated to produce natural toxins. A hazardous contaminant in food does not only come from chemicals or physical agents. Biological agents and hazards cause adverse effects and infections. This includes pathogens that are highly infectious at low levels ex. *Hepatitis A* virus, *E coli* 0157-H7, *Salmonella sps*, and *E. sakazakii* associated with infant formula. Chemical hazards of biological origin are toxins produced by fungus and algae. Processing of foods whether organic, conventional or bioengineered may also produce some levels of chemicals. These include polyaromatic hydrocarbons in smoked food and acrylamides. Chemical and biochemical hazards are carefully studied by FAO/WHO Codex Alimentarius Commission and its joint expert committees. They recommend maximum residue levels, acceptable daily intake and guidelines on good manufacturing practices to ensure safe levels, food availability and affordability of the products.

There are naturally occurring carcinogens occurring in a cup of certified organic coffee but the level does not pose real risk. Similarly, conventional farm food products may contain more pesticides compared with organically produced products, but the level of pesticides does not pose real risk. Pesticides in conventional food meet regulatory requirements on safety (again there are so many studies on produce exceeding MRL). Some organic farms overseas are allowed to use broad spectrum pesticides derived from some plants and bacteria which occur naturally. Some even allow antibiotics such as streptomycin derived through fermentation. In some countries, pasteurization which requires heating is not allowed. Plant food products that produce lesions wherein the fungi can grow and produce mycotoxins are common. Nuts for example may contain Aflatoxin from *Aspergillus sps*. Early spoilage of food due to microorganism is known problem. Finally, organic farmers prefer to apply pig and cow manures whenever available because of reduced cost. These “night soils” may harbor *E. coli* 0157. Some organic farmers use sulphur as pesticide but sulphur based preparations may contain lead.

The challenge really is to ensure that food production and processing guidelines, food safety standards and food regulatory measures are followed to assure food safety. Consumers should be protected against false, misleading health claims or labels that would create erroneous impression that processed food products superiority to others just because of the agricultural method or system employed that can not be backed by scientific studies. Research should continue to explore the role of organic foods and its claims in promoting human health safety. Studies are needed to show the health significance and impact of the level of nutrients after processing to public health in the long-term basis.

Organic Agriculture Perspective from the Consumer, Trader and Retailer

Marketing of Organic Product.

Mr. Antonio de Castro is the President of organic Producers Trade Association (OPTA), Project Farm Manager for the ABS-CBN Eco-Village Organic Farm in Iba, Zambales and owner of the Earthworm Sanctuary. OPTA is a network that spearheads the mainstreaming of organic agriculture as a way of life. One of its principal goals is to improve consumer awareness, accessibility and acceptability of organic products and contribute towards increase of sales volume of organic products. He believes that organic agriculture in the Philippines is really a question of food security. His presentation focused on the consumer’s/trader’s/retailer’s perspective of organic agriculture (Castro 2011). Related to cost of products, realistically, organic agriculture should be cheaper compared to conventional agriculture products since there are substantial savings from the use of farmer’s locally produced fertilizer and heritage seeds and non-use of pesticides. But there is a question of supply and demand; there are very few organic farmers now and the product demand is growing steadily fast. Most of the products are contracted to special markets abroad hence get higher prices with premiums. Consequently, very little supply is left for the local markets and prices are up as well. An example is DOLE, Philippines organically produced papaya, banana and pineapple are not seen here because it goes primarily to other Asian countries particularly to Japan with premiums. Now that organics are getting popular, quantity and quality of supply became uncertain: there are more organics in the market compared to what was actually produced and available. Knowing the farmer and his production practices are your insurance to obtain true organic products. Another way is to grow your own product in your backyard or in pots. Obviously no certification is required but still it does not address the major problems. Markets carrying organic products are still difficult to find. If one should go to big established supermarkets in the city such as Rustan's, Shoemart, Landmark, etc. the variety of products sold is very limited. A list of markets and outlets of organic products in the country is mentioned in the later part of this paper.

During the open forum, G. Sarmiento, Executive Director, OPTA, gave some perspective on marketing trends domestically and internationally. On the international front the health and wellness direction is becoming a mega trend and will continue to be so in the next 4 years. Part of that is organic agriculture where brand acquisitions and merging of international brands like Pepsi Co., Heinz, etc. comes in. Even home foods in US are into catering organic products as well as just recently, Uniliver had declared that they are in organic agriculture as well. In the Philippines, the number of organic practitioners has increased since 1990 and is now to the point of certification. The link between the producers and the consumers is actually the certification and that is why the consumers in the Philippines are also looking for organic products. Currently, more people are aware and know more about organic agriculture compared to the 1990s or early 2000. Most of these are small-scale producers whose need has to be addressed. The Philippine consumers' awareness is very high and their concern is really not on the environment but on the health issue. Are these products in compliant to the standards? Remember that in organic agriculture, there is certification and there is a standard.

Castro (2011) further described some organic farming methods employed in their farms at Panay and ABS-CBN Eco-Farm in Iba, Zambales where locally produced organic fertilizers from agricultural wastes are strictly used in production. The method used is Vermicomposting (decomposting using earthworms). Rice hulls are fed to earthworms and later mixed with water hyacinth and other farm wastes. Basically this is also called EM or IMO because of the culturing of the bacteria in the compost then making it as a concentrate of liquid bacteria which is in turn sprayed on the soil and plants. The composts are treated not as fertilizers per se but as microbial inoculant to the soil. This provides good growing conditions for the microbes bringing the soil back to life. Carbonized rice hull or Bio-char is also used as growth medium for the microbes; any charcoal can serve as substitute as well. A mixture of 50% compost and 50% Lahar (sourced from Mt. Pinatubo area) is recommended. The no-till method of land preparation, direct seeding and mulching are common farm practices. The cut grasses and weeds are used as mulch after seeding to keep the conditions wet and moist facilitating germination. The non-tillage of the soil render the bacteria unexposed to sun to be not killed nor disturb its microbial activities. With these practices, the farmer obviously cut costs on labor and use of equipments. The organic crops currently grown are cabbage, sweet-big strawberries, “cilantro”, Heirloom tomatoes, etc. He concluded that sustainable organic farming will take over the conventional chemical farming in the Philippines simply because it is better based on its economic feasibility, environmental impact, and production benefits to small farmers and consumers.

Sustainability of Organic Agriculture

When discussing organic farming and other systems of crop production, it is of utmost importance to examine without prejudice these systems of agriculture that can contribute to food sufficiency and security, at present and in the future. Separation of facts and wishful thinking is absolutely necessary and only an unbiased review of scientific literature can provide objective answers to the questions raised. Furthermore, a strong belief and enthusiasm for certain solutions cannot be allowed to hamper the search for objectivity. The basic scientific question remains, and it requires a stringent review and evaluation of the production potential of organic and conventional systems.

On a global perspective, Kirchmann et. al (2008) yield data evaluation from national statistics, organic and conventional long-term experiments and comparative studies compiled from scientific literatures shows that organic yields are between 25 and 50% lower than conventional yields, depending on whether the organic system has access to animal manure. Yields of organically grown crops in Europe are in most cases significantly lower than those of conventional crops. The amount of manure available on organic farms is usually not sufficient to produce similar crop yields as in conventional systems and therefore green manures are commonly used. However, organic crop yields reported for rotations with green manure require correction for years without crop export from the field, which reduces average yield over the crop rotation. When organic yields are similar to those in conventional production, nutrient input through manure is usually higher than nutrient addition in conventional agriculture, but such high inputs are usually only possible through transfer of large amounts of manure from conventional to organic production. The main factors limiting organic yields are lower nutrient availability, poorer weed control and limited possibilities to improve the nutrient status of infertile soils. It is thus very likely that the rules that actually define organic agriculture, i.e. exclusive use of manures and untreated minerals, greatly limit the potential to increase yields.

Yields of organic agriculture do not exceed conventional yields if the comparisons are made in a systematic and controlled way, as is the case in the field experiments of the temperate areas, or in the studies of Rasul and Thapa (2004) in Bangladesh, and Lyngbaek, et al., (2001) in Costa Rica. The same can be said in studies made by researches but are not organic practitioners in the Philippines. In contrast, when system productivity is estimated at farm level in the course of an agricultural project yield increases of up to 300 percent are reported for the organic system (Kilcher, 2007). The reason for this difference may be that these yield increases were not the outcome of organic agriculture techniques alone; they were at least as much the result of favorable cultural, social and economic dynamics such as the farmers' motivation, the sharing of experience in peer groups and successive learning, or the introduction of new crops which are often the beginning of a whole chain of innovations (Zundel and Kilcher, 2007).

Based on an extensive review of relevant studies Zundel and Klicher (2007) concluded that at national level, organic markets have the potential to improve food security and to improve national food supply. This is also because organic farms produce more efficiently, with more sustainable and stable yields. In some cases, organic farms even enable an increase in production. Organic farms being anchored on multiple cropping system or crop-livestock integration, harvest a higher diversity of products from the same area, providing more food for the farmers' families and reducing dependency on a few products in the market. Diversity in agricultural production and value added products increases income-generating opportunities and spreads the risks of failure over a wider range of crops and products.(Zundel and Kilcher, 2007).

Pimentel et. al. (2005) examined the data from the 22-year experiments carried out at the Rodale Institute, which compared the organic animal-based (animal manure and legume based system), organic legume-based, and conventional systems. Among the benefits of organic technologies are higher soil organic matter and nitrogen, lower fossil energy inputs, yield similar to those of conventional systems and conservation of soil moisture and water resources (especially advantageous under drought conditions).

Several organic technologies, if adopted in current conventional production systems, would most likely be beneficial. These include (a) employing off-season cover crops; (b) using more extended crop rotations, which act both to conserve soil and water resources and also to reduce insect, disease, and weed problems; (c) increasing the level of soil organic matter, which helps conserve water resources and mitigates drought effects on crops; and (d) employing natural biodiversity to reduce or eliminate the use of nitrogen fertilizers, herbicides, insecticides, and fungicides. Some or all of these technologies have the potential to increase the ecological, energetic, and economic sustainability of all agricultural cropping systems, not only organic systems.

Despite the growing consumer demand for organically produced foods, information based on a systematic review of their nutritional quality is very scarce. Dangour et. al. (2009) quantitatively assess the difference in reported nutrient content between organically and conventionally produced foodstuffs. Based on their systematic review of 55 studies of satisfactory quality, conventionally produced crops had a significantly higher content of nitrogen, and organically produced crops had a significantly higher content of phosphorus and titratable acidity (ripeness at harvest). No evidence of a difference was detected for the remaining 8 (vitamin C, phenolic compounds, magnesium, calcium, potassium, zinc, total soluble solids and copper) of the 11 crop nutrient categories analyzed. Analysis of the more limited database on livestock products found no evidence of a difference in nutrient content between organically and conventionally produced livestock products. The small differences in nutrient content detected are biologically plausible and mostly relate to differences in production methods. It is unlikely that consumption of these nutrients at the concentrations reported in organic foods in the study provide any health benefit.

In a study of Pacini et. al. in 2003, the authors evaluated the financial and environmental aspects of sustainability of organic, integrated and conventional farming systems (OFS, IFS and CFS, respectively) at farm level and on more detailed spatial scales by applying a holistic, integrated economic-environmental accounting framework to three case study farms in Tuscany, Italy. The impact of the farming systems (FSs) on a number of indicators was studied together with that of pedo-climatic factors at farm, site and field level. The gross margins of steady-state OFSs were found to be higher than the corresponding CFS gross margins. The OFSs perform better than IFSs and CFSs with respect to nitrogen losses, pesticide risk, herbaceous plant biodiversity and most of the other environmental indicators. However, on hilly soils, erosion was found to be higher in OFSs than in CFSs. The pesticide and the nitrogen indicators in this study showed a similar environmental impact caused by integrated and conventional farming practices. Regional pedo-climatic factors were found to have a considerable impact on nutrient losses, soil erosion, pesticide risk and herbaceous plant biodiversity, site-specific factors on nutrient losses and soil erosion. Results at field level suggest that herbaceous plant biodiversity and crop production are not always conflicting variables. The authors also concluded that the fact that OFS in most cases environmentally perform better than IFS and CFS does not mean ipso facto that they are sustainable when compared to the intrinsic carrying capacity and resilience of a given ecosystem.

Badgely, et. al. (2007) evaluated the universality of the claims that organic agriculture can contribute significantly to the global food supply are low yields and insufficient quantities of organically acceptable fertilizers. For the first claim, yields of organic versus conventional or low-intensive food production for a global dataset of 293 examples and estimated the average yield ratio (organic: non-organic) of different food categories for the developed and the developing world were compared. For most food categories, the average yield ratio was slightly <1.0 for studies in the developed world and >1.0 for studies in the developing world. With the average yield ratios, the global food supply that could be grown organically on the current agricultural land base was modeled. Model estimates indicate that organic methods could produce enough food on a global per capita basis to sustain the current human population, and potentially an even larger population, without increasing the agricultural land base. Data from temperate and tropical agro-ecosystems also suggest that leguminous cover crops could fix enough nitrogen to replace the amount of synthetic fertilizer currently in use. The results are not, however, intended as forecasts of instantaneous local or global production after conversion to organic methods. Neither claims that yields by organic methods are routinely higher than yields from green-revolution methods. Rather the results indicate that organic agriculture has the potential to contribute quite substantially to the global food supply, while reducing the detrimental environmental impacts of conventional agriculture. Evaluation and review of this paper have raised important issues about crop rotations under organic versus conventional agriculture and the reliability of grey-literature sources.

In the global scale, recent models (Badgley, et al., 2007; Halberg, et al., 2007) of a hypothetical food supply grown organically indicates that organic agriculture could produce enough food on a global per capita basis for the current world population: 2,640 and 4,380 kcal/person/day, depending on the model used. The lower value is based on the adult 2,650 kcal daily caloric requirement, while the higher value is based on expectations of a 57 percent increase in food availability, especially in developing countries, giving it the potential of supporting even a larger human population. The model was based on substituting synthetic fertilizers currently in use with nitrogen fixation of leguminous cover crops in temperate and tropical agro-ecosystems. These models suggest that organic agriculture has the potential to secure a global food supply, just as conventional agriculture today, but with reduced environmental impacts.

On the other aspects of sustainability, organic agriculture can provide more employment and reduce the social impact of family displacement as in the case of large scale conventional farming. By being labor intensive, organic agriculture creates not only employment but improves returns on labor, including also fair wages and non-exploitive working conditions. In all countries, the replacement of agricultural labor with chemicals and machinery raises concerns about social stability (e.g. breakdown of communities, mass migration, large-scale urbanization), as well as the devastating impact on the natural environment. (Scialabba, 2007)

In a study on profitability made on 50 cases of organic agriculture the following conclusions were made by Nemes (2009). The overwhelming majority of cases showed that organic farms are more economically profitable, despite frequent yield decrease – i.e. organic crop yields were higher in cases of bio-physical stress (drought); higher outcomes were generated by organic agriculture due to premium prices and predominantly lower production costs. The major difference in the profitability of the two systems was very often determined by the different management skills of the farmers thus, accounting for these seem to be fundamental for correct interpretations of results.

The crop yields and economics of organic systems, compared with conventional systems, appear to vary based on the crops, regions, and technologies employed in different studies abroad. However, the environmental benefits attributable to reduced chemical inputs, less soil erosion, water conservation, and improved soil organic matter and biodiversity were consistently greater in the organic systems than in the conventional systems.

Local Markets for Organic Products

What used to be the “niche” markets for organically produced products, these has expanded to weekend and regular markets for organically produced products. The regular markets are normally situated in super markets and special food outlets in Big cities as : OPTA Coop Store (Loyola Heights, Quezon City), Mario’s Café by the Ruins (Baguio City), La Top (La Trinidad, Benguet), Bios Dynamics Cooperative Store (Davao City), Healthy Options, French Baker, The Coffe Bean and Tea Leaf Coffee Shop, Landmark Supermarkets, Robinson’s Supermarkets, Rustan’s, SM Supermarkets, Iloilo Supermarket and nature’s Beauty (Cagayan de Oro). Moreso, the weekend markets remains to be an alternate outlet of organics. Some of the popular ones are: OPTA in the Lung Center of the Philippines (Quezon City), Mara’s Organic Market in Legaspi Village on Sundays (Makati City), Organic Market in Salcedo Village on Saturdays (Makati City), Magallanes Organic Market on Sundays (Makati City), Organic na Negros (Bacolod City), Tabo-an (Dumaguete City), etc. Also in many instances, organic products can be bought directly at farms of the organic practitioners, Eco-Farms, etc. As the supply and demand for organics get popular in the country, more markets and outlets will be established. The increase of market share of organic products is greatly dependent on the involvement of general retailers in the organic food market because it lowers cost and thus expands the consumer base.

