Special Issues in Agriculture
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Edited by
Eliseo R. Ponce
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In the Philippines, about one-half of the labor force is engaged in agricultural activities. Agriculture then plays a major role in the economy and if a stable national growth is to become a realization, a modern and competitive agricultural sector is a necessity. Thus, it is no surprise that the agricultural sector is one of the most studied areas in the country’s history. In spite of this, much is yet to be achieved to ensure food security and sustainable competitiveness. However, findings and recommendations from past researches have not been fully utilized and neither have current programs undergone regular analyses and intensive evaluation.

This book, *Special Issues in Agriculture*, focuses on concerns relating to resource management and sustainability that are critical to agricultural growth and development. It also gives premium to the institutional issues in the area of property rights: land, water, fishery, and forestry, including an evaluation of the CARP and other tenure-related government programs. Certainly, the four papers in this book present the strategies for the policy, regulatory and institutional framework crucial not only in promoting but in enforcing a more efficient, effective, equitable and sustainable agricultural growth for the country.

It is therefore hoped that this book will herald further researches geared for the analyses on the performance and development of the agricultural
sector. It is also our desire that studies in this book will be catalysts for positive changes in the field of agriculture.

Lastly, I thank the Bureau of Agricultural Resources (BAR) for giving the Philippine Institute for Development Studies the opportunity to work with the experts in the field of agricultural research. My deepest gratitude to all the authors included in this book for giving their time and sharing their knowledge and expertise in this favorable project.
It is the aim of the Department of Agriculture’s Bureau of Agriculture Research through the Social Science and Policy Network (SSPN) to develop a strong national program on social science and policy research as a dynamic component of the national research and development program in agriculture and fisheries. This is in line with the Agriculture and Fisheries Modernization Act (AFMA) of 1997, which mandated that the growth of agriculture must be technology-based within the overall framework of the Philippine Strategy for Sustainable Development. This book, *Special Issues in Agriculture*, is part of SSPN’s contribution to the AFMA mandate.

This book contains four chapters that look into four key issues that affect and remain outstanding in the agriculture sector, namely, agricultural distribution system, agricultural biotechnology, natural resource management and property rights reform. These chapters review related significant studies, the extent of technologies utilized and suggest further research in the agriculture and natural resources management.

Resource management and sustainability, and institutional issues are the two focal points of the book. The farmers’ and fishermen’s management practices as well as the cause and effect of natural resources degradation are given special attention. The availability of appropriate regulatory and market-based instruments crucial to agricultural sustainability is also
emphasized. Property rights, on the other hand, is discussed as an integral resource allocation mechanism.

The first chapter on research program planning for agricultural resource management highlights the significance of including natural resource management in regional research programs to attain the sustainable use of soil and water resources. Although numerous efforts have been undertaken on the subject, degradation still prevails. Inclusion of natural resource management in the regional research program, therefore, will help shed light in the ways resources are used by farmers.

The second chapter is a literature review of the agricultural distribution services sector and research issues. It shows that a competitive agriculture sector requires not only productive farms but also an efficient distribution system. One way to attain this is to have regular analyses and thorough assessments of the competitiveness of the agricultural distribution system.

The third chapter on agricultural biotechnology details the numerous written research works that promote biotechnology’s positive effect on the agricultural sector, specifically in food security. Its application, however, emphasizes safety and reliability as well as opportunities to increase farm productivity.

The fourth chapter is on property rights reform and discusses how much—or less—of the recommendations from various research works are yet to be employed in the natural and agricultural resource sector. Despite having experienced widespread property rights reforms, the sector has not been receptive to the utilization of research findings to address sectoral issues.

In conclusion, publishing this book is just one of the avenues identified by SSPN in realizing its goal of a modern and sustainable agricultural sector.

Cristina C. David, Ph.D.
Eliseo R. Ponce, Ph.D.
Project Leaders, PIDS–BAR Project
I
Research program planning for agricultural resource management: a background analysis

by Agnes C. Rola

Introduction
Conventionally, agricultural resource management per se is not a popular area of research. Previous agricultural production research studies aimed at optimizing fertilizer recommendations to maximize yields, or identifying cropping patterns that will maximize output and profits. Soil was considered a fixed input. Soil productivity was not considered an issue. Neither was water productivity.

It was during the 1980s that researchers began experiments that focused on sustainable agricultural resource management. Farmer participation got a foothold with the onfarm trial programs of the farming systems research institutes in several state universities and colleges (SUCs). These onfarm trials studied not just the productivity effects but the environmental effects of the alternative cropping systems as well. To date, however, there is no systematic way of determining the adoption of these technologies or the impact of these studies on soil and water quality.¹

This paper synthesizes and analyzes the results of studies on soil and water management conducted from the 1980s to the 1990s and provides background information for research program planning for Natural Resource Management (NRM) in agriculture. The analyses focus on three points. First, production losses as a result of nonsustainable resource use.²

¹Agricultural resources are also influenced by the wider environmental quality such as the state of the watershed health. The literature on watershed management as it affects sustainable agriculture is reviewed in Rola (2000).
Monocropping and intensive cultivation of steep slopes are examples of these nonsustainable practices. Second, there are available research products that could have minimized these losses; e.g., new technologies/knowledge on crop/resource management. Third, the evidence of continuous degradation of the agricultural resource base points to the serious constraints to adoption of these sustainable technologies/management options. Future NRM research programs then will need to highlight activities that relax these constraints. Data were sourced from different agricultural research institutions, graduate students’ theses and technical reports (see Rola 2000 for details).

The paper is divided into five parts. The first part establishes the current state of agricultural resources in the Philippines. The second part summarizes the research efforts on soil nutrient management (onsite effects). Upland soil conservation technologies and their adoption constraints are discussed in the third section. Research has produced a number of new location-specific and cropping system-specific techniques for soil conservation. Still, the big question is, why is adoption not satisfactory? The answers to this will be reviewed in this section.

The fourth part deals with water management/technologies/alternative delivery systems to increase water productivity and water use efficiency in agriculture. The last section lays out the discussion points that can be used for research program planning for natural resource management (NRM) in agriculture.

Status of the agricultural resource base in the Philippines

Soil resources

The total land area of the Philippines is only 30 million hectares (ha.), 8.2 million ha. of which are arable and permanent croplands. About 25.1 percent of the total area is constraint-free while the remaining 74.9 percent consists of areas with various kinds of problem soils. The Bureau of Soil and Water Management (BSWM) recognizes and classifies several categories of problem soils in the Philippines and their corresponding extent in Table 1.

About 16 million ha. (71.2%) of land with various forms of problem soils are further marginalized by various degrees of soil acidity. More disturbing statistics includes the current estimates of soil loss in the Philippine uplands. Land use statistics in the fragile Philippine uplands shows dominance of rice and corn over other crops (Table 2). Estimated total soil loss for various land uses and slopes reveal that corn production in the uplands could be contributing about 90 percent of the total soil loss (Table 3).
Table 1. Problem soils of the Philippines (1991)

<table>
<thead>
<tr>
<th>Problem Soils</th>
<th>% of Total Area</th>
<th>Extent (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steep slopes</td>
<td>29.7</td>
<td>8,900,000</td>
</tr>
<tr>
<td>Poor drainage</td>
<td>0.3</td>
<td>91,000</td>
</tr>
<tr>
<td>Coarse textured soils</td>
<td>1.6</td>
<td>360,000</td>
</tr>
<tr>
<td>Heavy cracking clays</td>
<td>2.5</td>
<td>766,000</td>
</tr>
<tr>
<td>Severe fertility limitations</td>
<td>39.2</td>
<td>12,000,000</td>
</tr>
<tr>
<td>Saline soils</td>
<td>1.3</td>
<td>400,000</td>
</tr>
<tr>
<td>Acid sulfate soils</td>
<td>0.1</td>
<td>27,000</td>
</tr>
<tr>
<td>Peat lands</td>
<td>0.1</td>
<td>16,000</td>
</tr>
<tr>
<td>Mine tailings &amp; polluted lands</td>
<td>0.1</td>
<td>22,000</td>
</tr>
</tbody>
</table>

Source: BSWM 1991

Table 2. Land use in the Philippine uplands (hectares)

<table>
<thead>
<tr>
<th>Slope Category (%)</th>
<th>Land Use</th>
<th>18-30</th>
<th>30+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rice</td>
<td>315,000</td>
<td>52,500</td>
<td>367,500</td>
</tr>
<tr>
<td></td>
<td>Corn</td>
<td>375,000</td>
<td>61,250</td>
<td>436,250</td>
</tr>
<tr>
<td></td>
<td>Fallow</td>
<td>3,970,000</td>
<td>1,540,000</td>
<td>5,510,000</td>
</tr>
<tr>
<td></td>
<td>Other Agriculture</td>
<td>592,000</td>
<td>96,250</td>
<td>688,250</td>
</tr>
<tr>
<td></td>
<td>Nonagricultural (Forest)</td>
<td>-</td>
<td>-</td>
<td>7,900,000</td>
</tr>
<tr>
<td></td>
<td>All Uses</td>
<td>-</td>
<td>-</td>
<td>14,902,000</td>
</tr>
</tbody>
</table>

Source: Coxhead and Shively 1998

On the other hand, the gross wetland rice soil resource base of the Philippines is estimated at 4.2 million ha. Its gross area of highly suitable and moderately suitable lands amount to 2.3 million ha. Thus, some 1.9 million ha. of rice lands are marginal and unsuitable for wetlands rice production.
As documented by existing literature, the productivity of soil resource is "intimately tied up" to the status of the host watershed areas. Among others, watershed health also influences the supply of irrigation water, occurrence of floods and encroachment of salinity in marine coastal and estuarine areas. However, many of these watersheds are in varying state of degradation (PCARRD et al. 1999). The report by David (1999) cites an alarming indication of decreasing efficiency in the planning and implementation of National Irrigation Systems (NIS) and Communal Irrigation Systems (CIS). It also reports that the area actually irrigated by these systems during the dry season is only about 75 percent of their designed serviced area. The estimate of potentially irrigable agricultural lands in the Philippines is 4.7 million ha of which an estimated 0.65 million ha., 0.44 million ha. and 0.5 million ha. are irrigated by national, communal and minor irrigation systems, respectively (David 1999).

The NIS and CIS utilize surface water. Because of watershed degradation, this resource is becoming limited. On the other hand, the country has abundant shallow groundwater resources, with an estimated 5.1 million ha. shallow well area.

### Table 3. Estimated total soil loss for land uses and slopes (tons/year)

<table>
<thead>
<tr>
<th>Slope Category (%)</th>
<th>18-30</th>
<th>30+</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>15,750,000</td>
<td>5,250,000</td>
<td>21,000,000</td>
</tr>
<tr>
<td>Corn with Fallow</td>
<td>217,250,000</td>
<td>240,190,000</td>
<td>457,340,000</td>
</tr>
<tr>
<td>Other Agriculture</td>
<td>14,800,000</td>
<td>4,812,500</td>
<td>19,612,500</td>
</tr>
<tr>
<td>Nonagricultural (Forest)</td>
<td>-</td>
<td>-</td>
<td>7,900,000</td>
</tr>
<tr>
<td>All Uses</td>
<td>-</td>
<td>-</td>
<td>505,852,500</td>
</tr>
</tbody>
</table>

Source: Coxhead and Shively 1998

### Irrigation water resources

As documented by existing literature, the productivity of soil resource is "intimately tied up" to the status of the host watershed areas. Among others, watershed health also influences the supply of irrigation water, occurrence of floods and encroachment of salinity in marine coastal and estuarine areas. However, many of these watersheds are in varying state of degradation (PCARRD et al. 1999). The report by David (1999) cites an alarming indication of decreasing efficiency in the planning and implementation of National Irrigation Systems (NIS) and Communal Irrigation Systems (CIS). It also reports that the area actually irrigated by these systems during the dry season is only about 75 percent of their designed serviced area. The estimate of potentially irrigable agricultural lands in the Philippines is 4.7 million ha of which an estimated 0.65 million ha., 0.44 million ha. and 0.5 million ha. are irrigated by national, communal and minor irrigation systems, respectively (David 1999).

The NIS and CIS utilize surface water. Because of watershed degradation, this resource is becoming limited. On the other hand, the country has abundant shallow groundwater resources, with an estimated 5.1 million ha. shallow well area.

### Soil degradation in lowland agriculture: The role of nutrient management

The degradation story in the lowland rice systems and other crops

In the early 1990s, evidence showed that the rice yields in irrigated areas leveled off and that there was a danger of future declines in the yield growth (Pingali, Moya and Velasco 1990). There also was a growing evidence that
unintended environmental effects from land intensification led to the decline in productivity growth. This was illustrated by Cassman and Pingali (1995) among others, via an analysis of yield trends from long-term trials conducted at the experiment stations of the International Rice Research Institute (IRRI).

Research at IRRI also showed that the decline in nitrogen productivity was due to the reduction in the nitrogen-supplying capacity of intensively cultivated wetland soils. There was likewise an increased incidence of phosphorus and potassium deficiency brought by the lack of nutrient balance in the applied fertilizers (De Datta, Gomez and Descalsota 1988). The imbalanced fertilization resulted in a decline in the efficiency of fertilizer use over time (Desai and Gandhi 1989; Stone 1986; Ahmed 1985).

Such is the case with bananas. In 1990, a survey was conducted in several plantations in Davao del Norte to identify soil properties that influence land productivity and to establish a soil fertility management technology to achieve sustained crop productivity (Sadasa et al. 1991). The study revealed that despite the maximum use of inorganic fertilizers, yields of banana declined steadily over time after reaching a peak during the first few years. The yield decline was associated with the alteration of the nutrient ratios—i.e., the application of some nutrients to some and none for others. The study recommended that nutrient ratios be carefully managed to sustain soil productivity even after long years of continuous cropping. These limited data show that intensive and continuous cultivation using pure inorganic fertilizers for longer periods is not sustainable in the long run.

**Technological options for improving soil quality**

Because inorganic fertilizer use practiced in intensive agriculture is not sustainable, technological options are needed. In the existing literature, there are at least three techniques for improving soil quality, and hence, improving/sustaining soil productivity. These are: (1) the use of organic fertilizer; (2) the integrated nutrient management or the combined use of organic and inorganic fertilizers; and (3) diversified farming. These are described in Table 4.

**Use of organic fertilizer**

Green manure was thought to have an advantage over other organic manures because the latter can be grown right in the field and incorporated during regular land preparation or weeding operations. However, this never
became popular due to several constraints (Table 5). The most serious constraint is the labor intensity of the process. With increasing commercialization of agriculture and higher wages, this constraint poses great limitation. There is sufficient evidence in the literature concerning the benefits in terms of grain yield increases from green manure. However, little is known about its long-term effects. The paper by Ventura and Ladha (1996) reports that the long-term biofertilizer experiment at IRRI showed an increase in the total nitrogen in soil after 10 years of green manuring. There is no such benefit from the urea fertilization. It is suggested that long-term field experiments be conducted to provide a better understanding of the nutrient constraints and management problems of soil.

**Integrated use of organic and inorganic fertilizers for nutrient management**

Integrated use of organic manures and mineral fertilizers has been found to be promising in maintaining stability in crop production on certain soils. Studies however show that while organic fertilizers improved soil fertility, it alone cannot sustain the high yield during the later years of production. An integrated fertilizer management is found to be more sustainable.

### Table 4. Technology options for soil management

<table>
<thead>
<tr>
<th>Options</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Organic fertilizer</td>
<td>This consists of organic manures from living organisms such as azolla and green manure; and decayed organisms including animal manure and compost.</td>
</tr>
<tr>
<td>2. Integrated use of organic and inorganic fertilizers</td>
<td>Recommendation for a 50% inorganic and 50% organic fertilizers. This was disseminated in a national program on rapid composting.</td>
</tr>
<tr>
<td>Balanced fertilization</td>
<td>This involved coming up with location-specific recommendations, where both the micronutrients and macronutrients were taken into account. This made use of the previously packaged diagnostics such as the soil test kit and the chlorometer at IRRI.</td>
</tr>
<tr>
<td>3. Diversified cropping</td>
<td>This recommends to go for diverse crops rather than monocrop that intensely uses inorganic fertilizer.</td>
</tr>
</tbody>
</table>
Table 5. Potential of nitrogen-fixing green manure as multipurpose crop in an integrated farming system

<table>
<thead>
<tr>
<th>Green Manure</th>
<th>N\textsubscript{2} Fixing Potential</th>
<th>Actual Adoption by Farmers</th>
<th>Potential to Overcome Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azolla</td>
<td>High 45-120 kg/ha. in 45 days</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technological and socio-economic constraints (inoculum, labor, water, pests) restrict adoption</td>
<td>Fast growth; can be used also as animal feed (poultry, hog, fish)</td>
</tr>
<tr>
<td>Semi-aquatic legumes (Sesbania Aeschynomene)</td>
<td>High 45-120 kg N/ha. in 60 d</td>
<td>Low</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Socio-economic constraints (seed, labor, opportunity costs) restrict adoption</td>
<td>With wide range of suitable species; can be grown under a wide range of soil and moisture conditions and used as feeds for ruminants (or the stem can be used as firewood)</td>
</tr>
<tr>
<td>Indigo</td>
<td>High 60 to 250 kg N/ha. in 60 d</td>
<td>Low</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Usage in the Philippines is limited in the Ilocos region. Socio-economic constraints (seed, labor)</td>
<td>Resistant to drought; adopted in the Ilocos provinces as a green manure; commonly intercropped with annual upland crops</td>
</tr>
<tr>
<td>Leguminous trees (Gliricidia, Leucaena)</td>
<td>High 40 to 120 kg N/ha. per pruning</td>
<td>Low</td>
<td>Medium to High</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technological and socioeconomic constraints (pests, competes with main crop for light, water and nutrients, labor, opportunity costs).</td>
<td>Low cultural management requirement; leaves used also as feeds for ruminants, stem as firewood; serves as windbreak and catch crop for excess NO\textsubscript{3}</td>
</tr>
</tbody>
</table>

Source: Ventura and Ladha 1996
The rice farm sector was first introduced to the Integrated Nutrient Management (INM) through the program using the Compost Fungus Activator (CFA). This recommended a combined use of one-half organic and one-half dose of inorganic fertilizer (Cuevas 1989). This technology improved crop yields by as much as 20 percent. Labor input cost in compost preparation and field application was expected to be offset by the gains in yield increase. Later studies show that this is true only if wages in the community are low and nonfarm incomes are not available (Rola et al. 1996).

One downside of this program was that the recommendation was generalized for the whole country. Aside from other administrative setbacks of the rice program (i.e., delay in supply of the compost, inadequate knowledge of both the technicians and the farmers on the use of compost), this technology did not quite prosper due to technical constraints. Only users who have a priori knowledge of the soil characteristics were able to capture the benefits (in terms of lower inorganic fertilizer use and stable yields) of this program.

A natural sequel to the blanket recommendation on the rapid compost is the balanced fertilization program launched in 1998. Balanced fertilization is defined as the optimum use of organic and inorganic fertilizers with the proper grades and amounts that supply the correct ratio of plant nutrients and ensure soils will sustain high crop yields over long cropping season. The Gintong Ani Balanced Fertilization Program was the central strategy for sustainable agricultural development. For this purpose, the BSWM classified the various soils devoted to rice and corn into five soil fertilizer groups.

In the balanced fertilization, the recommendations were location- and season- specific as well as dynamic. That is, the recommended mix of fertilizer this year is different from that for next year and the year thereafter. This technology is very knowledge intensive. Farmers need to know the base nutrient content of their soil, what amounts of organic and inorganic fertilizers have been applied and the crop grown in the current year. Thereafter, a corresponding adjustment in the proportion of organic and inorganic fertilizer will be applied the following year. Several research studies had backed up the balanced fertilization program. One is the characterization of the soil at the local level to get local recommendations. The others would be the use of the diagnostics such as the soil test kit and the leaf color chart.
Diversified cropping: the role of farming systems research

The farming systems research of the 1980s was meant to develop technologies that would increase small farmer incomes while promoting environmental sustainability. In the early period of this paradigm, the research activities focused on developing through onfarm research, cropping patterns that will increase farm incomes. It was only of late that data to support the sustainability of the resource base corresponding to the introduced cropping systems were generated. Hence, the merit of soil amelioration from diversified cropping vis-à-vis the monocrop was the highlight of some of these trials. Studies such as that of Oren in Iloilo (1992) had the kakawati as part of the cropping system and was a potential source of compost.

Farming systems research had several stages: technology development, verification, adaptation and dissemination. With the current trend of participatory research, these stages may be modified, where one starts with the farmer technology and build components from there. This is in contrast to the previous method where farmers’ indigenous practice was one of the technologies verified and pitted against the researchers’ technology.

Farming systems research was primarily done in resource-poor environments. Hence, the upland systems were a popular subject of research. Water scarce areas in the lowland were likewise given some attention. For instance, to find a way to go around the water scarcity in the lowland’s irrigated areas as well as to minimize the intensive and continuous rice cultivation, the adaptability of traditionally upland crops was studied in the lowland areas at the University of the Philippines-Los Baños (UPLB) and in Bulacan. Results showed that all the upland crops evaluated in this study can be grown after lowland rice under UPLB condition, while mungbean did not perform well in Bulacan (Labios et al. 1995). Yield performance differed for each crop and the combined use of bio-organic and inorganic fertilizers gave yields comparable to that of the inorganic fertilizer use only. Nutrient management in the highly acid upland soil was also studied via farming systems research. Other experiments in other soil types also indicate that time is a good neutralizer (Taburada 1994). Between relay cropping and monocropping systems, it was found that relay cropping is somehow environmentally and, in most cases, economically better than the monoculture scheme.
**Constraints to adoption of soil management technologies**

Constraints to adoption of sustainable soil management technologies can be grouped into the following: technical, socioeconomic and institutional constraints.

**Technical constraints**
Meeting the nutrient needs of modern short-duration, high yielding crops by introducing organic manures alone poses several problems such as low organic contents of organic materials, and slow and irregular release of nutrients from manures. This thus makes target fertilization impossible, among others (Schoning and Wickman 1990).

**Socioeconomic constraints**
Growing green manure means competing for land and water. Also, green manuring has not gained general acceptance for several reasons: (1) it gives no immediate income; (2) it has not fit into the farmer’s traditional mixed cropping systems; and (3) it requires labor that farmers consider unnecessary.

The low demand for commercialized organic fertilizers may be because farmers do not understand how to use this. Also, long-term effects are of course not immediately visible to the farmer, who always tends to have short-term production plans. Diversified cropping system is dependent on output prices, and prices are dependent on policies and other government incentives.

**Institutional constraints**
It has to be recognized that sustainable technologies are knowledge intensive, long-term in benefits and very location specific. In this sense, a major institutional restructuring is needed to meet the aim of promoting such technologies. The role of extension and the kind of extension strategies consistent with the nature of those technologies have to be investigated. Participatory approaches are warranted because one needs to know farmers’ level of awareness with respect to sustainability and resource management.

Commercialization of products such as biofertilizer failed to take off, again due to severe institutional constraints. Among the business requirements that private marketing agents need to comply with are: a patent, a permit from the Fertilizer and Pesticide Authority, and a mechanism for quality assurance of the product.
Imperatives for soil conservation in the uplands

*Does upland agriculture create an environmental problem?*

Because of population pressure, agriculture now encroaches on unfavorable upland suited only for forestry or perennial crops. The question here is whether and to what extent upland agriculture creates an environmental problem. If this were so, what would be the solutions for a more sustainable agriculture in the uplands? A recent investigation in the highlands of Lantapan, Bukidnon showed that expansion of sugar and corn cultivation at low altitudes, and of vegetables and corn at high altitudes, has occurred substantially at the expense of perennial crops, whether pasture/grassland, forest/bush fallow or coffee (Coxhead and Rola 1998). Field measurements and experiments with corn and vegetable crop cultivation under a range of management regimes in Lantapan confirm the existence of rapid soil erosion rates and depletion rates of soil nutrient and organic matter content in soils that are generally of poor initial quality (Midmore et al. 1997). The unchecked expansion of agricultural production at the margins of the remaining forest systems poses a potential threat to the integrity of such systems. One of the consequences is the reduction in water retention capacity of the upper watershed, which thus changes the quantity and seasonal distribution of water flow in the springs and rivers (Deutsch et al. 1998). Another is the possible irreversible change in biodiversity.

Other studies also showed severe land degradation as a result of upland farming (Navasero 1993) such as that shown in Lucban, Quezon. A number of studies investigated the onsite and offsite effects of upland agriculture. These studies also show the same results.

Understanding the policies and technologies plays a key role in countering environmental degradation. Most of the solutions center on the usefulness of soil conservation measures such as agroforestry and diversified cropping systems. Policy options, however, are not popular solutions to upland degradation.

**Technology options for upland soil conservation**

*Contours and hedgerows*

In the Philippines and Southeast Asia, in general, hedgerow or alley cropping is the most popular form of soil conservation technology. This technology is, however, indigenous in some parts of Asia. Farmers in Cebu, Philippines have used indigenously a contour hedgerow system of *Leucaena leucocephala* to cultivate steep slopes even before 1923, according to the research of Francisco (1998).
Planting hedgerows of leguminous tree species along the contour of sloping fields was deemed to be a promising technology. This technology provides a vegetative barrier to soil erosion while contributing green leaf manure to the cereal crops (rice or corn) grown in the alleys. By the early 1980s, hedgerow intercropping was advocated widely as a technology to better sustain permanent cereal cropping even with minimal or no fertilizer input (Garrity 1993).

**Agroforestry and diversified cropping in the uplands**

Like contour hedgerows, agroforestry is also an indigenous technology in the uplands. The study of the indigenous systems of the Hanunuo Mangyans revealed that they maintain three agroforestry systems: swidden/kaingin, multi-storey farming and home gardens (Gascon 1998). Swidden farms were cropped with rice or corn; multistorey farms, with cash crops such as bananas and mangoes. The basic need is produced in the kaingin farms, which were found to be nonsustainable because farmers tend to cut more forest land for swidden farming. The best recommendation to discourage opening up of more areas for swidden farming is to give more security of tenure to forest occupants.

The sloping agricultural land technology is another agroforestry scheme. In Laguna, this was studied in a modified form (from the one developed by the Mindanao Baptist Rural Life Center) (Calanog 1990). However, the recorded rate of adoption is also low (Garrity 1993).

An agroforestry farm assessment (AFA) was designed by Lasco and colleagues to assess the positive and negative impacts of any introduced agroforestry technology. This provides a continuous feedback mechanism for immediate technology refinement and improvement. Farmers and upland extension workers can use this. There are four defined criteria in this assessment: productivity, security, sustainability and adaptability. However, this has to be tested for practical use. There was no mention of how the sustainability criteria will be observed in the short term. In a similar manner, Lawas and his colleagues also recommended the use of agroforestry land capability mapping schemes (ALCAMs) to plan agroforestry programs. This answers two key questions: adaptability of the given site to or better use for agroforestry; and appropriate systems, practices and components of the area. No application of this or the AFA is reported in literature.

**Other upland soil conservation measures**

Most studies conducted under the orchestration of the Bureau of Agricultural Research (BAR) during the 1990s focused on the management
of soils and upland rice crop. The projects included an examination of indigenous materials to be used as fertilizer, the timing of fertilizer applications that will maximize yields, the timing of planting to minimize the harsh effects of the different mulch media and tillage practices for upland rice. Different rates of rice straw compost and guano as supplementary fertilizer to upland rice were also studied. Here, the exact or appropriate amount of supplemental fertilizer to be used was not established. All these studies are location specific. Almost all showed that the economic returns of the introduced practices are very high (probably because the family labor is not imputed as cost). Adoption studies were not available for these technologies.

Policy options for upland soil conservation

Policy options for soil conservation in the uplands have not been a popular area of study because of the common perception that technologies are the better option for subsistence upland farmers. There is an intricate story behind why there is a need to look at policy options for soil conservation. Coxhead and Rola (1998) argue that prices outside the watershed influence both land use and soil conservation decisions of upland farmers. This assumes that planting of perennial crops is also a soil conservation measure. It is likewise argued that nonfarm incomes affect upland farmers labor use and hence, technology choices. Commodity and input prices, and other economic instruments are affected by economy-wide shocks, both at the global and local levels. It is important to understand that intersectoral linkages can significantly influence environmental degradation caused by upland agriculture.