Research and Development on Organic Agriculture

Policy Framework on Organic Agriculture

The following are national policies and regulations which influence the development of organic agriculture throughout the Philippines:

Philippine Agenda 21 (PA 21) - PA 21 is officially known as the National Agenda for Sustainable Development, PA 21 envisions a better quality of life for all, through the development of a just, moral, creative, spiritual, economically vibrant, caring, diverse yet cohesive society characterized by appropriate productivity, participatory and democratic processes, and a living in harmony within the limits of the carrying capacity of nature and the integrity of creation. The country has developed programs and policies localizing the principles and strategies of the PA 21 down to the municipality and barangay (village) levels. This is the local version of the United Nations Conference on Environment and Development (UNCED) Global Agenda 21.

Agriculture and Fisheries Modernization Act (AFMA) - AFMA stipulates the government's policy to ensure the development of the agriculture and fisheries sectors in accordance with the principles of poverty alleviation and social security; food security; rational use of resources; global competitiveness; sustainable development; people empowerment; and protection from unfair competition. AFMA called for the formulation of medium and long term plans aimed at the reduced use of agro-chemicals that are harmful to health and the environment. AFMA was approved by the President of the Philippines last December 1997.

Executive Order 481 (EO 481) - EO 481 Executive was approved by President Gloria Macapagal-Arroyo on December 27, 2005. It hopes to promote organic agriculture as a farming scheme especially in rural farming communities; forge effective networking and collaboration with the stakeholders involved in the production, handling, processing and marketing of organic agriculture products; guarantee food and environmental safety by means of an ecological approach to farming; and ensure the integrity of organic products through the approved organic certification procedures and organic production, handling and processing standards. This legal instrument also goes with the creation of Bio-organic Farming Authority under the Office of the President. Other House Bills have already been filed on various aspects like training programs at the barangay level to educate more farmers, extension service to groups practicing organic farming, establishing training facilities in every barangay, and granting of special loans to farmers. At the municipal and barangay levels, Local Government Units are encouraged to engage in organic farming through various resolutions, master plans, and programs. Under Section 10 of the EO 481, the Department of Agriculture, through the Bureau of Agriculture and Fisheries Product Standards shall formulate the implementing rules and regulations to carry out the provisions of the said Executive Order.

Philippine National Standards for Organic Agriculture (PNSOA) **-** The Department of Agriculture through the Bureau of Agriculture and Fisheries Product Standards (BAFPS) approved the establishment of the PNSOA. These Standards for organic agriculture have been prepared for the purpose of providing a uniform approach to the requirements, which is the basis of the following: conversion to organic agriculture, crop production, livestock, processing, special products, labeling and consumer information. In 2004, the Philippine National Organic Board was created to support among others, the implementation of the Philippine National Organic Standards and Certification system; and the establishment of a Five-year Organic Industry Development Program for adoption by the respective units of DA in partnership with the private sector.

Department of Agriculture Administrative Order No. 25 Series of 2005 – Guidelines on the certification of Good Agricultural Practices (GAP) for fruits and Vegetable Farming (FV) - This establishes the rules applied by the Department of Agriculture (DA) for granting, maintaining and withdrawing Good Agricultural Practices (GAP) Certificate to individual growers or farms in the fresh fruit and vegetable sector or to their Produce Marketing Organizations (PMOs) that market and or trade the produce. The certification of agricultural farms is aimed to increase the market access of horticultural products both in the local and foreign markets, to empower farmers to respond to the demands of consumers that specific criteria to achieve food safety and quality be met, to facilitate farmer adoption of sustainable agricultural practices, to uplift GAP-FV farmers profile as member of the nationally recognized list of vegetable farmers who are setting the benchmark for the production of safe and quality fruits and vegetables, and to enable consumers exercise the option of buying quality fruits and vegetable from traceable and certified sources

Organic Agriculture Act of 2010 (Republic Act No. 10068) **-** An act providing for the development and promotion of organic agriculture in the Philippines and for other purposes was enacted last April 6, 2010. Subsequently, it was declared as the policy of the State to promote, propagate, develop further and implement the practice of organic agriculture in the Philippines that will cumulatively condition and enrich the fertility of the soil, increase farm productivity; reduce pollution and destruction of the environment, prevent the depletion of natural resources, further protect the health of farmers, consumers and the general public, and save the program for the promotion of community-based organic agricultural systems which include, among others, farmers produced purely organic fertilizers such as compost, pesticides and other farm inputs, together with a nationwide educational and promotional campaign for the use and processing, as well as the adoption of organic agricultural system as a viable alternative shall be undertaken.

Government Research-Development-Extension Initiatives

a. DA-BAR-Gap analysis on Organic Agriculture RDE

   As an initial effort to develop the Organic RDE Agenda for Philippine Agriculture, DA-BAR initiated the gap analysis on Organic Agriculture. Relevant RDE reports were collated across the country on crops, livestock and aquaculture. The result of this was compiled and a workshop was done to determine the gap and what more needs to be done to support the Organic Agriculture Program of the country.

b. PCARRD-DOST-National organic Vegetable RDE Program, Organic Arabica Coffee program

   PCARRD initiated a series of workshops to develop a comprehensive RDE program focused on developing technologies that will help the growth of the particular organic industry. After years of consultation and planning the National Organic Vegetable RDE Program was funded covering six (6) regions and 17 vegetable crops. The program includes subprograms on Supply chain analysis and policy studies, Variety Development abd seed production, Organic fertilizers and Nutrient management and pest management. The program is on its 2nd year of implementation.

A similar program was developed for organic coffee, focusing on Arabica coffee. It also includes variety selection, nutrient management, pest management as well as processing.

c. SUCs – various initiatives on crops and livestocks

Aside from the above initiatives, various SUCs have also embarked on their own organic programs mostly focusing on organic fertilizer production, crop and livestock production. Among the notable programs are at Benguet State University (BSU), Central Luzon State University (CLSU), Don Mariano Marcos State University, Pampanga State College (PAC), Misamis Oriental State College of Arts and Technology (MOSCAT).

Conclusion

Organic agriculture in its present state is still far from its full potential given the meager formal support throughout its supply chain including input supply, production and Research and Development on seeds, nutrient and pest management. There is still a vast range of opportunities for improvement in organic agriculture where the scientific community can contribute but in a slightly modified framework. Organic agriculture is a dynamic system and takes into account the individual contributions as well as the interactions of the different factors in a given production locus. R and D should work as much as possible within that holistic framework and not revert back to the isolation of active ingredients mimicking again the pesticide mindset of conventional agriculture.

Among the areas with abundant potential for organic agriculture research, where NAST and other government agencies can help are organic variety development in crops and improvement of local strains/stocks in livestock and poultry; microbials to aid nutrient and pest management in crops and livestock; population dynamics in variety, microbial, pathogen and pest management in the various organic production systems; product and process improvement in organic food, fiber, cosmetics, wellness and habitation; market and consumer studies; health, social, environmental and economic impacts in shifting to organic agriculture.

The technical, economic, and environmental sustainability of organic agriculture has been shown in numerous studies and reviews. It is also being argued that organic agriculture is the only way to go because the extractive nature of chemical agriculture cannot be sustained given our finite resource base. But the questions, doubts and criticisms keep on recurring on the same issues. This brings forth the idea that the sustainability of organic agriculture is not just about the above issues but that it runs counter to the present socio-economic realities which also shape and fuel the political realities. To make organic agriculture sustainable in a broader perspective the multi-functionality of organic agriculture, that is aside from food should be recognized and properly accounted for. It is an ideal platform for conservation of agrobiodiversity, mitigating climate change, ecotourism and preservation of social cohesiveness and tradition. The costs from the above benefits should be shared by the larger society and not just by the organic grower and consumers.

But organic agriculture going mainstream to be economically sustainable would defeat the philosophy behind organic agriculture altogether. As asserted by Risku-Norja and Mikkola (2009) there are indications that conventionalized organic agriculture with monocultures controlled by powerful companies does not pay also much attention to farmers, laborers, rural communities or the society as a whole. With the large agrifood corporations and supermarket distribution increasingly dominating the organic food market, consumers and producers gradually again lose their power (Follet 2009) as in conventional agriculture.

Products to be labeled as organic have to meet the requirements set in the Philippine National Standards for Organic Agriculture. The standards can appear to be restrictive but these are also based on logical and scientific fundamentals and are also subject to frequent review and improvement as the wealth of information, knowledge and technologies increase. The choice of subjecting a product for certification is however under the prerogative of the farmer producer. Under the Organic Agriculture Act of 2010 by which the government will subsidize the expenses for certification following a set of guidelines. This ensures that the farmers would try to meet the standards after being given a two-year period to scale up and meet the requirements for certification.

Export of organic produce remains to be the major thrust of the majority of the developing countries. Local markets have emerged and are also gaining ground. These domestic markets, though still relatively small, have led to consumer calls and government's interest to regulate the sector. Products certified as organic command high prices and henceforth premium organic products go to rich countries like Japan, where consumers are willing and are able to pay higher prices for such products. However, certifications and labels do not guarantee the safety of food products due mainly to the fact that a lot of things could happen during post-production before the product is consumed. The safety of food products does not begin or end with harvesting, certification or labeling.

Overall, the sustainability issue of organic agriculture must be assessed based on three or four elements that comprise it – ecological, financial, and social/cultural. Scientifically, the ecological aspect is the strongest because organic agriculture and its practices are agro-ecologically based. However, more extensive studies should be done to assess the financial sustainability which greatly influences the social and cultural aspects. The current niche of organic agriculture in the Philippines is at the extremes of the production and market spectra - the small and high-end growers in production and the wellness high-end markets. Obviously, the premium in terms of higher prices given to the produce being marketed from these farms is the driving force for their sustainability. But the question if it would be feasible for large conventional farms converting into organic agriculture is still to be tested. Constraints on yield must be assessed to determine the optimum for productivity and profitability. In the end, where can a farmer make money? Where can the industries be more competitive in the global stage? In all of these, the government should also be assertive of its regulatory role in protecting the environment and the health of its people.

In spite of our optimistic prognosis for organic agriculture, we recognize that the transition to and practice of organic agriculture contain numerous challenges —agronomically, economically, politically, and educationally. The practice of organic agriculture on a large scale requires support from research institutions dedicated to agro-ecological methods of fertility and pest management, a strong extension system, strong political support and a committed public. Finally, production methods are but one component of a sustainable food system. The economic viability of farming methods, land tenure for farmers, accessibility of markets, availability of safe water, trends in food consumption, and alleviation of poverty are essential to the assessment and promotion of a sustainable food system.

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WHY IS HUNGER ALL AROUND US? STRENGTHENING THE AGRICULTURE SUPPLY AND FOOD VALUE CHAINS

Arsenio M. Balisacan

Executive Summary

The Asian food markets have changed enormously in the past 30 years owing to a confluence of at least three major developments. First, the rapid urbanization and increasing integration of domestic markets to the global marketplace have created huge income in most of the countries in the region, combined with their growing population, has raised the demand for agriculture produce. More importantly, the income growth has induces shifts in consumer preferences and tastes toward increasingly diversified, safe, and high-value food products. The opportunities to diversify agricultural production toward crops that have increasingly become more valuable in the marketplace have been a positive force to farm income growth. Third, the expansion, both global and domestic, of modern supply chains- encompassing the modern logistics of production, processing storage, distribution, and marketing- has transformed the organization of agriculture and agribusiness. Increasingly, scale (farm size) and efficiency-enhancing institutions matter in the effort to seize opportunities for growth and poverty reduction, especially in rural areas, from the modern supply chains.

High transaction costs raise the wedge between what consumers pay for food products and what farmers are paid for their produce. Only by reducing these costs- the difference between the retail price and the farm price- can poor urban consumers and poor farmers and landless workers benefit simultaneously from the modern supply chains. Inefficiencies in each of the segments of the supply chain raise transaction costs. These inefficiencies can arise from infrastructure inadequacies, cartelistic or monopolistic trading practices, poor market information, lack of access to credit, archaic regulatory policies, and trade policies that reduce competition between foreign and locally produced goods.

Low investments in agriculture and persistently high transaction costs have severely constrained the performance of Philippine agriculture and the food economy, effectively inhibiting growth of farm productivity and

employment, reducing the earnings of poor farmers and landless workers, and making food more expensive and less accessible to poor urban consumers and even small farmers who are net buyers of food. Productivity growth in agriculture is low by the standards of the country's neighbors, owing partly to its relatively low rate of investment in connectivity infrastructure (transport, power, communication) and agricultural R&D. Various legal restrictions and regulatory policies in various stages of the supply chains also make the cost of doing business comparatively high. The potential of agriculture and the food value chains as key drivers for poverty reduction and food security is thus muted.

The response of small producers to market opportunities from the rapidly modernizing agribusiness supply chains is particularly weak. Small producers are fragmented, have limited resources, and are handicapped by the demanding market requirements quality, volume and frequency) of the modern supply chains, particularly in fruits and vegetables. Meanwhile, the modern retail is increasingly concentrated, food processing is vertically integrated, and fresh produce suppliers of supermarkets are consolidating and getting closer to source of production.

The government's pursuit of rice self-sufficiency policy ("buy high, sell low") has been very costly to the economy and the development of efficient food supply chains. While it may have been motivated by good intentions, the policy has, in practice, propped up local prices paid by consumers (though it somewhat succeeded in stabilizing rice retail prices in urban centers), increased volatility of domestic farm prices, discouraged private investments in the rice supply chain, impeded diversification to high-value crops and non-farm employment activities, and, in recent years, bred massive corruption.

To unleash the potential of agriculture and modern supply chains as key drivers of poverty reduction, the investment climate in the sector has to be substantially improved. This would require a departure from the business-as –usual approach to governing the sector. The aim is to achieve inclusive access to food while generating long-term sources of productivity growth, with special attention to:

- Reducing the 'cost of doing business' by investing in connectivity infrastructure (transport, power, and communication) and removing efficiency-inhibiting regulatory measures in all segments of the supply chains (e.g. Cabotage Law in shipping).

- Re-orienting the food-security policy toward facilitating-not inhibiting- trade, competition, and diversification to high-earning opportunities. Private (including foreign) investment in processing and trade logistics has to be harnessed to link small farmers to rapidly urbanizing market centers and growth poles in Asia. For the rice sector, this would necessitate the dismantling of the National Food Authority's extensive interventions in rice trade, including its virtual monopoly in rice importation, and the streamlining of its functions to focus on effective buffer stock management for emergency purposes.

- Aggressively investing in agricultural R&D to develop technologies appropriate for local conditions, especially in view of climate change, such as stress-tolerant varieties suitable fo cultivation in areas with abiotic problems (e.g., drought, floods).

- Increasing farmers' access to credit by making CLOAs (Certificate of Land Ownership Awards) bankable. This will require eliminating restrictions on land transferability, land use, and contractual arrangements. The Comprehensive Agrarian Reform Program must not be further extended beyond 2014. However, the collective CLOAs, which cover about 70 percent of the total land area distributed under the program, need to be converted to individual CLOAs. Individual ownership titles, not collective titles, are what matters most to household welfare and access to credit.

- Professionalizing the agricultural bureaucracy by restoring the integrity of appointments in the civil service.