Policies to promote soil conservation measures at the community level (i.e. through incentives or subsidies) may make economic sense. This is because the benefits derived will not only accrue to the individual farmers but to the community at large. There are instances where it had been difficult for individual farmers pay for soil conservation Technology (Francisco 1998). The appropriate subsidies and incentives are, however, still an issue that needs further research.

Factors influencing adoption of upland soil conservation practices

Early on, one of the identified reasons for the low adoption of perennial crops was the lack of security of tenant tenure. This could occur in areas where a lot of migrants come to use the lands. Native residents have to also be taught of more sustainable technologies to keep them away from the kaingin system of farming. Government, thus, has put in place such programs
as the stewardship contract certificate where tillers in government lands of more than 18 percent slope have a long-term contract to till. Other programs, such as those on reforestation and agroforestry, encourage farmers to go back to perennial crops. Accessibility to markets also increases farmers’ incomes and help sustain their means of livelihood with agroforestry systems. Note that high discount rates and unsecured land tenure are the ones that reduced farmers’ value over sustained economic returns from hedgerow intercropping (Garcia et al. 1996).

The literature likewise cite the following as factors affecting adoption of soil conservation practices in the uplands (Villanueva et al. 1993): (1) Farmers’ perception of the extent of the soil erosion problem; (2) Family income, liquidity position and debt-asset ratio; and (3) farm size, land tenure, age of farmer, land productivity and slope of the land.

Water and agriculture
If water supply for agriculture is at all declining, what are the alternatives? What needs to be done in the water stressed agricultural areas in the lowlands? What are more efficient types of water delivery systems? The review in this section will focus on the productivity of water, the available alternative water technologies and the constraints in the efficient delivery of water to the farmlands.

Water productivity
A recent investigation about irrigated rice farming in Iloilo showed that water was a major constraint to higher productivity. Water was the most significant source of yield loss and measured to be about 50 percent in one particular season (Rola et al. 1998). Such unavailability of water and incorrect water timing are due to the degraded watersheds and the poor maintenance of the CIS in the area. This case study shows that any efforts to maintain and sustain lowland agriculture must take into account the source of water. There is a need to come up with alternative water sources and water delivery technologies that will lead to an efficient and more productive water input.

The issue on water productivity was addressed in the paper of Guerra et al. (1998), where the authors reviewed the literature on irrigation efficiency and the potential for increasing water productivity in rice-based systems. They argued that there is a need to measure the productivity of water at the farm, system and the basin levels, and to understand how the productivity at one level relates to the productivity at another. Information from these water balance studies can be used to identify the potential
economic benefits of alternative interventions and the most appropriate strategies for increasing water productivity in rice-based systems.

**Water technologies**

Table 6 summarizes the different technologies for water delivery in agriculture. Experimental studies at the Philippine Rice Research Institute (Philrice) showed that intermittent irrigation can save about 40 percent of water without sacrificing yield in the dry season (De Dios et al. 1998). The results of the drip irrigation trials for cotton production as reported by Ganotisi et al. (1998) showed that drip irrigation was more economical than the conventional furrow irrigation methods. However, drip irrigation is quite expensive for small farmers, but affordable to medium- and large-scale farmers as noted in a study in Cavite (Lamanilao 1990).

Worth mentioning are the farmer friendly indicators for drip and furrow irrigation scheduling in tomato that were studied by Tanguilig et al (1996). The leaf of the upland rice was used as an indicator and compared with other indicators. Irrigation was done whenever the upland rice’s leaves rolled slightly. Water application was stopped when the leaves of the indicator became fully unrolled. Using this indicator, irrigation frequency was reduced by 67 percent (in drip) and 60 percent (in furrow) when compared to the control.

Results of a study on the trickle irrigation system using a twin-wall emitter tubing showed that its seed cotton yielded 25 percent higher than that via the conventional irrigation method (Cruz and Agulto 1996). At the same time, 30 percent of water can also be saved. Furthermore, Baradas and Mina (1998) argued that natural rainwater management is a very efficient and cheap precursor, complement or even alternative in some cases, to the irrigation of currently rainfed areas. Floods and droughts are nature’s solutions to low food production. To use this phenomenon to farmers’ advantage meant a thorough knowledge of weather trends and management of the water resource. In practice, these concepts boil down to sunshine harvesting, rainfall harvesting, and integrated flood, soil sediment and drought control.

Onfarm reservoir (OFRs) technology is found more favorable for areas that have mild slopes to support gravity distribution of the stored water and where water loss by seepage and percolation is low. The economic analysis, assuming a 15-year life span of the reservoirs with a three-year maintenance schedule, shows a high benefit-cost ratio of 5.1, or an internal rate of return of 177 percent. This was found to be viable in parts of Central Luzon (Moya
<table>
<thead>
<tr>
<th>Technology</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Intermittent irrigation</td>
<td>Used in rice, this consists of applying 5 cm. water every 14 days from 10 to 80 days after transplanting.</td>
</tr>
<tr>
<td>Drip irrigation</td>
<td>This method provides water most efficiently by applying it at the right rate and practically only to the plant root area.</td>
</tr>
<tr>
<td>Designed trickle irrigation system</td>
<td>This uses a twin-wall emitter tubing.</td>
</tr>
<tr>
<td>Rainwater management</td>
<td>A weather-based decisionmaking for water management and crop production, this involves developing localized cropping patterns based on climatological probabilities of the occurrence of significant weather.</td>
</tr>
<tr>
<td>Onfarm Reservoir</td>
<td>Stores water for intermittent production. Socio-economic and technical constraints impeded farmer adoption.</td>
</tr>
<tr>
<td>Shallow tubewells for irrigation</td>
<td>These are equipped with centrifugal pumps that are driven by single cylinder diesel engines. Optimal placement of rice in the fields can sustain continuous water supply. This is popular in most areas of the country.</td>
</tr>
<tr>
<td>Drainage technology</td>
<td>Practical surface drainage method that is used to reduce interlogging through a simple ridging technology.</td>
</tr>
<tr>
<td>Small electric pumps</td>
<td>Just like shallow tubewell principle, but needs electricity. This is only feasible if electric lines are near the fields.</td>
</tr>
<tr>
<td>Hydrophonics</td>
<td>Production is in a soil-less and waterless medium.</td>
</tr>
</tbody>
</table>

Note: For more information of constraints and advantages of some of these technologies, refer to David (1999)
et al. 1998). The technology was also found to be indigenous in origin. An OFR optimization model (FROM) was later developed (Galang and Bhuiyan 1994; 1995) with the objective of maximizing returns from the use of the OFRs. However, the researchers found some difficulty with this method at the level of the extension agents.

A nomograph\(^2\) was then developed, which allowed some practical use for the model. This nomograph was expected to help farmers as well as extension staff decide on the crops to plant and the area to cultivate for particular crops to maximize profits. It is not known whether this tool was actually used by farmers or by extension agents.

The Geographic Information Systems (GIS) method was recommended in identifying the ideal location for OFRs (Galang et al. 1994). The spatial analysis systems (SPANS) were used but only at the macro level. Micro level surveys are still needed to determine whether OFRs should be developed in a given area and where they should be located. A 1994 evaluation of the OFR showed that additional benefits included being able to grow dry season rice crop and fish in the reservoirs. On the other hand, some of farmers’ main complaints were insufficient capacity, high water loss and locations that required pumping (Fujisaka et al. 1994).

Small farmer reservoir (SFR) is an upstream defense against soil erosion and flooding of the low lying areas. Undan et al.’s paper (1994) focused on the pilot SFRs set up in 10 towns of six provinces in Central Luzon. Since the SFR technology promotion efforts started in 1990, some 572 SFRs have already been established in 42 barangays within the 12 towns of the six provinces. It is not known at this time whether this system became sustainable.

The shallow groundwater potential for irrigation was studied by Sibayan and Undan (1994). In this technology, farmers either dig wells or drive 4-inch GI pipes into the ground to draw water from shallow wells. Results revealed that the individual pump systems have service areas ranging from 1.3 ha. to 2 ha. for the nonrice crop and can increase to 1.9 ha. to 3.2 ha. for maximum pump efficiency. Small electric pumps were also introduced to Philippine farmers (Rotor et al. 1993). These were deemed to be a promising technology only if there are electric lines near the rice fields. Based on the Iloilo data, the total costs of the supplemental irrigation

\(^2\)This is a chart representing numerical relationships.
from the electric pump is P1,406 or 564 kg/ha (Resurreccion and Salazar 1991). Spiral pumps were likewise designed as nonconventional means to harness available water (Naegell et al. 1990).

One of the latest technologies for water as well as soil management is the hydrophonics (Dorado and Balimbing 1999). This is production in a soil-less medium and will produce higher quality products free of pesticides and other chemicals. This is a very promising technology although it needs an ex-ante economic analysis.

**Constraints to effective water delivery and efficient water use**

Why is there a decline in the system performance of the irrigation structure? The possible reasons are two-fold: (1) the deterioration of the quality/quantity of the irrigation water; and (2) the management of the system. When it comes to management of public irrigation systems, the poor performance of many governments is well documented (Easter 1993). In this study, Easter (1993) uses a model that includes internal and external assurance, commitment and fairness to explain the performance of irrigation systems in the various Asian countries.

Public investments in irrigation have tapered off due to lack of funds for systems operations and maintenance (Marciano et al. 1997). The resulting deterioration in the condition of some systems encouraged investments in privately owned irrigation facilities instead. The economics of the private system as analyzed by Gascon and Hossain (1995) showed that pump-irrigated farms improved land productivity and profitability. This is due to the reliable and efficient water source.

The irrigators’ association has an important role in increasing efficiency in water use. Llandelar (1995) showed that irrigators’ association can bring about more services (and better quality). Oliva (1995) also notes that the NIA’s support to the agrarian reform beneficiaries significantly affected the extent of the irrigation project in Legaspi, Albay. Nonetheless, a number of questions continue to plague the water delivery system. For instance, what has been the impact of the NIA policy to turn over the irrigation management to farmers’ coops? What are the changes made in the NIA? What extent have farmers taken over the management of the irrigation and how did they perform? What are the productivity effects (Wijayaratne and Vermillion 1994)? What are the indicators for evaluating whether the farmer-managed system works?

An earlier study in Iloilo by Alicante (1991) showed that irrigation systems that were economically and socially sustainable were those with larger farms and involving mostly farm owners and lessees. Other factors
affecting conflicts and performance among communal irrigation system members are kinship and political relationship (Poudel 1990). The political relationships and kinship had a significant negative impact on members’ time for repair and maintenance, while farmer-to-farmer reciprocal relationship and agricultural incomes had positive effects. The location of the members’ farm within the service area had no significant effect on any of their performance except their participation in repair and maintenance.

A recent analysis showed that the thrust in the development of new irrigation facilities should be on small scale, private sector-led, farmer-controlled, cost effective and efficient minor irrigation technologies (David 1999), instead of the traditional NIS/CIS systems. In other Asian countries, water markets are also getting to be popular in the farming communities. Such arrangement is especially convenient in cases where farmers’ plots are far apart from each other. The farmer can sell his water from the pump to his adjoining (neighboring) farmer and buys water from whoever is near his plot (Bhandari 1999).

Part of the efficient use of water for irrigation also requires a disciplined scheme for water distribution and rotation in the service areas. During the dry months, where water level is very low, a scheme of water rationing may have to be devised (PCARRD et al. 1999).

Proposed research program for NRM: focus on agricultural resource management

Soil management

Several research areas can be defined for sustainable soil resource management in particular, and NRM in general. These are:

1. **The characteristics of the soil and the dynamics of such features as a result of the farmer’s cropping patterns.** In the case of problem soils both in the upland and lowlands, studies may focus on whether subsidizing the treatment to bring the soil back to its fertile state may make economic sense. In such a case, the soil can also be treated as a common property resources. What is the economics of giving the information on sustainable soil management technologies to the community as a whole rather than expecting individual farmers to be optimal managers of the resource?

   What is the cost of agricultural sustainability? Who is going to shoulder this cost? Is it fair for farmers to bear this burden alone? What policies can be formulated to share this cost to consumers and other beneficiaries?
2. **The development of management information as the most important input in sustainable agriculture.** How do farmers handle this information? How can government upgrade farmers’ management skills so the latter can perform better for sustainable agriculture?

There is also a need to unravel the processes farmers decide in agricultural resource management. What are farmers’ knowledge bases? What other information can increase that knowledge base for sustainable resource management? How can this knowledge-intensive technologies be extended? How do researchers scan farmer knowledge and determine the base by which intervention would be useful?

One can also study farmers’ responsiveness to diagnostic kits as aids/tools in his soil management decisions. What are the roles of government laboratories as decision support to farmers? How can impact be measured in terms of improvement in soil quality?

3. **Long-term farming systems research on the impact of alternative cropping patterns and soil management technologies on the resource base, and on farmer incomes.** The Regional Integrated Agricultural Research Council (RIARC) can do this, but only on a long-term basis. The choice of crops and technologies should be attuned to the market demand in the area, and the feasibility and social acceptability of the technologies. Along this line, *ex-ante* technology assessment can use the data from these experiment stations.

4. **The commercialization of biofertilizers.** What are the merits of biofertilizers’ use? What would be the economics of purely subsidizing the use of biofertilizers? What would be the economics of having a package of fertilizers that contain both the organic and inorganic elements? Why does the private sector not respond to the knowledge that a combination of organic and inorganic fertilizer is more sustainable across all crops studied, and thus package the combination of such? What is the role of the Fertilizer and Pesticide Authority (FPA) in the use and commercialization of biofertilizers?

5. **Sustainable soil management technologies in the context of the broader economic development objectives.** How does the country reconcile labor-intensive sustainable agricultural technologies and the
growing scarcity of labor in agriculture as a result of increases in nonfarm income opportunities? This condition is to be expected as the country shifts to a higher level of economic development.

6. **Contribution of the resource base, that is, soil productivity, in future productivity growth analyses.** This area requires an interdisciplinary work between soil and social scientists in assessing soil productivity in the different production environments.

**Water management**

The issue in water management is also about water productivity. This is, however, a function of water quantity, quality and water delivery efficiency. Agricultural decisionmakers should take active part in the management of the watershed as a significant source of surface water for irrigation. The shallow groundwater should be guarded from the environmental pollutants that could affect its utility in agriculture. The current debate by experts on the optimal combination of two sources of irrigation water, i.e. surface water and groundwater, should also be taken into consideration. Finally, the most efficient mode of delivery should be studied. Research areas for water management in agriculture could fall under any of the following:

1. **Good watershed management as a prerequisite for a sustainable source of irrigation water.** How can the Department of Agriculture help in preventing future degradation of this water resource? What is the economics of water use in agriculture when compared to other competing uses? How can the roles of institutions and policies in the sustainable management of watersheds be highlighted? What are local initiatives for watershed development and management?

2. **Water quality and its use in agriculture.** What are the causes of the water pollution? How can these be minimized? What are the impacts of polluted water on productivity?

3. **Alternative delivery of water.** Use of small water pumps and other private initiatives are getting popular. Water markets are developing in other countries. This is to make the most efficient use of water in particular locations. What are incentives for efficient water market to work?

Public sector research on the optimal distancing, coverage and timing of water extraction is also needed. The design development of irrigation machines may be left with the private
sector. However, institutional support in terms of credit for small farmers and subsidies in gasoline/diesel fuel has to be studied.

4. *The merits of the use and promotion of more knowledge-intensive water management (i.e., rainwater harvesting) technologies.* Optimal timing of irrigation in crops, use of diagnostics for the right timing of irrigation, farmers’ indicator of timing of water use, etc. have been studied but not popularized. What could have been the constraints?

**Conclusion**

The findings of this review show that research on soil and water management has in the past been substantial. Despite the volumes of research reports and other publications, the ongoing resource degradation implies that the desired sustainability objectives of all these studies are not attained. There may be a need to reexamine (1) the context in which soil and water management research agenda are designed, and (2) the process of filtering the results to people who actually use and/or decide on the use of the resource.

One approach to achieve impact is to put NRM research in the context of regional research program. Regional research programs contribute to agricultural development in a number of fields (Janssen and Kissi 1997), among which is the rational exploitation of the natural resources such as water, soil, vegetation and genetic resources. Among others, regional research programs take into account the different ways natural resources are used by farmers and others, and the links between resource use and resource quality.

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II
Literature review of the agricultural distribution services sector: performance efficiency and research issues

by Ponciano S. Intal Jr. and Luis Osman Ranit

Introduction
A competitive agriculture sector requires not only more productive farms and agricultural processors but a more efficient agriculture distribution system as well. This is especially the case for the Philippines, an archipelago of thousands of islands but where only a few are large enough to have the farm size that allows economies of scale in processing. In comparison to Vietnam or Thailand or Peninsula Malaysia, the Philippine agricultural economy is more vulnerable to the inefficiencies and vagaries of the country’s distribution system. There is a familiar lament about the state of the Philippine agricultural distribution system; that is, it is cheaper to bring corn from Bangkok to Manila than to bring corn from Cotabato to Manila. This familiar lament exemplifies a fragmented agricultural economy.

A fragmented agricultural economy has negative welfare effects on the country. First, as the Congressional Commission on Agricultural Modernization (Congress of the Philippines 1997) noted, "marketing inefficiencies result in farmers’ getting low prices for their produce and consumers paying more than the fair price.” Second, unexpected large harvests leave farmers with much lower farm prices in a fragmented economy than in a well-functioning distribution system. Third, the unexpected demand surges would increase imports rather than sales of domestic farmers. Part of it may be the result of the system’s limited capacity to absorb fluctuating volumes of production. The farmer’s capability to respond to market demand is also a critical issue here. Fourth, an inefficient distribution system leads to additional pressure for agricultural protection so that
domestic producers will be able to compete with imports in Greater Manila, the country’s largest net deficit food market. And finally, the resulting high food prices lead to demands for higher wages.1

The last mentioned effect deserves elaboration. Higher wages without corresponding increases in labor productivity means higher unit labor costs, which—other things being equal—result in the decline of the international competitiveness of the country’s export and import-substituting industries. In addition, higher wages lead to higher-than-necessary wage bill in the country’s nontraded sectors (e.g., government). Indeed, for the government that is faced with tight budget constraint, the higher wage bill leaves less room for expenditures in the very important areas of operations and maintenance as well as capital expenditures. In short, the protection-induced higher domestic food prices, caused in part by the fragmentation of the agricultural economy and the inefficiency of the agricultural distribution sector, have significant macroeconomic impact on the rest of the economy.

The macroeconomic implications of high food prices cannot be underestimated. Indeed, it can be argued that one key reason for the comparatively lackluster performance of the Philippine manufacturing sector during the 1990s was the higher wages in the country compared to those of competitor countries such as Indonesia and China. The higher domestic wages coincided with the significant rise in agriculture protection, and the consequent higher food costs, in the country during the latter 1980s and the 1990s. Aggravating the cost-push effect of the higher food prices on the manufacturing sector were the decline in industrial protection and the appreciation of the Philippine peso. As a result, many manufacturing plants folded up. It has been mainly in the semiskilled, less wage-sensitive industries such as electrical machinery and automobile parts where the Philippine manufacturing sector registered robust growth.

Even the country’s nontraded sector has been affected by the agriculture protection-induced higher wages during the 1990s. Thus, for example, the World Bank (2000) asserts that the rise in the share of personnel expenditures in the total government budget in the 1990s can be explained in part by the salary increases during the decade as induced in part by higher food costs. Because of the higher wage bill, the government budget for operations and maintenance suffered, leading to, for example, poorly maintained irrigation facilities, roads and bridges. It must be

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1Higher prices do not filter down fast enough to the production and remains in the intervening system; therefore, high prices take time to become incentives for more production. Intermittent high price fluctuation also does not significantly improve farmers’ purchasing power.
emphasized that the poor maintenance of the country’s main irrigation facilities, for example, has contributed to the significant drop in recent years in the proportion of farms irrigated compared to the total programmed irrigated areas (Tolentino et. al. 2001). Clearly, with the drop in the actual irrigation rate, agricultural productivity is ultimately compromised. Similarly, the inefficiency of the agricultural distribution system can be attributed in part to poor rural infrastructure facilities such as rural roads and bridges.

It is therefore important that the government gives as much policy importance to the distribution system as to the production sector. How can the Philippines have an efficient and dynamic agricultural distribution services sector? How can the sector be a catalyst for changes and innovation in the agricultural sector? Making the distribution system and the market work better for the farmers, processors and consumers is a continuing challenge. This means, on the one hand, allowing private sector reforms under competitive or contestable conditions that encourage continuing private investment in the distribution services sector. This also means, on the other hand, high social returns to the government’s complementary roles and investments in the sector. By making the market work better, farmers and processors are provided better information on the changing demands on the agricultural sector and its products. Also, farmers, distribution service providers and processors will be able to coordinate better in meeting effectively the changing demands for agribased products. With the agricultural sector remaining as a major economic sector of the Philippine economy, a more efficient agricultural distribution sector will lead to greater social benefits to the whole society.

Because there is a critical need for the agricultural distribution service sector to be efficient, progressive and dynamic in the long term as well as for the Philippines to be competitive, productive and dynamic in an increasingly liberalized trading environment, one has to understand the agricultural sector in the following areas:

1) the organization and dynamics of the agriculture distribution services sector;
2) the interaction and interrelationship of markets and prices across area and over time; and
3) the impact of government policies and programs on the workings of agricultural markets and the agricultural distribution services sector.

This implies a need for a research program on the Philippine agricultural distribution sector as well as agricultural markets.
This paper is a review of literature to jumpstart the research program. It focuses on the characterization of the structure and performance of the agricultural distribution sector, and on the efficiency or inefficiency of agricultural markets as well as its distribution services sector. Specifically, the literature studied can tell something about how the flow of agricultural goods is characterized through the distribution system. It can say a lot about the efficiency of the price transmission process in the Philippine agricultural economy. Its studies on price margins can show the (in)efficiency of agricultural product markets and how such could be explained by monopoly elements or by transport, storage and handling costs. From there, one can glean the research gaps and possible solutions to the issues of agricultural market (in)efficiency and the development of the agricultural distribution services sector.

This paper consists of five sections. Section Two is a characterization of the Philippine agricultural distribution system. Section Three examines the issue of market integration and the efficiency of the price transmission process. Section Four discusses determinants of price margins, including the issue of monopoly in agricultural trading. The section also discusses policy issues. Section Five presents research issues and gaps.

The Philippine agriculture distribution system

Agricultural distribution or marketing is primarily concerned with moving agricultural produce from the farm gate to consumers at home and abroad. However, bringing agricultural produce from the farm to the consumers involves a complex distribution system involving several functions, including assembling, cleaning, sorting, transporting, storing, processing, grading, wholesaling, retailing, importing and exporting. Complementary or support services include financing and market information services. Marketing costs are necessarily incurred at each stage of the distribution system.

Complex and diverse distribution system

The prevailing impression about the Philippine agricultural distribution system is best exemplified in the following excerpt from the Report and Recommendations of the Congressional Commission on Agricultural Modernization (Congress of the Philippines 1997).

The country’s agricultural marketing system is complicated, unwieldy and chaotic. Too many layers impede the smooth flow of agricultural commodities from the producers to the consumers. The system could be compared to an hourglass, where the producers are
on top and the consumers in the bottom. The market intermediaries are crowded in the neck of the hourglass…. High marketing costs are partly due to poor infrastructure and the multiple layers of trade margins.

The complexity, diversity and multiple layering of the agricultural distribution system are best illustrated by a number of studies on the marketing systems of a number of agricultural products in the Philippines. These studies were undertaken by the Foundation for Resource Linkage and Development, Inc. (FRLD) and the Confederation of Grains Association, Inc. for the Department of Agriculture and United States Agency for International Development (USAID). Studies include those on corn, potato, mungbean, mango, tomatoes and cutflowers. Other important studies are on rice (Lantican 1992), livestock (Galvez 1998) and fish (Sikap/Strive Foundation 2000). A good review of the marketing participants and marketing flows is given in Sikap/Strive Foundation’s (2000) final report of the study on strategic food and agricultural commodity exchange.

Various studies show that market participants in the agricultural distribution system are numerous and varied. Similarly, the distribution channels and networks differ among commodities and even by area.

Participants and their relationships in the distribution system are illustrated in the case of corn in Cagayan Valley (see Figures 1a and 1b and Malenab et al. 1991). Farmers’ link to the demand market is primarily through the hierarchy of traders at the barangay, municipality and provincial levels. The municipal and provincial traders distribute the yellow corn mainly to the integrators and feedmillers in Central Luzon, the National Capital Region and Southern Tagalog. The less important links are through the farmers’ cooperatives (which then feeds into the National Food Authority) and the direct links to poultry integrators and feedmillers in the Cagayan Valley region. Other distribution links include:

1) the so-called viajeros or itinerant traders from the demand regions (Central Luzon and Southern Tagalog) who travel to Cagayan Valley for the yellow corn;
2) agents and brokers who are individuals acting as intermediaries between the viajeros and municipal traders; and
3) Trader-brokers who are feed ingredient suppliers and who broker between corn traders to supplement their feed ingredient business.

Itinerant traders usually offer slightly higher prices to farmers than the prevailing prices to make sure that their trucks brought to the site are filled up. Agents and brokers receive commissions for their services.
Notice that the participants in the yellow corn distribution system barely include retailers. This is because yellow corn is largely a production input into the feedmilling, livestock and poultry industries. In contrast, in largely consumer agricultural produce such as potatoes (Figures 2a and 2b) and mungbeans (Figures 3a and 3b), wholesalers-retailers and retailers play large roles in the distribution process, although producers have direct links primarily with wholesalers and assemblers (also called viajeros), wholesalers (for potatoes), contract buyers and agents (for mungbeans).

The case of rice also brings out the multilayered relationship at the wholesale level before the commodity reaches the consumer. Generally, the producers’ link is with assembler-wholesalers, wholesalers and commission agents, except for those with limited marketable surplus where palay is sold primarily to nearby millers or local buyers. The assemblers-wholesalers and commission agents pass the palay to rice millers-wholesalers
and to wholesalers-retailers before rice (unhusked palay) is sold to consumers, primarily through retailers (see Lantican 1992 as presented in Sikap/Strive Foundation 2000).

The marketing channel of roses for Benguet, Cebu and Davao City further illustrates the diversity of marketing flows and relationships (Figure 4 and FRLD 1993). In major supply areas where local demand is limited, or
in the major demand areas that are far from production areas (e.g., Benguet and Davao City), the marketing flows are primarily through the assembler-wholesalers, wholesalers-retailers and the assembler-wholesalers-retailers. In sharp contrast, in places such as Cebu—where production is barely enough for the local market—the preponderant marketing link is from
Figure 3a. Marketing channels of green mungbean in Pangasinan, December 1993-April 1994

Source: FRLD 1995b
Figure 3b. Marketing channels of yellow mungbean in Pangasinan, December 1993-April 1994

Source: FRLD 1995b
the producers to the retailers and florists, rather than to the assembler-wholesalers.

In the case of carabao mangoes in Cebu, where the fruit’s producer is also the main producer of processed mangoes, the bulk of the marketing flows is from farmers to processors (Figure 5). In Batangas, where carabao
mangoes are mainly for the out-of-province markets (e.g., Manila), the marketing flows are primarily through the wholesalers directly or indirectly that is, through contract buyers who then sell to wholesalers (Figure 6).

The diversity of marketing participants, channels and network of relationships suggest that economic specialization of marketing functions depends on a number of considerations. The factors include the need for processing (or not) the product, the extent of economies of scale in processing as well as the physical distance from the producers to the consumers. Thus, a commodity that requires huge volume to maximize economies of scale of processing (primarily for feeds, in the case of yellow
Figure 6. Marketing channels of carabao mangoes in Batangas, March - May 1993


corn) requires a hierarchy of traders to assemble the needed volume from widely dispersed producers. In contrast, for commodities with virtually no economies of scale of processing and with production largely geared for a large local demand (e.g., roses in Cebu) or for commodities where the main market is locally based (as in carabao mangoes in Cebu), the marketing channel can be direct from producers to retailer-florists or food processors. For commodities without significant economies of scale in processing but
which, nonetheless, face a wide physical distance between the supply areas and the major demand areas (e.g., roses and potatoes from Benguet or potatoes from Northern Mindanao), a reasonable amount of volume is needed to minimize the cost of transport. In such circumstances, assemblers become more important. Thus, the farther the distance, the greater the reliance on assembler-wholesalers in the distribution chain. In addition, assembling and wholesaling chain is much more differentiated and structured in commodities where producers are far more dispersed, demand is large and main demand areas are either geographically distant from the supply areas but narrowly confined (e.g., Metro Manila for corn) or geographically dispersed (as in the case of rice). As a result, the potentials for profitable niches in the distribution chain become greater.