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SUSTAINING ECOLOGICAL SERVICES FOR AGRICULTURAL PRODUCTIVITY, SUSTAINABILITY AND COMPETITIVENESS

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Abstract

Philippine agriculture is dependent on natural ecosystems for its productivity, competitiveness and sustainability. The last century witnessed massive destruction of terrestrial, wetlands, and marine ecosystems in the country. This has adversely affected agriculture productivity. Provision of water from watersheds has been impaired and soil resources have been degraded. There is a need to engage in massive rehabilitation activities in the country's watersheds. Biodiversity resources are being decimated. This could have long term impacts on sustainability of agriculture production. The ability of natural systems to regulate climate has been impaired. However, there is potential for carbon sequestration in forests. Natural ecosystems can also help small holder farmers adapt to a changing climate. There is need to re-examine policies and institutions so that ecological services are restored and enhanced. One promising approach is through the use of rewards and incentives to conserve natural ecosystems and the services they provide.

Introduction

For agriculture to flourish in the Philippines, a healthy natural resource base is a necessity. Natural ecosystems provide supporting, provisioning, regulating and cultural services to farmers (**Figure 1**) which help them adapt to climate risks. For example, watersheds supply water for irrigation. A diverse set of plant species in forests provide genetic material for food, fiber and tree crops. Forested landscapes minimize soil erosion that could damage water reservoirs and farm lands through silt deposition.

Unfortunately, the Philippines have a severely degraded natural resources capital base which has adversely affected the environmental services they provide. In the early 1900s, it was estimated that 70% of the country was covered with 21 million ha of forests (Garrity et al. 1993). However, at present only about 7 million ha of forests remain (FMB 2011). Thus, in the last century alone, the Philippines lost almost 15 million ha of tropical forests.

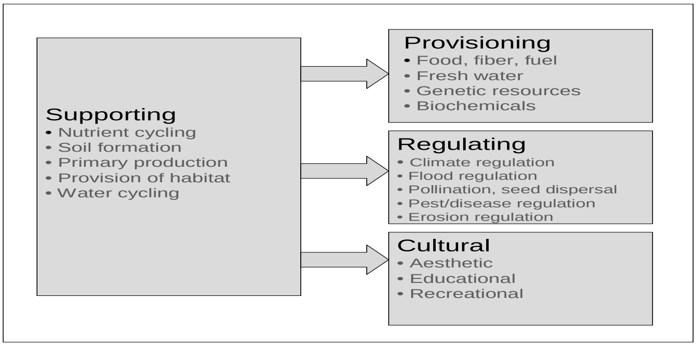

Figure 1. Ecological services provided by natural ecosystems to agriculture (adapted from the Millennium Ecosystem Assessment 2005a).

Since the early 1970s, when extensive reforestation efforts began in the Philippines, various incentives schemes have been devised and implemented to encourage people to plant trees on private and public lands. However, after more than three decades of support, reforestation in the Philippines has largely been ineffective and inefficient (Chokkalingam et al. 2006), partly because the incentives provided were either inappropriate or neglected the long-term nature of reforestation. For instance, on public forest lands, the 25-year renewable instrument of land tenure is not a sufficient incentive to invest in long-term forestry and environmental protection (Garrity et al. 1993). Moreover, resource-use rights are transferred just partially. Short-term contracts and direct payments to farmers were not able to draw a genuine interest in tree planting either.

This has resulted in the rapid deterioration of ecological services from forest ecosystems and watersheds of the country. For example, water for irrigation has been decreasing and the supply has been erratic. Intensive agricultural production in the uplands was observed to affect supply of irrigation water in the lowlands (Lantican et al. 2003). Annual flooding events destroy millions of pesos worth of agricultural crops and produce. Accelerated soil erosion decimates thousands of hectares of prime agricultural lands through sedimentation (Coxhead and Shively 2005).

In this paper, we analyzed the key ecological services that impact agricultural productivity, sustainability and competitiveness. We focused on water and soil conservation, biodiversity resources, and climate change. In addition, we discussed relevant policies and institutional issues and present the potential of rewarding and/or paying local communities for the ecological services they provide.

Water and Soil Resources

State and drivers

Water and soil resources are two of the most essential natural assets needed to sustain agricultural productivity in the Philippines. However, soil and water are also two of the most extensively degraded natural resources due mainly to anthropogenic activities (Vorösmarty et al. 2010, Cruz et al. 2011). Soil and water resources degradation is largely driven directly by widespread land use and land cover change through land conversion, rapid urbanization, accelerated industrialization, overuse of natural resources, species introduction and infrastructure development (Cruz and Folledo 2005, LLDA and ICRAF 2005, Millennium Ecosystem Assessment 2005a, 2005b and 2005c). In turn, land use change is influenced by output prices (Coxhead et al. 2001). As climate change intensifies, the adverse influences of the above direct drivers are likely to be amplified with serious implications on water supply, soil fertility and land productivity. These direct drivers of soil and water degradation are underlain by fundamental demographic, socioeconomic, political, institutional, scientific, technological and cultural drivers (**Figure 2**).

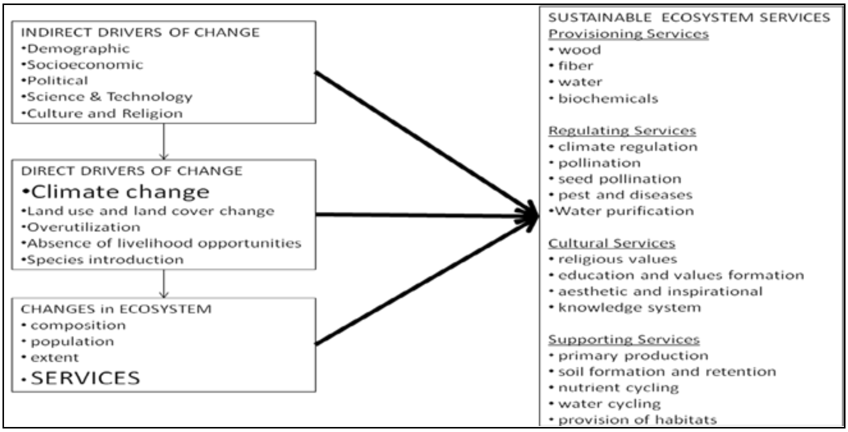

Figure 2. Drivers of changes in ecosystems and its services.
Source: Cruz et al. 201

The loss of forest cover in most watersheds in the Philippines has been severe. Based on the latest estimates of forest cover in the country (**Table 1**) only watersheds in Regions 2, 4, 8 and 11 have more than 30% of land area with forest cover, while Regions 5 and 7 have less than 10% forest cover (Cruz et al. 2011). The ratio of forest cover to irrigated and irrigable lands in many large watersheds is generally low, which could have serious implications on the rate of soil erosion and the availability and quality of water for irrigation. As forest cover dwindles because of the unregulated cultivation and illegal harvesting of timber, soil erosion worsens with the downstream siltation of rivers, lakes, reservoirs, farms, coastal and marine ecosystems that translate into substantial economic losses.

Table 1. Philippine forest cover (by region in ha) as of December 31, 2003

REGION	CLOSED FOREST	OPEN FOREST	MAN-GROVE	PLANTATION FOREST	TOTAL FOREST
NCR	0	2,790	30	*	2,820
CAR	384,877	246,848	0	40,595	672,320
R-01	37,723	117,217	151	34,710	189,801
R-02	503,149	604,473	8,602	33,621	1,149,845
R-03	226,241	304,214	368	58,672	589,495
R-04a	117,162	161,165	11,346	*	289,673
R-04b	484,866	604,246	57,567	48,465	1,195,144

R-05	50,618	90,284	13,499	2,075	156,476
R-06	105,873	104,686	4,600	49,355	264,514
R-07	2,231	43,026	11,770	17,842	74,869
R-08	36,473	410,111	38,781	34,483	519,848
R-09	29,652	126,790	22,278	3,474	182,195
R-10	107,071	226,400	2,492	1,530	337,493
R-11	177,503	240,986	2,010	536	421,035
R-12	126,385	218,858	1,350	2,641	349,234
R-13	64,729	431,832	26,731	*	523,292
ARMM	106,319	96,661	45,786	1,580	250,346
PHILIPPINES	**2,560,872**	**4,030,588**	**247,362**	**329,578**	**7,168,400**

The decline of the country's forest cover is perhaps the most important direct driver of the changes in key ecosystem services and resources, particularly soil and water. The recent economic downturn and subsequent stagnation have further forced marginalized rural population to recourse to unsustainable interventions in ecosystems such as illegal logging, slash and burn, overgrazing and use of harmful chemicals that have been destroying the foundation of long-term land productivity and ecosystem integrity. As a long term impact, the local people are deprived of an important resource base for sustaining their livelihood and their access to food and water are critically reduced.

With respect to the country's Forestry Code, watersheds with 18 percent slope should be vegetated. Yet it is hard to find a watershed in the Philippines with ≥ 18 percent slope which is not at least 50% deforested, with virtually no soil and water conservation strategy in place (Tabios et al. 2008). There is a need to understand more specifically what role forests and reforestation play in soil hydrology dynamics and proper study must be undertaken on how to make reforestation programs more cost effective. This is where science and technology can be employed as indirect drivers of change as indicated in **Figure 2**.

Box 1. Prioritizing reforestation in the Lower Agno River Basin

Tabios et al. (2007) illustrates how to prioritize watershed reforestation efforts with limited resources to minimize soil erosion for the case of the Lower Agno River Basin. Using 70 years of stochastically generated hourly rainfall data, the watershed flows and sediment yields of each of the 164 subwatersheds of the Lower Agno River Basin were calculated using a physically-based watershed model for the existing land use and soils data. The total sediment yield from all these subwatersheds in 70 years is 155.5 MCM (million cubic meters) or an average of 2.22 MCM per year. **Figure 3** shows the watersheds with the highest sediment yields by volume (left figure) and per unit area (right figure). The information provided in these two figures can be used to prioritize watersheds to implement sediment control measures.

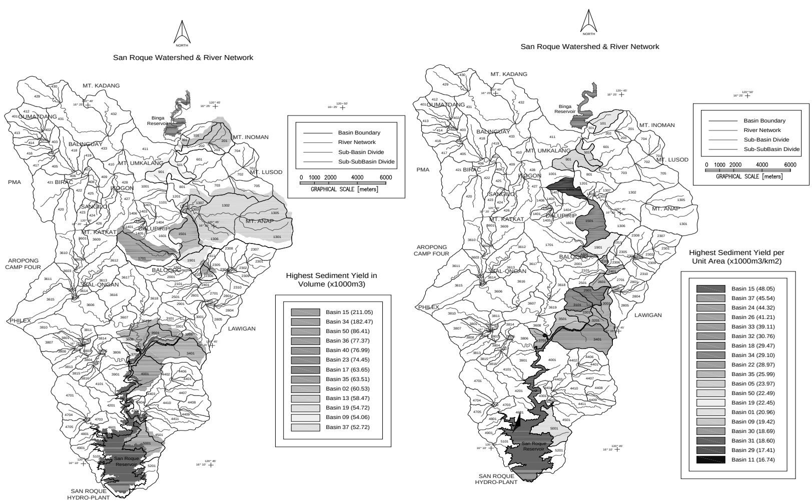

Figure 3. Watersheds with highest sediment yield according to volume (left) and according to unit area (right).

Assuming reforestation is implemented to increase soil infiltration rates by 50 percent, model results show that the total sediment yield in 70 years is 90.2 MCM or an annual average sediment inflow of 1.29 MCM. This implies that reforestation resulted in a reduction of about 65.2 MCM or 42 percent from 155.5 MCM in 70 years. However, a reforestation program for the entire Lower Agno River watersheds may be financially prohibitive. Reduction of the total sediment yield of about 122 MCM in 70 years or 1.75 MCM annual sediment inflow may be based on reforestation efforts only in subwatersheds with the highest sediment yield by volume or per unit area as shown in **Table 2**. The left table shows that a total of 133.48 km^2. in 13 subwatersheds (listed as basin numbers in the table) either need to be reforested or their land-use modified according to watersheds with highest sediment yield by volume. In contrast, model results show that only a total area of 40.82 km^2 in 19 watersheds either need to be reforested or their land-use modified according to watersheds with highest sediment yield by unit area (right table). Thus, it would be more cost effective if the reforestation program will be prioritized based on highest sediment yield by unit area.

Table 2. Accumulative list of subwatersheds to reduce the annual sediment inflow by about 22 percent from 2.22 MCM to about 1.75 MCM according to: (a) highest sediment yield by volume (table on left); and, (2) highest sediment yield by unit area (table on right).

Basin Number	Annual Sediment Inflow(MCM)	Basin Area (sq.km).
15	2132	4.39
34	2.056	10.66
50	2.019	14.50
36	1.987	70.22
40	1.955	75.12
23	1.923	89.04
17	1.896	94.90
35	1.870	97.35
2	1.844	102.03
13	1.819	127.10
19	1.796	129.54
9	1.774	132.32
37	1.752	133.48

Basin Number	Annual Sediment Inflow (MCM)	Basin Area (sq.km.)
15	2.132	4.39
37	2.110	5.55
24	2.099	6.15
26	2.080	7.23
33	2.060	8.47
32	2.044	9.71
18	2.034	10.52
34	1.958	16.79
22	1.954	17.09
35	1.927	19.53
5	1.913	20.96
50	1.877	24.80
19	1.854	27.24
1	1.836	29.31
9	1.813	32.10
30	1.796	34.35
31	1.778	36.63
29	1.763	38.67
11	1.748	40.82

Another key fundamental driver of forest cover loss and soil and water resources degradation in the country is the absence of an integrated, system-based development and management framework within which the multiple uses and functions of forests, soil and water resources can be optimally harmonized amid the growing demands of population and climate impacts. To date, there is no legislation for a unified land use planning and management framework from the national down to the local level leading. This lack leads to uncoordinated land uses and inequitable land allocation, erosive land uses and undue exposure of communities, properties and livelihoods to natural hazards as a result of indiscriminate disposition of lands that are unfit and unsafe for human habitation and related uses. The comprehensive land use plans (CLUPs) at the LGU level are highly localized and often are largely not implemented and hence fail to contribute in promoting the efficient and coordinated uses of land resources.

The absence of an integrating framework also manifests in the fragmentation of authority and jurisdiction over the management of water resources that is unduly shared by more than 30 government agencies. **Figure 4** shows the various agencies with varying mandates concerning water resources administration, development and use. Proliferation of agencies concerned with water complicates the process of drawing a unified vision for the water sector and breeds conflicts amongst the various agencies that often favor decisions that are politically acceptable but are usually technologically and scientifically unsound.

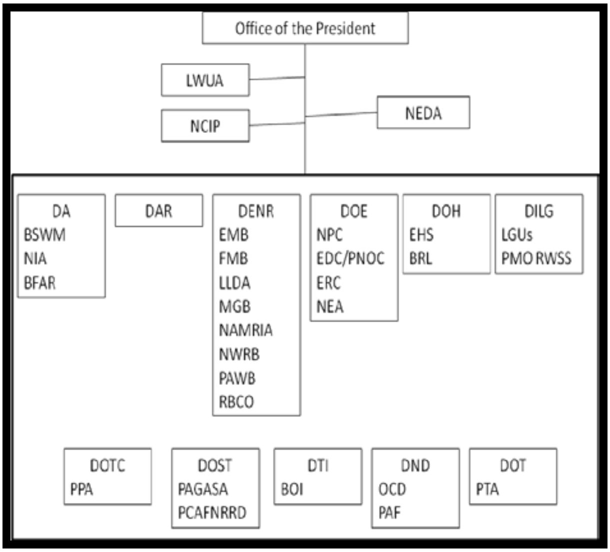

Figure 4. Government agencies with water and watershed related mandates and functions.

Another illustration of how different water agencies can be fragmented and mandated with overlapping range of functions is shown in **Figure 5**. It may be noted that the Philippine Water Code of 1973 already embodied integrated water resources management (IWRM) even before the 1992 Rio Earth Summit. However, the implementing rules and regulation of the Philippine Water Code adopted in June 1979 still recognized the legislated roles of so many players in the water sector resulting in coordination problems and overlap of water management functions. For instance, the mandate of watershed conservation is with the Department of Environment and Natural Resources (DENR), domestic water supply is with the Local Water Utilities Administration (LWUA), irrigation water supply is with the National Irrigation Administration (NIA) and flood control management is with the Department of Public Works and Highways (DPWH). This is in contrast to water district organizations in the United States where watershed conservation, utilization of water for domestic or irrigation water supply, and flood control is the responsibility of one major water agency or district.