The studies cited above also provide a good description of the nature of niches, specialization of functions, and network of relationships in the distribution chain. Thus, for corn in the Cagayan Valley and Southern Mindanao (Malenab et al. 1991; Manalaysay et al. 1988), the barangay-based traders tend to be small traders, usually residing in the same (or nearby) barangay as the farmers and acting as agents or assemblers for large municipal traders. They have credit marketing tie-up with the farmers, too. That is, they usually have sari-sari stores that allow themselves to extend subsistence credits to farmers in terms of dry goods in exchange for the latter’s harvested crops. The municipal and provincial traders are the large traders, who buy either directly from farmers or through the assemblers (e.g., barangay traders) and own warehouses and transport equipment to carry the produce from the farmers’ land to the demand markets. The municipal and provincial traders tend to have multiple businesses and, especially for provincial traders, have access to formal financial institutions. The provincial traders, usually based in the major regional trading centers, are big volume traders who get orders from big buyers in major demand areas; e.g., for corn, these purchases may be integrators, feed millers and medium-to-large hog raisers and poultry growers in Metro Manila, Central Luzon and Southern Tagalog.

Assemblers-wholesalers are major players in the distribution process in a number of agricultural commodities: e.g., potatoes, mungbeans and cutflowers. They have both the financial and logistical capability to procure and transport agricultural produce to the major demand centers. Because of the needed large volume, some provide financing and cash advances to farmers to guarantee the volume of procurement (FRLD 1995a and 1995b).

There are other examples of specialization of functions and niches in the agricultural distribution process. For example, in the potato industry,
barangay-based agents for the assemblers-wholesalers supervise (in return for a commission) the sorting/grading and packaging activities done by the farmers to conform to their trader-buyers’ requirements (FRLD 1995a). In the mungbeans industry, the contract-buyers who offer bids to farmers for their whole harvest (pakyaaw) take care of the harvesting and post-harvest activities (FRLD 1995b). For cutflowers, specialized or multi-commodity brokers facilitate the entry of planting materials, cutflowers, and cutflower tools and equipment into the country.

It may be argued that farmers’ heavy reliance on traders to bring their produce to consumers is because farmers themselves failed to band together into organizations such as cooperatives that can provide the services provided by traders. However, a few success stories have shown how this weakness was resolved. In the case of cutflowers in Negros Occidental, the growers formed a strong and well-organized cooperative that effectively prevented the entry of traders except for the local retailers and florists of Bacolod (capital city of Negros Occidental). The cooperative sells cutflowers for the grower-members as well as provide planting materials, farm inputs and technical information on proper cultural practices (FRLD 1993).

The credit-marketing tie-up and the multibusiness nature of many of the traders are two of the striking characteristics of the agricultural distribution system. The credit-marketing tie up stems from the farmers and even small traders’ lack of access to the formal credit market.² Thus, the implicit financial advances given by traders to farmers allow the latter to smooth out their consumption pattern despite the seasonality of production. In addition, the credit-marketing tie-up provides traders a mechanism to effectively monitor and generate information on the reliability of farmer-borrowers. It also allows traders to reduce the uncertainty of supply; that is, akin to a futures contract. The multibusiness nature of many traders appears to be a response to the seasonality of crop production and harvesting. Because of the large fixed costs incurred by large traders (in terms of storage and transportation facilities, for example,) traders need to engage in related businesses to maximize the use of their fixed capital, especially during the off season.

There are indications from studies that credit-marketing tie-ups are not always resorted to by traders. Thus, for example, the newer corporate-type "trader-shippers" in Southern Mindanao buy spot rather than extend credit to farmers in exchange for crops during harvest time (Manalaysay et

²For instance, there was a time when trade of commodities in Bicol was dominated by the use of privately issued “drafts” and “scripts” for the payment of goods.
al. 1988). The de-emphasis of the credit-marketing tie up appears to be in response to farmers' inability to repay their loans. The studies provide a snap shot at a point in time. What is not clear is whether or not credit-marketing tie-ups are indeed being resorted to less and less in the agricultural distribution system and if so, why.

In summary, the complexity, diversity and multiple layers of the agricultural distribution system is the market's response to the differing requirements of, and the profit opportunities accorded by, the different commodities because of varying infrastructure bottlenecks and credit constraints in various parts of the country.

Are the complexity, diversity and multiple layering of the agricultural distribution system in the Philippines unique among developing countries? If the Vietnamese rice marketing system is any gauge, then the Philippine situation is most likely typical of a developing country's agricultural markets. As the International Food Policy Research Institute (IFPRI) report on the Vietnamese rice economy (Goleti et al. 1996) points out, the web of relationships among the marketing agents in the Vietnamese rice system is "... very complex. Farmers, assemblers, wholesalers, retailers, millers, and SOEs (state enterprises) all interact with each other and are responsible for the movement, storage, processing, export and distribution of the paddy produced in the country."

In the distribution of paddy or palay, the strongest link is from farmers to traders, and then from traders to millers. "This link is related to the farmers' lack of transportation, their remote locations and their need for quick cash to repay the loans they incurred in production process. Similarly, the link between traders and millers is being strengthened by credit relations whereby millers give short-term credit to traders to facilitate procurement activities (Goleti et al. 1996). The weak links are from farmers to millers as well as from farmers to state enterprises (which are akin to the Philippine National Food Authority).

The IFPRI Report further notes:

[There is a]...very complex set of relations between retailers, wholesalers, and assemblers. The intermediation takes place at different sizes of operation, so that a small
assembler sells to a larger assembler or to a wholesaler. These transactions are partly related to spatial dimension, so that a wholesaler working at the district level might sell to another wholesaler working at the provincial or regional level. There is a particularly strong link between assemblers and wholesalers.

It is apparent from the IFPRI Report that the Vietnamese rice marketing system is almost a carbon copy of the Philippine marketing system for grains such as corn.

**Marketing institutions: food terminals and commodity exchanges**

The rich detail on marketing channels and participants in the studies cited above, conducted primarily for the Department of Agriculture includes the description and analysis of major public markets and the Food Terminal Incorporated (FTI). Indeed, a key component of the "Global Competitiveness Strategies for Philippine Agribusiness" project is the study on the desirability and feasibility of a system of commodity exchanges in the country. The study included the analysis of the experiences of other countries (Thailand, Japan, Taiwan and South Korea) in the development of commodity exchanges and wholesale markets. Underpinning the government’s interest in the development of commodity exchanges appears to be the presumption that the agricultural distribution in the country is disorganized and haphazard, that the facilities for storage, refrigeration, handling and trading are inadequate resulting in high spoilage costs, and that farmers implicitly shoulder the attendant high marketing costs through lower and unstable farm prices.

The Sikap/Strive Foundation report (2000) shows that the ownership of such commodity exchanges and wholesale markets ranges from purely private (in the case of Thailand) to joint public-private ventures (Taiwan and South Korea) to totally government-owned (Japan and Philippines). Of the cases studied, only FTI, the Philippine food terminal, failed. The report states that the failure of FTI stems from unclear vision and mission, its overdesign given the lack of provincial linkages (e.g., packing houses), bureaucratic constraints to its operations, politically motivated entry into retail operations (in the case of the Kadiwa program), and fast turnover of management. Despite the failure of FTI, the Sikap/Strive Foundation report proposes the establishment of four Food and Agricultural Commodity Exchanges (FACEs) in the country located in Bulacan (for provinces north of Manila), Batangas (for Southern Luzon), Cebu (for the Visayas) and Cagayan de Oro (for Mindanao). The report proposes either a build-
operate-transfer (BOT) or a build-operate-own (BOO) scheme, or a joint venture between the government and the private sector, with the private sector managing the exchanges and the government providing the support services (e.g., farm-to-market road leading to the exchanges).

The Sikap/Strive Foundation report fails, however, to examine what is probably the most important failing of the FTI. That is, FTI attempted to supplant the prevailing distribution system. As the discussion on the complexity and diversity of the agricultural distribution system suggests, the distribution system is a product of thousands—if not hundreds of thousands—of participants who search for profitable niches in the distribution chain and who adjust their operations to adapt to each participant’s unique operating circumstances. It is apparent that FTI would fail especially given the organizational, resource, bureaucratic and political constraints during the 1970s through the 1990s. The failure of the Sikap/Strive report to examine the FTI experience in terms of its lack of congruence with the over-all dynamics, networks and relationships in the distribution system is also evident in its analysis of the four proposed food and commodity exchanges.

This brings out the issue of efficiency of the agricultural distribution system, which is the focus of a later section of this paper.

**Economic contribution of agricultural wholesaling and retailing**

Wholesaling and retailing are central to the distribution process. Data on the wholesalers and retailers of agricultural products may provide some indication of the economic importance of the agricultural distribution system in the country. The available data from the census and surveys of establishments are on wholesalers of farm, fishery and forestry products and on the retailers of cereals, beans and pulses, fruits and vegetables, fish and other seafoods, and meat and poultry products. It must be noted, however, that the available published data do not cover all the wholesalers and retailers of agricultural products as will be discussed later. Suffice to say, the complexity and diversity of the agricultural distribution system and its participants are not well captured in the country’s statistical system.

Table 1 presents data on the number of agricultural wholesale and retail establishments for both "large" and "small" establishments, drawn

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4 An issue that is not covered in this section concerns the conversion process from the informal system to the informal system that the traders have incorporated as part of their function. For example, farmers do not issue invoices for the product they sell. On the other hand, industries need to have invoices for their purchases to comply with BIR regulations.
### Table 1. Number of agriculture-related wholesale and retail establishments

<table>
<thead>
<tr>
<th>PSIC Code</th>
<th>Industry Description</th>
<th>1988 Large Establishments</th>
<th>1994 Large Establishments</th>
<th>Change in No. of Establishments</th>
<th>Percentage Change**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level</td>
<td>Share* (%)</td>
<td>Level</td>
<td>Share* (%)</td>
</tr>
<tr>
<td>611</td>
<td>Farm, forest and marine products (WSAGL)</td>
<td>533</td>
<td>5.8</td>
<td>9,107</td>
<td>6.3</td>
</tr>
<tr>
<td>6110</td>
<td>Farm, forest and marine products (WSAGL)</td>
<td>533</td>
<td>5.8</td>
<td>9,107</td>
<td>6.3</td>
</tr>
<tr>
<td>61101</td>
<td>Palay, corn (unmilled) and other grains (WSAGL)</td>
<td>166</td>
<td>1.8</td>
<td>3,273</td>
<td>2.3</td>
</tr>
<tr>
<td>61102</td>
<td>Abaca and other fibers, except synthetic fibers (WSAGL)</td>
<td>21</td>
<td>0.2</td>
<td>102</td>
<td>0.1</td>
</tr>
<tr>
<td>61103</td>
<td>Coconut and coconut by-products (WSAGL)</td>
<td>165</td>
<td>1.8</td>
<td>4,371</td>
<td>3.0</td>
</tr>
<tr>
<td>61104</td>
<td>Fruits, nuts (except coconut) and vegetables (WSAGL)</td>
<td>20</td>
<td>0.2</td>
<td>237</td>
<td>0.2</td>
</tr>
<tr>
<td>61105</td>
<td>Tobacco Leaf Dealing</td>
<td>53</td>
<td>0.6</td>
<td>49</td>
<td>0.0</td>
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<tr>
<td>61106</td>
<td>Forest Products Dealing</td>
<td>19</td>
<td>0.2</td>
<td>94</td>
<td>0.1</td>
</tr>
<tr>
<td>61107</td>
<td>Livestock and poultry unprocessed animal products, dealing</td>
<td>11</td>
<td>0.1</td>
<td>127</td>
<td>0.1</td>
</tr>
<tr>
<td>61108</td>
<td>Fish and other seafood (WSAGL), NEC</td>
<td>60</td>
<td>0.7</td>
<td>691</td>
<td>0.5</td>
</tr>
<tr>
<td>61109</td>
<td>Farm, forest and, marine products (WSAGL), NEC</td>
<td>18</td>
<td>0.2</td>
<td>103</td>
<td>0.1</td>
</tr>
<tr>
<td>62214</td>
<td>Rice, corn and other cereals, and beans and pulses (RTLG)</td>
<td>61</td>
<td>0.7</td>
<td>12,119</td>
<td>8.4</td>
</tr>
<tr>
<td>62215</td>
<td>Meat and poultry products (RTLG)</td>
<td>10</td>
<td>0.1</td>
<td>680</td>
<td>0.5</td>
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<tr>
<td>62216</td>
<td>Fish and other seafood (fresh and dried), RTLG</td>
<td>16</td>
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<td>1.3</td>
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<tr>
<td>62217</td>
<td>Fruit and vegetables (RTLG)</td>
<td>13</td>
<td>0.1</td>
<td>2,090</td>
<td>1.4</td>
</tr>
</tbody>
</table>

*Share relative to total number of all wholesale and retail establishments.

**Percentage Change between 1988 and 1994.

Source of raw data: PDIF Retail Trade Policy and the Philippine Economy (2000)
from the 1988 and 1994 censuses of establishments. Small establishments have total employment of less than 10 persons; large establishments have 10 persons or more. Table 1 shows that out of the total number of 144,384 small wholesale and retail establishments, 6.3 percent were wholesalers of farm, forest and marine products; 8.4 percent were retailers of rice, corn, other cereals, beans and pulses; 1.5 percent were retailers of fruits and vegetables; 1.3 percent were retailers of fresh and dried fish and other seafoods; and 0.5 percent were retailers of meat and poultry products. Among the agri-products wholesalers, half were in coconut and coconut byproducts while another third were in rice, corn and other cereals trading.

Similarly, Table 1 shows that there were 9,173 "large" wholesale and retail establishments in 1988, of which 5.8 percent and 1.0 percent were wholesalers and retailers respectively of agricultural, fishery and forestry products. As in the case of "small" establishments, wholesalers of coconut products and grains formed the majority of wholesalers in 1988. Similarly, retailers of grains, beans and pulses formed the largest group of "large" retailers among agricultural products.

Table 1 also shows the number of small and large establishments in 1994. Out of 179,428 small wholesale and retail establishments in 1994, 6.59 percent were wholesalers of farm, forest and fishery products; 7.44 percent were retailers of cereals, beans, and pulses; 0.79 percent were retailers of meat and poultry products; 1.45 percent were retailers of fresh and dried fish and other seafoods; and 1.71 percent were retailers of fruits and vegetables. As in 1988, the preponderant small retailers of agricultural products in 1994 were the retailers of cereals, beans and pulses. The wholesalers of coconut and coconut byproducts as well as of grains dominated the small wholesalers.

In 1994, there were 9,775 large wholesale and retail establishments in the country. Large wholesalers of agricultural products accounted for 3.9 percent while large retailers of agricultural products consisted of 1.41 percent of the total. Wholesalers of coconut and coconut byproducts and of grains accounted for most of the large wholesalers of agricultural products. Similarly, large retailers of cereals, beans and pulses were the most numerous among those classified as large retailers of agricultural products.

The table shows that there was a decline in the total number of large wholesalers of agricultural products during 1988-1994. The decline is almost across-the-board. Nonetheless, the drop is particularly substantial in the wholesaling of coconut and coconut byproducts, tobacco leaf dealing, forest products dealing, and wholesaling of grains. Those that increased in number
were large wholesalers in fruits, nuts and vegetables as well as in livestock and poultry.

Given the appreciable gap between the two censuses (1988 and 1994), and the rise in the level of population and per capita income during the period, the decline in the number of large wholesalers of agricultural products is somewhat surprising. Such decline may indicate some restructuring within the industry toward fewer but larger establishments; this seems to be the case for the wholesaling of rice, corn and other grains. Another likely major reason for the decline is that the industries themselves registered sluggish growth, if not actual decline (as in the case of forestry) in 1988-1994.

The data also lead one to speculate on whether the actual number of nonregistered players is on the upward trend or not. There may be indications that bureaucratic abuse has been increasing and the response is to become "invisible," that is, to opt to remain unregistered. This creates additional layers of players as unregistered traders sell to bigger traders who undertake the paper work to make transaction with formally organized buyers feasible. The increase in number of large establishments was in the retail sector, especially in the fast growing meat and poultry products (which is consistent with the robust growth of the country's livestock and poultry industry).

Much of the increase in the number of establishments of agricultural products was in the small wholesalers and retailers. The increase was nearly across-the-board, except most in the wholesaling of forest products (the industry that has seen a continuous decline since the 1970s). In terms of the absolute number, the largest increases were in the wholesaling of grains and of coconut and coconut byproducts as well as in the retailing of cereals and fish and fish products. In terms of the rate of increase, however, the most notable growth was in the wholesaling and retailing of livestock, poultry and meat products. This reflects the higher-than-average growth rate of the livestock and poultry industry during the period.

Tables 2a and 2b present the total employment, gross sales and value added for small and large wholesalers and retailers of agricultural products in 1988 and 1994. It is likely that the actual number of participants in the wholesaling and retailing of agricultural products is underestimated. First, as noted earlier, the barangay traders tend to be sari-sari storeowners; hence, they are likely to be excluded from the list of wholesalers. "One-man" operations like agents and brokers are also likely to be excluded in the Census list of establishments. Second, multiproduct retailers such as supermarkets are not included in the list of retailers of agriculture products.
<table>
<thead>
<tr>
<th>PSIC Code</th>
<th>Industry Description</th>
<th>Employment</th>
<th>Gross Sales</th>
<th>Value Added</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Level</td>
<td>Level</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Share (%)</td>
<td>Share (%)</td>
<td>Share (%)</td>
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<td></td>
<td></td>
<td>(In Thousands)</td>
<td>(In Thousands)</td>
<td>(In Thousands)</td>
</tr>
<tr>
<td>61</td>
<td>Wholesale Trade</td>
<td>217,067</td>
<td>175,057,474</td>
<td>21,821,776</td>
</tr>
<tr>
<td>611</td>
<td>Farm, forest and marine products (WSAGL)</td>
<td>90,347</td>
<td>112,363,509</td>
<td>14,732,630</td>
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<tr>
<td>6110</td>
<td>Farm, forest and marine products (WSAGL)</td>
<td>10,721</td>
<td>7,548,103</td>
<td>55,904</td>
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<tr>
<td>61101</td>
<td>Palay, corn (unmilled) and other grains (WSAGL)</td>
<td>2,959</td>
<td>1,419,381</td>
<td>-366,192</td>
</tr>
<tr>
<td>61102</td>
<td>Abaca and other fibers, except synthetic fibers (WAGL)</td>
<td>610</td>
<td>382,666</td>
<td>47,233</td>
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<tr>
<td>61103</td>
<td>Coconut and coconut by-products (WSAGL)</td>
<td>2,260</td>
<td>1,952,933</td>
<td>116,177</td>
</tr>
<tr>
<td>61104</td>
<td>Fruits, nuts (except coconut) and vegetables (WSAGL)</td>
<td>399</td>
<td>437,446</td>
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<tr>
<td>61105</td>
<td>Tobacco Leaf Dealing</td>
<td>2,409</td>
<td>949,182</td>
<td>20,490</td>
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<tr>
<td>61106</td>
<td>Forest Products Dealing</td>
<td>245</td>
<td>32,287</td>
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<tr>
<td>61107</td>
<td>Livestock and poultry unprocessed animal products, dealing</td>
<td>316</td>
<td>101,268</td>
<td>63,134</td>
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<tr>
<td>61108</td>
<td>Fish and other seafood (WSAGL)</td>
<td>1,618</td>
<td>1,792,068</td>
<td>76,274</td>
</tr>
<tr>
<td>61109</td>
<td>Farm, forest, and marine products (WSAGL), NEC</td>
<td>269</td>
<td>543,873</td>
<td>34,708</td>
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<td>62</td>
<td>Retail Trade</td>
<td>126,720</td>
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<tr>
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<td>Rice, corn, and other cereals, and beans and pulses (RTLG)</td>
<td>564</td>
<td>181,345</td>
<td>18,540</td>
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<td>62215</td>
<td>Meat and poultry products (RTLG)</td>
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<td>Fish and other seafood (fresh and dried), RTLG</td>
<td>181</td>
<td>55,283</td>
<td>4,718</td>
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<td>62217</td>
<td>Fruit and vegetables (RTLG)</td>
<td>70</td>
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Table 2a. (cont’d.)

<table>
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<td>Share&lt;sup&gt;a&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>(%)</td>
<td>(In Thousands)</td>
<td>(%)</td>
<td>(In Thousands)</td>
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<tr>
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<td>346</td>
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<td>2,674</td>
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<td>314,090</td>
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<tr>
<td>61109</td>
<td>435</td>
<td>0.1</td>
<td>88,541</td>
<td>0.2</td>
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<sup>a</sup>Share to total for all wholesale and retail industries.

Source of raw data: PDFI 2000
Table 2b. Employment, gross sales, and value added of agriculture-related wholesale and retail establishments (1994)

<table>
<thead>
<tr>
<th>PSIC Code</th>
<th>Industry Description</th>
<th>Employment</th>
<th>Gross Sales</th>
<th>Value Added</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td>Level</td>
<td>Level</td>
<td>Level</td>
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<tr>
<td></td>
<td></td>
<td>(In Thousands)</td>
<td>(In Thousands)</td>
<td>(In Thousands)</td>
</tr>
<tr>
<td>61</td>
<td>Wholesale Trade</td>
<td>105,225</td>
<td>260,677,903</td>
<td>50,929,603</td>
</tr>
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<td>611</td>
<td>Farm, forest and marine products (WSAGL)</td>
<td>10,641</td>
<td>8,952,020</td>
<td>1,541,206</td>
</tr>
<tr>
<td>6110</td>
<td>Farm, forest and marine products (WSAGL)</td>
<td>10,641</td>
<td>8,952,020</td>
<td>1,541,206</td>
</tr>
<tr>
<td>61101</td>
<td>Palay, corn (unmilled) and other grains (WSAGL)</td>
<td>2,539</td>
<td>2,110,362</td>
<td>246,501</td>
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<tr>
<td>61102</td>
<td>Abaca and other fibers, except synthetic fibers (WAGL)</td>
<td>582</td>
<td>545,664</td>
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<tr>
<td>61103</td>
<td>Coconut and coconut by-products (WSAGL)</td>
<td>1,923</td>
<td>2,981,351</td>
<td>466,387</td>
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<tr>
<td>61104</td>
<td>Fruits, nuts (except coconut) and vegetables (WSAGL)</td>
<td>1,490</td>
<td>603,127</td>
<td>301,931</td>
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<tr>
<td>61105</td>
<td>Tobacco Leaf Dealing</td>
<td>777</td>
<td>663,567</td>
<td>55,642</td>
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<td>Forest Products Dealing</td>
<td>259</td>
<td>14,362</td>
<td>24,381</td>
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<tr>
<td>61107</td>
<td>Livestock and poultry unprocessed animal products, dealing</td>
<td>604</td>
<td>659,923</td>
<td>250,097</td>
</tr>
<tr>
<td>61108</td>
<td>Fish and other seafood (WSAGL)</td>
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<td>809,094</td>
<td>96,257</td>
</tr>
<tr>
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<td>Farm, forest, and marine products (WSAGL), NEC</td>
<td>503</td>
<td>435,171</td>
<td>52,096</td>
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<tr>
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<td>Retail Trade</td>
<td>181,642</td>
<td>237,657,063</td>
<td>25,151,745</td>
</tr>
<tr>
<td>62214</td>
<td>Rice, corn, and other cereals, and beans and pulses (RTLG)</td>
<td>869</td>
<td>803,913</td>
<td>73,461</td>
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<tr>
<td>62215</td>
<td>Meat and poultry products (RTLG)</td>
<td>6,223</td>
<td>1,017,102</td>
<td>133,506</td>
</tr>
<tr>
<td>62216</td>
<td>Fish and other seafood (fresh and dried), RTLG</td>
<td>336</td>
<td>238,231</td>
<td>19,316</td>
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<td>62217</td>
<td>Fruit and vegetables (RTLG)</td>
<td>190</td>
<td>56,256</td>
<td>8,241</td>
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</table>
### Table 2b. (cont'd.)

<table>
<thead>
<tr>
<th>PSIC Code</th>
<th>Industry Description</th>
<th>Employment</th>
<th>Gross Sales</th>
<th>Value Added</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Level</td>
<td>Share&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Level</td>
<td>Share&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
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<td>178,170,059</td>
<td>36,328,216</td>
</tr>
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<td>4,525,761</td>
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<td>97,269</td>
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<td>15,799</td>
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<td>2,109,697</td>
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<td>371,358</td>
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<tr>
<td>61106</td>
<td>165</td>
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<td>34,363</td>
<td>0.0</td>
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<tr>
<td>61107</td>
<td>620</td>
<td>0.1</td>
<td>364,192</td>
<td>0.2</td>
</tr>
<tr>
<td>61108</td>
<td>3,335</td>
<td>0.6</td>
<td>1,273,946</td>
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<tr>
<td>61109</td>
<td>300</td>
<td>0.1</td>
<td>70,783</td>
<td>0.0</td>
</tr>
</tbody>
</table>

<sup>a</sup> Share to total for all wholesale and retail industries.

Source of raw data: PDFI 2000
Similarly, legions of sari-sari stores and itinerant vendors of vegetables, fruits, fish and meat are excluded from the list in Table 1. Thus, the total number of participants in the wholesale and retail of agricultural products is much higher than what is formally listed in the country's census statistics.

It is worth noting that the share of "small" wholesalers of agriculture products to total employment and sales is higher than to the total number of establishments. This suggests that they tend to be larger than the average small wholesale establishment. In contrast, small retailers of agriculture products have smaller share of total employment as well as of sales. This reflects the apparent "mom and pop" nature of most small retailers of agricultural products. The table nonetheless presents a slightly different picture for large wholesalers and retailers of agricultural products. It indicates that, with the exception of tobacco leaf dealers and wholesalers of fish and other seafoods, the average large wholesaler and retailer of agricultural products is comparatively smaller than the average large wholesale or retail establishment.

Table 2 highlights the trends among the industries. Specifically, total employment declined during 1988-1994 in large wholesalers of coconut and coconut by-products, tobacco leaf and forest products. Likewise, employment rose significantly among large wholesalers and retailers of livestock and poultry products as well as of fruits, nuts and vegetables. As noted earlier, these two industries are the faster growing segments of Philippine agriculture.

The estimation of value added in Table 2 shows generally lower share to total value added in the wholesale and retail sector. As in the previous discussions, the industries with the largest number of establishments and employment tend to be the ones with the largest contribution to sectoral value added. Notice also the sharp rise in the value-added shares of retailers of meat and poultry products during the period.

Estimates of labor productivity in the wholesale and retail of agricultural support services are shown in Table 3. Of interest are the last two columns of the table, which show the change in labor productivity in real terms over the period 1988-1994 for large enterprises and small enterprises. The change in labor productivity in real terms was measured by the rate of change of labor productivity at current prices minus the general rate of inflation (proxied by the rate of change of the gross domestic product deflator). Table 3 shows that labor productivity in real terms in

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5The negative estimate for large wholesalers of cereals is likely caused by data error.
most of the agriculture-related wholesale and retail industries declined during the 1988-1994 period.\textsuperscript{6} The major exceptions are coconut and coconut by-products wholesaling, tobacco leaf dealing, and fruits and vegetables retailing among large enterprises and meat and poultry products retailing among small firms.\textsuperscript{7} Notice that among the large enterprises, the industries that streamlined generated significant rise in labor productivity. The robust growth of labor productivity in meat and poultry products retailing among small enterprises may reflect the significant rise in meat and poultry consumption in the country, together with the rise in the more professionally run stand-alone meat and poultry products retailers (e.g., "Monterrey meat stores") during the period.

The decline in labor productivity of most of the agriculture-related wholesale and retail industries is consistent with the results of studies showing poor overall productivity performance of the Philippine economy (see e.g., Cororaton). The decline in the labor productivity of the agriculture-related wholesale and retail industries could likely be even lower if the more informal traders and retailers (excluded from the census of establishments) were included in the total employment for the industries. This reflects one role of the wholesale and retail sector; that is, as reserve pool of underemployed workers in the nonagricultural sector. Only when there is sustained fast economic growth would underemployment in wholesaling and retailing, especially in the informal sector, decline and correspondingly, labor productivity in the sector increase over time.

The regional distribution of small wholesalers of agricultural products is shown in Table 4. It is interesting to note that the Mindanao regions, together with Southern Tagalog, Bicol and Eastern Visayas, have mostly small wholesalers. Also note the regional distribution of total employment and paid employees of small wholesale establishments in agriculture, fishery and forestry products. The table shows that Southern Mindanao, Central Mindanao and Cagayan Valley account for nearly one-half of all paid employees. The three regions, especially Southern Mindanao and Cagayan Valley, are major agricultural surplus regions in the country. Hence, it is

\textsuperscript{6}The estimates for the large enterprises under farm, forest and marine products wholesaling (611) and palay, corn (unmilled) and other grains wholesaling (61101) are not credible. Labor productivity estimates for 611 in 1988 are extremely low and the gross margins for 61101 in 1988 are negative. Negative gross margins in an industry with many firms indicate problems with data.

\textsuperscript{7}The estimate for fish and other seafood wholesaling under small enterprises is also suspect because of the extremely low value of labor productivity in 1988.
### Table 3. Labor productivity in agriculture-related wholesale and retail industries

<table>
<thead>
<tr>
<th>PSIC Code</th>
<th>Industry Description</th>
<th>Column 1 Value (1,000)</th>
<th>Column 2 Value (1,000)</th>
<th>Column 3 At Current Prices in Percent</th>
<th>Column 4 At Current Prices in Percent</th>
<th>Column 5 At Constant Prices in Percent</th>
<th>Column 6 At Constant Prices in Percent</th>
<th>Column 7 Change in Labor Productivitya</th>
<th>Column 8 Change in Labor Productivityb</th>
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</thead>
<tbody>
<tr>
<td>61</td>
<td>Wholesale Trade</td>
<td>Large 163.1</td>
<td>Small 63.2</td>
<td>Large 484.0</td>
<td>Small 112.4</td>
<td>Large 196.8</td>
<td>Small 77.7</td>
<td>Change in Labor Productivitya 63.2</td>
<td>Change in Labor Productivityb -104.3</td>
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<td>Farm, forest and marine products (WSAGL)</td>
<td>5.2</td>
<td>16.5</td>
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<td>2677.6</td>
<td>130.6</td>
<td>2495.6</td>
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<td>Farm, forest and marine products (WSAGL)</td>
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<td>16.5</td>
<td>144.8</td>
<td>38.1</td>
<td>2677.6</td>
<td>130.6</td>
<td>2495.6</td>
<td>-51.4</td>
</tr>
<tr>
<td>61101</td>
<td>Palay, corn (unmilled) and other grains (WSAGL)</td>
<td>-123.8</td>
<td>17.2</td>
<td>97.1</td>
<td>44.8</td>
<td>-178.4</td>
<td>160.5</td>
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<td>Abaca and other fibers, except synthetic fibers (WAGL)</td>
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<td>82.3</td>
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<td>119.5</td>
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<td>Coconut and coconut by-products (WSAGL)</td>
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<td>13.5</td>
<td>242.5</td>
<td>19.9</td>
<td>371.8</td>
<td>122.3</td>
<td>189.8</td>
<td>-59.7</td>
</tr>
<tr>
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<td>Fruits, nuts (except coconut) and vegetables (WSAGL)</td>
<td>140.4</td>
<td>23.2</td>
<td>202.6</td>
<td>36.1</td>
<td>44.3</td>
<td>55.9</td>
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<td>Tobacco Leaf Dealing</td>
<td>8.5</td>
<td>35.3</td>
<td>71.6</td>
<td>96.4</td>
<td>741.9</td>
<td>173.0</td>
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<td>-9.0</td>
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<td>Forest Products Dealing</td>
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<td>94.1</td>
<td>48.3</td>
<td>186.6</td>
<td>149.6</td>
<td>4.6</td>
<td>-32.5</td>
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<td>61107</td>
<td>Livestock and poultry unprocessed animal products, dealing</td>
<td>199.8</td>
<td>24.8</td>
<td>414.1</td>
<td>69.4</td>
<td>107.3</td>
<td>179.8</td>
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<td>Fish and other seafood (WSAGL)</td>
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<td>30.9</td>
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<td>Farm, forest, and marine products (WSAGL), NEC</td>
<td>129.0</td>
<td>26.6</td>
<td>103.6</td>
<td>71.4</td>
<td>-19.7</td>
<td>168.0</td>
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<td>62</td>
<td>Retail Trade</td>
<td>55.9</td>
<td>17.5</td>
<td>138.5</td>
<td>56.8</td>
<td>147.5</td>
<td>224.7</td>
<td>-34.5</td>
<td>42.7</td>
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<td>62214</td>
<td>Rice, corn, and other cereals, and beans and pulses (RTLG)</td>
<td>32.9</td>
<td>13.0</td>
<td>84.5</td>
<td>26.8</td>
<td>157.2</td>
<td>105.9</td>
<td>-24.9</td>
<td>-76.1</td>
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<tr>
<td>62215</td>
<td>Meat and poultry products (RTLG)</td>
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<td>17.9</td>
<td>21.5</td>
<td>66.0</td>
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<td>268.7</td>
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<td>Fish and other seafood (fresh and dried), RTLG</td>
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<td>57.5</td>
<td>17.9</td>
<td>120.5</td>
<td>33.6</td>
<td>-81.5</td>
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<td>Fruit and vegetables (RTLG)</td>
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<td>28.2</td>
<td>297.9</td>
<td>81.5</td>
<td>115.9</td>
<td>-100.5</td>
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</tbody>
</table>

*a* Change in labor productivity between 1988 and 1994.

*b* The general inflation rate (using GDP deflator) between 1988 and 1994 is 182.04%.

Note: The estimate for 611 and 6110 in columns 5 and 7 as well as the estimates for 61101 in columns 1 and 7 are questionable. Please see text.

Source of raw data: PDFI 2000
Table 4. Summary statistics for agriculture-related small wholesale establishments (1988) for farm, forest and marine products (WSALG, 611)

### Level (In thousands)

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of Establishments</th>
<th>Total Employment</th>
<th>Value Added</th>
</tr>
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<td>1,047</td>
<td>36,143</td>
</tr>
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<td>20</td>
<td>80</td>
<td>1,500</td>
</tr>
<tr>
<td>Region 1 Ilocos</td>
<td>129</td>
<td>367</td>
<td>9,170</td>
</tr>
<tr>
<td>Region 2 Cagayan Valley</td>
<td>533</td>
<td>2,750</td>
<td>50,919</td>
</tr>
<tr>
<td>Region 3 Central Luzon</td>
<td>718</td>
<td>2,681</td>
<td>36,400</td>
</tr>
<tr>
<td>Region 4 Southern Tagalog</td>
<td>1,126</td>
<td>3,008</td>
<td>52,126</td>
</tr>
<tr>
<td>Region 5 Bicol</td>
<td>884</td>
<td>2,259</td>
<td>58,838</td>
</tr>
<tr>
<td>Region 6 Western Visayas</td>
<td>278</td>
<td>1,138</td>
<td>16,460</td>
</tr>
<tr>
<td>Region 7 Central Visayas</td>
<td>251</td>
<td>789</td>
<td>11,585</td>
</tr>
<tr>
<td>Region 8 Eastern Visayas</td>
<td>828</td>
<td>2,875</td>
<td>31,746</td>
</tr>
<tr>
<td>Region 9 Western Mindanao</td>
<td>1,249</td>
<td>3,427</td>
<td>47,832</td>
</tr>
<tr>
<td>Region 10 Northern Mindanao</td>
<td>946</td>
<td>2,969</td>
<td>27,536</td>
</tr>
<tr>
<td>Region 11 Southern Mindanao</td>
<td>1,136</td>
<td>5,630</td>
<td>74,060</td>
</tr>
<tr>
<td>Region 12 Central Mindanao</td>
<td>812</td>
<td>3,745</td>
<td>85,681</td>
</tr>
</tbody>
</table>

**Source:** 1988 Census Data

### Regional Share (In percentage)

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of Establishments</th>
<th>Total Employment</th>
<th>Value Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCR</td>
<td>2.16</td>
<td>3.20</td>
<td>6.68</td>
</tr>
<tr>
<td>CAR</td>
<td>0.22</td>
<td>0.24</td>
<td>0.28</td>
</tr>
<tr>
<td>Region 1 Ilocos</td>
<td>1.42</td>
<td>1.12</td>
<td>1.70</td>
</tr>
<tr>
<td>Region 2 Cagayan Valley</td>
<td>5.85</td>
<td>8.39</td>
<td>9.41</td>
</tr>
<tr>
<td>Region 3 Central Luzon</td>
<td>7.88</td>
<td>8.18</td>
<td>6.73</td>
</tr>
<tr>
<td>Region 4 Southern Tagalog</td>
<td>12.36</td>
<td>9.18</td>
<td>9.64</td>
</tr>
<tr>
<td>Region 5 Bicol</td>
<td>9.71</td>
<td>6.89</td>
<td>10.88</td>
</tr>
<tr>
<td>Region 6 Western Visayas</td>
<td>3.05</td>
<td>3.47</td>
<td>3.23</td>
</tr>
<tr>
<td>Region 7 Central Visayas</td>
<td>2.76</td>
<td>2.41</td>
<td>2.14</td>
</tr>
<tr>
<td>Region 8 Eastern Visayas</td>
<td>9.09</td>
<td>8.77</td>
<td>5.87</td>
</tr>
<tr>
<td>Region 9 Western Mindanao</td>
<td>13.71</td>
<td>10.46</td>
<td>8.84</td>
</tr>
<tr>
<td>Region 10 Northern Mindanao</td>
<td>10.39</td>
<td>9.06</td>
<td>5.09</td>
</tr>
<tr>
<td>Region 11 Southern Mindanao</td>
<td>12.47</td>
<td>17.18</td>
<td>13.69</td>
</tr>
<tr>
<td>Region 12 Central Mindanao</td>
<td>8.92</td>
<td>11.43</td>
<td>15.84</td>
</tr>
</tbody>
</table>

**Source:** 1988 Census Data
probably not surprising that the larger of the small wholesalers of agricultural products are located in the three regions. The large share of Western Mindanao and Eastern Visayas in the number of establishments and total employment is due to coconut production’s dominance in their agricultural economies. As stated earlier, wholesalers of coconut products and cereals comprise most of the wholesalers in agricultural products.

Available data for 1995 from the Annual Survey of Establishments still show the large number of agri-based wholesale establishments in Western Mindanao and Eastern Visayas. The figure is comparable with that of Southern Mindanao and is higher than that of Cagayan Valley (Table 5). It is, however, Southern Mindanao and Cagayan Valley (and to a less extent, Western Mindanao and Southern Tagalog) that contribute most to total employment. Again, this reflects the roles of Southern Mindanao and Cagayan Valley (and for coconut, Western Mindanao and Southern Tagalog) as major agricultural surplus regions in the country.

Tables 1 to 5 are illustrative of the information that can be drawn from the census and the annual surveys of establishments. However, the information from these sources on establishments in wholesaling and retailing has barely been mined and analyzed. It is apparent that continuing analyses of the data on wholesalers and retailers in the census and annual surveys would be useful in understanding the performance of the agricultural distribution system over time.

**Price transmission and market integration**

The complexity and diversity of the Philippine agricultural distribution system is not surprising given that producers are spread out in the country and generally situated far from the main demand areas. Thus, the view that "...produce should move from the farm directly (italics supplied) to retail outlets... (rather than) travel in a more roundabout way through layers of middlemen" (CRC 2000) is likely to be unrealistic. Nonetheless, it is important to examine whether or not agricultural markets work well and the distribution system are competitive and efficient. There are two dimensions of this issue that are of interest to this review paper.

The first issue is how the supply and demand markets are well integrated across the country so that unexpected supply and demand shocks in some parts of the country are readily addressed through appropriate changes in prices, behavior of suppliers and demanders, and commodity flows. Considering that prices signal thousands, if not millions, of farmers,
consumers and middlemen across the country to coordinate, the extent of market integration can be examined by studying the transmission of price shocks across the country and within the agricultural supply-distribution chain. This issue of market integration and price transmission is discussed in this section.

The second dimension is whether distribution margins are relatively high or not compared to some international standards or competitive norm. Margins make it possible for storage, transport, handling and processing services to transform agricultural produce in form, over time and across space so as to meet the needs of local consumers. Clearly, the policy challenge is in ensuring a competitive and efficient distribution system such that the margins do not suddenly incorporate significant monopoly

Table 5. Summary statistics for agriculture-related wholesale establishments (1995), regional share of farm, forest and marine products (WSAGL, 611) in percentage

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of Establishments</th>
<th>Employment</th>
<th>Value Added (In thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level for Philippines (In thousands)</td>
<td>344</td>
<td>10,784</td>
<td>731,905,775</td>
</tr>
<tr>
<td>Philippines</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>NCR</td>
<td>11.6</td>
<td>12.3</td>
<td>40.0</td>
</tr>
<tr>
<td>Cordillera Autonomous</td>
<td>8.1</td>
<td>7.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Ilocos</td>
<td>5.2</td>
<td>5.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Cagayan Valley</td>
<td>2.3</td>
<td>2.8</td>
<td>7.5</td>
</tr>
<tr>
<td>Central Luzon</td>
<td>7.6</td>
<td>6.6</td>
<td>-18.9</td>
</tr>
<tr>
<td>Southern Tagalog</td>
<td>4.9</td>
<td>11.8</td>
<td>7.9</td>
</tr>
<tr>
<td>Bicol</td>
<td>2.9</td>
<td>1.3</td>
<td>4.8</td>
</tr>
<tr>
<td>Western Visayas</td>
<td>5.8</td>
<td>14.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Central Visayas</td>
<td>4.9</td>
<td>4.6</td>
<td>5.0</td>
</tr>
<tr>
<td>Eastern Visayas</td>
<td>8.4</td>
<td>8.2</td>
<td>5.5</td>
</tr>
<tr>
<td>Western Mindanao</td>
<td>8.4</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>Northern Mindanao</td>
<td>18.0</td>
<td>15.6</td>
<td>16.0</td>
</tr>
<tr>
<td>Southern Mindanao</td>
<td>5.8</td>
<td>1.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Central Mindanao</td>
<td>1.5</td>
<td>0.8</td>
<td>0.9</td>
</tr>
<tr>
<td>ARMM</td>
<td>1.5</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Caraga</td>
<td>2.9</td>
<td>1.4</td>
<td>0.6</td>
</tr>
</tbody>
</table>
Table 5. (cont’d.)

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of Establishments</th>
<th>Employment</th>
<th>Value Added</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Philippines (In thousands)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>12,446</td>
<td>22,067</td>
<td>3,350,721,149</td>
</tr>
<tr>
<td>Metropolitan Manila</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Cordillera Autonomous</td>
<td>1.5</td>
<td>2.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Ilocos</td>
<td>0.4</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Cagayan Valley</td>
<td>2.7</td>
<td>2.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Central Luzon</td>
<td>6.3</td>
<td>16.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Southern Tagalog</td>
<td>8.4</td>
<td>5.4</td>
<td>10.9</td>
</tr>
<tr>
<td>Bicol</td>
<td>13.4</td>
<td>10.4</td>
<td>2.2</td>
</tr>
<tr>
<td>Western Visayas</td>
<td>8.5</td>
<td>5.3</td>
<td>46.9</td>
</tr>
<tr>
<td>Central Visayas</td>
<td>2.8</td>
<td>2.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Eastern Visayas</td>
<td>2.1</td>
<td>2.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Western Mindanao</td>
<td>9.3</td>
<td>3.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Northern Mindanao</td>
<td>13.6</td>
<td>10.5</td>
<td>7.1</td>
</tr>
<tr>
<td>Southern Mindanao</td>
<td>6.7</td>
<td>3.4</td>
<td>2.3</td>
</tr>
<tr>
<td>Central Mindanao</td>
<td>10.5</td>
<td>24.7</td>
<td>13.1</td>
</tr>
<tr>
<td>ARMM</td>
<td>6.0</td>
<td>1.7</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>4.4</td>
<td>7.9</td>
<td>2.5</td>
</tr>
</tbody>
</table>

rents nor unnecessary transactions costs such as police "tongs." In addition, the policy challenge includes how to encourage efficiency improvements in storage, transport, handling and processing through technological and organizational/institutional changes as well as capital investments. The level and evolution of distribution margins and the related issues of transport, storage, handling and processing will be discussed in the succeeding section (i.e., on Marketing Margins and Distribution Services).

**The importance of market integration**

The welfare implications of market integration can perhaps be best illustrated through an example. Assume initially that region A and region B, each with equal population, are not market-linked (i.e., they are segregated markets). A negative supply shock in region A, which significantly raises prices in A, will not affect region B at all. If markets in A and B are integrated, prices in B would increase. However, the increase in prices in A
would be less than under the first scenario of complete market separation. To the extent that the welfare of each person in the country has equal weight, then it is likely that the country’s over-all welfare would be lower under the first scenario (i.e., complete separation) than under the second scenario (i.e., market integration).

Underpinning market integration is the ability of the market mechanism to reallocate resources in response to changes in supply or demand conditions across space within a country. The scenario where markets A and B are completely separated means that the market mechanism has failed. That is, the transactions costs of moving goods between A and B are so high to nullify the price gap between the two areas. This last point has significant policy application in the case of an open economy. Supposing markets A and B are Manila and Mindanao: The transport cost between the port city (Manila) and the main domestic surplus region (Mindanao) is substantially higher than the transport cost between the port city and a foreign supplier (example, Bangkok). In this case, an unexpected increase in demand in Manila could likely result in higher importation (assuming no problem in customs) rather than increased commodity supply from Mindanao. As a result, price stabilization in Manila is achieved but without the benefit to the farmers of Mindanao. In this case, there are only two options that can bring market integration between Manila and Mindanao: either to impose a fairly high tariff (or administrative protection through customs) against imports or to move toward reducing the distribution costs between Mindanao and Manila. Since the global direction is now toward economic openness, including the implementation in the near future of a free trade area in the ASEAN, the best policy option for the Philippines is to reduce distribution costs within the domestic economy, thereby improve market integration domestically.

Understanding the extent of market integration among supply and demand areas in the Philippines is the first step in examining the efficacy of the country’s agricultural distribution system and in pinpointing possible sources of market imperfection or failure among the country’s regions. Although it is accepted that market integration is not a sufficient condition for the Pareto optimality of a competitive equilibrium, measurement of market integration remains the starting point for understanding how specific markets work (Ravallion 1986, p. 103).

**Market integration: methods of analysis**

There are a number of measures of market integration discussed in economic literature. Among these are the following:
1. **Correlation coefficients.** The easiest way to estimate is the correlation of prices in different markets. This has intuitive appeal because co-movement of prices is a hallmark of market integration. The traditional tests of market integration use correlation coefficients or regression coefficients on prices as arguments. For example, a regression model to test for short-run market integration can be (Sexton, Kling and Carman 1991, p. 569):

\[
P_{1t} = \alpha_0 + \alpha_1 P_{2t} + \alpha_2 T_t + e_t
\]

Where \( P_1, P_2 \) are prices in regions 1 and 2 respectively and \( T \) is the transactions cost to move a good between the two regions. Short-run market integration is indicated by:

\[
\alpha_0 = 0; \quad \alpha_1 = \alpha_2 = 1
\]

However, correlation tests of price levels face the problem of common economy-wide phenomena such as general inflation and agricultural seasonality, which affect all prices and therefore raise correlation coefficients between prices. Correlation between price changes is one means of addressing this problem. However, in addition to the problem of spurious correlation, correlation tests fail to address the problem of heteroskedasticity common in high frequency price data. In addition, correlation tests may overestimate market segmentation if lags in information, delivery or contract expirations result in natural lags in the price response between markets (Barrett 1996). Because of such potential statistical problems in the use of correlation coefficients, later analyses of market integration have shifted to cointegration analysis and more sophisticated approaches.

2. **Ravallion’s model and cointegration analysis.** A major methodological innovation came from Ravallion (1986) whose model avoids the inferential dangers of bivariate correlation or regression coefficients. The error correction form of the Ravallion model allows for autocorrelation, distinct short-run and long-run dynamics, and common inflationary and seasonal components. The model has, in fact, become the standard for market integration testing (Barrett 1996, p. 826).
The basic Ravallion model is as follows:

For $N$ regions:

$$P_{it} = \sum_{j=1}^{N} a_{ij} P_{1t-j} + \sum_{j=1}^{N} b_{ij} P_{1t-j} + X_{it} e_{it} + e_{it}$$

$$(i = 2, \ldots, N)$$

$$P_{1t} = \sum_{j=1}^{N} a_{ij} P_{1t-j} + \sum_{k=2}^{N} \sum_{j=0}^{N} b_{ij} P_{kt-j} + X_{it} e_{it} + e_{1t}$$

Where $P_1$ is the price in the central market, $P_i$ is the price in the $i$th local market, $X$ is a vector of other influences (e.g., inflation, seasonality indices) and the $e$’s are error terms. Ravallion applied his model to Bangladesh and results suggest the existence of substantial impediment to trade between Dhaka and its main rural supply areas.

The Ravallion error-correction model allows the testing for market segmentation between the central market and a given local market; that is, $b_{ij} = 0$. It also allows for short-run market integration; i.e., $b_{i0} = 1$ and allows for market integration with the central market within one time period; $b_{i0} = 1$ and $a_{ij} = b_{ij} = 0$ ($j = 1, \ldots, N$). With some reformulation, the model also allows for long-run market integration.

The Ravallion model can be transformed into an error correction representation of a co-integrated system (Barrett 1996). Two stationary price series are co-integrated if there exists a stable long-run linear relationship between them. The presence of co-integration in both directions between the two price series is indicative of interdependence. Likewise, the absence of co-integration in both directions is indicative of market segmentation.

However, the Ravallion model has its weaknesses. The model assumes that price shocks originate from the central (urban) market, which is plausible for demand shocks but not for supply shocks. The model and the related co-integration analyses assume constant intermarket transfer costs that are either additive or proportional. If transfer costs are time varying, then the Ravallion model’s inference is biased in favor of market
segmentation. In addition, where there are discontinuous trade flows and strong seasonality patterns in agricultural demand, supply and transactions costs (as is likely the case in developing countries such as the Philippines), then the findings of co-integration analyses become more suspect because co-integration tests impose a linear approximation to a non-linear function (see Barrett 1996).

3. **Dynamic adjustment and speed of adjustment.** It is usually not enough to know whether or not markets are integrated. It is important to know the extent of market integration. This can be done by measuring the magnitude of price transmission through estimates of dynamic multipliers. In addition, it is useful to determine the speed of adjustment. Given the same value of dynamic multiplier for two regions vis-à-vis a third market, the faster the completion of the price adjustment, the better integrated the market. The dynamic multipliers can be computed from an estimate of a Ravallion-type model of market integration. Similarly, the speed of adjustment can be computed from the estimates of dynamic multipliers (Goleti et al. 1996).

4. **More recent market integration models.** A weakness of the Ravallion model and cointegration test is that they do not explicitly consider actual data on transaction or transfer costs in moving goods from supply areas to demand areas. The more recent models—e.g., Parity Bounds Model (Baulch 1997) and that of Sexton, Kling and Carman (1991)—address this constraint. Baulch uses exogenous transactions cost data to estimate the probability of attaining intermarket arbitrage conditions; the Sexton, Kling and Carman model assumes fixed transfer margins (Barrett 1996, pp.827-828). Other newer models and theoretical approaches are those of Acharya (2000), Goodwin and Piggott (1999), J. R. Li and C. Barrett (1999) and Dercon and Van Campenhout (1999).

The newer models show that price comparisons are not enough to establish the optimality of market integration. More importantly, the newer models point toward the integration of both price data and data on trading activities as the appropriate way of analyzing the efficiency and optimality of market relationships in the agricultural sector especially in developing countries. As Barrett (1996) concludes, the challenge now is "…not so much statistical refinement of existing methods as
reorientation of data collection to pay greater attention to trading activities."

**Empirical studies on market integration**

Virtually all the methods of analysis described above have been applied to actual economic cases, mainly in developing countries. The studies of particular interest to the Philippines are those for the Vietnamese rice economy (Goleti et al. 1996), China’s rice and corn markets (Rozelle et al. 1997), the application of the Ravallion-type model to the Philippine corn (de los Reyes 1994) and Indonesian rice markets (Alexander and Wyeth 1994), the application of ARCH Time Series Model to the Philippine corn market (Mendoza and Rosegrant 1995), the application of the Parity Bounds model to the Philippine rice market, and the re-examination of the Philippine rice market using the Band-Threshold Autoregression model (Dercon and Van Campenhout 1999).

It must be emphasized that, despite their weaknesses, simple bivariate price correlations and coefficients of variation are useful first steps in analyzing market integration. These can provide important insights as well as leads for further in-depth study using more sophisticated models and detailed data. The availability of price data makes the estimation of bivariate price correlations and coefficients of variation easy to undertake. Finally, such simple measures have intuitive appeal.

The study of Rozelle, Park, Huang and Jin (1997) on China’s rice and corn markets is a good example of an empirical application of market integration tests. The authors started with simple coefficients of price variation and then moved to more sophisticated models to examine the issue of rural market integration in China. They found falling coefficients of variation for provincial rice and corn prices in China from 1988 to 1993. This is one sign of an increasing grain market integration. More formal analyses using cointegration analysis and parity bounds analysis along the lines of Sexton, Kling and Carman confirm further the above findings for 1988-1993.

The IFPRI study (Goleti et al. 1996) on the Vietnamese rice market also used a variety of measures to examine the extent of market integration for Vietnamese rice. While correlation coefficients of rice price levels in Vietnam’s major rice markets were almost uniformly united during 1986-1990, they dropped significantly during 1991-1995. The high price correlations during 1986-1990, which suggest high market integration, were caused by the highly inflationary macro-economic environment at that time. Correlation coefficients of price differences are significantly lower in 1986-
1990 as well as in 1991-1995. More formal analysis using co-integration analysis and dynamic multipliers indicate mixed but improving market integration during 1986-1995. There remained one-fifth of all market pairs that were segregated; moreover, the estimates show that the speed of price adjustment slowed down in the second half of the period, the early 1990s. The IFPRI report indicates significant challenges for the Vietnamese rice market. Indeed, the report points out that Vietnam’s indicator of market integration is comparable to Malawi (with its poor infrastructure) and Pakistan and Egypt (with their restrictions on internal trade).

The Vietnam and China studies are noteworthy in that each used an array of analytical and statistical tools to examine the state and evolution of market integration in the two countries. The Vietnam study also includes some comparison of indicators with selected countries for further insightful analysis. In short, it is best to look at the various tools as complementary and must be used together to have more robust conclusions about the state and evolution of market integration.

It is interesting to note that the Philippines figures prominently in the empirical application of some of the analytical and statistical models of market integration. For one, Baulch applied his parity bounds model to the Philippine rice market. He finds the rice market to be integrated within a single period (i.e., month) almost 100 percent of the time. In this study, the findings using parity bounds analysis differ from findings from Granger causality and Ravallion-type models that show one- to two-month lags. According to Baulch, standard tests failed to detect high levels of market integration because the earlier models did not take into account transfer cost and discontinuity of trade flows between regions.

Dercon and Van Campenhout (1999) used a Band-Threshold Autoregression Model and threshold co-integration analysis to reexamine the Philippine rice market analyzed by Baulch. In contrast to Baulch’s finding, Dercon and Van Campenhout found that there are a number of trade routes where price adjustment is sluggish (i.e., reaching up to 2.5 months), although there is market integration in the long run. Moreover, in the route between Western Visayas and Central Visayas, there are indications that the slow pace of price adjustment between the two regions may be attributed to monopoly in shipping.

The differing results between Dercon and Van Campenhout and Baulch suggests the need for more data on trading activities and intermarket transfer costs if one where to understand the state and evolution of agricultural market integration in the Philippines. It is worth noting that the data used in the Baulch and Dercon-Van Campenhout studies covered
1980-1993, which includes the period of significant economic and political turmoil in the country. The economic and political crisis may have disrupted rice trade flows between regions, thereby making it more difficult to have analytically consistent results. It is useful to reexamine the issue using more recent data in the 1990s.