	NWRB	LWUA	DENR	WD's	LGU's	DPWH	DOH
Policy Planning	●	●	●	●		●	●
Monitoring	●	●	●	●	●	●	●
Enforcement		●	●	●	●	●	●
Setting of Rates	●	●		●	●		
Adjudication of Complaints	●	●	●	●	●		
Project Implementa-tion and Financing		●	●	●	●	●	●

Figure 5. Fragmented and overlapping range of functions of key Philippine water-related agencies.

Equally a challenging fundamental driver of degradation of forests, soil and water resources is the rapidly growing population that triggers increases in demands and competition for land, water, food and other resources including livelihood opportunities and social services. With the continuous rise in population the scarcity of ecosystem resources, goods and services together with opportunities for development sets in leading to pervasive poverty and degradation of the forests, soil, water and other natural resources. Intuitively, this attribution can be seen in the declining trend of forest cover alongside the rising trajectory of the country's population over the last 450 years or so **(Figure 6)**. Extreme poverty forces people to defy good judgment and sound practices in using land and other natural resources. This is why many people continue to encroach into legally and physically constrained areas such as forests in steep slopes and continue to buck the odds against them and the marginal opportunities these areas offer to make a decent living. The increasing number of people in the fragile sloping lands led to clearing of vast tracts of logged over and primary forests in many parts of the country and the eventual conversion of these areas into mostly agricultural lands that are unsuitable for cultivation purposes.

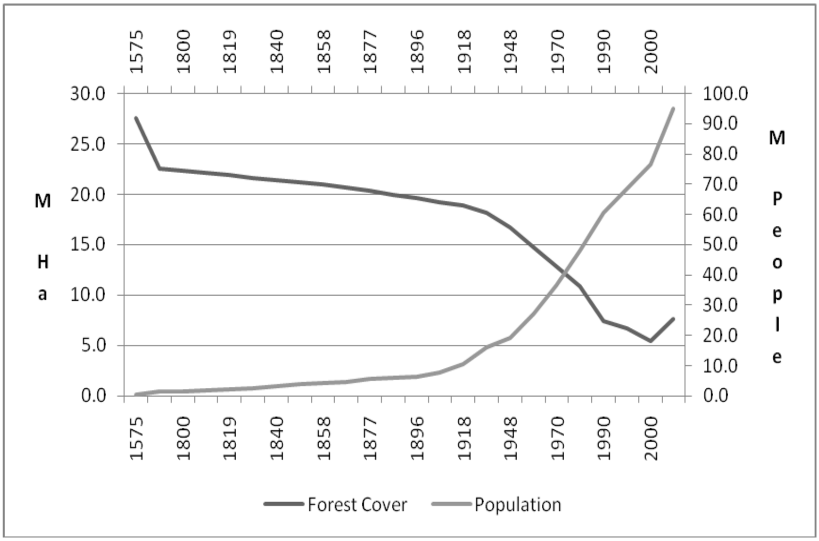

Figure 6. Forest cover and population trend over the years
(Revised MFDP 2005, NCSB 2004, Cruz et al. 2011).

Other fundamental drivers of natural resources degradation in the country include the following (Cruz 2001):

- Poor governance characterized by corruption, weak participation by key stakeholders in development programs and projects, poor accountability, absence of transparency, unpredictable policies, strong political interference;
- Weak capacities of institutions for law enforcement and implementation of appropriate programs;
- Poor coordination among implementing and planning agencies;
- Weak monitoring and feedback system; and
- Fragmented and uncoordinated development planning across various sectors and agencies.

Global, regional and local environmental changes represent an immediate and unprecedented threat to agricultural productivity, sustainability and competitiveness. These changes affect food security especially those who depend on small-scale agriculture for their livelihoods.

Some studies at the global level have reported evidences of a broadly homogenous trend of changes in annual runoff which are attributed to non-climate drivers, as well as climate drivers such as changes in temperature and precipitation (Bates et al. 2008). Moreover, while there is no observed globally consistent trend in the levels of freshwater lakes, other levels of lakes in other parts of the world have declined due to combined effects of many factors such as drought, warming and anthropogenic activities (Bates et al. 2008). In the Philippines, water depths of major lakes have been reduced due mainly to siltation attributed to human activities such as land use changes, accelerated soil erosion, and shifts in agricultural production systems.

Multiple uses of available water resources, including inputs for agricultural production, are determined by local changes in population, food consumption, technological advances, lifestyle and societal views on the value of freshwater ecosystems. The quality of water resources in many rivers in the country have been degraded by pollution from residential, commercial, industrial and agricultural areas (**Figure 7)**. Because of the excessive pollution from these areas, 16 rivers throughout the country have become usually biologically dead during the summer months.

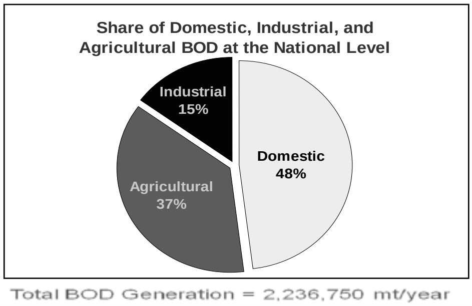

Figure 7. Sources of water pollution in the Philippines
Source: World Bank,2003

The demand for water across all users is rising and by 2025, all user groups in various regions of the country would experience water deficits (**Tables 3** and **4**). Increasing water pollution, worsening climate change and variability, inefficiencies in distributing and using water and continuous degradation of watersheds will exacerbate the situation.

Table 3. Current and projected demand by major user groups

Annual Water Demand (m^3)	1995	2025
Domestic	1958	7430
Agricultural	25533	72973
Industrial	2234	3310- 4998

Source: NWRB Master Plan

Table 4. Water demand in major cities (m^3/yr)

Cities	1995	2025	Groundwater availability	Surplus/(Deficit) (per cent)	
				1995	2025
Metro Manila	1 068	2 883	191	(82)	(93)
Metro Cebu	59	342	60	2	(82)
Davao	50	153	84	69	(45)
Baguio City	12	87	15	21	(83)
Angeles City	11	31	137	1 148	343
Bacolod City	37	111	103	179	(7)
Iloilo City	9	47	80	788	70
Cagayan de Oro City	29	98	34	18	(65)
Zamboanga City	28	203	54	92	(73)

Source: 1998 NWRB Master Plan

Impacts on agricultural productivity

Freshwater resources have an important role in agricultural food production at the local and global levels. Agricultural productivity, especially in rain-fed areas, is dependent on the availability of rainfall to meet the requirements for yield production. Thus, water plays a crucial role in ensuring food security in such an area. Limited water makes agricultural production systems vulnerable to environmental stresses such as droughts. But excess water also makes them vulnerable to floods which destroy crops and affects livelihood activities.

As population increases rapidly at a seemingly uncontrolled rate coupled with depleting trends of water availability, freshwater resources are approaching a critical state in many parts of the country, threatening both agricultural production and livelihoods. Drivers of environmental change are exerting tremendous pressures on the already limited land and water resources for rice production in the country (Lansigan et al. 2007). Changing land use often results to reduction in agricultural lands particularly for rice farming due to conversion of productive farmlands for urban and/or industrial uses. In particular, the sustainability of rice production system in the Philippines is dependent on the availability of adequate suitable agricultural lands as well as the availability and access to adequate water.

Historically, however, significant changes in land use and land cover also lead to modifications of the hydrologic regime of the watershed altering the temporal and spatial patterns of water flows and water resources availability (Lansigan et al. 2007, Bates et al. 2008). Use and management of land and water resources including forests continue to be conducted in a fragmented manner with often limited consideration and attention to the finite nature and interconnections of the ridge-to-reef ecosystem. Maintenance of the ecological flows in rivers and creeks are not even considered. It is observed that despite the comprehensive land use plan (CLUP), conversion of land from agricultural food production to other uses is often not rationalized in the context of food security, watershed integrity, and environmental conservation.

Table 5 shows the scope of land degradation due to water erosion while **Table 6** shows the soil fertility decline in various soil areas in the country and some South East Asian (SEA) countries. Water induced erosion primarily surface soil erosion and gully formation lead to land degradation and reduce the capacity of soils to support the production of food and fiber crops to supply the needs of the growing population in the Philippines and the SEA sub-regions.

Close to 80% of the country's total land area are affected by soil erosion of which about 45% suffers from moderate to severe soil erosion (DA-DENR-DOST-DAR 2004). The high rate of soil erosion induces

Table 5. Distribution of subtypes of water erosion per country in million ha (Concepcion 2006)

Countries	Total land area	Loss of topsoil (wt)					Terrain deformation (wd)				
		Negligible	Light	Moderate	Strong	Extreme	Negligible	Light	Moderate	Strong	Extreme
Malaysia	33.5	8.0	3.2	1.7	-	-	-	-	-	-	-
Myanmar	66.6	0.4	1.3	0.4	-	-	-	3.4	2.6	-	-
Philippines	29.2	0.4	1.4	4.0	3.7	1.9	-	-	0.6	0.4	-
Thailand	51.4	-	-	7.8	-	-	-	-	0.1	-	-
Vietnam	38.6	0.9	4.2	3.3	0.2	-	-	-	-	-	-
Total	451 Million Hectare excluded Brunei Darussalam										

Source: van Lyuden and Oldeman 1997

Note: - No significant occurrence, + Less than 0.1 M. ha but more than 0.01 M. ha
wt: loss of topsoil by sheet erosion/surface washes
wd: terrain deformation by gully and/or rill erosion or mass movement

Table 6. Distribution of the dominant subtypes of chemical deterioration per country in million ha (Concepcion.2006)

Countries	Total land area	Fertility decline (Cn)					Salinisation (Cs)				
		Negligible	Light	Moderate	Strong	Extreme	Negligible	Light	Moderate	Strong	Extreme
Malaysia	33.5	7.6	2.2	1.7	+	-	-	-	-	-	-
Philippines	29.2	1.6	+	-	-	-	-	-	-	-	-
Thailand	51.4	-	1.1	24.5	-	-	-	-	1.0	-	1.0
Vietnam	38.6	0.2	3.6	0.8	0.4	-	+	0.3	+	-	-

Source: van Lyuden and Oldeman 1997

Note: - no significant occurrence, + less than 0.1 M. ha but more than 0.01 M. ha
Cn fertility decline and reduced organic matter content
Cs salinisation/alkalinisation

sedimentation that reduces the storage and water holding capacity of rivers, lakes and major reservoirs altering water supplies for domestic, industrial, irrigation and power-generation purposes. The country has several large scale dams mostly located in Luzon and Mindanao that are used mainly for irrigation, domestic water supply and power generation. From 1973 to 1998, the area irrigated during the dry season decreased by 20-30% due to the decrease in the storage capacity of reservoirs caused by severe siltation (DENR 1999).

Agricultural productivity of staple crops such as that of rice production systems is a function of the biotic and abiotic factors including climate variability, soil fertility, nutrient and water availability. However, current practices do not promote sustainable rice productivity as well as efficient and optimal use of land and water resources. Crop yields continue to decline due to depletion of soil fertility, inadequate water supply, and other environmental stresses associated with continued reduction in ecological services provided by watersheds. Sustainability of rice production system particularly in the rain-fed farm areas in the Philippines requires an effective and integrated management of land and water resources within the watershed which have to be protected.

2.3 Issues, gaps and research agenda

The succinct foregoing description of the state and drivers of soil and water resources points to the need to explore integrated and comprehensive solutions to the interrelated problems besetting the sustainability of services provided by forests and related ecosystems. The complexity of the interacting drivers and cascading impacts of soil and water degradation **(Figure 8)** underscores the proposition for comprehensive policy, research and technology interventions described below. Once in place the comprehensive solutions will not only ensure the sustainability of agricultural productivity but also bring along co-benefits such as renewable energy supply enhancement, reduction of water related disaster risks and health hazards.

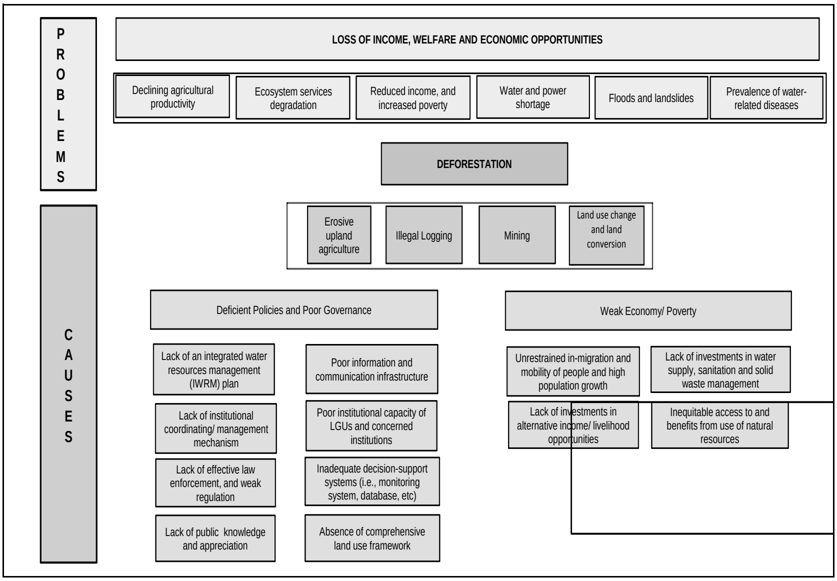

Figure 8. Climate and non-climate related sources of stress on forests and downstream communities, ecosystems and resources
Source: Cruz and Bantayan, 2011

While research continues to improve the intrinsic ability of crop varieties to produce more yields (i.e. potential yield), knowledge how other factors extrinsic to crops could be enhanced to promote greater productivity should also be examined. This also needs a comprehensive approach to address land degradation due to soil erosion, increasing water scarcity, decreasing arable lands due to conversion of crop lands to other uses, underdeveloped production potential of irrigated and irrigable lands, pervasive inefficiency in the use of water and land resources, and other factors that limit crop productivity (Lansigan et al. 2007).

Moreover, it is commonly known that the sustainability of soil and water is critical to the success of watershed management (Cruz 2006). Deterioration of soil and water leading to reduction of ecological services of watersheds will have wide ranging impacts on agriculture as well as on livelihoods, and practically all other sectors of the society. Thus, it is imperative that soil and water resources should be conserved through improved process of determining the best land uses and suitable land use practices that may be allowed in an area, protection of the natural forests and other critical terrestrial ecosystems, restoration and rehabilitation of degraded areas, stabilization of areas prone to erosion and floods, and reduced impact use of the land and other natural resources. Monitoring of land use and land use practices will also prove critical and helpful in the conservation of soil and water resources.

It is recognized that unsustainable agricultural practices as well as current uses and management of natural resources are threatening food and water security. It is estimated that about one-third of the population of the world (circa 2.7 billion people) will experience severe water scarcity by 2025. At current levels of water productivity and water use, a 34% increase in agriculture would be needed (IWMI 2000).

There is a crucial need for a systematic accounting procedure within a spatial accounting framework that considers human security, water and food security, biodiversity, and ecosystem protection. This tool is helpful to be able to reconcile the competing multiple uses of limited soil and water resources as well as maintaining ecological services to conserve biodiversity while satisfying the human requirements for various needs (Vorösmarty et al. 2010). Such tool is also useful for prioritizing policy and management interventions and responses that takes into account agricultural productivity, sustainability and competitiveness of production systems.

Moreover, a strategy has to be developed that considers environmental flow requirements in the revision of the operational rules of reservoirs and dams which may also affect the multiple uses of water resources (Bates et al. 2008). This involves a paradigm shift on the use and management of resources using an integrated ecosystem-based water resources management (IEWRM).

It is also observed that water resources are rapidly being depleted with water withdrawals exceeding recharge rates. Often, water supply is being provided through an overdraft of groundwater resources. Competing multiple uses for water resources due to increasing human demands usually lead to reduction in water for agricultural use in favor of other uses such as domestic and industrial uses, and also for environmental flow. Emerging water scarcity is further exacerbated by the rapid denudation of watersheds. As farmlands, forests and water within a watershed are interlinked in terms of biophysical and social processes; change in one affects the other components. Changes in the forest conditions results in alteration in water regime of the watershed and also lead to changes in social dynamics in the area. These processes and interrelationships have to be better understood so that knowledge-based solutions can be determined to come up with management strategies for optimal use of limited resources as well as meeting the environmental flow requirements to maintain ecological services. This is where the establishment of a network of learning watersheds in key strategic places around the country will be indispensable as venue for long term integrative and comprehensive watershed biophysical and socioeconomic studies.

The extent by which available forest and water resources constrain rice production in the upland and lowland watersheds is a function of efficient use and management of these resources. Efforts should be exerted to lessen the competition for water resources which will enhance local food security, and also make more water available for nature, domestic and industrial uses. Addressing the interrelated issues of food security through self-sufficiency in rice, impending water scarcity, and environmental protection requires an integrated framework and approaches that consider the interconnections of component biophysical and social processes, and interrelated drivers of change. A collective strategy involving the contributions of individuals, groups and sectors will be needed to achieve sustainable rice production and forest resources management vis-à-vis water security.

Sustainable ecosystem management requires a sound planning and policy formulation that will provide a framework conducive to facilitating sustainable land use and ecosystem management practices. Some ecosystems are remote, but share generic characteristics for which common approaches can be undertaken to enhance land use and ecosystem management practices and techniques. Some ecosystems that encompass multiple countries require trans-boundary intervening measures.

In the light of changes in land use and land cover, together with changing climate, there is a need to re-evaluate the dependability of water supply from watersheds particularly in critical agricultural crop production areas. The types and magnitudes of potential changes due to climate change and other drivers of change as well as changes in hydrology have to be determined. These include re-analysis of frequency of droughts and floods, changes in seasonal patterns, water withdrawals, and also water quality.

In adopting a comprehensive agricultural water and land management system, some elements of integrated flood management (IFM) advocated by the World Meteorological Organization-Global Water Partnership (WMO-GWP 2009) may be adopted as follows. In the context of agricultural water and land management, the first major element is *to manage the water cycle* as a whole such that it includes management of all water sources (rainfall, forest streams, upland and lowland lakes and rivers, brackish water near coastal areas), and that management plans should include normal flows, floods and droughts, and that the quantity and quality of both water and agricultural return flows should be managed. Another major element is *to integrate land and water management* so that land-use planning and water management should be in one synthesized plan to enable the sharing of information between land-use planning and water management authorities. The third element is *to manage risk and uncertainty from a holistic point of view* since agricultural risks, although more related to climatologic, hydrological and geologic uncertainties, can also be overwhelmed by social, economic and political risks and uncertainties (e.g., unpredictable changes may come from drastic population growth and unexpected political changes).

Finally, it is strongly suggested that to efficiently implement agricultural land and water resource management strategies, a computerized decision support system (DSS) is needed to link science and technology (i.e., hydrology, ecology, agriculture, sociology, economics and policy science) and the policy actors (civil society, stakeholders, government agency, financial institutions and non-government organizations). When policy makers, planners, regulators, operators and stakeholders seat together to make important water and land policies and management decisions for sustainable agriculture, the DSS can be a very useful tool as a processor, integrator and feedback control of knowledge and actions to develop policy options and decisions.

Biodiversity Conservation

State and Drivers

The Millennium Ecosystem Assessment (2005a) concluded that in the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in history. These changes have been made mainly to meet the rapidly growing demands for food, fresh water, timber, fiber and fuel. These changes have resulted in a substantial and largely irreversible loss in Earth's biodiversity. It is expected that climate change will exacerbate existing pressures on biodiversity resources.

The Philippines is one of 18 mega biodiversity countries due to its geographical isolation, diverse habitats and high rates of endemism (PAWB 2009). It is ranked 5th globally in terms of the number of plant species and maintains 5% of the world's flora. Species endemism is very high covering at least 25 genera of plants and 49% of terrestrial wildlife. It also ranks 4th in bird endemism. In terms of fishes, there are about 3,214 species with 121 endemic and 76 threatened species. The Philippines is one of the world's most threatened hotspots as it continues to lose its rich biodiversity resources (Conservation International 2011). As a leading indicator of the state of its biodiversity, forest cover declined by 50% in the last century **(Figure 9)**.

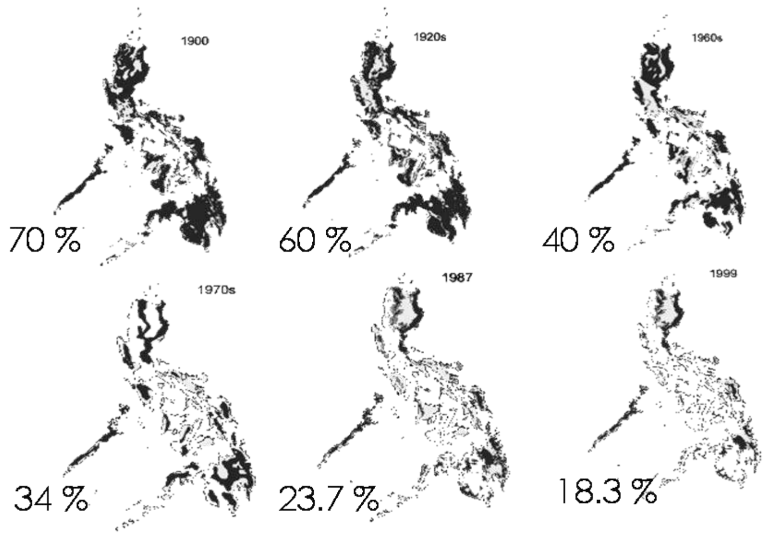

Figure 9. Extents of forest cover in the Philippines for the last 100 year (adapted from Dolom and Dolom 2006)

The key drivers of biodiversity loss include deforestation due to logging and conversion to agricultural land, mining, land conversion and introduction of exotic species (Conservation International 2011, PAWB 2009). Between 1969 and 1988, 2,000 km² were logged annually, three times the global rate for tropical forest conversion. With forests dwindling, logging has recently been banned in all natural forests. However, illegal logging activities still persist. There are more than 10 million people, mostly very poor, who depend on agriculture production in the uplands. The government is promoting mining activities but many of the mining areas overlap key biodiversity areas. The introduction of exotic species has also taken a toll both in terrestrial and freshwater ecosystems.

In addition, there are also governance issues that constrain the country's ability to conserve its biodiversity resources. There are overlapping mandates between the DENR, LGUs, NCIP and other stakeholders in public (forest) lands creating confusion on the ground.

Impacts on Agricultural Productivity

Biodiversity is essential to sustainable agriculture. In general, natural ecosystems and their biodiversity provide many services critical to agriculture such as water as discussed earlier and climate regulation as will be discussed below. Within agricultural systems there is also a range of diversity of plants and animals. This has given rise to a new field of study called agrobiodiversity. *"Agrobiodiversity refers to all crops and animal breeds, their wild relatives, and the species that interact with and support these species, e.g., pollinators, symbionts, pests, parasites, predators, decomposers, and competitors, together with the whole range of environments in which agriculture is practiced, not just crop lands or fields"* (Jackson et al. 2005). From this point of view, agrobiodiversity is the natural capital from which agriculture draws its productivity. In addition, the diverse set of plants and animals in an agricultural landscape provides resilience or ability to change in the long run ("*sustainagility*") (Jackson et al. 2010).

The government recognizes the critical role of biodiversity in sustaining agriculture in the country. The diversity in agricultural ecosystems provides food, medicine and shelter, and indirectly, sustains the sources of farmer's livelihoods (PAWB 2009). It also promotes soil and water conservation, maintenance of soil fertility and biota, and pollination. At the genetic level, it can provide plants and animals the ability to adapt to changing environment by increasing their tolerance to frost, high temperature, drought, water-logging, pests, parasites and diseases.

Issues and Policy Implications

There are still very limited studies on the role of biodiversity in enhancing agricultural productivity in the Philippines. There is a lack of information on the level of supporting, provisioning, and regulating services provided by biodiversity. For example, there is still misunderstanding on the role of forests in providing water and preventing floods. The role of agrobiodiversity in sustainable agriculture is still poorly defined. For example, some sectors of civil society recently raised concerns on the safety of genetically modified crops.

It is recommended that a Philippine ecosystems assessment be conducted similar to the global Millennium Ecosystem Assessment to provide policy makers an overall perspective on the role of natural ecosystems in the life of Filipinos. A panel of eminent scientists from various disciplines such as from the National Academy of Science and Technology (NAST) can be constituted to perform the assessment.

Climate Regulation and Adaptation

Climate change is one of the critical issues of our time. It is projected that small holder farmers will suffer the brunt of its impacts being one of the most vulnerable sectors.

There are two ways by which forest ecosystems can help small holder farmers cope with climate change. On the global scale, forests ecosystems can help in climate change mitigation by conserving carbon stocks and accelerating carbon sequestration from the atmosphere. At the local scale, natural ecosystems can promote adaptation of small holder farmers to changes in climate. This has been called “ecosystems-based adaptation” (EBA).

There is considerable interest on the role of terrestrial ecosystems in climate change, more specifically on the global carbon cycle. The world’s tropical forests covering 17.6 million km^2 contain 428 G t C in vegetation and soils. It is estimated that about 60Gt C is exchanged between terrestrial ecosystems and the atmosphere every year, with a net terrestrial uptake of 0.7 ±1.0Gt C. However, land use, land-use change and forestry (LULUCF) activities, mainly tropical deforestation, are also significant net sources of CO2, accounting for 1.6Gt C/yr of anthropogenic emissions (Denman 2007, Watson et al. 2000). Tropical forests have the largest potential to mitigate climate change amongst the world's forests through conservation of existing carbon pools (e.g. reduced impact logging), expansion of carbon sinks (e.g. reforestation, agroforestry), and substitution of wood products for fossil fuels (Nabuurs et al. 2007).

The Philippines has a small land area so the global contribution of our forests ecosystems is not large. However, each nation must do its share to mitigate climate change. In total, it is estimated that there are around 1,100 Tg C stored in the Philippine uplands composed of forests and other vegetation types (Lasco and Pulhin 2000, Lasco and Pulhin 2001). In relative terms, total carbon stored in forest lands is equivalent to about 40 times the 1994 net C emissions of the Philippines (Lasco and Pulhin 2009). On a per unit area basis, natural dipterocarp forests may contain up to 260 tC per ha while a grassland area will only have < 5% of that value **(Table 7)**. Logging activities lead to a loss carbon stocks which is slowly recovered as the forest regenerate. In Mindanao, about 50% of carbon stocks were lost right after logging (Lasco et al. 2006). On the other hand, deforestation will lead to the loss of more than 90% of carbon stocks.

Table 7. Above ground biomass and carbon density of forest land cover in the Philippines

Land Cover	Biomass (t/ha)	Carbon (tC/ha)
A. Protection Forests		
1. Old growth	370-520	165-260
2. Mossy	409	184
3. Pine	185	90
4. Mangrove	402	177
B. Secondary Forest	466	208
C. Brushlands	64	29
D. Tree Plantation	132	59
E. Grasslands	29	12
F. Agroforestry	103	45

Source: Lasco and Pulhin, 2003

In terms of carbon sequestration, tree plantations have the fastest rate as expected while natural forests have the lowest because they are mature ecosystems **(Table 8)**. As will be discussed later, there is some interest in the Philippines on obtaining carbon credits through forestry projects that sequester carbon. Examples of these are the projects in Quirino, Nueva

Viscaya and Laguna Lake basins which are in various stages of preparation (Villamor and Lasco 2006, Lasco and Villamor, 2010).

Table 8. Mean annual increment (MAI) of above ground biomass and carbon in the Philippines

Land Cover	Biomass MAI (t/ha)	Carbon MAI (t/ha)
Secondary Forest	3.5	1.1
Brushlands	9.5	4.3
Tree Plantation	9.1	4.2
Agroforestry (improved fallow)	10.6	5.3

Source: Lasco et al. 2003

The research community must also ensure that relevant information are made available to project developers. Among the knowledge gaps that need to be filled include:

- Carbon sequestration rates of Philippine trees, especially in various agro-ecological zones of the country;
- Economic analysis of forestry carbon projects;
- Models of production systems (e.g. agroforestry) that will optimize carbon and economic benefits.

On the national scale, there is a need to assess the forestry sector's contribution to the national GHG emissions and sinks using the new 2006 IPCC guidelines. On the policy side, incentives must be provided to project developers of carbon forestry projects. At the same time, proper safeguards must be put in place but without over-burdening project participants. The government must actively participate in the UNFCCC negotiations related to role of forests especially on REDD (reducing emissions from deforestation and forest degradation).

With the expected change in climate, many sectors are assessing how natural and social systems can prepare for this inevitability. Natural ecosystems can help small holder farmers adapt to climate change. EBA is increasingly being used in the international arena such as by IUCN (IUCN 2009). The ecosystem management approach, from which the concept of EBA is based, is supported by many national and international organizations including UNEP, World Bank, IUCN, WCMC and many others (UNEP 2010).

EBA includes a range of local and landscape scale strategies for managing ecosystems to increase resilience and maintain essential ecosystem service and reduce the vulnerability of people, their livelihoods and nature in the face of climate change (IUCN 2009). It addresses the role of ecosystem services in reducing the vulnerability of natural-resource dependent societies to climate change. It is a set of adaptation policies or measures that address jointly the vulnerability of ecosystems and the role of ecosystem services in reducing the vulnerability of society to climate change, in a multisectoral and multiscale approach. EBA involves national and regional governments, local communities, private companies and NGOs in managing ecosystems for reducing the vulnerability of ecosystems, people and economic sectors to climate change (Locatelli 2009 *pers comm*). Fundamentally it is an approach to ensure the provision of the essential ecosystem services that human society depends on.

For example, the Provincial Government of Albay is spearheading the rehabilitation of mangrove forests. Once established mangrove forests will help stabilize coastal zones and those who reside there. The concept of EBA is still new and there are very limited information on this. Research areas include: assessment of the role of forests and natural ecosystems in enhancing the resilience of small holder farmers to climate risks, documentation of indigenous practices, and economic analysis of EBA practices.

In the last decade or so, the climate change issue had already emerged as a burning issue but it appears that there is still skepticism, hesitation or complacency in most sectors of society to seriously take on the climate change issue and challenge. Perhaps one reason is that climate change is a slow process and internalizing this issue on the part of our planners and decision makers is even a slower process with no sense of urgency. Another reason is that truth verification or validation for investments in climate change mitigation or adaptation measures is an evolution in reality, thus the wait-and-see attitude. But perhaps, even with or without climate change, current management strategies and infrastructures are not even developed or designed to deal or handle the historical climate variabilities, anomalies or extremes. For instance, flood control infrastructures in major cities in the country are designed to provide only at 20-year or 30-year return period level of protection when almost yearly, 50-year to 60-year return period floods occur somewhere in the country (Tabios 2010). In order to bring the climate change issue and challenge to the government and people, there should be a national effort to define the climate change scenarios and parameters with support from international and local climate experts. This requires deciding what global climate change scenarios to adopt, deciding what global climate models are appropriate for our country, then deciding what is the appropriate downscaling methodology - tasks that can be tackled by researchers and professionals. Then, finally, translate these climate change scenarios into planning, design or management parameters useful to climate change adaptation measures at the local government units or community level through specific water resources, crop yield, agricultural production and other climate change-related studies.

Governance and Policies

Water

To sustain ecological services by water, i.e. irrigation water, a watershed-based water resource management framework is suggested (Rola et al. 2004a). This framework proposes for the watershed as the primary unit of water resource planning, just as a barangay is the primary administrative unit in the Philippines. It has four elements:

- biophysical, resulting from a watershed-based water resource management strategy;
- legal-institutional, to provide the legal basis and supporting institution to implement the proposed water resource management strategy;
- economic, that is led by economic efficiency consideration; and
- socio-political, defined by the need to have wide support from local communities and political/government units.