Mendoza and Rosegrant applied a more sophisticated approach to cointegration analysis using Bivariate Exponential Autoregressive Conditional Heteroskedasticity Model (E-ARCH model) and dynamic multipliers to examine the market integration of the Philippine corn market. The study found that:

1) Manila is the price leader in the country for yellow corn;
2) There is mixed granger causality between Central Visayas and Mindanao with respect to white corn;
3) Limited spatial integration of the Philippine corn economy with long-run multipliers range between 0.23 and 0.61; and
4) The market response to price changes in the central market (Manila for yellow corn; Central Visayas for white corn) is sluggish, with price adjustments taking up to two months (for yellow corn traders in Mindanao).

Mendoza and Rosegrant attribute the low long-run multiplier and relatively sluggish price adjustments to inadequate shipping opportunities and erratic shipping schedules, high transport and storage costs, and other market barriers.

Similarly, De los Reyes used correlation analysis and a Ravallion-type model to examine the market integration of the Philippine economy. She also found a general lack of integration among the regional corn markets, with the exception of the Metro Manila-Southern Tagalog link. Her estimates of market integration range from 0.17 to 0.43. These estimates are consistent with Mendoza and Rosegrant’s. De los Reyes considered the following as factors for the low market integration: (1) infrastructure and transportation bottlenecks within the country; and (2) "...the strategic location of Manila relative to the international market...why its wholesale market were not connected with rural markets."

It is worth noting that despite the use of the Philippine examples in a number of innovative methodologies on market integration, there is virtually no empirical application of such models in the Philippines except for the masteral thesis of De los Reyes. Certainly, there is yet no intensive and extensive analysis of price correlations and alternative measures of market integration over time similar to the Vietnam and China studies. The
Mendoza-Rosegrant study on the Philippine corn market is the closest to the Vietnam and China studies but lacks the detailed price correlations and coefficients of variation that forms intuitive foundation for an indepth and sophisticated time series analyses. The De los Reyes study, on the other hand, may have the price correlations but lacks the use of the more recent and statistically robust time series models needed to validate the regression results of a Ravallion-type model. It is useful to undertake such studies not just for the rice and corn markets but also for other commodities such as coconut.

Clearly, because of the mixed results of the studies on Philippine food markets, it is important that a comprehensive analysis of market integration for several key commodities in the country be undertaken. The extensive and intensive analysis need to use methodologies ranging from simple price correlations and coefficients of price variation to the more sophisticated models like the Parity Bounds and the Band-Threshold Autoregressive.

**Marketing margins and distribution services**

More than the extent and pace of the transmission of price shocks (which is the focus of the previous section), it is the magnitude of marketing margins, which is the main concern of policymakers with respect to the distribution sector. As the Report of the Congressional Commission on Agricultural Modernization suggests, there remains a popular view that marketing margins are unreasonably high in the country, primarily because of traders’ implicit market power. As a result, farmers earn less than they should and consumers pay more than necessary.

A key function of markets is price formation. An efficient price formation is one that matches the costs of storage, transportation, processing and other distribution services to their respective price margins. The price margins influence private and government decisions on provision, and the government regulations on agricultural distribution services (Timmer 1987). When margins are too low, marketing participants are being squeezed by government policy. When margins are too high, they may indicate any or all of the following: (a) there are informal taxes (e.g., lagay) or barriers to domestic trade; (b) the quality of roads and other infrastructure facilities as well as domestic shipping services are so bad; or (c) traders have some monopolistic power. Processing margins that are much higher than those of other countries with technically efficient and competitive processing industries, there may be indications of high processing losses and/or barriers to entry in the processing sector in the local front, which resort in high profit rates (Timmer 1987).
Marketing margins determine the "competition contour" relative to imports in the country (Timmer 1987). For a small, open economy, the landed cost of imports including tariffs and other cost of moving the imported good to the port city(ies) (e.g., Manila, Cebu) is the reference price of the good. Then the cost of imports minus the domestic distribution cost determines the regions in the country that can compete with imports. Thus, given the world price of imports and the domestic distribution costs, the lower (higher) the tariff, the nearer to (farther from) the port city(ies) are the import-competitive regions. Similarly, given the landed cost of imports, the lower (higher) the domestic distribution costs (and margins), the farther from (nearer to) the port city(ies) are the import-competitive regions.

The discussion above is a useful framework for understanding why Philippine agriculture has been losing competitiveness vis-à-vis imports during the past two decades. On the demand side, the country’s high population growth meant that the demand for food products has increased substantially during the period, which can be supplied either by imports or by domestic production. On the supply side, world prices of food products (e.g., grains) have declined. In addition, transport links between Manila and the rest of the world, especially with East Asia and North America, have significantly improved. On the other hand, the rising population and urbanization in the country centered in Metro Manila, Central Luzon and Southern Tagalog. This meant that the food needs of Metro Manila would have to be sourced farther and farther from the metropolis. Thus, Central Luzon has ceased to be the country’s rice granary. As a result, domestic sourcing of food for Manila has been increasingly sensitive to domestic distribution costs and margins.

In short, due to the declining world food prices and improving international transport links, the country needs to greatly improve its transportation and distribution systems (to thereby reduce distribution costs) and/or sharply improve its agricultural productivity so that domestic producers from, say, Mindanao, will be competitive with imports. However, agricultural productivity has been sluggish and the quality of domestic infrastructure and inter-island shipping remains unsatisfactory. The country has to raise the rate of agricultural protection during the past one and a half decades so as domestic producers—increasingly from Mindanao and Cagayan Valley—will be competitive with imports in the Manila market.
**Distribution margins**

A number of existing studies can provide ideas about the magnitude of margins in agricultural distribution industries. At the macro level, the Policy and Development Foundation, Inc. (PDFI) Report (2000) provides data on gross margin to sales ratios of agriculture-related wholesalers and retailers in 1994. The FRLD studies and the Center for Research and Communication (CRC) Report (2000) provide information on gross margins in selected trade routes.

Table 6 presents the gross margin-to-sales ratios of small and large agriculture-related industries and the average gross margin-to-sales ratio for all small and large wholesale and retail establishments. At the most aggregative level, the table shows that gross margins at the wholesale level are generally higher than the gross margins at the retail level in the Philippines. As the PDFI study notes, this finding is the opposite of findings for a number of developed countries, where their gross margin-to-sales ratio at the wholesale level is lower than that at the retail level.

The table shows that the gross margin-to-sales ratios of agriculture-related wholesale and retail industries in 1988 and 1994 are lower than the average for all wholesale establishments or for all retail establishments. The noteworthy exceptions are fruits, nuts and vegetables wholesaling and retailing, forest products dealing, livestock and poultry dealing in 1988, and meat and poultry products retailing among large enterprises. The exceptions, especially for fruits and vegetables, are probably not surprising partly because of comparatively higher spoilage rate.

Table 6 seems to suggest that the marketing margin of agriculture-related industries are not overly high especially at the wholesale level relative to the average for all wholesale establishments. However, it must be noted that the table is an average of wholesalers’ margins at the wholesale level and of retailers’ margins at the retail level. It does not capture the multilayer nature of agricultural marketing described earlier in the paper. The impact of the multilayering of wholesale distribution is best exemplified by Japan’s wholesale sector. Japan’s gross margin-to-sales ratio at the wholesale level is lower than those of the US, Germany, the UK and France; in addition, Japan’s gross margin ratio at the retail level is lower than those of the US and Germany and comparable to those of the UK and France. However, Japan’s gross margin for the whole distribution sector (wholesale and retail) is the highest among the five developed countries because of the greater multilayering of the farmers’ wholesale trade (Intal 1999).
### Table 6. Gross margin to sales ratio of small and large agriculture-related establishments (1988 and 1994)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
<td>Wholesale Trade</td>
<td>0.25</td>
<td>0.18</td>
<td>0.24</td>
<td>0.23</td>
</tr>
<tr>
<td>611</td>
<td>Farm, forest and marine products (WSAGL)</td>
<td>0.21</td>
<td>0.08</td>
<td>0.17</td>
<td>0.24</td>
</tr>
<tr>
<td>61101</td>
<td>Palay, corn (unmilled) and other grains (WSAGL)</td>
<td>0.20</td>
<td>-0.14</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>61102</td>
<td>Abaca and other fibers, except synthetic fibers (WSAGL)</td>
<td>0.21</td>
<td>0.16</td>
<td>0.15</td>
<td>0.16</td>
</tr>
<tr>
<td>61103</td>
<td>Coconut and coconut by-products (WSAGL)</td>
<td>0.19</td>
<td>0.08</td>
<td>0.22</td>
<td>0.21</td>
</tr>
<tr>
<td>61104</td>
<td>Fruits, nuts (except coconut) and vegetables (WSAGL)</td>
<td>0.32</td>
<td>0.32</td>
<td>0.25</td>
<td>0.32</td>
</tr>
<tr>
<td>61105</td>
<td>Tobacco Leaf Dealing</td>
<td>0.10</td>
<td>0.08</td>
<td>0.12</td>
<td>0.14</td>
</tr>
<tr>
<td>61106</td>
<td>Forest Products Dealing</td>
<td>0.25</td>
<td>0.37</td>
<td>0.28</td>
<td>0.34</td>
</tr>
<tr>
<td>61107</td>
<td>Livestock and poultry unprocessed animal products, dealing</td>
<td>0.30</td>
<td>0.70</td>
<td>0.15</td>
<td>0.22</td>
</tr>
<tr>
<td>61108</td>
<td>Fish and other seafood (WAGL)</td>
<td>0.30</td>
<td>0.13</td>
<td>0.09</td>
<td>0.13</td>
</tr>
<tr>
<td>61109</td>
<td>Farm, forest, and marine products (WSAGL), NEC</td>
<td>0.19</td>
<td>0.17</td>
<td>0.26</td>
<td>0.30</td>
</tr>
<tr>
<td>62</td>
<td>Retail Trade</td>
<td>0.24</td>
<td>0.16</td>
<td>0.25</td>
<td>0.15</td>
</tr>
<tr>
<td>62214</td>
<td>Rice, corn, and other cereals, and beans and pulses (RTLG)</td>
<td>0.21</td>
<td>0.14</td>
<td>0.21</td>
<td>0.12</td>
</tr>
<tr>
<td>62215</td>
<td>Meat and poultry products (RTLG)</td>
<td>0.24</td>
<td>0.20</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>62216</td>
<td>Fish and other seafood (fresh and dried), RTLG</td>
<td>0.32</td>
<td>0.12</td>
<td>0.23</td>
<td>0.11</td>
</tr>
<tr>
<td>62217</td>
<td>Fruit and vegetables (RTLG)</td>
<td>0.21</td>
<td>0.40</td>
<td>0.32</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Source of Data: *PDFI Retail Trade Policy and the Philippine Economy 2001*
As emphasized in an earlier section, agricultural distribution in the Philippines generally relies on a hierarchy of traders from the farms to the consumers (who are located primarily in the urban areas). Thus, it is likely that Table 6 underestimates the over-all wholesale margin for agricultural products. That is, assuming the wholesale distribution is more multilayered for agricultural products than for other commodities, then it is likely that overall wholesale gross margin for agricultural products is higher than the average for all wholesale products. This is the opposite of what Table 6 suggests.

A number of case studies provide indications of the distribution costs and margins from the farm to the main demand areas. The studies, exemplified by the FRLD studies on potatoes (1995 a), mungbeans (1995b), cutflowers (1993), the Malenab et al. (1999) study on corn and the Cabanilla study (1997), add up the components of the distribution costs depending on the supply-demand route. For example, the distribution costs for corn from Cagayan to Manila include hauling, shelling and drying costs at the farm level; loading and unloading, rebagging, hauling, sacks, and driver’s commission at the municipal trader’s level; and loading and unloading, weighing, shrinkage, hauling and agent’s commission at the provincial trader’s level (Malenab et al.). Similarly, for potatoes, the distribution costs of an assembler-wholesaler include sorting and grading, packaging, storage, transport from the farm to the regional center (e.g., Cagayan de Oro) and from the regional center to the main urban market (e.g., Cebu), interest on operating capital, stall rental, depreciation and others (FRLD 1995a). In addition to the adding up of the components of the distribution costs, the FRLD studies and the Cabanilla study also provide information on the total marketing costs and marketing margins of the traders by type of traders and by major supply-demand routes (e.g., assembler-retailer or wholesaler in the Iloilo to Manila route). The Cabanilla study also illustrates that the marketing costs differ depending on the route to a given demand area. Thus, the distribution costs of moving grains from San Jose, Mindoro to Manila depends in part on whether the route to Manila is via direct sea transport (cheaper) or via the roads of Batangas (more expensive). With limited shipping bottoms, only those with access to the San Jose to Manila boats would be able to transport their grains at a cheaper cost (which would generally be the case for bigger traders).

The case studies, while insightful because of the details they provide about the distribution system, present information essentially at a point in time or within a short period of time. However, the distribution system and the distribution costs are strongly influenced by changes in the over-all
economy and in the other sectors of the economy. Hence, significant changes in the rest of the economy have impacts on the distribution system and on distribution costs. Time series data are needed to analyze the evolution of the distribution system and distribution costs and margins over time.

Due to the role of the distribution system in expanding the "competition contour" of the country (given the government's tariff and nontariff measures against imports), it is very important to conduct the analysis on a regular basis. The price data being collected currently by the government can provide the foundation and bridge to the regular analysis on the performance and evolution of the agricultural distribution system. Thus, it is useful to have the time series data on the ratios and/or margins between the farm prices in the major supply areas and the wholesale and retail prices in the main demand areas. The time series data on the price ratios or price margins between markets can then be complemented by regular (e.g., every three years) indepth case studies or industry surveys on the agricultural distribution system and intermarket distribution costs. The aim here is to examine the evolution of the competitive environment and efficiency of the agricultural distribution system.

A comparison of the price margins or ratios (between the farm gate price in the supply area and the wholesale price in the demand area) and of the distribution costs between the two supply and demand areas can provide some indication of whether or not the returns to marketing are particularly high in any of the trade routes. Very large gaps between the price margins and the actual distribution costs between two markets may be indicative of the existence of some monopoly or monopsony of traders, thereby calling for more in-depth investigation and analysis.

Monopoly in agricultural distribution

The perception that agricultural traders in the country wield monopsony and monopoly powers, exemplified by say, the so-called Binondo rice cartel, still persists. Indeed, the call to continue existence of the National Food Authority is sometimes anchored on this perceived monopsony and monopoly power of the Binondo-based Chinese-Filipinos in food trading in the Philippines. Supporting this is the view that Binondo-based traders are the ultimate sources of informal agricultural credit given to farmers by the provincial, municipal and barangay-based traders. The informal credit is linked to either the purchase of inputs or the sale of output by farmers.

Despite such perception among the media and sometimes, as insinuated in policy discussions, there is yet no rigorous test of the existence
and/or magnitude of monopoly power in agricultural trading. On the contrary, the literature on market integration and agricultural marketing seems to suggest that agricultural markets in the Philippines are competitive. The studies earlier reviewed here suggest that markets are on the whole integrated (although as noted by Barrett, market integration can be consistent with noncompetitive markets). On areas where the markets fail, analysts have pointed structural bottlenecks such as infrastructure problems or, as in the case of the Iloilo-Cebu rice route, a shipping monopoly (Dercon and Campenhout) rather than to monopoly of traders. The FRLD case studies on agricultural marketing paint a picture of intense competition among traders (whether based locally or itinerant) during harvest. Thus, for example, itinerant traders offer farmers prices higher than the prevailing prices to fill up the trucks the traders bring with them to the site.

It may be argued that the big traders have locked in their supplies through the tied-credit scheme. However, the findings of Yotopolous and Floro (1991) show that the effective interest rate of linked loans tied to the sale of output is lower than for unlinked loans in marginal production areas and only slightly higher than unlinked loans in developed production areas. (The stipulated interest rate of linked loans is always lower than the rate for unlinked loans. The effective rate includes the purchase price of output at lower-than-prevailing prices.) This means that the underpricing of output by trader-lenders was just about enough to bring the tied loan to market interest rate. In effect, the trader-lenders did not have monopsony power over farmers because they could not significantly underprice farmers’ output (which would have resulted in much higher effective interest rates on the linked loans than unlinked loans).

It is likely that the presence of itinerant traders provide the contestability and competitive pressure—in the agricultural output market at the farm gate. It is also more likely that the overriding concern of the trader-lenders is not to exact monopsony rent from farmers but to have as much access to farmers’ output as possible. It can be viewed that in so doing, trader-lenders would have "control" and "monopoly power" in the distribution of agricultural produce in the main demand (urban) areas. Unfortunately, there are no indepth studies on trader behavior and performance in the demand markets in the country. Moreover, any study on the monopolistic behavior of traders would have to take into consideration the government’s behavior on the importation, regulation and pricing of imported agricultural produce (e.g., rice, corn). It must be noted that the Philippines is a small player (either as importer or exporter) in the world agricultural market. Importation and exportation therefore
provide the contestability and competitive pressure to traders, preventing them to reap significant monopoly rent from consumers if the management of the country’s agricultural trade policy is managed well.

At present, an analysis on the monopoly power of traders would have to rely on indirect indicators such as gross margins and net returns of traders. As mentioned earlier in the section, the gross margin-to-sales ratio of agriculture-related wholesalers are on the whole lower than the average of all wholesale establishments. Other things being equal, this suggests that agricultural traders are not gouging consumers. Nonetheless, if Table 7 is indicative of agriculture-related wholesalers, the net marketing margin seems to be robust despite the less-than-average gross margin because the marketing cost is significantly lower than the gross margin.

Clearly, what is needed is an intensive and extensive analysis of indicators of traders’ behavior and performance. Thus, a regular comparison of the wholesale-farmgate price margins with intermarket distribution costs for as many of the supply-demand routes as possible would provide analysts sounder basis for examining the issue of monopsony and monopoly power of agricultural traders. The price comparisons and analyses should include the less well-traveled (i.e., secondary or tertiary) routes because it is likely that monopsony/monopoly power could exist in these routes, albeit probably temporarily only.

Table 7. Marketing margin and cost: two examples

<table>
<thead>
<tr>
<th>Granola Potatoes From Benguet, Nov. 1993 - April 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesale price in Manila</td>
</tr>
<tr>
<td>Marketing cost of assembler-wholesaler from Benguet selling in Manila</td>
</tr>
<tr>
<td>Marketing margin of assembler-wholesaler from Benguet selling in Manila</td>
</tr>
<tr>
<td>Marketing margin as percentage of Manila wholesale price</td>
</tr>
<tr>
<td>Marketing cost as percentage share of Manila wholesale price</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Yellow Mungbean From Iloilo, December 1993 - July 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wholesale price of yellow mungbean from Manila</td>
</tr>
<tr>
<td>Marketing cost of assembler-wholesaler from Iloilo selling in Manila</td>
</tr>
<tr>
<td>Marketing margin of assembler-wholesaler from Iloilo selling in Manila</td>
</tr>
<tr>
<td>Marketing margin as percentage of Manila wholesale price</td>
</tr>
<tr>
<td>Marketing cost as percentage share of Manila wholesale price</td>
</tr>
</tbody>
</table>
Transport and infrastructure

Transport cost forms the bulk of distribution cost. Based on NFA cost surveys, transport costs’ share accounts for at least two-thirds in rice and corn (CRC 2000), potatoes (FRLD 1995a), mungbeans (FRLD 1995b) and cutflowers (FRLD 1993). As expected, the share of transport cost to the total distribution cost increases as the travel distance increases. Thus, for example, the share of transport cost to the total cost of marketing gladiola in Metro Manila is 52 percent for Laguna traders and 74 percent for Benguet traders (FRLD 1993). Similarly, the share of transport cost to the total distribution cost of Tarlac, Iloilo and Davao del Sur-based assembler-wholesalers selling mungbeans in Metro Manila is 64 percent, 65 percent and 78 percent, respectively (FRLD 1995b).

The heavy weight of transport cost in the total distribution costs makes transport and infrastructure a critical policy issue for the agricultural distribution system. Inadequate and poor infrastructure raises distribution costs considerably. Vehicle operating costs are higher by at least 50 percent on bad roads and nearly double on very bad roads (CRC 2000). Of particular concern is domestic shipping because Mindanao is increasingly the country’s main source of agricultural produce. This means that, unless domestic shipping becomes efficient, the marginal cost of domestic sourcing of agriculture produce will rise fast. However domestic port services are among the worst in the region and domestic shipping leaves much to be desired. In a comparative analysis of ASEAN port costs by Lantican (1997, summarized in CRC 2000), the Philippines had the highest port costs in the ASEAN in the late 1980s and early 1990s. Moreover, domestic port operations are inefficient, such that domestic liner vessels spend about 50 percent to 70 percent of their operating time moored in ports (Nathan Associates 1990, as summarized in CRC 2000). Service hours in the North Harbor are very long, ranging from 12 hours in Pier 2 up to 231 hours in Pier 18, or an average of 51 hours per vessel (CRC 2000). Such poor port services can cause cargo handling costs to constitute an excessive share of total shipping costs, amounting to 47 percent for the Manila-Cebu routes for example (CRC 2000).

The CRC report (2000) summarizes those studies that examined the issue of freight rates and port service. Although some of these studies debated on the freight rates in the Philippines vis-à-vis other countries, it is clear from results that poor port services and poor infrastructure facilities have contributed to the comparatively high domestic distribution costs in the country. In addition, the transport of agriculture produce faces
unnecessary additional costs: e.g., unauthorized police harassment and "tongs." Thus, the key challenge is in the policy and implementation arena. In the short run, the studies’ policy recommendations include further liberalization of the freight rates (especially basic agricultural products) and the removal of the 10 percent share of the Philippine Port Authority on the cargo handlers’ gross income. For the long run, recommendations pertain to infrastructure investments and dispersal of agribased industries (CRC 2000).

With the number of studies examining domestic shipping and ports, it can be argued that there may be no need for further research, and what matters now is the implementation process. There is a lot of merit to this view. Nonetheless, any future researches that could help prod the country’s policymakers to further reform the domestic shipping, ports and infrastructure development and management remain useful. For example, studies that provide a cost-benefit analysis of the Cabotage Law could encourage the policymakers to be more flexible and strategic in their use of such law. A strict implementation of the Law may be disadvantageous, ironically, to archipelagos such as the Philippines as compared to contiguous countries (e.g., Thailand), because the latter can rely on the country’s road and rail systems to move products domestically, with exports and imports coursed through the international ports. In contrast, the Philippines, as an archipelago, is hamstrung by the inadequacy of shipping bottoms among liners, thereby forcing producers with/or traders to use the more expensive trampers. A cost-benefit analysis as well as an organizational analysis on the Philippine Ports Authority can also help suggest how the agency can be more facilitative rather than regulatory.

**Transport handling, technology and incentives**

There is one major concern that deserves more research and policy discussions. This concerns private and government investment in the newer cargo handling and packaging technologies that can reduce handling time and losses (e.g., from pilferage) as well as maintain product quality. For fruits, vegetables and cutflowers, this means adopting cold chain technology. That is, "... modern post-harvest shelf-life extensive treatments such as controlled atmosphere or extended nitrogen storage facilities… (because) high postharvest losses for fruits, vegetables and cutflower (stem from) high temperatures..." (CRC 2000).

Similarly, placing cargoes in containers would reduce domestic stevedoring work, speed up loading and unloading of cargo, decrease time of ships moored in piers and improve turnaround time of ships. The net
result is an effective increase in the shipping bottoms in domestic liners. There will also be a much more efficient use of ships and ports, thereby likely reducing overall shipping cost. According to the CRC Report (2000), stevedoring charges are higher than vessel operations in the financial statements of domestic shipping lines. For the Manila-Cebu routes, cargo handling costs account for 47 percent of shipping costs.

The main research issue here is the nature of government intervention to encourage the adoption of more efficient technologies in ports and postharvest facilities. There is, of course, greater likelihood that there are more public interest and public good in ports than in postharvest facilities. Should the government impose technology standards such as containerization when it bids out the operations of port facilities to the private sector? Or should the government provide fiscal incentives or explicit subsidies to the private sector? How would the adoption of the newer cargo handling technology (e.g., containerization) impact on the whole post-harvest product packaging and handling? What are the overall costs and benefits to the various players in the agricultural distribution system and to the consumers? These questions need to be answered if the government is to determine the appropriate policies and programs to implement.

**Food terminals and commodity exchanges**

The government funded a prefeasibility study on the development of an agricultural commodity futures exchange. However, for such project to take off, the government must first deal with the perennial problems of Philippine agricultural distribution: insufficient linkages and information, poor packaging, handling and storage, and inefficient distribution. The government may therefore need to be a catalyst for the improvement in the country’s agricultural distribution system.

As part of the prefeasibility study on the commodity futures exchange, Sikap/Strive Foundation (2000) examined the wholesale markets and/or commodity exchanges in Thailand, Japan, Taiwan and South Korea as well as the Philippine FTI. As noted earlier, the Philippine FTI failed while the others succeeded. The Sikap/Strive Foundation report (2000) examined the causes for the failure of FTI. That is, FTI was a modern facility with virtually no link to the country’s distribution network. It was also located far from the port (for trade with Mindanao and the Visayas) and from the entry point from Northern Luzon (in contrast to Divisoria). In addition, since it was government-run, it carried politically-motivated strategies, confused vision and mission, and crippling financial and bureaucratic problems.
What the report did not highlight, however, are the common success factors of the food terminals in the other countries. That is, all of the foreign food terminals were not meant to supplant the private traders (although in Thailand’s case, the long-run objective is to eliminate middlemen). In addition, the food terminals or wholesale markets in Korea and Taiwan are joint public-private ventures while Thailand’s are totally private ventures. Second, all these terminals’ key service is to provide modern and physical facilities, efficient transportation access and auction system where wholesalers and retailers can interact. It is apparent that such facilities in the main demand market (e.g., Bangkok, Tokyo) are only workable if they are integrated in the country’s distribution network. In the case of Taiwan, this is assured because the Taiwan Agricultural Product Marketing Corporation is owned by farmers’ cooperatives, wholesalers/dealers, fruits and vegetables cooperatives, and the city and provincial governments with an island-wide marketing network (Sikap/Strive Foundation 2000). South Korea’s wholesale markets also have a strong presence of cooperatives, under the National Agricultural Cooperative Federation (NACF) at the Apex. The NACF has a network of collection points, warehouses for cold storage and packaging warehouses in the rural areas and cooperative marketing and distribution centers in the urban areas.

Nonetheless, despite the failure of the Philippines’ FTI, it is important to examine how the government can help improve the physical distribution system of local agricultural products. Clearly, the aim is not to supplant traders but to work with traders. Trading institutions can expand to include marketing cooperatives similar to those in Taiwan and South Korea. What incentive structure would encourage private investments in putting up more modern wholesale facilities similar to Talad Thai in Bangkok? Should the government encourage joint venture arrangements with producers, cooperatives, wholesalers and dealers, and local governments similar to that of Taiwan or South Korea? If so, how? Should it be through fiscal incentives, setting rules and standards, or providing corollary support infrastructure like roads? In some respect, therefore, the issue would need to be reconciled with the overall public investment program of the national government and the local governments. Despite the massive volume of the Sikap/Strive Foundation’s pre-feasibility study, the issues raised above were not adequately addressed.

Other research concerns: price policy, multimarket analysis and export marketing

There are other policy and research concerns of interest to agricultural distribution. Two of these are the price policy and external trade.
Price policy

Price policy, in its macroeconomic and sectoral senses, influences very strongly the agricultural distribution system. Price ceilings and floors directly affect private storage activities; they also encourage the private sector to concentrate their marketing in the main urban areas, thereby influencing commodity flows and private sector needs for transportation services. Interest rates affect storage costs and private investments in transportation, warehousing and processing facilities because the more technically efficient technologies tend to be more capital intensive (Timmer 1987).

Thus, price policy is central to agricultural distribution. There is a huge literature on agricultural price policy. This paper will not undertake a review of this literature; rather, Peter Timmer’s book Getting Prices Right (1986) provides an excellent discussion on the scope and limits of agricultural pricing policy.

Nonetheless, there remains an important research challenge with significant impact on policy. In addition to the detailed micro level analyses and regular surveys on the agricultural distribution system as suggested earlier in the paper, it would be useful to develop agricultural policy models with a well articulated agricultural distribution subsystem. These models would have to consider explicitly the spatial dimension (rather than just assume a national, single market agri distribution submodel) to bring out the transportation concerns. The models would need to highlight also the vertical linkages from the farm to the consumers. The models may need to be multicommodity because policies affecting agricultural commodities differentially would necessarily have different implications on the spatial network of the agricultural distribution system. This is because the country’s regions have different comparative advantages in the production of various agricultural commodities.