What is needed is to define a watershed unit that a given group of administrative units could co-manage (Francisco 2004). The need for a legal and institutional framework to support this coalition of administrative units belonging to a watershed is an important element. Since the watershed transcends administrative units, the need to have a watershed council or authority seems to be a move in the right direction. For instance, Bukidnon province is divided into seven watershed clusters, each cluster consisting of several towns (Rola 2011), and each cluster having its own watershed management plan, consistent with the larger watershed as well.

Local governments also play a major role in water resource management. Key to the success of the required local governance structures are (a) the support of water users; (b) the LGUs' responsiveness to local conditions; (c) the availability of information databases (rather than theoretically better but unavailable information); and (d) the adaptability to the evolving environment. In the Philippines, local governments are empowered to manage natural resources within their spheres of influence and are in a position to make residents comply with best practices in water resource management. However, sometimes capacity to do so is absent, or local officials just refuse to order compliance because they cannot reprimand a "brother" (Rola 2011). In Bukidnon, community water watchers volunteered to monitor river water quality (Deutsch et al. 2001), but have not caught any violator. On the other hand, the economic efficiency consideration requires that situations be created to allow water to flow where its value is highest. These situations include the provision for charging the full water price and clearly defining property rights to water use/access. There is considerable scope to increase the efficiency of water use by introducing market-based instruments. Examples of said instruments are water charges, water markets and imposing effluent charges. It also calls for the payment of compensation to those who provide environmental services (e.g., watershed protection) by those who benefit from these services.

To implement the framework, the NWRB, which is planned to be transferred to the DENR's jurisdiction, could also be strengthened and given more funds to pursue its mandate. At the local level, LGUs can establish water councils or watershed authorities. There is a need to establish a legal environment that allows advocacy initiatives to happen at the local level (Contreras 2004).

Forest Land and Soil

Property rights shaped the fate of forest land and its ecological services. Open access of forest resources contributed to the decline of the forest cover especially upon the advent of logging as the forest land was opened by commercial loggers who were granted a Timber License Agreement (TLA). As these lands became alienable and disposable, and coupled with favorable prices, agricultural land use in the uplands shifted from the traditional perennials such as coffee to erosive annuals such as corn and vegetables (Coxhead et al. 2001), thereby causing soil degradation and water pollution. Protected areas are also in danger of conversion into other uses such as mining, despite the existence of the current laws, such as the Public Land Act and the National Integrated Protected Areas Systems (NIPAS).

The agriculture sector is threatened by this conversion. There is a need to have both a national land use policy and respect for local Comprehensive Land Use Plans. If there is a law to protect the watershed functions (NIPAS), there must be a law to protect the prime agricultural lands. To date there is no legislation on the framework for land use planning and management from the national down to the local level that protects such function as food security. What's available are different versions of the National Land Use Bill awaiting for Congress' approval.

Biodiversity Conservation

Based on the empirical evidence at the ecosystem level, institutions such as the PAMB and policies such as decentralized governance could potentially have an important impact on biodiversity conservation and bio resource management. While the ecosystems serve as habitats of species, what is perceived to be urgently needed are measures to assure that species are themselves managed properly, in as much as loss of species qualify the country as "hot spots" in terms of internationally crafted biodiversity indicators. Several innovative ideas are summarized in Rola et al. (2007):

- Make bio resources management as an integral part of the development plans, where planning exercise starts at the lowest level of governance.
- The science community can build capacities at various levels, like introducing participatory approaches and good governance indicators. Fund management skills by local officials are also to be developed.
- Science contributed to the protected area management planning by supplying the necessary data to the decision makers. In ideal situations, scientists shall continue to work with the other sectors

including government to help develop monitoring and evaluation methods in order to monitor outcomes and evaluate the performance of these management strategies.

- Bio resource indicators are biological variables; management and governance concerns are social sciences, therefore a multidisciplinary team is needed to work with the implementers of the management plan. Researchers and development workers can also help in evolving community based institutions that would be relevant for bio resource management.
- The question of benefit sharing in the commercial use of bio resources should be studied rigorously, to have potential sources of funds for management.
- Study the indigenous peoples' governance and management practices, considered as having sustainable outcomes. Most of the studies in the past focused on resource management practices, including anthropologic and cultural norms. Studies can also include governance sanctions, norms, and incentives.
- Another area of challenge would be how to integrate information and communication technology in bio resource governance. Maps will be needed, so use of GIS can be handy. Mapping will not only be an exercise of identifying and locating the specie, but also of knowing its value or use.
- More efforts on theory development will be needed for meso- level analysis of factors that condition governments, the private sector, local organizations and other stakeholders to work together to support a more sustainable, equitable and efficient bio-resources management decisions.

Climate change

Aside from the threats to food security due to reduction in area of prime agricultural lands, climate change also poses some serious threats. Lasco and Markus-Liss (2008), in their assessment of mainstreaming climate change impacts on the agriculture, forestry and natural resources (AFNR) sector policies in the Philippines showed the lack of recognition of climate hazards. There are currently no existing policies or measures which directly address climate change and its impacts on the population, natural resources, and infrastructures. However, there are a number of laws, which may not directly deal with climate change, but could contribute in strengthening of adaptive capacity to deal with the impacts of climate change in agriculture. For instance, current laws provide for the wise use of water resources, which is largely affected by climate variability. In the near future, the Climate Change Commission (Climate Change Act 2009) can enhance institutional capacity to tackle climate change issues and assure the Philippines' food security needs.

Payments and Rewards for Ecological Services

Maintaining and enhancing ecological services in support of agricultural productivity demands new paradigms. One of most the promising approaches is to use rewards, incentives and/or payments to encourage local communities to protect and conserve natural resources.

There is a lot of interest in payments for environmental services (PES) schemes around the world (Landell-Mills and Porras 2002). An environmental service payment or reward refers to compensation for service, merit or effort, and/or incentive for maintaining or enhancing environmental service functions, received by the sellers or paid by the buyers of the environmental service(s) (van Noordwijk 2005). It is a voluntary transaction in which a well-defined environmental service (or a land use likely to secure that service) is "bought" by a (minimum of one) buyer from a (minimum of one) provider if and only if the provider continuously secures the provision of the service (conditionality) (Wunder 2005). Compensation and incentives can be financial, social and moral. These may be made in terms of direct payments, financial incentives, or in kind. Rewards and payments in kind may include the provision of infrastructure, market preference, planting materials, health and educational services, skills training, technical assistance or other material benefits. In addition to indirect and direct monetary payments, rewards can take the form of land tenure security (which may be considered an economic incentive). Social and moral incentives and rewards may address non-material aspects of poverty including recognition and respect in the community, and personal satisfaction for doing something, which is currently considered beneficial to the society now or in the future or in some cases, the recognition of the service providers in maintaining or enhancing ecosystem services.

Partly in response to the limited success of government-initiated programs, a number of local governments, research organizations and NGOs in the Philippines are testing various PES schemes as a way of reversing environmental degradation. The environmental services being compensated in existing projects include water resources, carbon sequestration, seascape and landscape beauty, and biodiversity.

Watershed functions are considered to be the first environmental service function that has been recognized for payments due to its immediate relevance to the people (van Noordwijk 2005). Communities from different parts of the world are benefited from the commodities that are derived from watersheds such as water flow regulation, water quality maintenance, erosion and sediment control, land and salinisation reduction/ water table regulation and maintenance of aquatic habitats (Landell-Mills and Porras 2002). Countries such as Columbia, Ecuador and Costa Rica are among the countries with established payment schemes for such kind of functions.

In the Philippines, the World Agroforestry Centre's (ICRAF) Rewarding the Upland Poor for Environmental Services (RUPES) project is pilot testing various mechanism for compensating the upland poor. The conditions for developing payments for carbon sequestration and watershed services mechanism have been studied (Lasco and Villamor 2010). After ten years of limited project development in carbon sequestration projects, several lessons have emerged. First, the Philippines have a great potential for climate change mitigation projects in forestry. Planted trees can sequester significant amount of carbon (ca 5 tC/ha/yr). The country has a long experience in reforestation and tree farm development albeit with mixed success. Second, initial economic studies have shown the income from carbon credits is not sufficient to recover the cost of tree planting (using standard government costs). This implies that carbon credits are best used as a supplemental source of income for farmers and project developers. Third, the initial or base costs (including upfront costs, establishment and admin costs) of engaging of forestry carbon projects are enormous (up to US$ 200,000 per project) and could prove to be the most significant barrier to project fruition. One way to overcome this barrier is to partner with a potential buyer who may be able to shoulder the upfront costs as in the case of LLDA and the World Bank projects. Also, government institutions particularly the DENR-FMB must find ways to encourage project developers by simplifying rules and regulations for forestry carbon projects. As it is, forestry projects have few takers because of its complexity and high transaction costs.

The research community must also ensure that relevant information is made available to project developers. Among the knowledge gaps that need to be filled include: carbon sequestration rates of Philippine trees, especially in various agro-ecological zones of the country; economic analysis of forestry carbon projects; models of production systems (e.g. agroforestry) that will optimize carbon and financial benefits.

For watershed payments, the key lessons that have emerged from the Philippines experience are as follows (Lasco and Villamor 2010). First, the value of payments for water services is more easily recognized at various levels from local to national and by different stakeholders. Second, various forms of payments exist but most of them do not satisfy the two main criteria as set by Wunder (2005): voluntary and conditional. Third, the involvement of the government, especially LGUs, is important for the success of PES schemes. Fourth, PES works when threat (e.g. water scarcity), value (e.g. strategic point for commerce), opportunity (e.g. people see the benefits from ES in watershed rehabilitation) and trust are met (e.g. local trust between government, local people and buyers).

While PES offers a promising approach to sustainable financing for the conservation and management of natural ecosystems, there are still many knowledge gaps. A research agenda on PES could focus on: developing PES schemes suited to Philippine conditions, assessment of policy and governance barriers to PES implementation, economic analysis of PES schemes, and pilot testing PES schemes.

Synthesis and Conclusions

Philippine agriculture is dependent on natural ecosystems for its productivity, competitiveness and sustainability. However, the last century witnessed massive destruction of terrestrial, wetlands, and marine ecosystems in the country. This has modified water flows, degraded soils, decimated biodiversity, and reduced climate regulation function. There is no single approach that can address all these challenges. The science community could help by developing options for a more holistic approach in natural ecosystems management.

In order to achieve sustainability, productivity, and competitiveness of agricultural production systems a holistic and ecosystems-based integrated approach is needed to address soil and water resources degradation driven largely by land use and land cover change, rapid urbanization and industrialization, and non-optimal use of natural resources. This requires an integrating framework in the management and multiple uses of resources such as forests, land and water in the continuum from the upper catchment, down to the hilly lands, lowlands and coastal areas.

Optimal use of natural resources to achieve the multiple objectives can be facilitated by the use of a systematic accounting procedure with a spatial analysis in the form of a decision support system (DSS) that consider food security, biodiversity, and ecological services.

The observed changes in hydrologic regimes as well as in land use and land cover changes require the re-assessment and analysis of the dependability of water resources in key and strategic agricultural production areas in critical watersheds. Moreover, re-assessment will also involve the re-evaluation of frequencies of occurrences of floods and droughts, rainfall patterns, and seasonal distribution of hydrologic events that affect agricultural production systems.

There is still very limited information on the role of biodiversity in enhancing agricultural productivity in the Philippines. We recommended that a Philippine ecosystems assessment be conducted similar to the global Millennium Ecosystem Assessment to enlighten policy makers on the role of natural ecosystems in the life of Filipinos. A panel of eminent scientists from various disciplines such as from the National Academy of Science and Technology (NAST) can be constituted to perform the assessment.

Unequivocal climate change which adversely affects agricultural production systems requires appropriate location-specific adaptation strategies and coping mechanisms. This also calls for the mainstreaming of adaptation not only in national and local government planning and operations but also in local communities and farm levels. Strategies which are ecosystem-based adaptation are expected to increase climate resilience as well as maintain ecological services. These strategies and measures should all be incorporated in the Comprehensive Land Use Plan (CLUP) which takes into account for the processes and factors that bring about the changes in natural resources, hydrologic regimes, and livelihoods.

Novel sources of sustainable financing could be explored to support the maintenance and rehabilitation of natural ecosystems. There is a growing interest on payments and rewards for ecological services. The Philippines can explore ways of the emerging global and local markets to ensure that natural ecosystems support our aspirations for sustainable and competitive agriculture.

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IMPERATIVES OF EXTENSION, e-INFORMATION, COMMUNICATION AND STATISTICS IN AGRICULTURAL DEVELOPMENT[1]

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Executive Summary

The Philippine agricultural landscape is so dynamic that several processes and systems are needed to address the requirements of its key actors, players and stakeholders. Because of this, agricultural development programs must be appropriate and responsive to the needs of the farmers and fisher folks. Also, the programs must be continuously anchored on areas particularly in food security, global competitiveness & profitability, environmental integrity, poverty alleviation and social equity.

The role of agricultural research and extension including e-information, communication and statistics is very critical in attaining the outputs and achieving the desired outcomes of development. There is still the reality, however, about the weak research and extension linkages, and this limits the full implementation of successful agricultural development efforts. Recognized as such, the Philippine agriculture development must view agricultural extension, together with strong research base, as crucial for more effective and efficient technological and sociological interventions. Agricultural stakeholders must also define the research and extension efforts for development.

Over the years, agricultural extension in the country has been affected by the implementation of the Local Government Code (Republic Act 7160), although its relevance has been emphasized in the Agriculture and Fisheries

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Modernization Act of 1997 (Republic Act 8534). It brought back the importance of the dynamic interplay of influencing factors in development affecting the farmers and fisher folks, including the local government units and the different institutions enhancing the provision and delivery of extension services.

Rural development goals through effective and efficient agricultural extension should consider the following: a.) Enhance access to knowledge information and technologies, products and services to allow farmers in the value chain deal with changing markets; b.) Enable farmers to understand new challenges arising due to climate change and their vulnerabilities; c.) Support communities to manage their natural resource endowments effectively; d.) Assist farmers make optimal use of their resources to ensure food for the household.

In relation to these goals, there are four reality concerns in agricultural extension and development which need to be addressed. These are the following; 1) Agriculture is changing: global, regional, and country forces; 2) Clientele are changing and their needs are becoming more complex and varied; 3) Social institutions are changing; and 4) The money situation is changing. Given these realities, there is a need to change the direction of agricultural extension from mere provision and delivery of technologies and services to management of knowledge behind the system, structure and processes of technologies and services for agricultural clientele. Agricultural extension must depend on sociological interventions particularly behavioural outcomes toward improved productivity and profitability. These can be done through enhancing capabilities, improving the clientele access to agriculture and fisheries data, information and knowledge, enhancing governance of agriculture and fisheries extension, and improving partnerships in information, education, communications and statistics (IECS).

Furthermore, agricultural extension must also consider the following strategic shift in order to realize the changes towards more dynamic and systematic development.

- **Decentralization.** The LGUs shall serve as the frontline agency to provide services aimed at empowering the farmers and/or producers and their organizations for global competitiveness.

- **Strong private sector role.** The private sector shall play a pivotal role in linking the farmers to the global market and in the provision of private extension goods and services.

- **Market-led.** Clients shall be capacitated to enable them to take advantage of the market to attain higher profit and income.

- **Total farm, total technology approach.** The unit of intervention is the total farm; the intervention must draw from the best knowledge and technologies available towards optimum profitability.

- **Inclusive development.** The projects and programs shall employ participatory approaches in planning, implementation, monitoring and evaluation. It shall focus on the whole household and all clients along the value chain. The livelihood projects must meet environment and sustainable development objectives.

- **Value chain orientation.** To achieve optimal efficiency of the system so that products reach the consumers at the highest quality at least cost, extension shall focus on the "seed-to-shelf" principle. This means that extension will focus on the whole value chain and deal with all the clients along the chain i.e., from the producers to the consumers.
- **Total community approach.** To achieve economies of scale, the project shall aim to involve the whole community of farmers to attain the volume required by the buyers. At the same time, motivate the target communities through their LGUs to provide the appropriate physical and social infrastructure support to the project.

- **Timely provision of best technical advice & increased access to data and information.** Through the use of ICT, the project shall link the farmers to the best technical advice, data and information available in the country and the world to address production and marketing problems.

- **Three Dimensional.** The direct outcome of agriculture extension services are behavioural changes in the three domains: knowledge, attitudes, and skills or KAS. Therefore, the AF extension services shall use a variety of proven methods and practices towards the achievement of the desired behavioural outcomes.

- **Comprehensive Capability Building.** Human resource in agricultural extension development and stakeholders must be instituted in all educational and training institutions for clientele development. It must also reflect the need and competencies of stakeholders who would like to gain knowledge, enhance skills and change attitude for the better.

- **Institute Strategic partnerships.** Agriculture and fisheries should be encouraged. It must have strong government support and active participation on the private sector agricultural extension system for increased agricultural productivity, competitiveness and sustainable development**.**

Strategic Paradigm Shift of Agricultural Extension and Development

In order to operate and institute reforms in agricultural extension, it should consider a major paradigm shift by enhancing and supporting agriculture and fisheries into a business endeavour. It should consider the appropriate extension models for change to transform farmers and fisher folks as well as communities. Making business in agriculture is the ultimate result of extension intervention which highlights the acceptability, utilization and application of technologies.

In so doing, key actors, players and stakeholders must understand that all efforts in agricultural development should be information-sensitive and information-oriented. Likewise, resource management for assured, sustainable and quality agriculture and fishery products for global competitiveness is needed. Similarly, a unified development modality and program should be utilized to enhance the delivery of accurate agriculture and fisheries information to users for appropriate decision making and business development.

Introduction

The entry of development efforts in communities especially in agriculture and fisheries and in science and technology have been highly recognized by individuals and institutions. They have placed these two sectors as the pillars of social and economic growth and development which are observed globally. In the Asia-Pacific region, agriculture including fisheries is vital to development. This is the very reason why individuals and institutions especially on agricultural research, development, extension, and training placed the sector as the center piece of economic and technological development (Aquino 2010)[6].

According to Maru and Singh (2007)[7] nearly 60% of the region's population derives its livelihood from agriculture which is now gradually increasing because new direction is emerging as enterprise development and business ventures shape into mainstream agricultural development (Dar and Bonifacio 2007)[8]. This could be attributed to the programs of agricultural research, development and extension (ARDE) including its systems, structure and key actors that made agriculture and its industries what they are today. However, it was not only on these aspects that led to the new trend in development. There were also changes in the introduction, acceptability, utilization and application of knowledge, management aid in agricultural productivity, profitability, security and sustainability.

The Philippine agricultural landscape is so dynamic that several processes and systems are needed to address the requirements of its key actors, players and stakeholders. Because of this, agricultural development programs must be appropriate and responsive to the needs of the farmers and fisher folks. Also, the programs must be continuously anchored on areas particularly on food security, global competitiveness & profitability, environmental integrity, and poverty alleviation & social equity.

The role of agricultural research and extension including e-information, communication and statistics is very critical in attaining the outputs and achieving the desired outcomes of development. There is still the reality,

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however, about the weak research and extension linkages, and this limits the full implementation of successful agricultural development efforts. Recognized as such, the Philippine agriculture development must view agricultural extension, together with strong research base, as crucial for more effective and efficient technological and sociological interventions. Agricultural stakeholders must also define the research and extension efforts for development.

The objectives of this paper are the following: 1) provide a description and contextualization of the Philippine agricultural extension, 2) discuss institutional transformation and reforms affecting agricultural development, 3) identify and describe agricultural extension strategies, and 4) encourage exchange of ideas and insights toward an effective and efficient program implementation of agricultural extension and research interventions at all levels and key actors from the government organizations, non-government organizations, private sector, civil society and other interest groups.

The Philippine Agricultural Extension

The Philippine agricultural extension has taken a major step in improving the condition of the farmers and fisher folks in the rural areas. Specifically, it has emphasized on the delivery of technologies and services that affect the value chain of agricultural commodities. Because of this, extension service is slowly making waves and now adjusting to the requirements and situation of our country as well as the encountered phenomena the world is facing such as climate change and globalization.

In addition, there are several realities affecting the management of extension development in the country. Over the past decade, there is still a manifestation of weak linkage between research and extension. This could be attributed to the outputs of research (technologies) which are not properly translated or utilized based on the needs and available resources of the farmers and fisher folks. In relation to this, there were different strategies used by the local government units and private sectors with respect to the promotion of production technologies. Furthermore, there is limited complementation on extension activities at the ground level especially on crop, livestock and fisheries processing and marketing initiatives. On the other hand, the local government code should be revised to place agricultural extension towards a demand-driven orientation for better program implementation.

Moreover, the agricultural sector is becoming a great challenge to our government because there are constraints that limit its mainstream development. Take the case of its decreasing importance in national economy. Recent studies show that a number of farmers are no longer engaged in farming because they are getting older and their children do not like to work in the farms. The younger generation prefer to work outside the farm and deal with other industries which require minimal manual labour such as call center agents, merchandizers in supermarkets, waiters and food attendants in fast food chains. These reasons have influenced the agriculture sector to be the last priority of the younger generations. Agriculture is no longer viewed as an exciting source of livelihood. However, the government is still steadfast on working for the betterment of the key players of agriculture.

It is in this area that agricultural extension and research must be the primary focus of the government in order to bring back its glory as the main propeller of development in the country especially in the countryside. These questions now remain; – *How can agriculture change the condition of our farmers? Can extension solve this? How about research?* Numerous questions were raised, but let us look at the present situation of agricultural extension.

Situation of the Agricultural Extension System

In the realm of globalization, it was observed that the agricultural extension system is no doubt separated in the discussion of issues and concerns in agricultural research and development (Dar and Bonifacio 2007)[9]. Accordingly, agricultural extension in the current road map of agriculture is not in any way seen as a separate entity but rather closely tied with research. This is common to most Asian countries which depend on agriculture for its livelihood and economic growth and development. However, it is the service to clientele that is viewed and believed that differentiate the conditions in agricultural system.

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[9] Ibid.

In the Philippines, agricultural extension service was devolved to local government units through the Local Government Code of 1992. The devolution process affected mostly the delivery of basic agricultural services in rural communities. Some claim that this move was the greatest improvement of decentralization. But on one hand, it is the farmers or fisher folks that are mostly affected especially in the provision of agricultural technologies for better farming and fishing practices.

The extent of damage at the local levels brought serious disadvantage because a lot of changes were done to adjust and restructure the system and operation at local level. Even the skilled workers in agriculture were replaced by unfamiliar agriculturally trained individuals who provided the needed services like crop production, integrated pest management, animal husbandry, animal health and nutrition, fishing ranching and aquaculture.

Because of this, certain restructuring and reprogramming on agricultural extension programs were done. This highlighted and incorporated specific aspects in agricultural production system in addition to the information and communication technology management to be attuned to the requirements of the key players and stakeholders in agricultural development.

In 2000, the creation and establishment of the Open Academy of Philippine Agriculture (OPAPA) and the restructuring of the Agricultural Training Institute (ATI) under the Department of Agriculture (DA) led to the new direction of agricultural extension in the Philippines. Structures, systems, operations, management, programs and activities became more client-oriented by the use of state-of-the-art technologies and improved strategies in the delivery of extension services.

At the time, there was a massive re-orientation and retooling (training) of agricultural extension workers on the new paradigm and trends in the fields including the application of knowledge management concepts and perspectives in agricultural development. Information on agriculture became more visible via different media because knowledge management was revolutionized in the social and economic development of Philippine agriculture. It was strongly supported by in-depth and appropriate research and development programs, projects and activities.

Based on the different situations and conditions of agricultural extension in the country, it can be emphasized that agricultural extension is still focused on clientele-orientation, and services are provided by the government or private organizations with direct involvement in farming, fishing or processing activities. Key actors use several strategies to effect change and improvement on agricultural production systems. Also, it is noted that our farmers and fisher folks are now slowly shifting from the traditional practice to a combination of new trends by incorporating the use of information technology and proper communication management. In a way, it is the new direction of knowledge management in agricultural development that is emerging and evolving for productivity, profitability, security and sustainability.

Issues and Concerns in Agricultural Development and Extension System (AFMA Evaluation Team 2009)
(*Note: Based on a study on the Evaluation of Philippines Implementation on AFMA of 1997*)

- Presently, in the region, agriculture is not attractive to young people as a means of earning a living. It has been said that steps must be taken to attract young farmers to agriculture. This appears to assume that, to begin with, agriculture is attractive. To a substantial degree, this is not the case.
- It is rather with a sense of urgency that the present state of agriculture must be turned around and made attractive to young people.
- Rural poverty remains high.
- Agriculture and fisheries are in crisis. Their overall organization and management are in disarray.
- The current state of regional agriculture and fisheries can be best understood by looking into the way a community is managing its resources.
- Many of the problems encountered by individuals and institutions in agriculture could have been easily avoided if only more attention was given to processes involved in production and processing.
- Regardless of the state of production, it must always be assessed in terms of management.
- The social aspect of production management must be given major attention.

- When one talks about paradigm shift in production, one cannot escape the social structure of production. To talk about paradigm shift, one must likewise talk about changing mind-set.

In addition, DA-ATI extension evaluation (2011) identified the following as issues and concerns which limit the full implementation of extension service in the country. These include 1) extension funds are not sustainable at all levels of implementation, 2) lack of systematic institutional monitoring and evaluation across the system, 3) lack of systematic and comprehensive human resource development plan and program for extension workers, and 4) lack of database on extension interventions including profile of extension workers around the country.

The Latest Agricultural Extension Challenges

Today, Philippine agriculture is faced with several challenges. In this prepared paper, agricultural extension is highlighted in view of its changing roles in development. The following are the identified challenges which could be immediately addressed by policies, research and development including system and structural reforms:

- Decreasing importance of agriculture in national economy
- Changing aspirations – most children of farming families do not prefer farming; there is a decrease of enrollment and few younger individuals study agriculture and its related fields
- Changing demographics and increasing urbanization
- Limited capabilities of rural LGUs engaged and work on agricultural extension
- Inclusion of knowledge management in agricultural development highlighting business perspective and entrepreneurship
- Farmers are becoming aware of the dynamic processes of strategic management through information and communication technologies
- Adverse impacts of climate change
- Increasing agricultural globalization and competitiveness
- Influence of systematic public-private partnership at all levels of agricultural development

Given these challenges, it is but appropriate and necessary that the new direction of agricultural extension system be viewed on the value of information and knowledge circulated within the system and processes of implementation. This is noted within and among the key players and stakeholders of agricultural development. The key to the new extension system must combine the positive impact of information and knowledge management to attain the goals of enhancing the business management skills of farming communities towards agricultural business development. In so doing, the creation and establishment of a new innovative strategy combing the agriculture production system, business management and information technology and communication management must be done.

Transformation and Reforms Necessary for the Philippine Agricultural Extension

In the last two decades, agriculture including fisheries is placed in the core of Philippine economic development. This was shown in the implementation of the Agriculture and Fisheries Modernization Act of 1997 (AFMA) or the Republic Act 8435. Several key players and stakeholders have assumed key roles and shifted their responsibilities to address development of the agricultural sector. The major shifts resulted to transformation and structural reforms at all levels of implementation. For example, the agricultural research and development and extension (RDE) made a drastic move and made research, development and extension the focus of rural development. The R&D approach of one program-one system and the unification of extension services for local development ensured that the programs and services are utilized to the fullest. These were observed in the RDE institutions and partner agencies from the national to local levels especially on how the policies, programs and activities were developed, implemented and evaluated by the agricultural stakeholders.

Specifically under the AFMA, the agricultural research, development and extension instituted areas on complementation and collaboration. The Department of Agriculture (DA) together with state colleges and universities shall assist in the LGU's extension system by improving their effectiveness and efficiency through capability-building and complementary extension activities such as provision of technical assistance; support training of LGU extension personnel; improvement of physical facilities; conduct of extension cum research; and enhancement of information support services. At the same time, the intensification of public-private partnerships was done to ensure that extension services are maximized. In view of this, the introduced reforms provided an area of innovative processes to effect agricultural growth and development. While the idea of change is paramount in the overall strategies of extension, it must be recognized that a reorientation of strategies is in order.

Development of New Extension Framework

The new extension framework must be focused on the overall management of community resources. These resources are easily divided into social, technological, economic, ecological and political units. These resources are interactive and complementary. The cutting edge of farming as business is responsible management of community resources. As such, the new framework of action must be embraced by those involved in agriculture. It is the responsibility of new extension to develop core competencies basic to farming as business. These competencies are focused on Commitment, Responsibility, Accountability, Trust, Efficiency, and Discipline (CRATRED). Making business out of agriculture is an organized activity involving networks and relationships.

Furthermore, the extension system is responsible for the initiation and development of such a framework. To institutionalize and enhance the structure and performance of networking, a unified framework using resource management must be agreed upon. With the use of a unified framework, the new extension system will be able to design an efficient and effective monitoring and evaluation schemes. With the adoption of a unified framework the overall performance of the extension system is readily amenable to evaluation.

In view of the complex nature of agriculture, the new extension system must be conscious of the indispensability of complementation and networking. Working with the local government units, civil society groups, non-government organizations, farmers' groups and private sectors is imperative but only within the context of an agreed upon framework.

As such, the real essence of the new extension is truly holistic and systems oriented. A holistic orientation is imperative giving due attention to systems and relations. Meaning – there is no other way!

Instituting Agricultural Knowledge Management

Knowledge management is the new and emerging direction of agricultural extension. Since extension must begin from where the farmers are, then the correct management of resources must begin from knowledge management. Instead of extension given substantial attention to technology transfer, its new orientation must be focused on information management. The most important aspect of agriculture as business is information management for effective decision-making. Extension must be recognized that information is inherently social and social in its consequences. Information is only meaningful when taken in the context of the farmers and their communities. Information must, therefore be seen always in terms of its most appropriate context. Hence, information management and knowledge management are the new mind-set.

As such, the creation of new knowledge system is needed to make business out of agriculture. In relation to this, the new extension worker must be an information manager who is adept at linking information to knowledge. It is important for extension to be sensitive to farmers' access to information and how it is being used in the management production. The success of farming as business is information dependent.

Furthermore, the management of knowledge and the management of market strategies are basic as market driven farm business. Market driven farm business must demonstrate strength in managing the demands of local market first and second, international market.

Operationalization of Agriculture Business Enterprise

Making business out of agriculture of all key players and stakeholders at all levels of implementation must be viewed holistically by providing a new perception of the agricultural environment. Extension must improve its orientation from resource-based to technology-based to output-based to process-based. Processes are best understood in terms of improvement, innovation and change. They go together to effect change especially on the farmers and fisher folks who are responsible for appropriate decision making in farming and fish production and processing management systems.

Also, the developed extension modalities must be in line with the new trends of agriculture as a business activity for farmers and fisher folks wherein they can make use of all their resources to the fullest and the agricultural partners can provide the necessary assistance at the right time and place.

Establishment of Sustainable Partnership

The environment under which extension operates has changed substantially and the traditional modality of extension service needs to be changed. Complementation and partnership are the two influencing factors for effective management. There is a need to forge stronger linkage and establish networks between the government and non-government organizations and private sectors in the implementation of agricultural extension programs and activities. The end result is an effective and efficient agricultural knowledge system that requires institutional action needing the involvement of a team approach.

Agricultural Research and Development Sensitivity

In order to ensure that the results of agricultural research and development are properly utilized and applied by farmers and fisher folks through extension, research process must view the total farming and fishing conditions and incorporate the conditions and competencies of the end-users. It is only in this area that research results will be fully utilized. In relation to this, it is quite urgent that research must develop an integrated body of information useful to farmers engaged in farming as business. The new farmer must no longer be viewed merely as producer but more of a decision-maker who must have direct access to information. The utility of information for decision-making must be organized with a framework that jibes with the framework used by the farmers.

Professionalization of the Agricultural Extension

There are a number of professional organizations, associations and societies that recognize the importance of agricultural extension. These entities place under their care how extension professionals would be at par in terms of effectiveness and efficiency on roles and responsibility in the field. Based on this, agricultural extension is now part of the professional list of technical capacitation and development of the Professional Regulatory Commission (PRC) of the Philippines. Extension professionals are recognized as contributors in the development of agricultural development. They are equipped with competencies that reflect responsibility and accountability. With this reform, agricultural extension can be viewed as an emerging and revitalized professional in agriculture and fisheries. The services these individuals provide guarantee holistic and realistic agricultural service provision at all levels.