An example of a multicommodity, multiregion agricultural policy model is the Vietnam Agricultural Spatial Equilibrium Model (VASEM), developed by the International Food Policy Research Institute (IFPRI) as part of its study on Vietnam’s rice economy. The model has seven regions and several commodities. It takes into account the regional differences in production and consumption pattern on each of the commodities as well as the cost of transporting goods from one region to another. The specifications of the model allow for an analysis of alternative policy options on Vietnam’s rice sector; for example, elimination of restrictions on domestic rice trade, reduction of interregional transport costs, imposition of variable levy for domestic stabilization and imposition of export quota.

A similar multicommodity and multiregion model but with a more articulated agricultural distribution submodel may need to be developed for the Philippines so as to highlight the important policy issues. These
issues could include price stabilization strategies such as the imposition of a variable levy for rice; impact of reduced tariffs especially for corn and sugar; changes in the distribution costs between markets; and technical change in production. Changes in macroeconomic prices such as interest rates, exchange rate and wage rate would have varying impacts on agricultural commodities, regions and the agricultural distribution system. Policy simulations using such multicommodity, multiregion models can provide valuable policy insights at an economy wide, multiregional perspective. Policy insights from the model simulations, together with the results of the more detailed microlevel analyses and industry surveys discussed here earlier would contribute to more robust policy and institutional reforms as well as program implementation decisions.

**Export marketing and trade**

An additional yet related research concern involves export marketing and international trade. Although the Philippines is increasingly a net food importer, the country has some areas of comparative advantage in agriculture. The challenge is in building and strengthening the country’s niches in agriculture and agribased processed products. Certainly, the fundamental requirement for maintaining comparative advantage is to improve agricultural productivity. Nonetheless, it is useful to examine how the country can go beyond price as basis for export competitiveness: specifically, these would be how to strengthen the country’s export niches in agriculture through product branding, which can be attained by product differentiation, innovation and quality as well as through improvement in trade-related services.

While the leeway for product differentiation is much more limited for agricultural products than for manufactures, product branding is still possible to some extent. Examples are the Thai jasmine rice or Japanese rice, Australian wine or French wine, Fuji apples or Washington apples. Successful product branding (which would allow for some export premium) may require consistency of product quality and distinctive product

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*A less well-articulated model with marketing margins at the national level (without regional breakdown) is that of Arndt et al. on Mozambique (1999). The model essentially assumes fixed input-output relationship of distribution services with agriculture at the national level. Although simpler than the Vietnamese model, the Mozambique model is still useful for Mozambique because it highlights the importance of improving the distribution system since marketing margins are even three times higher than producer prices in some cases.*
characteristics. Thus, product-based branding requires stringent quality control, credibility of the product certification process, and product innovation (e.g., development of new varieties with better product characteristics; intensive soil analysis to determine impact of soil characteristics on product characteristics).

It is likely to be difficult for the Philippines to develop product brands on fresh produce given the very stringent phytosanitary standards of developed countries. It is probably more realistic to develop product brands in processed foods, relying initially on Filipinos residing abroad as the staging ground for the export market. However, it appears that Filipino exporters are in fact losing out to exporters from other countries like Thailand for even ethnic Filipino foods for export to Filipinos residing abroad. Reasons for the Filipino exporters’ losing competitiveness over the Filipino export markets abroad include poor packaging, poor quality control and higher prices (because of the high cost of inputs such as sugar).

Considering that product branding or value adding through processing is one key means for the Philippines to improve its export niches in agri-based industries, it is useful to undertake more intensive analyses on how the country can strengthen this area. What policy and institutional measures can the government undertake to promote product innovation, quality control and export niche market development among farmers and food processors? How can the government research and development (R&D) system help product development and process innovation in the agri-based industries to meet the changing tastes and demands in the export and domestic markets? What is the export market environment in terms of foreign government rules and regulations, customer preferences and competitor offerings? Pursuing the above questions requires more "action type research" that involves the private sector as well as government agencies concerned with export market development, product standards, food safety and R&D.

Conclusion: Research gaps and suggestions for research on agricultural distribution and development
The following are the major research gaps earlier identified and the corresponding suggestions for research.

1. **There are no regular analyses on the performance and evolution of the Philippine agricultural distribution system.**
   
   While the FRLD studies are a good start, they are essentially one-off activities. Because the agricultural distribution sector
impacts on the overall performance and competitiveness of Philippine agriculture, the government should develop well-designed survey materials on the agricultural distribution sector (e.g., performance, marketing costs, returns, commodity flows, credit tie-ups, formal and informal financing systems). Surveys on the sector be undertaken on a regular basis (say, every two years). Such surveys, together with the results of the Annual Survey of Establishments in the Wholesale and Retail Sector currently undertaken by the National Statistics Office, provide the foundation for analyses on the performance and evolution of the agricultural distribution sector.

2. **There is yet no intensive evaluation of the efficiency and competitiveness of the agricultural distribution sector.**

   In addressing this research gap, there are at least two key research activities that can be undertaken. The first is the comparison of, on the one hand, price margins between markets or between processed and unprocessed forms of a commodity and, on the other hand, estimates of actual costs of transport, storage and processing. The comparisons need to be for as many supply-demand routes as possible so as to capture the transport factor well.

   The intermarket price comparison with transport cost is useful in indicating the presence of monopoly/monopsony power of either traders or shippers. They would also be useful in prioritizing infrastructure projects. Specifically, where it is apparent that high price margins in certain areas are caused primarily by high transport costs arising from poor infrastructure facilities, then it is likely that the welfare benefits from infrastructure investments would be better if the investment program of the government prioritize such infrastructural bottlenecks.

   The second research area is the comprehensive and intensive analysis of market integration for several key agricultural products in the country. This would also include issues pertaining to upstream industries such as the seed distribution system for rice, vegetable and other major crops. The analysis should preferably use both simple and more sophisticated statistical and analytical tools.
While the focus of the analysis is the integration of the domestic markets with one another, it is also useful to determine the dynamics of the transmission of international price shocks (e.g., change in the world commodity prices) on the domestic economy. Here it is useful to compare the analysis for the Philippines with the experience of comparator countries such as Thailand. Such comparative analyses can provide insights on how insulated domestic markets are from world market fluctuations.

3. The third research gap involves policy-oriented studies on how the government can facilitate or jumpstart private sector investment in improving the physical distribution aspect of agricultural marketing. Such studies pertain to how the government can encourage private investments in more effective technologies that improve distribution-related services such as transport and port services, and storage and processing (e.g., cold chain technology, containerization, modern wholesale market facilities). These studies form part of the broader research challenge of analyzing and developing alternative institutional approaches and regulatory refinements that can lead the private sector to invest in agriculture and the agricultural distribution sector (e.g., putting export-oriented product innovative food processing firms on a "free trade status" similar to firms in export zones).

4. There is a need for more intensive analyses of the export market environment, especially as it relates to how the country can develop export niches and understand the regulatory environment better. The important focus here is on the analysis of the demand patterns, marketing practices and the regulatory regimes in major export markets. A subset of the study involves exploring potentials for "branding" of Philippine agricultural exports, at least in well-chosen niches. The results of such analyses can help the country prepare and/or refine its export development strategy for agriculture-based products.

5. It is time to have more multimarket, multiregional agricultural policy models with well-articulated agricultural distribution submodels. Such models help provide quantitative and well-integrated evaluation of alternative policy options of interest to the Philippines, e.g., improvements in transport services and reduction in tariffs in corn, rice and sugar.
The research suggestions presented above—the skeleton of a research agenda for the Philippine agricultural distribution sector—could help the country develop an efficient and dynamic agricultural distribution sector and, in the process, become a catalyst for change and innovation in the whole Philippine agricultural sector.
Appendix
Summaries of selected papers and articles on agriculture distribution and related topics
Maricar Paz M. Garde

1. Title: Testing the link between public intervention and food price variability: evidence rice markets in the Philippines

Authors: Elmer Martinez, Gerald Shively and William Masters

Monthly price and stock data are used to test the influence of Philippine government buffer stock programs on seasonal and annual variability of producer and consumer rice prices. The period examined is 1974-1990. The National Food Authority (NFA) stock changes are shown to have had some stabilizing influence on seasonal and annual prices, but the magnitude is small and not statistically significant.

Objective:
To examine the relationship between the government buffer-stock programs and the level and variability of rice prices in the Philippines.

Background of the study:
- Philippine scenario:
  - NFA established stocks and controlled imports in an effort to stabilize domestic prices during the past two decades.
  - When prices were falling during the wet-season harvests, the NFA bought rice from producers at a set price. When market supplies were low and prices high during the dry season, the NFA released stocks to licensed outlets to be resold at the established maximum retail prices.
  - Previous studies show that government policies tend to raise rice prices (STAT-USA 1996).

The authors would like to express their sincere thanks to Ms. Maricar Garde for her excellent research assistance.
The paper uses producer and consumer data to test whether government buffer stock actions stabilized rice prices in the Philippines from 1974-1990.

**Methodology:**
- Estimate two econometric models to test the relationship between price changes and government stock actions over the period 1974-1990.
- Investigate whether the NFA successfully stabilized seasonal price fluctuations by estimating regressions for farmgate and retail prices.
- NFA actions might have reduced the sensitivity of prices to harvest size, stabilizing interannual price fluctuations. To test this hypothesis, annual regressions were utilized.

**Results:**
- Results show that there is a strong seasonal pattern in farmgate and retail prices. Monthly farmgate prices were negatively correlated with NFA stock changes at a statistically significant level over the given period.
- Monthly changes in retail were not correlated with NFA stock changes at standard significant levels.
- NFA interventions affect monthly price changes in the desired way during the sample period, but the magnitude of the effect was very small.
- Farmgate price changes were negatively correlated with production changes over the period.
- NFA stock change variable is not significantly correlated with price changes.
- Adding the NFA stock change variable to the regression has a small impact on the relationship between production and prices in the harvest period.
- NFA intervention seem to lower the sensitivity of price to harvest size by 10 percent, but the differences are not statistically significant. This fails to support the hypothesis that postharvest NFA stock purchases were enough to stabilize prices interannually.

**Conclusion:**
- Arguments that NFA actions altered the seasonal pattern of prices or interannual variability are valid but not compelling.
- The results put into doubt the effectiveness of NFA activities, especially with regard to producer prices.
2. Title: Spatial market integration in the presence of threshold effects  
Authors: Barry Goodwin, Nicholas Piggot  

Threshold cointegration models are used to evaluate spatial price dynamics among the regional corn and soybean markets in North Carolina. Thresholds, reflecting the influences of transaction costs, are confirmed and spatial integration is strongly supported. Results indicate that equilibrating adjustments to market shocks are generally complete in two weeks.

Objective:
To evaluate price linkages among several local corn and soybean markets in North California.

Background:
➢ Tests of market integration consider the extent to which shocks are transmitted among spatially separate markets.
➢ Market integration is important because its absence may imply riskless profit opportunities for spatial traders.
➢ Early studies used price correlation and regression-based tests.
➢ Recent studies conclude that the price data typically used to evaluate spatial integration are often nonstationary.
➢ Regression and correlation tests have also been criticized for the ignorance of transaction costs.
➢ Failure to include transactions costs in the test result to a neutral band within which prices are not linked to one another.

Methodology:
➢ Utilized model developed by Balke and Fomby (1997):
  - "A multiple-threshold error correction model allowing asymmetric adjustments is estimated and used to evaluate the dynamic time paths of price adjustments in response to spatially isolated shocks in each of the markets."
➢ Study utilized a large sample of daily prices quoted at the four principal corn and soybeans markets over a seven-year period.
➢ Specific estimation can be summarized as follows:
  1. Standard Dickey-Fuller unit root tests and Johansen co-
integration tests are used to evaluate time series properties of the data.

2. Researchers followed the general two-step approach of Engle-Granger and ordinary least squares estimates of a cointegrating relationship among variables.

3. The error correction terms were defined by the lagged residuals from the regression.

4. The two thresholds were defined by conducting a two-dimensional grid search.
   - The process involves searching for the first threshold between 1 percent and 99 percent of the largest (in absolute value) negative error correction term and the second threshold between 1 percent and 99 percent of the largest positive error correction term.

5. The error correction is then estimated conditional on the threshold parameters.

- Daily corn and soybean prices were observed at four important North Carolina terminal markets. The largest markets were taken as the central markets against which the smallest markets were compared. Observations were done in pairs; prices in each market were compared to the central market price.

Results:
- Prices in central markets, as compared to smaller markets, are lower in all cases. "Outlying markets have higher prices, reflecting the transportation costs associated with moving corn and soybeans towards the central (high volume) markets."
- "Shocks result in permanent shifts in the price series, reflecting the nonstationary nature of the price data."
- Prices converge to one another over the long run (i.e., generally after seven days following the shock).
- "Evidence of asymmetries in price adjustments is limited. In most cases the responses to negative shocks, though naturally of an opposite sign, are quite similar to the corresponding responses to positive shocks."

Conclusion:
- Results confirm that the observed markets are integrated.
- Analysis confirms the significance of threshold effects and suggests that their presence may significantly influence spatial price linkages.
This paper examines price integration in the MERCOSUR countries of Argentina and Brazil after the creation of this regional economic agreement using a fractional cointegration analysis. The results suggest that Argentine wheat and corn prices are fully cointegrated with the corresponding world prices, whereas Brazilian wheat prices are not cointegrated with the world price. These results support the idea that, for these markets, MERCOSUR is operating more like a free trade area than a customs union with harmonized trade policies. Neither is the soybean price integrated with the world price, implying that both countries are pursuing similar export strategies that have the effect of isolating these markets from the world markets. Within MERCOSUR, Argentine and Brazilian wheat prices are fractionally co-integrated, suggesting that the law of one price (LOP) holds within MERCOSUR although the restoration of equilibria is slower than in the case of the fully cointegrated series. Similarly, Argentine and Brazilian soybean prices are fully cointegrated, suggesting a quick restoration of the equilibrium relationships. Based on the results, it appears that MERCOSUR has led to tight agricultural markets in Brazil and Argentina while the relationships between the markets in the two countries and the corresponding world markets are subject to particular national policy interventions.

**Objectives:**
To examine the LOP in MERCOSUR countries—particularly Argentina and Brazil for major crops such as wheat, corn and soybeans—and test the hypothesis that the LOP is more likely to hold during the post-unilateral reform period.

The LOP between MERCOSUR and non-MERCOSUR countries will also be examined.

**Background:**
- Most Latin American countries implemented unilateral reforms after the 1980s debt crisis, often at the insistence of the International Monetary Fund and the World Bank.
Market-oriented policies and trade liberalization were included in the reforms.

Argentina and Brazil, along with Uruguay and Paraguay, formed a new organization called MERCOSUR with the signing of the Treaty of Asuncion in 1991.

"The effects of policy reforms by trade block members on the LOP is an important and relevant market efficiency issue (Bierlen et al.)."

**Methodology:**

This study uses the fractional cointegration analysis approach introduced by Granger and Joeyux to test the LOP.

"This approach combines the concept of integration introduced by Engle and Granger and fractional differencing introduced by Hosking. Both cointegration and fractional cointegration test for long-run relationships between economic variables or the mean reverting behavior of equilibrium errors with few restrictions on the short-run dynamics, but they differ in the manner the hypotheses are tested."

"Fractional cointegration analysis allows the equilibrium errors to follow a fractionally cointegrated process, such that the order of cointegration is a fraction between 0 and 1.

"The advantage of fractional cointegration relative to standard cointegration methods is that it is able to discern long-run price behavior despite the substantial short-run deviations from the equilibrium."

The study used monthly price data for the period of January 1990 to July 1996 to test the price cointegration hypothesis through fractional cointegration.

"Representative world prices for wheat, corn, and soybeans include the FOB Gulf price for the hard red winter, the FOB Gulf price for yellow corn, and the CIF Rotterdam price for soybeans, respectively."

**Results:**

Argentine wheat and corn prices are fully cointegrated with corresponding world representative prices.

No cointegration was found between Argentine soybean price and Rotterdam soybean prices.

"Argentina is a major exporter of wheat and corn in the world market and it is likely that Argentina and Gulf prices respond to each other to restore equilibrium."
Brazilian wheat and soybean prices are found to be not cointegrated or even fractionally cointegrated with the corresponding world representative prices.

Results indicate long-run relationships between Argentine and Brazilian prices. As a member of MERCOSUR, internal tariffs were reduced every six months starting March 1991 and were finally eliminated by January 1995. The absence of internal tariffs most likely results to long-run relationships between prices in these two countries.

Argentine and Brazilian wheat markets are fractionally cointegrated, and soybean prices are fully cointegrated.

The slow response of wheat prices in Brazil may be the result of stickiness in the Brazilian marketing channel, where traders or importers do not allow domestic prices to change immediately but eventually respond to it over a longer period.

In the case of soybeans, where both Argentina and Brazil are exporters without any internal tariffs, any discrepancy between prices will prompt traders to act quickly and equilibrium will be restored quickly.

4. Title: The provision of rail service: the impact of competition
(Policy Issues Paper 7)

Authors: Murray Fulton, Richard S. Gray
Montana State University, Department of Agricultural Economics and Economics, Trade Research Center, P.O. Box 172920, Bozeman, MT 59717-2920
Source: http://www.trc.montana.edu/publications/policypapers/pp7.htm

Grain transportation is one of the most important economic issues for grain producers in the Northern Plains. The reliance on export markets and the long distances to port position means that transportation costs have a significant effect on the price received by farmers. In the prairie region of Canada, rail transportation is undergoing a major transformation that will affect the competitive positions of agriculture in both the United States and Canada and influence the direction of grain flows between the two countries. Rail rates are no longer legislated although a cap is still in place, restrictions on branch line abandonment have been lifted, and further deregulation of price and car allocation is being considered. Some parties, including the railways, argue that a completely deregulated system, similar to the US system, is the only way to achieve transportation efficiencies. Other groups supporting the status quo argue that the regulation of rates is essential to control the monopoly power of the railways.
There has been very little discussion of other policy options, with the exception of a limited discussion of nationalized railbeds. The US experience provides a stark view of the likely outcome of deregulation. When railways are not faced with competition from other railways or from other forms of transportation such as barges, the evidence suggests railways will price freight services at or near truck competitive rates. Freight rates in Montana, where no effective rail and/or barge competition exists, are approximately twice those at Kansas City and Denver/Commerce City, where such competition exists. The current cost-based regulated rates in Western Canada are similar to those at Kansas City and Denver/Commerce City. Given similar distances to port and the existence of only two railways (and no likelihood of new entrants), deregulation in Western Canada is likely to result in freight rates closer to those in Montana than to the current regulated level. The increase in freight costs will result in transfers from producers to the railways, distort production incentives and create losses elsewhere in the economy.

While maintenance of a regulated freight rate structure would address the freight rate issue, other problems would result. The lack of price signals reduces incentives for industry participants to perform. Branch lines are less likely to be maintained in a regulated environment because railways may be unable to charge the extra amount necessary to make them viable. Railways may also disrupt the system—as a form of bargaining—to create pressure for deregulation.

This report explores the option of the government encouraging entry into rail service provision. Just as telecommunication companies are required to allow competitors to use their phone lines, existing railways could be required to make their track and switching equipment available to rail operators who wish to run train service on a line, on the condition that the access price covers the infrastructure cost.

The paper examines the case of the British railway system where the ownership of the track has been separated from the operation of the rail equipment and the provision of service, and explores the applicability of this model to grain transportation on the Great Plains. In Britain, ownership of the track rests with a company called Railtrack (although Railtrack was government-owned, it has been privatized). Railtrack leases access to thirty train operators for fees that are regulated by the Office of the Rail Regulator to cover maintenance costs and provide a return on investment. The thirty rail operators then compete to provide service to customers. This model and others similar to it need to be developed and articulated before they can be considered in the public policy forum. Nevertheless, given the
importance of rail transportation to the grain industry in the Northern Plains, it is imperative that options such as these be investigated to address the very thorny issues of freight rate and entry regulation.

5. Title: Canadian rail subsidies and continental barley flows: a spatial analysis
Author: Demcey Johson and William Wilson
Source: http://agecon.lib.umn.edu/cgi-bin/pdf_view.pl?paperid=237

Rail subsidies provided under the Western Grain Transportation Act (WGTA) have been controversial within Canada and an issue in recent trade disputes with the United States. A detailed spatial equilibrium model of the North American barley market is used to assess the effects of WGTA subsidies. Simulation results indicate that elimination of these subsidies would induce a larger flow of barley from Canada to the United States.

Subsidies provided by the Canadian Government to rail shipments to Vancouver (for offshore exports) and Thunder Bay (for eastern destinations) raise producer prices in the Prairie Provinces. The issue of rail subsidies has been controversial since changes in the system would affect producer prices and the flow of barley trade in North America. A mathematical programming model was utilized to identify optimal trade flows under a liberalized barley trade regime in Canada. The study considered two Canadian transportation regimes: the current rail rate structure (base case) and compensatory rates. Barley was allowed to be shipped by truck to shipping points in the US under each regime.

US barley imports from Canada reach about 1.6 mmt in the current rate structure. The results show that under the compensatory rate regime, average producer decrease and the equilibrium trade volume increases to 3.0 mmt. One significant change is higher Canadian barley shipments to the California feed market.

If the Canadian Government stops the transport subsidies, there will be higher shipper costs, which in turn will result to lower prices in the producing regions. Barley flows to the US would increase, a big amount would comprise of shipment by truck to US shipping points for rail shipment beyond. There will indeed be significant changes brought about by any reform in the current transport regime. Trade flows, prices and even transportation rates would be affected. Rail operators would have to come
up with competitive rates since producers might look for other transportation modes when the subsidies are eliminated.

6. Title: Technology in Mozambique

**Author:** Channing Arndt, Henning Tarp Jensen, Sherman Robinson, and Finn Tarp

*Discussion Paper No. 43, International Food Policy Research Institute, July 1999*

*Source: http://www.ifpri.cgiar.org/divs/tmd/dp/dp43.htm*

Improvements in agricultural productivity and reductions in marketing costs in Mozambique are analyzed using a computable general equilibrium (CGE) model. The model incorporates detailed marketing margins and separates household demand for marketed and home-produced goods. Simulations improving agricultural technology and lowering marketing margins yield gains across the economy, but with differential impacts on factor returns. A combined scenario reveals significant synergy effects, as welfare gains exceed the sum of gains from the individual scenarios. Factor returns increase in roughly equal proportions, an attractive feature when assessing the political feasibility of policy initiatives.

The findings of the study highlight the large potential gains Mozambique could obtain out of increasing agricultural productivity. However, doing so when marketing costs are high leads to significant fall in prices. The study says that the decline in prices transmits most of the gains in factor income to nonagricultural sectors and prices of production. Households in rural areas benefit though out of greater food availability and lower producer prices, which decrease the cost of home-consumed goods.

Meanwhile, decreasing marketing cost would bring the gap closer between producer and purchaser prices in all markets. Agriculture benefits relatively more because of its higher marketing margins. Lower marketing costs also boost exports and imports. The study reveals that lower marketing margins yield higher returns to producers supplying to export markets. At the same time, it also leads to lower domestic prices of imports.

The study reports that combined policies of increasing agricultural productivity and decreasing marketing costs are beneficial and appealing. It should improve the welfare of poor rural households without causing too much political strain. This paper is indeed helpful for policy purposes.
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Confederation of Grainers’ Association, Inc. (CONFED), Manila.
III
Agricultural biotechnology research and development in the Philippines: the need for a strategic approach

by Saturnina C. Halos

Introduction
Much has been written about biotechnology’s role in helping developing countries attain food security, increase farm productivity and profitability while minimizing environmental damage from conventional agricultural practices. Current data from countries adopting modern biotechnology products, particularly transgenic crops, show increased productivity and profitability, with lower health risk to farm workers and lesser environmental change (James 1998). An analysis of the global implications of the various roles of the United States, Europe and developing countries in the biotechnology revolution indicates a biotechnology-led growth for developing countries producing biotechnology products (Weatherspoon et al. 1999). However, the diffusion of biotechnology to developing countries such as the Philippines is not as rapid as the adoption rate in a few developed countries. Also, in some European countries, there is resistance to agricultural biotechnology and the adoption and use of crops developed through modern biotechnology.

Biotechnology applications should benefit the Philippines where opportunities to increase farm productivity is apparent. To date, the average farm yields are significantly low for major crops (such as rice, corn, coconut and sugar) that occupy about 90 percent of agricultural lands. In addition, the reliable production of some crops introduces more pesticides into the environment and/or results in soil degradation. In answer to all these, a secretary of agriculture stated that genetically modified organisms (GMOs) are advances that may be helpful to Philippine agriculture.
This paper reviews world trends and issues, and Philippine agricultural biotechnology R&D contents, directions and management using published literature, annual reports, symposia proceedings, thesis manuscripts, papers written by individuals, project listings provided by pertinent agencies, and limited field visits and interviews. This paper has three parts: part one presents the scope of biotechnology applications in agriculture; part two discusses world trends and issues in biotechnology; and part three presents the state of the art in analysis of agricultural biotechnology R&D in the Philippines.

**Scope of biotechnology applications in agriculture**

**Definition and applications of biotechnology**

Environmental changes, most of which are damaging, are always associated with conventional agriculture. The doubling of agricultural production during the past 35 years was associated with a 6.87 fold increase in nitrogen fertilization, 3.48 fold increase in phosphorus fertilization, 1.68 fold increase in the amount of irrigated cropland and 1.1 fold increase in land in cultivation (Tilman 1999). These changes have wrought havoc to some ecosystems, causing lakes to die (eutrophication) and topsoils to erode. Nitrogen fertilization of rice paddies has been associated with increasing soil acidity and lower crop productivity. Pest and diseases that cause an average of 30 to 40 percent loss in crop production are controlled by chemical pesticides (Thomas 1999). The decrease in wildlife populations, loss of beneficial organisms and impairment of farm workers’ health due to pesticides have been well documented. Thus, technologies to minimize these changes are therefore necessary for sustainable agriculture.

- Biotechnology is interpreted differently among different people. Official definitions include:
  - Biotechnology is any technique that uses living organisms or substances from these organisms to make or modify a product, to improve plants or animals or to develop microorganisms for specific uses (US Congress).
  - Biotechnology is the application of science and engineering in the direct and indirect use of living organisms or parts or products of living organisms in their natural and modified forms (Barber 1997).
  - Agricultural biotechnology is modifications of any living organisms in ways that improve the efficiency, competitiveness and sustainability of food production (Ontario Agri-Food Technologies).
The range of techniques in biotechnology requires different levels of sophistication in facilities, basic science foundation and technical skills. The first level involves the manipulation of microorganisms and includes centuries-old fermentation technologies such as beer brewing, wine making, production of organic chemicals such as antibiotics and mushroom production. The second level involves the manipulation of tissues and cells from multicellular organisms such as plant tissue culture and mammalian cell cultures. The third level involves the manipulation and analysis of the genetic material DNA such as recombinant deoxyribonucleic acid (rDNA) technology, genetic engineering and applications of genomics, the study of whole genomes or the totality of the genetic material of a species at the molecular level.

The first level is referred to as traditional biotechnology. Developed countries define biotechnology as the application of DNA manipulation techniques such as recombinant DNA and novel methods of using and manipulating cells to produce novel crops, animals and micro-organisms generally referred to as GMOs. In the Biosafety Protocol being framed at the Convention on Biological Diversity, modern biotechnology means the applications of in-vitro nucleic acid techniques, including recombinant DNA, direct injection of nucleic acid into cells or organelles and application of fusion of cells beyond the taxonomic family. (Plant) Biotechnology uses the disciplines of molecular biology, microbiology, genetics, biochemistry and plant breeding to translate basic biological knowledge into practical processes and products that have economic implications. It encompasses a range of techniques and technologies requiring different levels of investment. The techniques range from the simple, widely-used tissue culture to rDNA and genetic engineering techniques (Maredia and Byerlee 1999).

Biotechnology applications in agriculture are numerous. Although research in the past two decades show different emphasis by different countries, developing countries in the ASEAN region particularly focused their resources on the use of microorganisms to maintain soil fertility, add value to agricultural byproducts, improve traditionally fermented foods and hasten plant propagation by tissue culture. Hence, R&D focus was on organic fertilizers, soil inoculants, protein-augmentation of farm produce, soy sauce production, mushroom production, etc. Plant tissue culture is mainly for the rapid propagation of selected planting stock. All these technologies are targeted for small farmers and appear to reflect the extent of available resources not only in terms facilities and maintenance funding but in manpower as well.
Through rDNA techniques, developed countries have produced safer vaccines, more reliable diagnostic kits and GMOs such as crop plants requiring less pesticide, allowing zero tillage for soil protection and acquiring longer shelf life, better processing properties or novel use. A major application of modern biotechnology is the development of reliable, specific, novel genetic improvement techniques that shorten periods of breeding programs and attain objectives not previously possible.

**Techniques of biotechnology compared with traditional methods**

Deoxyribonucleic acid (DNA) manipulation comprises the most revolutionary biotechnology technique. As applied to crop and animal improvement, DNA manipulation and analysis fall into two categories: those used directly to modify genetic content (genetic engineering) and those used to dissect the genome to gather information and fasttrack classical breeding method.

Traditionally, an organism is genetically improved through hybridization—that is, by mating two individuals/populations with desirable properties to obtain a single individual or population that acquired both desirable properties. Another traditional method is to produce genetic variation within a population by exposing the population to a mutagen or an agent that causes mutations followed by the selection for a desirable mutant. Both methods have their limitations. Hybridization allows recombination of properties only within species or, with some technical difficulties, among related species whereas mutations are random and limited by the genetic make-up of the target organisms. Genetic engineering aims to genetically improve an organism by introducing a foreign DNA coming from any species or synthesized in the laboratory. Properties of an organism are permanently changed since the DNA gets integrated into the genome of the recipient; thus, such change is handed down to succeeding generations.

As a breeding method, genetic engineering broadens the germplasm base from where traits are transferred. Also, it enables the repeated transfer of new genes to existing cultivars without many generations of additional crosses, transfers specific genes without the concomitant transfer of other genes and allows the manipulation of genes to alter their mode and level of expression (Conner 1997). Genetic engineering involves transferring specific genes from one species to another, whether related or unrelated. Only the gene of interest and other DNA sequences needed to indicate its presence and enable production of its product are transferred. Conventional breeding produces a hybrid possessing traits of both parents, whether
desirable or undesirable. Hence, the process of obtaining the desired combination of traits often takes years of repeated selection and hybridization.

The rDNA technology is the construction of a self-replicating DNA unit or DNA vector where the desired foreign gene is attached. The vector is then introduced into the host of interest, where it may multiply independently or integrated into the genetic machinery of the host. The transferred gene contains an ordered mix of DNA sequences with different functions affecting the expression of the gene and is referred to as a gene construct. The process wherein the gene construct enters a cell and gets to produce its gene product is called transformation. The recipient organism expressing the foreign gene product is called transgenic or GMO. A particular DNA sequence, gene or gene construct may be used to transform different cultivars or different plant species. A widely transferred gene is the toxin gene of *Bacillus thuringiensis* (or Bt for short), which confers insect protection for the transgenic plant. This is often referred to as the Bt technology. Any crop containing this gene is referred to as a Bt crop (Bt corn, Bt rice, etc). A virus resistant transgenic plant is obtained from the transfer of a virus coat protein gene into the plant; this is referred to as the coat protein (CP) technology that falls within a more general technology: the pathogen-derived resistance. Another widely used technology is the antisense technology, a DNA manipulation technique that turns off or prevents a gene from producing an unwanted trait. Hybridization technologies such as the PGS Seedlink (comprising of male sterility, sterility maintainer and restorer genes) are widely used to facilitate the production of pure hybrid seeds (Rudelsheim 1997).

Molecular markers are DNA variations in plant and animal genomes. These are used in tagging agronomic traits and in selecting in-breeding populations (or MAS, short for marker-assisted selection). The use of DNA markers associated with desirable traits reduces the time and guesswork in the selection process. Selection is often the rate limiting step in plant breeding as it requires that the plants be sustained through out their growth cycle, allowed to express their genes at the right time and exposed to certain field conditions such as insect attack, drought, etc. that limit growth and yield. Hence, selection is traditionally a long and laborious process. The DNA markers are detected as early as the seedling stage without exposing the plants to their selective environments. Detection is highly reliable and rapid since one technical personnel can process at least a hundred samples per day.
Molecular markers are also used to construct genetic maps, measure the genetic diversity of breeding materials and identify individuals, breeds, isolates or species. These include random amplified polymorphic DNA, restriction fragment length polymorphisms, expressed sequence tags, microsatellites such as simple sequence repeat and short tandem repeat and known genes.

Genomics is an emerging research field of molecularly characterizing whole genomes or the total genetic material of a species. This follows the success of the Human Genome Project. Applications of genomics such as information about the structure of economically important genes, their locations relative to each other, their products and the effect of other DNA sequences on the production and function of these products, are considered the next revolution in biotechnology. These applications could either offer technical solutions to biosafety issues currently raised against transgenic crops or develop novel crops not yet imagined today.

In addition, DNA-based techniques have been developed for improved diagnostics and therapeutics. An appropriate, timely therapeutic regime can only be delivered after accurate diagnosis of the causal agent of a disease. The DNA sequences specific to pathogenic agents are being packaged into diagnostic kits that are convenient and accurate. Safer recombinant vaccines can totally remove the capacity of the attenuated organism to cause disease. A recent development, DNA vaccines are transiently expressed DNA sequences that produce antigens, thereby triggering the immune response of an animal to produce the corresponding antibodies against a specific pathogen. Such DNA vaccines may now require no refrigeration and would have the advantage of better shelf life than current cell or protein-based vaccines in the market. Farmers in remote areas are expected to have better access to these new vaccines.

Genetically modified animal cell cultures have developed rapidly as a result of the inability of microbial cells to produce complex foreign proteins such as human proteins in culture. In addition to mammalian cell lines, insect cell lines—especially those that support the growth of baculoviruses (insect-specific viruses) genetically engineered to produce human proteins—are also developed. Obtaining a hybrid cell through fusion techniques in the laboratory was found to have many applications. Hybridomas are cell cultures used commercially in the production of monoclonal antibodies that have applications as diagnostics in identifying specific cells or tissues, or in therapy. Hybridomas are derived from the fusion of spleen cells and cancer cells. The spleen cell endows the hybridoma
the ability to produce a specific antibody and the cancer cell, the ability to
grow in culture indefinitely.

So-called reproductive technologies involve manipulation of the egg or sperm cell to modify mammalian reproduction. Included is in-vitro fertilization, which is the fusion of the isolated egg with a selected set of sperm cells outside the womb, the fused cells or embryo induced to divide and implanted to the receptive uterus of the female when it develops to term. In-vitro fertilization has led to the development of techniques that allow storage of sperm cells for later use and selection of a sperm that carries the male or female chromosome—thereby allowing the preselection of the resulting embryo’s gender—as well as cloning. Gender preselection uses a very sophisticated technique called fluorescence-activated cell sorting, which has been successfully used on pigs in 1998 and tested successfully on man early in 1999. Cloning is the production of new individuals without sexual union. In mammals, this feat began in 1997, with the birth of Dolly the sheep. Dolly was born out of the union of an enucleated egg cell from an ewe and a cell from the udder of another ewe. The resulting fused cell behaved like an embryo and was implanted in the uterus of a third ewe. Successes with cows and mice have been reported since but various governments have adopted a policy to prevent such applications in the cloning of human beings. Reproductive and DNA manipulation techniques are also referred to as genetic technologies.

Plant tissue culture refers to the aseptic propagation of plants or plant parts. As the definition implies, it requires a highly controlled environment to prevent contamination and promote growth of plants/plant parts in confinement. Tissue culture is used either for micropropagation or as a plant breeding tool. Micropropagation results in the rapid release of a new variety or selected cultivar with concomitant removal of seed-borne pathogens and avoids the production of genetic off-types. There are three generally used procedures: meristem culture, shoot multiplication and somatic embryogenesis. Meristem culture induces the actively dividing tissues of the plant to produce new plants. Shoot multiplication is the induction of a shoot to produce many resulting shoots that are subsequently rooted into new plants.

Somatic embryogenesis induces individual plant cells to develop into embryos. These embryos are encapsulated to produce artificial seeds. The method is hoped to produce cheaper and genetically similar planting stocks when compared to meristem or shoot cultures.

All other tissue culture procedures are used for plant breeding. Somaclonal variation with in-vitro selection is a protocol for selecting
desirable variants during tissue culture at relatively shorter period of time and lesser expense compared with traditional field screening and selection. In-vitro selection allows for the use of more straightforward, rapid and objective selection procedures not feasible in the field. The selected variant may be developed into new commercial lines such as those reported for corn, tomato, papaya, apple, peach and citrus (Drew 1998). The selected variants may be also used as parental stocks in breeding.

This technique also reduces the time needed to produce breeding lines for hybrids. Commercial hybrid seeds are produced from two isogenic lines, each possessing the desired genes in pure form that is different from that of the other line. The traditional method of producing isogenic lines takes years but one intervening biotechnology is the production of haploid plant with subsequent diploidization to produce pure breeding lines or doubled haploids. Haploid plants are regenerated from anther, microspore or ovary cultures. These haploid plants have their chromosome number doubled to produce doubled haploids used like isogenic lines. This technique drastically reduces the time of producing isogenic lines by at least one half. For distantly related species, an intervening technique is embryo rescue, which meant a resulting embryo is obtained and allowed to grow in tissue culture. Embryo rescue and culture are used to overcome the incapacity of the ovary to support hybrid embryo growth. Somatic hybridization is the production of hybrids through fusion of cells from two selected parental lines. Techniques involving the isolation of single cells and their regeneration into whole plants are essential tools in the application of rDNA for plant genetic improvement.

On the other hand, plant cell cultures are being developed to produce specialty plant chemicals that cannot be chemically synthesized such as cancer drugs, vincristine and vinblastine from the tropical plant Vinea rosea (chichirica in Tagalog). One plant cell culture system that is already commercialized produces shikonin, a red dye used in lipsticks. The system provides better control of production without regard for the vagaries of nature. A major technical drawback of the system is its inability to maintain a uniform genetic make-up of the plant cells in culture. The system is also more expensive to set up, compared with microbial-based systems. Hence, to this day, no other commercial-scale plant cell culture is reported.

Cell fusion meant to achieve novel gene combinations has been tried with plants. Plant cells have their cell wall removed with enzymes to produce protoplasts, which are then fused in the presence of agglutinating agent. Although new hybrids can be derived from this technique, a commercially grown plant hybrid derived by protoplast fusion has yet to be reported.
Fermentation technology is a production system designed to maintain microbes in a state that enables them to produce microbial biomass or substances of economic value. The industrial-scale technology is a complex engineering system that requires large-scale aseptic conditions and includes a bioreactor or fermentor and the necessary downstream processing equipment that isolates the substance of interest. These systems traditionally manufacture high-volume, low-value products for various industries or for the public. In advanced countries, such systems are several decades-old, capital-intensive industries that currently supply the world with amino acids, enzymes, antibiotics, citric acid, vaccines, etc. In developing countries such as the Philippines, fermentation systems are traditionally home-scale, using centuries-old practices and vessels lacking any control in the process. Within the past decade, industrial countries have fermentation systems redesigned to suit genetically-modified yeast, bacteria or mammalian cells and produce novel, high-value substances such as hormones or human proteins.

The continuum of biotechnology techniques requires increasing levels of scientific knowledge, technical sophistication, financial support and time to achieve desired results (Croucher 1995). The development of microbial-based technologies and plant tissue culture requires conventional knowledge and laboratory skills such as aseptic culture techniques, which are usually included in most college Biology curricula. Research facilities are relatively easy to procure and inexpensive. Mammalian/plant cell culture and attendant technologies require special training in laboratory skills as well as indepth knowledge of physiology. Mammalian cell culture facilities and maintenance cost are relatively more expensive. Recombinant DNA requires extensive knowledge of genes and their mode of action in biochemical terms as well as sophisticated facilities for storing and growing cells and manipulating DNA, and involves quite expensive reagents. Compared with rDNA, DNA variation analysis requires less expensive standard equipment, less reagents and more manageable techniques. The DNA synthesis and sequencing services are now available at reasonable cost, which obviates the need to set up one’s own facilities. Hence, active rDNA research is done mostly in developed countries.

The development of a novel biotechnology product requires compliance to biosafety regulations because of the biological nature of the product. That is, living organisms multiply, can become wild and contribute genes into the genetic pool; thus, they must be handled differently from, say, a machine or a chemical compound. Research and development in as well as biotechnology products developed through genetic engineering must comply with biosafety guidelines. Most countries, including the Philippines,
have adopted biosafety guidelines on research with GMOs. The Philippines has recently adopted DA AO No. 8, which regulates the import and propagation of GMOs.

It must be noted that the requirements for the dissemination or commercialization of a technology is not dependent upon the manner of development but upon the final product itself. For example, the commercialization of a traditional fermentation process such as antibiotic production is usually capital intensive as it requires a large infrastructure that must be kept aseptic whereas a transgenic crop plant simply has to be grown to produce the seeds for dissemination. Clearly, the form of the final biotechnology product sets the limitations to its commercial applicability. In a developing country such as the Philippines, the capital available for the commercialization of technologies and the small size of the market often limit the extent the private sector picks up technologies for commercialization.

**Trends and issues**

**Market trends**

Antibiotics, alcohols, organic acids, amino acids, vitamins and industrial enzymes are some traditional biotechnology products that are often encountered and used. Antibiotics, amino acids such as lysine and methionine, vitamins and enzymes are feed components imported into the country. Some of these could be products of GMOs (Bigelis 1995). Organic fertilizer is gaining acceptance locally, and its rapid adoption is considered one of the success stories for sustainable agriculture internationally. Fungal- and bacterial-based biocontrol agents against crop diseases are commercially available in many countries. Other microbial-based biotechnologies for agriculture that are still being developed include genetically engineered baculoviruses for insect control and genetically engineered soil inoculants that promote plant growth. Monoclonal antibodies are used in many diagnostic kits as they provide the specificity, speed and ease required. Recombinant vaccines are also commercially available. Tissue-cultured ornamental plants, white potato and banana plants are available from commercial and government laboratories in many countries, with banana as the most tissue-cultured crop in the world. Automated fermentation systems for the mass production of artificial seeds (gel-encapsulated plant somatic embryos developed through tissue culture) are being developed to reduce the cost of tissue-cultured planting stock.

Transgenic crops (i.e., the virus-protected tobacco) were first grown in commercial scale in China in 1992, and then in the United States in
1994, with the delayed ripening tomato (James 1996). They are designed to possess traits that not only address various impediments to crop production but also to avoid post-harvest losses, improve product quality and endow novel capabilities (Table 1). Other traits currently incorporated into crop plants are tolerance to abiotic stress such as drought, increased photosynthetic ability and improved nutritional qualities.

Multiple benefits reported by growers for selected transgenic crops include more flexibility in terms of crop management (particularly important for herbicide-tolerant crops), decreased dependency on

<table>
<thead>
<tr>
<th>Crops</th>
<th>Traits already commercialized</th>
<th>Traits in Field Trials/Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canola</td>
<td>1. Herbicide tolerance</td>
<td>1. Improved disease resistance</td>
</tr>
<tr>
<td></td>
<td>2. Hybrid technology</td>
<td>2. Other oil modifications</td>
</tr>
<tr>
<td></td>
<td>3. Hybrid technology and herbicide tolerance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. High lauric acid</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>1. Control of Corn-Borer</td>
<td>1. Control of Asian-Borer</td>
</tr>
<tr>
<td></td>
<td>2. Herbicide tolerance</td>
<td>2. Control of Corn Rootworm</td>
</tr>
<tr>
<td></td>
<td>3. Insect protected/herbicide tolerance</td>
<td>3. Disease tolerance</td>
</tr>
<tr>
<td></td>
<td>4. Hybrid technology</td>
<td>4. Higher starch content</td>
</tr>
<tr>
<td></td>
<td>5. Hybrid/herbicide tolerance</td>
<td>5. Modified starch content</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. High lysine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7. Improved protein</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8. Resistance to storage grain pest</td>
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<tr>
<td></td>
<td></td>
<td>9. Apomixis</td>
</tr>
<tr>
<td>Cotton</td>
<td>1. Bollworm Control with Single genes</td>
<td>1. Bollworm control with multiple genes</td>
</tr>
<tr>
<td></td>
<td>2. Herbicide resistance</td>
<td>2. Control of Boll Weevil</td>
</tr>
<tr>
<td></td>
<td>3. Insect protected/herbicide tolerance</td>
<td>3. Improved fiber/staple quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Disease resistance</td>
</tr>
<tr>
<td>Potato</td>
<td>1. Resistance to Colorado Beetle</td>
<td>1. Resistance to Colorado Beetle+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Virus resistance</td>
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<tr>
<td></td>
<td></td>
<td>2. Multiple Virus resistance (PVX, PVY, PLRV)</td>
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<tr>
<td></td>
<td></td>
<td>3. Fungal Disease resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Higher starch/solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Resistance to potato weevil/ storage pests</td>
</tr>
</tbody>
</table>
conventional insecticides and herbicides; higher yield, cleaner and higher-grade grain/end product (i.e., no worms, no mycotoxin-producing fungi in Bt corn); increased yields for pest-protected crops; decreased use of pesticide that redounds not only to savings in pesticide cost but also to lesser environmental pollutants; lower risk for farm workers as well as consumers; zero or minimal disturbance in the population of beneficial species; and better soil conservation. Combined, they all lead to increased farm profitability and less disruptive environmental impact (Table 2).

Thus, farmers have adopted transgenic crops at a rate greater than any other technology in the history of agriculture (Langridge 1999). Planted areas have rapidly increased from 1995-1998 (Figure 1) as well as in 1999.

The net return per hectare of these benefits for American and Canadian farmers ranges from US$19.76 for herbicide-tolerant cotton, to US$175 for Bt cotton. In fact, this first wave of transgenic crops are considered farmer-friendly. Contrary to charges by critics that biotechnology companies are the ones to benefit more from the technology, farmer/company benefit ratio has been calculated at 2:1 for Bt cotton in the United States in 1996.

Table 1. (cont’d.)

<table>
<thead>
<tr>
<th>Crops</th>
<th>Traits already commercialized</th>
<th>Traits in Field Trials/Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>1. Resistance to bacterial blight</td>
<td>1. Resistance to bacterial blight</td>
</tr>
<tr>
<td></td>
<td>2. Resistance to rice-borers</td>
<td>2. Resistance to rice-borers</td>
</tr>
<tr>
<td></td>
<td>3. Fungal disease resistance</td>
<td>3. Fungal disease resistance</td>
</tr>
<tr>
<td></td>
<td>4. Improved hybrid technology</td>
<td>4. Improved hybrid technology</td>
</tr>
<tr>
<td></td>
<td>5. Resistance to storage pests</td>
<td>5. Resistance to storage pests</td>
</tr>
<tr>
<td>Soybean</td>
<td>1. Herbicide tolerance</td>
<td>1. Modified oil</td>
</tr>
<tr>
<td></td>
<td>2. High oleic acid</td>
<td>2. Insect resistance</td>
</tr>
<tr>
<td></td>
<td>3. Virus resistance</td>
<td>3. Virus resistance</td>
</tr>
<tr>
<td></td>
<td>4. Resistance to bacterial blight</td>
<td>4. Resistance to bacterial blight</td>
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<tr>
<td></td>
<td>5. Resistance to rice-borers</td>
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<td></td>
<td>7. Improved hybrid technology</td>
<td>7. Improved hybrid technology</td>
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<tr>
<td></td>
<td>8. Resistance to storage pests</td>
<td>8. Resistance to storage pests</td>
</tr>
<tr>
<td>Tomato</td>
<td>1. Delayed/improved ripening</td>
<td>1. Virus resistance</td>
</tr>
<tr>
<td></td>
<td>2. Insect resistance</td>
<td>2. Insect resistance</td>
</tr>
<tr>
<td></td>
<td>3. Disease resistance</td>
<td>3. Disease resistance</td>
</tr>
<tr>
<td></td>
<td>4. Quality/high solids</td>
<td>4. Quality/high solids</td>
</tr>
<tr>
<td>Vegetables</td>
<td>1. Virus resistance</td>
<td>1. Insect resistance</td>
</tr>
<tr>
<td>and Fruits</td>
<td>2. Delayed ripening</td>
<td>2. Delayed ripening</td>
</tr>
</tbody>
</table>

Source: James 1997
In 2002, global genetically modified crop areas continue to grow for the sixth consecutive year at an annual rate of 10 percent (James 2002). The estimated global area of transgenic crops for the year is 58.7 million ha., which is grown by 5.5 million to 6 million farmers in 16 countries. About 27 percent of these is in nine developing countries. Four countries—two industrialized nations (US and Canada) and two developing ones (China and Argentina)—grew 99 percent of the global genetically modified crop areas.

There are four transgenic crops being raised: soybean, corn, cotton and rape seed oil, that showed two dominant traits: herbicide tolerance and insect resistance (Bt). Of these, the dominant crop and trait

Table 2. Benefits reported from the commercial production of transgenic crops

<table>
<thead>
<tr>
<th>Crop/Country</th>
<th>Yield/income increase</th>
<th>Reduction in pesticide use</th>
<th>Other benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bt cotton/USA</td>
<td>Yield up to 20%</td>
<td>0-1 insecticide application from 4-6 applications</td>
<td>no effect on nontarget beneficial species compatible with IPM</td>
</tr>
<tr>
<td>Bt corn/USA</td>
<td>~ 9%</td>
<td>0 insecticide application reduced insecticide application by 1-2</td>
<td>-ditto-</td>
</tr>
<tr>
<td>Bt potato</td>
<td>US$35/ha</td>
<td>1-3 herbicide application</td>
<td>-ditto-</td>
</tr>
<tr>
<td>Herbicide tolerant soybean</td>
<td></td>
<td>1-3 herbicide application</td>
<td>increased flexibility in management, better yield dependability, improved soil and moisture conservation, compatibility with tillage conservation that reduces soil erosion</td>
</tr>
<tr>
<td>Herbicide tolerant canola</td>
<td></td>
<td>reduced to only 1 herbicide application, reduced herbicide use from 570 to 160 g</td>
<td>-ditto-</td>
</tr>
<tr>
<td>Virus resistant tobacco</td>
<td>5-7 % more leaves</td>
<td>reduced by 2 the usual 7 insecticide applications</td>
<td>-ditto-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>plus improved seed quality</td>
</tr>
</tbody>
</table>

Source: James 1997
Figure 1. Traits of some selected transgenic crops commercialized and for field test

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<td>3. Hybrid technology and herbicide tolerance</td>
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<td>4. Hybrid technology</td>
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<td>3. Improved fiber/staple quality</td>
</tr>
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<td></td>
<td></td>
<td>4. Disease resistance</td>
</tr>
<tr>
<td>Potato</td>
<td>1. Resistance to Colorado Beetle</td>
<td>1. Resistance to Colorado Beetle + Virus resistance</td>
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<td>2. Multiple Virus resistance (PVX, PVY, PLRV)</td>
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<td></td>
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<td>1. Modified oil</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3. Virus resistance</td>
</tr>
<tr>
<td>Tomato</td>
<td>1. Delayed/improved ripening</td>
<td>1. Virus resistance</td>
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<tr>
<td></td>
<td></td>
<td>2. Insect resistance</td>
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<tr>
<td></td>
<td></td>
<td>3. Disease resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Quality/high solids</td>
</tr>
<tr>
<td>Vegetables and fruits</td>
<td>1. Virus resistance</td>
<td>1. Insect resistance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Delayed ripening</td>
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</tbody>
</table>

Source: James 1997
combinations are herbicide tolerant soybean and Bt corn. In 2001, 80 percent of soybean grown in the US was herbicide tolerant and 30 percent of corn is of the Bt type. Since genetically modified and nongenerically modified crops are mixed in the US and simply imported into the Philippines as soybean and corn, the latter’s food supply contains these two GMOs. Following the awarding of the biosafety permit to propagate in December 2002 to Monsanto for its Bt corn MON810, farmers in the Philippines have grown Bt corn in 126 ha. of land during the dry season of 2002-2003.

**Issues**

*Emerging trends in the development of agricultural applications of modern biotechnology*

Research and development in transgenic food crops are placing products in the market in four waves. The first wave targets farmers’ concerns on productivity and profitability, workers’ safety and environmental integrity. The second wave targets processing and marketing concerns on reducing postharvest losses and higher processing profitability. The third wave includes transgenic food crops that provide nutrition as well as serve as a prophylactic or therapeutic group of food. For instance, being developed are the so-called nutraceuticals or functional foods such as a banana that can deliver a vaccine when eaten. The fourth wave offers transgenic crops that produce specialty chemicals for industries such as biodegradable "plastic"—thereby using plants in place of microbial fermentation.

The availability of techniques that transform mammals with rDNA and the high cost of animal cell-based fermentation systems led to research on the use of transgenic farm animals for the production of protein pharmaceuticals. Transgenic cows, sheep and goats are envisioned to secrete therapeutic human proteins such as factor VIII for hemophilia, collagen II for arthritis, Pro542 for HIV, and others in the milk or urine, with the objective of reducing the cost of producing these proteins (Breekveldt et al. 1998). Transgenic animals are themselves technical feats and the natural progression now is to multiply animals through cloning. Cloning produces organisms of similar genetic make-up, and its widespread application in propagating transgenic farm animals will depend on whether cloning will be cheaper and more reliable than rDNA technology.

Pharming or the production of human protein pharmaceuticals in transgenic farm animals is a specialized and limited area of animal husbandry but expected to be part of the pharmaceutical production chain. It should be noted, however, that more advanced research results in this area would include its commercial applications in animal husbandry *per se.*
The first group of transgenic crop plants has acquired genes derived from nonfood organisms, which made them unacceptable to some people. Controversies surrounding this first group of transgenic crops—especially in markets (such as Europe), where mistrust on transgenic food crops has taken root—is putting undue pressure on the release of such crops. On the other hand, new uses for crop plants that produce specialty chemicals will provide a management tool for farmers. A farmer, without changing his practices and investments, will be able to shift production from one specialty crop to another depending upon economic considerations.

A recently reported technology that has elicited much criticism is the Technology Protection System (TPS) being developed by Monsanto from patents owned by the US Department of Agriculture and Pine & Delta Co. The TPS is a very imaginative use of genes and their controls that allows a seed producer to render seeds sterile when wanted. The system comprise of three genes and their control systems or promoters. Gene 1 codes for a protein that is toxic to the germination apparatus of the seed but leaves the rest of the seed normal. This gene makes the toxic protein only when placed adjacent to its promoter. However, between gene 1 and its promoter is a short DNA sequence block. Gene 2 codes for an enzyme that cuts the DNA block and allows the cells to produce the toxin. Gene 3 makes repressor proteins that prevent gene 2 from making the DNA-cutting enzyme. The repressor proteins are inactivated by exposing the seeds to an antibiotic (tetracycline). The plant produced by these seeds will therefore produce sterile seeds (Feder 1999).

The TPS is designed to protect the interest of the seed producer. It also prevents the transfer of a transgene to the wild, weedy relatives of the GMO. However, it received much flak especially from the nongovernmental organization Rural Advancement Foundation International director who dubbed TPS as the "terminator technology" allegedly because pollen from the TPS-containing plant could render non-GMO crops growing nearby sterile as well. If the non-GMO crop is grown by a subsistence farmer, then the economic lifeline of the farmer is severed because he normally uses this year’s seed for next year’s planting. However, subsistence farmers usually grow crops in marginal uplands; hence, their plants would unlikely be fertilized by pollen coming from progressive farms located in more fertile areas.

Researchers and the industry see much application of the genetic switch technology-activating gene 3. Promoters can be designed such that farmers could control the different traits of the crop, depending upon the weather or market demands.
Genetic imperialism: potential effect of the consolidation of life science companies

The significant number, magnitude and extent of biotechnology-driven acquisitions, mergers and alliances of companies with complementing strengths in biotechnology R&D and global marketing resulted in an unprecedented consolidation in the industry. About 50 transactions have been recorded between 1995 and 1998, and some 25 of which were valued at about US$17 billion. These mergers effectively united the agricultural and pharmaceutical interests of these companies involved. The rapid rate at which these transactions occurred were apparently driven by the desire to gain a share of the fast emerging market of transgenic crops in both developed as well as developing countries. Considering the huge volume involved, these transactions are expected to have far reaching policy and technology implications in these countries. Mergers reduce costs as a result of lower administrative overhead costs, balanced credit, debt and cashflow, streamlined research functions, combined global market strategy and finally, lower legal and regulatory costs associated with proprietary products. Hence, there are now fewer companies with a larger market share in the transgenic crop market. These consolidations are expected to sustain agricultural biotechnology R&D, which often needs 10 years for product development. The strategy for deploying transgenic crops has reached international scope and scale, which coincides with the implementation of world trade protocol. Thus, biotechnology is included in the agenda of the coming World Trade Organization (WTO) negotiations, where various governments and the private sector have to work closer in developing the regulatory framework for the adoption of transgenic crops.