Innovative Strategies in Agricultural Extension

Over the years, the agricultural extension strategies have been evolving from resource-based to technology-based to output-based to process-based orientation. The strategies ensure that the key players and stakeholders in agriculture are provided with the necessary support services and technologies to improve their present condition especially on production and processing activities and at the same time on their capacitation to increase their knowledge, improve their skills and change their attitude to a more acceptable one. However, it must be noted that agricultural extension strategies are guided by the following areas from the government (extension service providers at all levels) and the private sector.

Private Sector

The existence of private sector extension service has created a new direction of implementation. For most private companies providing extension service, there is a direct relationship between these companies and the farmers and fisher folks. The service includes provision of technical assistance on crop, livestock and fisheries technologies and also market assistance of specific commodities in specific location. In doing so, the following strategies are practiced and followed to effect the required support services for the end-users:

- Recognize productive partnership between the government and the private sector through shared resources and provision of technical assistance

- Introduce the extension modality shift from Production-led Extension (PLE) into Market-led Extension (MLE)[10]. This will support the lowering of production cost, encourage the introduction of export-oriented product and the modernization of the wholesale markets into more innovative markets
- Enhance orientation of extension system with knowledge and skills related to the market though appropriate information exchange and practice application
- Restore or build into government system capability similar to the experiences encountered during past agricultural development programs like the *Masagana 99* program[11]

    - *Recognize reality of existing setup and build strong coordinating mechanism from central to village levels*
    - *Recognize municipal LGUs as frontline organizations*
    - *Institutionalize village-based extension workers*
    - *Build capacity in various levels while filling the gaps at the provincial level*

- Strengthen the practice of capacitating model of local government units (LGUs) or champion mayors under whom innovative schemes are piloted
- De-bureaucratize field level extension units; and privatize existing government extension workers to be paid based on outputs
- Evolve an infrastructure or mechanism for sustainable support to the Municipal LGUs and field extension workers, e.g.: *Province or district-based Agricultural Development Teams of specialists from DA, SUC and private groups that advice LGUs and support the field agents and serve as facilitators or enablers and custodians of farmers' resource book*

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[10] Sayoc MA 2011. Why Private-led Extension is Working. A paper presented during the roundtable discussion on agricultural extension, e-information communications and statistics during the National Academy of Science and Technology Roundtable Discussion held at the Traders Hotel, Roxas Boulevard, Pasay City on 03 May 2011.

[11] Sison, Eduardo 2011. Options for Strengthening Agricultural Extension Services: A Private Sector Perspective. A paper presented during the roundtable discussion on agricultural extension, e-information communications and statistics during the National Academy of Science and Technology Roundtable Discussion held at the Traders Hotel, Roxas Boulevard, Pasay City on 03 May 2011.

- Avail of development assistance from multi-lateral agencies to capacitate the agricultural extension system

State Universities and Colleges (SUC) Strategies

The involvement of the Commission of Higher Education (CHED) in agriculture development proved to be a very interesting area to be commended. This is especially seen during the recent CHED search for outstanding extension program from different higher educational institutions (HEIs) in the country. As a result, the University of the Philippines at Los Banos emerged the national winner and 13 regional winners were declared to support the agriculture sector.

This initiative gave the extension system a boost in terms of making and developing the appropriate technologies for farmers and fisher folks. Such initiatives enhance the capability of the end-users while providing the necessary support services through technical assistance.

As identified in the different national, regional and local agriculture-based SUCs, the following strategies have contributed to the development and enhancement of farmers and fisher folks' welfare:

- Farmer Scientist Training Program (FSTP). The FSTP is an extension program that integrates agricultural research and development to help small farmers engage in comprehensive farming for increased production and income. It was originally developed through corn-growing areas in Cebu and is now applied in all commodities where farmers and fisher folks become the center of farm/fishing activities. Across the country, this has been piloted to serve as an alternative extension service modality. Today, the UPLB scientists and researchers spearhead the program in their service area and others use regional technical staff from the different SUCs. The scheme ensures that farmers are trained to be location and commodity specific scientists and are developed to become effective farmer leaders as trainers to their fellow farmers.
- Farmer Field School (FFS). This is one of the dynamic strategic approaches in agricultural extension development. For more than two decades now, the FFS has evolved from the original Integrated Pest Management (KASAKALIKASAN) to other multi-commodity and

system approach like the integrated crop management, integrated goat management, and the integrated farm management approach using several agriculture and fishery commodities.

- *FFS is a season long activity where farmers do experiential learning on crop establishment, crop care, pest, nutrient and water management*
- *SUC personnel are organizers, facilitators, subject matter specialists, and do monitoring and evaluation.*
- *However, SUCs are not institutional partners for this activity.*

- Collaborative Development, Research and Extension System (CDDES). The CDRES is the newest extension modality implemented by SUC. It was developed and is implemented by the University of the Philippines Los Banos with the support of the Bureau of Agricultural Research (DA-BAR) to come up with innovations to address the still weakening research and extension linkage. Implemented with the Department of Agriculture (DA) regional field units and research centers, the CDRES is an evolving strategy that combines technological interventions with technical assistance like pilot testing and demonstration of agricultural commodities at the local farm levels with the assistance of the local government units.

  - Goal: *Food self sufficiency and increased farmer income.*
  - *Objectives: Strengthen RDE Partnerships-DA-RFUs, SUCs and LGUs*
  - *Strategies*
    - Strengthen Agricultural Planning Capacity of Provincial LGUs;
    - Strengthen Extension Units of SUC
    - Improve seed and stock systems
      - Activities
    - Improve Provincial Rice Action Plan; conduct training on strategic planning /food security code
    - Trainings on: skills to service seed diagnostic lab, research proposal development, soil fertility assessment, seed certification and inspection/extension policy study, animal

production management, product development and marketing initiatives

- Strengthen seed growers group; put up seed diagnostic lab at the SUC, CS demo study/seed systems policy study
- Enhance capability and improve system of animal breeding and reproduction health and nutrition and other services and link with existing laboratory facilities for animal management

Department of Agriculture – Agricultural Training Institute (ATI) and its Regional Centers

Equipped with the latest system of operation, state-of-the-art equipments and delivery of services, the Agricultural Training Institute (ATI) has resulted into a more dynamic and systematic system of delivery extension services and capability building activities to its front liners and clientele[12]. The extension system has developed new strategies that encourage active involvement and participation of key players and stakeholders. The use of e-extension proves to have contributed in the improvement of the farmers' condition.

Although this has been conducted and is presently being implemented, ATI continuously develop strategies and encourage the participation of all stakeholders. Among the emerging strategies developed and formulated by ATI, the clientele and development oriented ones are the most feasible for implementation. Aside from these, the following are in the pipeline for collaboration and complementation for all agricultural extension partners.

- Decentralization. The LGUs shall serve as the frontline agency to provide services aimed at empowering the farmers and/or producers and their organizations for global competitiveness.
- Strong private sector role. The private sector shall play a pivotal role in linking the farmers to the global market and in the provision of private extension goods and services.

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[12] Saliot, AP 2011. Agricultural Extension in 2011 and Beyond. A paper presented during the roundtable discussion on agricultural extension, e-information communications and statistics during the National Academy of Science and Technology Roundtable Discussion held at the Traders Hotel, Roxas Boulevard, Pasay City on 03 May 2011.

- Market-led. Clients shall be capacitated to enable them to take advantage of the market to attain higher profit and income.
- Total farm, total technology approach. The unit of intervention is the total farm; the intervention must draw from the best knowledge and technologies available towards optimum profitability.
- Inclusive development. The projects and programs shall employ participatory approaches in planning, implementation, monitoring and evaluation. It shall focus on the whole household and all clients along the value chain. The livelihood projects must meet environment and sustainable development objectives.
- Value chain orientation. To achieve optimal efficiency of the system so that products reach the consumers at the highest quality at least cost, extension shall focus on the "seed-to-shelf" principle. This means that extension will focus on the whole value chain and deal with all the clients along the chain i.e., from the producers to the consumers.
- Total community approach. To achieve economies of scale, the project shall aim to involve the whole community of farmers to attain the volume required by the buyers while, at the same time, provide motivation to the target communities through their LGUs to provide the appropriate physical and social infrastructure support to the project.
- Timely provision of best technical advice & increased access to data and information. Through the use of ICT, the project shall link the farmers to the best technical advice, data and information available in the country and the world, if necessary, to address production and marketing problems.
- Three Dimensional. The direct outcomes of agriculture extension services are behavioural changes in the three domains: knowledge, attitudes, and skills or KAS. Therefore, the AF extension services shall use a variety of proven methods and practices towards the achievement of the desired behavioural outcomes.
- Comprehensive Capability Building. Human resource for key actors in agricultural extension development and stakeholders must be instituted in all educational and training institutions for clientele development. Also, it must reflect the need and competencies of stakeholders who would like to have gain in knowledge, enhance skills and change attitude for the better.

- Institute Strategic partnerships. Agriculture and fisheries should encourage and must have a strong government-led and active support from the private sector agricultural extension system for increased agricultural productivity, competitiveness and sustainable development**.**

Future Directions for Unified and Comprehensive Agricultural Extension System

The evolving processes in agricultural development resulted to influence the dynamics and system of implementation at the national, regional and local levels. Because of this, it was observed that there should be a major effective and efficient theoretical, conceptual and methodological shift of agricultural development. This is more evident in agricultural extension where support is required to ensure the improvement of the conditions of the farmers and fisher folks.

The need for a strong government-led and actively supported agricultural extension system for increased agricultural productivity, competitiveness and sustainable development is necessary to be in placed**.** This could be achieved through the following:

- Strengthen decentralized system with a national lead agency that would provide strategic framework for extension personnel within the provincial units; with involvement of the SUCs and other providers.
- Extension programs will be time-bound, in the same way as research.
- Need to monitor and evaluate the extension program initiatives; this can be the best role for the SUCs.
- SUC will need a dedicated extension unit to cater to the LGU capacity building needs. CHED can influence this move.
- SUC to provide diagnostic laboratories for farmer needs.
- Build capacities at the UPLB and other SUCs for emerging agricultural related problems such as climate change (crop protection scientists, hydrologists, geophysical experts, climate risk management specialists etc).

Conclusions

With the numerous strategies and innovations developed, implemented, observed, experienced, and attained through dynamic and participatory extension service, all of us should not forget the essence of our existence, the farmers and fisher folks who rely on our appropriate and timely delivery of technologies and services for their development and improved conditions. They need us. We should constantly be sensitive and responsive to their needs, work with them and ensure that their farming and fishing activities are enhanced and supported for maximum productivity, profitability and sustainability.

We should also assure that we are equipped, competent, and capable of doing the right kind of extension work. If at the end of the day, we can say that we have done our part, then the extension we are talking about is not just a word to be argued and contextualized but a REALITY to be provided to all those who are in need – farmers, fisher folks, researchers, scientists, development workers, policy makers and administrators for the holistic development of the agriculture sector.

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RESOLUTIONS ON MEETING THE CHALLENGES OF AGRICULTURAL PRODUCTIVITY, COMPETITIVENESS, AND SUSTAINABILITY

Whereas, the majority of Filipinos specifically in the countryside are heavily dependent on agriculture, accounting for about 14% of the gross domestic product, 6-8 percent of exports and 37% of employment;

Whereas, the science community, led by the National Academy of Science and Technology (NAST), Philippines, recognizing the pivotal role of modernizing agriculture in achieving the national development goals of poverty alleviation, global competitiveness, food security and sustainability has crafted a medium term strategic plan for agriculture and natural resources entitled Philippine Agriculture 2020 (PA 2020);

Whereas, the Department of Agriculture (DA), DA-Bureau of Agricultural Research, Department of Science and Technology through the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development and Philippine Council for Aquatic and Marine Resources Research and Development and other concerned agencies are starting to take cognizance of and adopt the recommendations in PA 2020;

NOW, THEREFORE, the National Academy of Science and Technology (NAST), Philippines on their 33rd Annual Scientific Meeting recommends the following actions to be addressed accordingly by the appropriate offices and agencies:

Office of the President and Legislative Bodies

a) Enactment of a Comprehensive National Land Use Plan Law, Lands Administration Reform Law and the establishment of the Lands Administration Authority (LAA) under the Department of Environment and Natural Resources for an integrated, unified, synchronized system of land use planning at all levels. LAA will integrate the functions of Lands Registration Authority, Registry of Deeds, Lands Management Bureaus, Lands Management Services and National Mapping Resources Information Authority (NAMRIA);

b) That the Comprehensive Agrarian Reform Program (CARP) be phased-out by 2014 as planned, and the residual functions and staff be integrated with DA and respective LGUs and the parcelization of CLOAs to individual titles be completed;

Office of the President, Department of Budget and Management (DBM), Department of Finance (DoF), Department of Agriculture (DA);

a) Creation of a Small Farmers Fund combined with Farm Insurance with single digit interest rates (subsidized credit and insurance for small farmers/fisherfolks);

b) Upgrade and a regularize the budget and resources of DA bureaus and agencies commensurate with their mandated functions

Department of Environment and Natural Resources (DENR) and Department of Interior and Local Government (DILG)

a) Immediate completion of cadastral maps to delineate forestlands, protected areas and ancestral domains;

b) Facilitating and expediting the completion by LGUs of their respective comprehensive land use plan (CLUPs) to serve as an integrating framework in the management of resources;

Department of Agriculture (DA)

a) Comprehensive external review of the National Irrigation Authority (NIA), its mandate, functions, performance, future plans and programs;

b) Exploring the possibility of allowing Irrigators Associations to keep the majority of irrigation fees, of providing incentives for them to organize their associations, pay and collect water fees and properly maintain and manage irrigation systems;

c) Rationalize allocation of government spending to different crops to reflect their relative importance in the agriculture sector value added. In particular, increase of government support for conservation and development of the country's fisheries resources;

Department of Science and Technology (DOST) and Department of Agriculture (DA)

a) Raise the share of agricultural R&D to 1% of GVA of agriculture;

Further resolved as it is hereby resolved that we, members of the scientific community, strongly support the following initiatives:

a) The convergence initiative being pursued among Department of Agriculture (DA), Department of Agrarian Reform (DAR) and Department of Environment and Natural Resources (DENR) to maximize the investment and initiatives in the countryside and in preparation for the phase-out of DAR in 2014;

b) The rationalization and redirection of National Food Authority (NFA) in particular, the increase in the share of rice imports by the private sector at the same tariffs as state imports;

c) Re filing and immediate passage of the following legislative bills: An Act Strengthening the Animal Industry and Veterinary Services In the Philippines; the National Land Use Act of the Philippines; Land Administration Reform Act; and Agricultural Education Act.

ABOUT NAST

The National Academy of Science and Technology, Philippines (NAST, PHL) is the country's highest advisory body to the government and the science community on matters related to science and technology. It also has the mandate to recognize outstanding achievements in science and technology made by Filipino scientists in all fields of science.

VISION, MISSION AND MANDATE

The National Academy of Science and Technology, Philippines, founded in 1976, continues to stand today with a firm resolve to faithfully pursue:

Its **VISION: A PROGRESSIVE PHILIPPINES ANCHORED ON SCIENCE**

Its **MISSION:**

1. To recognize exemplary science and technology achievements among the young and among peers.
2. To encourage individual Academy members to continue their scholarly pursuits thereby making the Academy the principal reservoir of scientific and technological expertise in the nation.
3. To provide independent and science-based advice on problems facing the nation and the world.
4. To link with like-minded institutions and individuals in promoting scientific achievement in the Philippines and abroad.
5. To promote a strong science culture in Philippine society.

Its **MANDATE:**

1. To recognize outstanding achievements in science and technology as well as provide meaningful incentives to those engaged in scientific and technological researches (PD 1003-A)
2. To advise the President and the Cabinet on matters related to science and technology (EO 818).
3. To engage in projects and programs designed to recognize outstanding achievements in science and promote scientific productivity (EO 818).