These consolidations led critics from civil society to contend that large companies will dominate the world seed supply, making farmers too dependent on these companies. The term genetic imperialism has been coined to refer to this. The criticism increased when the TPS was reported to render seeds from the TPS-containing crop sterile. Monsanto responded by proposing that an international review of the costs and benefits of the technology and related inventions be done, and subsequent actions be taken only after such a review is completed.

IPR issues

Most of the tools for genetic engineering are proprietary and in the hands of the private sector. The development of a GMO and the isolation and identification of desirable genes and of the various functional DNA
sequences are intellectually creative endeavors and are subjects of intellectual property rights (IPR). Forms of traditional IPR systems for biotechnology products include patents, plant breeder’s rights, trade secrets and trademarks (Lesser 1997; De Guzman et al. 1999). Proprietary materials or processes have restrictions on their use. Proprietary materials and processes currently used in agricultural biotechnology research, in addition to the GMOs, include selectable marker genes, reporter genes, promoters, genes of interest, genetic markers, transformation systems, genetically modified cells and experimental animals, research techniques and diagnostic probes. Selectable markers are genes that allow the recipient cell to grow while preventing nonrecipients from growing, hence, enabling a researcher to obtain only the recipient cell. Promoters are DNA sequences that determine how much protein a gene can produce (gene expression). This is important especially in the Bt technology where the level of gene expression is essential for resistance management. Genes of interest include those that confer special properties to a plant such as the Bt genes protecting the plant from insect attack. Reporter genes indicate when a cell contains a foreign gene (the green protein gene renders the transgenic cell green, for example) and how much new protein is produced. Transformation systems are used to deliver a gene construct into a cell. The Dupont’s biolistic system, for example, transforms cells by bombarding them with gene-coated particles. Special genetically modified cells are commonly used to determine the activity of a cloned gene. Diagnostic probes are DNA or monoclonal antibodies that identify cells containing specific DNA sequence or substance. Use of these materials are either covered by a material transfer agreement (MTA), technology-use agreements, license or sublicense that impose certain obligations to the user.

**Awareness of IPR among public research institutions and researchers**

The increasing legal complexity involved in the supply of proprietary technologies may raise matters related to contract, IPR, biodiversity and biosafety, technology transfer and competition laws (where restrictive provisions are imposed). A research institution may not have clear knowledge regarding the type of IPR provided. This could lead them to inadvertently infringe on legal conditions regarding the use of these inputs (Cohen 1998). Lack of information leaves a researcher unclear as to his legal responsibilities, both to the owner of the technology and to other researchers. Hence, it is necessary for research centers to develop a system that clarifies its obligations in accordance with the MTA and informs staff accordingly.
Public institutions are often constrained by practice and mandate to apply patents on their new technologies. Defensive patenting in order to stake out a claim and ensure access is being considered to protect innovations from Consultative Group in International Agricultural Research (CGIAR) institutions. Coordination in the access of certain research materials for efficiency is also considered to reduce problems of managing proprietary materials.

**IPR and grower autonomy**

To ensure protection, companies selling genetically modified seeds enter into agreements with farmers, where the latter is to produce the crop using appropriate practices such as establishing a refugia in case of a Bt crop, refraining from using or selling the seed crop for next year’s planting and allowing the company representatives to visit the field within the period and two years after the period of the agreement. Company representatives see to it that farmers refrain from planting the seeds from the crop not only within the farm but elsewhere. Although some farmers expressed resistance to this system, most farmers in North America hardly oppose. The ethical issue raised is that the system promotes a culture of whistle-blowers, where farmers tell on neighbors who used genetically modified seeds without license.

The above requirements were not applied by Monsanto to Philippine farmers planting their first Bt Corn MON 810 seeds. According to the Plant Variety Protection Act, Philippine farmers have the right to produce their own seeds. Furthermore, the country’s Intellectual Property Code specifically prohibits patents for plants and animals.

**Current IPR laws disregard previous contributions to crop development**

Many of the world’s crop plants were developed through centuries of selection in developing countries. These plants were freely disseminated throughout the world. However, when these crop plants are modified by adding one or two genes and patented, they then become private properties. Since the resources required to develop a product through modern biotechnology are beyond the means of developing countries, the IPR system favors rich countries. Critics argue against the patenting of GMOs primarily because of the failure of the IPR system to recognize the contribution of farmers of long ago. Also, civil society is actively promoting awareness of biodiversity in developing countries to stem the free flow of genetic materials to the developed countries. This strategy is also embodied in the Convention on Biological Diversity. There is, therefore, a need to design an international
system of intellectual property that balances the private property interests of the rich countries with the public good needs of the poor (Serageldin 1999).

A novel mode of sharing the benefits of commercialization has been developed by the University of California, Davis. This is in connection with the patent of a wild rice gene, Xa21, which makes the crops resistant to diseases caused by the bacterium, Xanthomonas. Licensing fees are placed in a trust fund, the interest of which will be used by the University to support the graduate studies of a student from the source country of the species where the gene was derived. In this case, it was Malta.

Biosafety issues
Of the various genetically modified organisms, food plants have elicited some controversies and may even result in a trade dispute between the United States and its trading partners. Major issues raised against the widespread adoption and use of genetically modified crops include possible health risks and ecological change or damage. Genetically modified crops often contains a gene or DNA sequence from a non-food organism. This foreign gene produces a foreign protein that could be toxic or allergenic to humans. The genetically modified plant may run wild and becomes a weed in itself. It may transfer its foreign gene to weed species conferring advantage to the weed, making it more difficult to eradicate (where gene flow = genetic pollution). One containing an antibiotic resistance gene may transfer this gene to a microbe in the wild and eventually, into human pathogens. Likewise, Bt crops may promote the selection of insects resistant to Bt, which can no longer be controlled by insecticides. It may adversely affect non-target beneficial organisms. Regulatory bodies are unable to ensure that genetically modified crops and their derivatives are safe for human consumption and to the environment. The public is allegedly kept ignorant and rather made the experimental guinea pigs for GMOs.

Possible allergenicity and toxicity of foods derived from GMOs
Scientists agree that genetic engineering could produce a toxic or allergenic protein. Since virtually all food allergens are proteins, all food derived from genetically modified organisms must be tested for allergenicity. Even early in the development of a genetically modified food plant, the production of a toxic or allergenic component due to genetic engineering were tested. The research was cut short after findings showed that the seed protein being transferred from the Brazilian nut to improve the protein profile of the recipient food plant was highly allergenic. Now, countries
permitting the sale and use of GMOs require these genetically modified products to undergo toxicity and allergenicity tests.

The random insertion of a gene construct in the plant genome may disrupt or modify the expression of an existing gene. Possibly, the gene construct may be placed adjacent to a sequence that can modify its expression. It may activate pathways or cause the fusion of genes, thereby producing new toxins or allergens. It should be noted that in traditional plant breeding, the above-mentioned events are also possible. Hybrids between crop plant and their wild relatives transfer blocks of genes that may also produce toxins and allergens. However, unlike transgenic food plants, hybrids of wide crosses—except in Canada recently—are not subjected to the rigorous toxicity and allergenicity testing undergone by genetically modified crops. Note that allergenicity is not unique to genetically modified food plants. Common food allergens include milk, egg, fish, chicken, crustacea and peanuts. On the other hand, it has been proven that genetic engineering can remove toxicity, allergenicity or any other unwanted trait of an organism (Tada et al. 1994).

Presently, researchers are trying to do away with genes from non-food organisms. Such genes are isolated from varieties or relatives of a crop or other food organisms. For instance, the bacteria resistance gene transferred to elite rice varieties can be isolated from a wild relative of rice (Khush 1998).

**Possible creation of super weeds**

The transfer of herbicide tolerance trait to crop plants has raised concern that it could produce super weeds. Yet, the scientific community still has to obtain proof that a genetically modified crop can become weedy. No experiment has been able to show this allegation (Deshayes 1994). On the other hand, there is the possibility of a genetically modified plant transferring its gene construct to a wild, weedy relative. In most groups of plants, related species regularly form hybrids and such exchanged genes tend to improve on each population (Kendall et al. 1997). In some countries, wild rice is a weed in direct seeded rice. It has been shown that wild rice and cultivated rice naturally exchange genes. Consistent gene flow has been shown between the cultivated sugar beet and its weedy relatives (Boudry 1994). The transfer of a stress tolerance gene (such as insect resistance or drought tolerance genes) from a genetically modified crop to its weed relative could make the weed weedier. The weed may eventually become dominant, changing the composition and structure of the plant community and the fauna that thrives on it. Hence, a major concern is the ecological
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havoc a GMO could create in the center of the crop’s origin, where most of its wild relatives exist.

Creation of new human, crop plant and animal pathogens

The transfer of a gene construct from one cell to another is very inefficient. Sometimes, only one cell out of 10,000 will be transformed. Selecting for the transformed cell would have been costly and tedious without the use of selectable markers. Selectable markers are genes included in the gene construct and confer to the transformed cell an ability to grow in a special (selective) medium that kills cells without the marker. A selectable marker commonly used in plant transformation is the kanamycin resistance gene, which confers resistance to the antibiotic kanamycin. Some quarters, however, have expressed concern over the possibility that some microbe might pick up the kanamycin resistance gene during the disintegration of the genetically modified crop in the field. Microbes are known to freely exchange genes in nature and the kanamycin resistance may eventually find its way into human, animal or wildlife pathogens. Hence, this planting of a genetically modified crop containing an antibiotic-resistant gene has been banned in Switzerland (Dow Jones News 1999).

A gene construct containing an antibiotic resistance gene may remain intact as the feed processes through the animal. It could be picked up by a gut bacterium. Since microbes freely exchange their genetic materials, this antibiotic-resistant gene may find its way into human pathogens. Coupled with the extensive use of antibiotics in animal feeds, the development of antibiotic-resistant bacteria could happen at very high rates although experiments that test this possibility have so far not proven such.

Research testing did not elicit proof of a possible transfer of kanamycin resistance during the degradation of transgenic plants in the soil (Smalla et al. 1994). Nonetheless, the scientific community responded by using innocuous selectable markets such as herbicide genes that do not pose such risk at all.

Other reports show that a new, more potent viral pathogen can be generated by recombination between the coat protein gene and a wild infecting virus within transgenic plants (Salanki et al. 1997; Maiss et al. 1994). However, since this finding has not been observed in certain viruses, tests for this phenomenon should always be made in the local area where the GMO will be introduced. On the other hand, recombination between viruses is a natural phenomenon and not unduly favored for genetically modified crops.
Resistance management for insect resistant genetically modified crops

Insects are known to overcome insecticides by developing resistance over time. Those that are continuously exposed to Bt crops could eventually develop Bt resistance. Organic farmers are very concerned because the microbial insecticide, *B. thuringiensis* is the only acceptable insecticide for organic farming that is highly effective for common insect pests. Development of resistance strains would leave them without an effective insecticide. Companies owning Bt crops have been required to develop insect resistance management (IRM) programs that farmer licensees must follow to prevent the rapid development of resistance in insects. This program consists of planting a refugia in combination with the high expression of the toxin gene. Refugia refers to the population of non-Bt crops planted alongside the Bt crop. The idea is to maintain a plant population where the insect may freely multiply. Without the Bt crops present, most insects that thrive on the non-Bt crop will be sensitive to Bt. Whereas, insects that survive in the Bt crop will be resistant to Bt. Since there will be more Bt-sensitive insects, these will interbreed with the Bt-resistant insects, producing hybrids that are susceptible to Bt. This idea is based on the assumption that insect resistance to Bt is recessive.

However, a recent report indicated that insect resistance to Bt appears to be co-dominant, rendering the refugia strategy less effective. Hence, there is a need to develop a more effective strategy. Strategies being adopted include pyramiding or incorporating several insect toxin genes in the gene construct. In transferring the Bt technology, it is necessary to determine the type of resistance to Bt that local insects can develop before a resistance management program can be adopted.

Possible deleterious effect of pesticide crops on nontarget, beneficial organisms

The farm is an ecosystem that supports a wide variety of life comprising of animals, plants and micro-organisms. Critics of biotechnology contend that genetically modified crops can disrupt the fragile ecosystem of farmlands. Genetically modified crops containing genes such as an insect toxin gene is considered a pesticide crop and must be assessed for properties similar to a chemical pesticide. Regulations require that the effect of a pesticide crop on non-target, friendly organisms, especially natural enemies of the crop’s pest, be tested. However, from the hundreds of species that may come in contact with the crop during its lifespan, only representative organisms are tested. Studies along this tact from Cornell University and another group in Iowa State University showed that monarch butterflies in
the laboratory as well as fields were killed or stunted in their growth after ingesting Bt corn pollen in relatively large doses. The monarch butterfly is regarded as an indicator of environmental pollution. Hence, the study has elicited environmentalists’ concern over the possible deleterious effects of Bt crops on the ecosystem.

Others argue that agriculture is by its nature disruptive of the ecosystem. A rational approach to the debate is to weigh possible risks versus benefits of GMOs as well as of other current agricultural practices.

**Biosafety and the capability of regulatory bodies for biotechnology products**

Specific decisions on whether to give permits for the use of GMOs in the environment depend on the worldwide assessment of what would constitute an adequate and sufficient biosafety test for that purpose. A biosafety test is a list of specified research questions that need to be posed and answered (Maiss et al. 1994). These questions relate to human health and environmental risks. For GMOs, the question is whether traditional tests for toxicity and allergenicity are sufficiently vigorous to detect possible toxic and allergenic substances in them or not. There are now proposals to regulate GMOs containing genes from nonfood sources such as nonfood substances added to foods like dyes. This would increase the cost of risk assessments and negate the cost advantages of developing the crop. There are doubts whether such added cost is at all warranted since only a single property of the plant was changed anyway.

Another issue is whether short-term tests are predictive of long-term environmental effects. Apparently, scientific experts do not agree on a satisfactory design for such biosafety tests. There is therefore doubt as to whether regulations based on these tests are sufficient. All of these doubts notwithstanding, better testing methods continue to be currently developed. Also, an international group of experts has proposed to convene so as to develop protocols for toxicity and allergenicity testing of genetically modified foods (Taylor 1994; Noteborn and Kiuper 1994).

**The harmonization of biosafety guidelines**

Most countries developing and/or commercializing biotechnology products have a regulatory framework covering research, development and commercialization. However, there are differences on the methods and extent of tests. Also, there remains a need for an internationally accepted guideline on risk assessment of biotechnology process and products for two reasons: (1) to accelerate the transfer of technology where these are
needed most; and (2) to prevent the creation of trade barriers involving the movement of GMOs. A call to harmonize biosafety guidelines in South America has been expressed especially because its countries share common borders and ecosystems, and some are already growing GMOs in commercial scale (Noteborn and Kiuper 1994). The Philippines itself is involved in two current international initiatives to harmonize regulatory requirements for transgenic crops. A Biosafety Protocol is being prepared in conjunction with the Convention on Biological Diversity, and the ASEAN countries are formulating similar guidelines for the region. All these science-based regulatory procedures are strongly advocated to provide a stable atmosphere where research and development may flourish.

Increasing awareness and consumer perceptions
Public opinion, regardless of how well experiments are designed, is not necessarily based on scientific considerations. Public attitudes are shaped more by history, culture and sociological factors than they are by scientific considerations. Based on the experience of Monsanto in the US market (Debus 1997). Public acceptance can be fostered by the presence of an appropriate, knowledgeable, science-based regulatory oversight. Also, public awareness campaigns should provide food supply providers and health professionals, policymakers, media and the consuming public an understanding of basic biotechnology products, their benefits and safety, the regulatory mechanisms needed and consumer behavior.

The clear regulatory policy about GMOs has promoted acceptance. Here, the concept of substantial equivalence is critical to the commercialization of many biotechnology products. Substantial equivalence in this regulatory context means that there is no meaningful change in the nutritional value or composition of the improved crop variety. It is because of their substantial equivalence to traditional counterparts that some products are not anymore required by the US Food and Drug Administration to be labeled.

The movement against biotechnology has gained momentum especially in Europe. The so-called Puzstai affair in the United Kingdom prematurely announced the results of a study that claimed to show the toxic effect of genetically modified potato on rats. This announcement was blown out of proportion by the media and caused public suspicion over GMOs. Analysts claim that mad cow debacle caused an apparent dip in public confidence on regulatory and scientific bodies, and the ensuing media frenzy resulted in the public’s rejection of genetically modified food crops. The effect was disastrous for the biotechnology industry as it caused large supermarket
chains to withdraw food preparations containing GMO-derived ingredients from their shelves. Field trials were also destroyed, forcing one biotechnology company to stop them. Prince Charles of the United Kingdom expressed his concerns over the lack of information about GMOs, cautioning on its adoption and the tendency to tamper with nature. He further contended that the technology appeared to benefit only the owners of the technology and farmers of industrial-scale farms. Certain genetically modified crops were banned in Austria and Luxembourg. Austria banned the cultivation of Bt corn-MON810 following the publication of a Cornell University study indicating the deleterious effect of Bt corn pollen on monarch butterfly larvae. The same study prompted the European Commission to freeze the licensing of genetically modified crops for commercial planting. The Supreme Court of India banned the testing of genetically modified crop plants. Citing potential health risks, the British Medical Association called for an open-ended moratorium on the commercial planting of genetically modified food crops. A fast food chain, Burger King, in Portugal banned the use of ingredients derived from genetically modified crops. In the Philippines, a bill has been filed in the Senate proposing a ban against the entry of GMOs.

To address consumer concerns, European nations went for food where labels indicate the absence of GMO-derived ingredient in their products. The rapid development of consumer-friendly products such as food plants containing cholesterol-lessening substances was also proposed.

Today, India has already approved the commercialization of Bt cotton and field trials on other genetically modified crops are continuing. The bill barring entry of GMOs and similar anti-GMO initiatives in the Philippines did not prosper.

**Ethical issues**

Civil societies and religious organizations question the right of individuals and companies to patent life forms. Some contend that since life came from a more Powerful Being, man has no right to assign life forms to himself. Others contend that patenting life forms is similar to the industrialization or commercialization of life—where life here becomes a tradable commodity. There is also a perception that traditional farming will be marginalized (although presently, traditional farming is already marginalized). The use of human, animal or microbial genes in crop plant is not acceptable to some people as this is seen as a violation of the laws of nature. For instance, the ingestion of a plant transformed with a human
gene is allegedly tantamount to cannibalism. If this food crop is sweet potato protein-enriched with the transfer of human milk protein genes, would that be cannibalism, too?

**Biotechnology transfer to developing countries**

Biotechnology is recognized as a major tool to improve agricultural productivity and ensure food security for all. However, the challenge is in the transfer of this technology to developing countries, where the majority of the poor are and where agricultural production is at its lowest. There are 43 international programs that aim to facilitate access of developing countries to modern agricultural biotechnology (Cohen and Komen 1997). These initiatives consists of research programs, advisory programs, bilateral and multilateral donor agencies and regional and international biotechnology networks. Most offer opportunities to apply biotechnology for a country’s specific need. Furthermore, by collaborating with these initiatives, a developing country’s scientists and policymakers can have opportunities to benefit from the knowledge and expertise gained from specific technologies and their applications, biosafety and technology transfer issues, and broader policy and planning implications in national research systems. To be effective, developing countries must also provide the necessary environment. First, international programs tend to concentrate on countries with relatively high levels of scientific and technological capability such as the Philippines. Second, an effective biosafety system must be present. Third, policies that stimulate private-public sector collaboration, transfer public innovations for commercial production and stimulate investments in agricultural development, should be in place.

The bottomline is to give technology access to the sector that needs biotechnology interventions the most: the small resource-poor farmer. Following the experience with hybrid seeds not affordable to small farmers, it is now imperative that systems allow biotechnology tools to be available to small farmers. For instance, an improved seed is a very effective and powerful means of delivering novel technologies to the farmer. It is the core and the most familiar input to production. Farmers, whether big or small, appreciate the value of an improved seed. Unlike the seeds of the Green Revolution that required a package of technologies (e.g., fertilizers, pesticides) to fully deliver its benefits, genetically modified seeds contain within themselves the new technologies and thus require less or zero additional inputs. This is the major advantage of transgenic crops over traditional biotechnologies (such as biological control agents that represent
an additional cost to the farmer). It is thus imperative for a developing
country such as the Philippines to develop the appropriate strategy that
gives farmers access to genetically modified seeds.

The International Service for the Acquisition of Agri-Biotech
Applications (ISAAA) has been purposely set to facilitate the transfer of
biotechnology to developing countries, including capability building and
acquisition of specific genes and related technologies at equitable terms.
The ISAAA has successfully arranged the donation of genes from private
companies to countries where the final product benefits the subsistence
farmer and does not compete with the intended market of the company
(Raman and Krattiger 1995). Several countries have already benefited from
such services. Malaysia, Thailand, Mexico, Brazil and Costa Rica developed
local capability in genetic engineering and acquired genes through
agreements facilitated by ISAAA. The CGIAR centers also solicit the services
of ISAAA in the acquisition of biotechnology tools. In the Philippines,
negotiations with the ISAAA Asia-Pacific regional office (which is located
at the International Rice Research Institute in Los Baños, Laguna) regarding
the transfer of specific technologies through the Philippine Council for
Agriculture, Forestry and Natural Resources Research and Development
(PCARRD) for the development of papaya ringspot virus (PRSV) resistant
papaya.

**Philippine agricultural biotechnology R&D**

The establishment of the National Institutes of Biotechnology and Applied
Microbiology, or BIOTECH for short (now called the National Institutes of
Molecular Biology and Biotechnology) at the University of the Philippines
in Los Baños (UPLB) in 1979 marked the formal start of a biotechnology
R&D program in the Philippines supported by a grant from former President
Ferdinand Marcos. Its mandate was to develop cost-effective technologies
for the production of goods and services that are cheaper alternatives to
conventional products but safe to the environment and makes use of locally
available materials. Such mandate directs BIOTECH to be a generator of
technology. With former and existing faculty members of the UPLB College
of Agriculture as part-time research leaders, the initial R&D program leaned
toward microbial-based technologies of agricultural applications such as
food and feeds applications, nitrogen fixation and bio-insecticides. Various
research on plant tissue culture was implemented mainly by the UPLB
Institute of Biological Sciences. Its Botany Laboratory conducted one on
macapuno embryo rescue; the UPLB Department of Horticulture, on
orchids; and the Institute of Plant Breeding (IPB) at UPLB, on banana and
white potato. The Leyte State University Root Crops Research and Development Center also had, at about the same time, research works on tissue culture and protein enrichment of rootcrops. The University of the Philippines Natural Sciences Research Institute made a project on protein enrichment of Cavendish banana waste.

Biotechnology was identified in the late 1980s by the Department of Science and Technology as one of the cutting edge of science for development. Between 1990 and 1995, a biotechnology R&D program for agriculture was prepared as a component of the sectoral plan prepared by the Philippine Council for Advanced Sciences and Technology Research and Development (PCASTRD) of the DOST. The Council defined the scope of research projects for funding and selected priority projects. For 1995-2000, the Council’s priority list included the development of three groups of products, seven groups of processes and one selected or so-called vanguard project, and the establishment of database in the agriculture, forestry and environment sectors. The vanguard project was selected based on its social or economic impact: if service-oriented, it must be a response to a need, cover a wide target population, cater to a global market, and incur savings for the government. If profit-oriented, the product must be better than the one existing in the market and can be patented, have a ready market (or its market can be developed) and allow a cost-effective development (considering developmental time vis-à-vis patentable time). It must be timely. The project must be doable; that is, the local infrastructure is adequate, local resources (e.g., expertise) is sufficient and the project has technical and scientific merit. It must be environment friendly, too.

While most projects focused on research using microbial systems, the 1995 vanguard project was on genome mapping of mango and coconut with molecular markers. There is therefore no integrated agricultural R&D program and when taken on the overall, the research directions were mainly dependent on senior scientists’ ability to access funding from various agencies.

Between 1977 and 1996, about 75 percent of agricultural biotechnology research projects were on the production of biocontrol agents, soil amendments, food and beverages and development of tissue culture methods (Table 3). About 15 percent were on other applications of microbial systems (feed additives, enzymes/cells for agriprocessing, farm waste management, vaccines) and about 10 percent were in the applications of modern techniques such as monoclonal antibodies, molecular markers and rDNA.

Biocontrol agents are the natural enemies of pests and a component of the integrated pest management (IPM) strategy. Those agents being
studied include bacteria (Bacillus thuringiensis against diamondback moth), fungi (Paecilomyces lilacinus against nematodes, Metarrhizium anisopliae against several insect pests, Trichoderma spp against root rot pathogens) and baculovirus, which are identified and produced using traditional microbial techniques.

Meanwhile, soil amendments include organic fertilizers and inoculants that enable the plant to use atmospheric nitrogen (the nitrogen fixers) or to increase a plant’s capacity to use nutrients efficiently (the mycorrhizae). Soil amendments cause significant reduction of fertilizer requirements, better crop survival and higher yields.

Table 3. Product target and techniques used in Philippine biotechnology research (1979-97)

<table>
<thead>
<tr>
<th>Product</th>
<th>No. of Projects (%)</th>
<th>Techniques commonly used</th>
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<tbody>
<tr>
<td>1. Biocontrol agents</td>
<td>55 (20.9%)</td>
<td>Fermentation</td>
</tr>
<tr>
<td>2. Soil amendments (Inoculant, compost)</td>
<td>44 (16.7%)</td>
<td>Fermentation</td>
</tr>
<tr>
<td>3. Food/beverage</td>
<td>43 (16.3%)</td>
<td>Fermentation</td>
</tr>
<tr>
<td>4. Tissue-culture methods</td>
<td>52 (19.77%)</td>
<td>Cell Culture</td>
</tr>
<tr>
<td>Micropropagation</td>
<td>31</td>
<td>Tissue culture</td>
</tr>
<tr>
<td>Plant breeding techniques</td>
<td>19</td>
<td>Tissue culture</td>
</tr>
<tr>
<td>Cell culture technique</td>
<td>2</td>
<td>Tissue culture</td>
</tr>
<tr>
<td>5. Feed Component (enzyme, antibiotic, improved material)</td>
<td>20 (7.6%)</td>
<td>Fermentation</td>
</tr>
<tr>
<td>6. Enzymes/cells for agriprocessing</td>
<td>16 (6%)</td>
<td>Fermentation</td>
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<tr>
<td>7. Diagnostics</td>
<td>7 (2.6%)</td>
<td>Monoclonal antibody, Fermentation</td>
</tr>
<tr>
<td>8. Farm waste management</td>
<td>4 (1.5%)</td>
<td>DNA markers</td>
</tr>
<tr>
<td>9. Molecular markers 1 techniques</td>
<td>12 (4.6%)</td>
<td>Fermentation</td>
</tr>
<tr>
<td>10. Vaccine antibody, conventional methods</td>
<td>3 (1.1%)</td>
<td>Molecular</td>
</tr>
<tr>
<td>11. Animal reproductive technologies</td>
<td>3 (1.1%)</td>
<td>Monoclonal</td>
</tr>
<tr>
<td>12. Genetically modified organisms</td>
<td>7 (2.7%)</td>
<td>Cell manipulations</td>
</tr>
<tr>
<td>Total</td>
<td>263</td>
<td>rDNA</td>
</tr>
</tbody>
</table>

Source: Compendium: Biotechnology Research in the Philippines, 1997. BIOTECH, UPLB-PCASTRD, DOST.

*Includes additional projects (mango, coconut, rice, carabao, microbes, zooxanthellae, tuna done at the Institute of Plant Breeding, PCA, PhilRICE, MBB, MSI and BIOTECH) not listed in above source.
Bioorganic fertilizers are compost supplemented with nitrogen fixers or mycorrhizae. Composting studies delved on hastening the process using local isolates of *Trichoderma spp*. Inoculants studied are *Rhizobium/Bradyrhizobium* for legumes, *Azospirillum* for rice and corn and mycorrhizae for peanut, cassava, sweet potato, mungbean and sugarcane. Production of these agents uses conventional fermentation processes.

Studies on microbe-derived foods and beverages included those on *nata de coco*, mushrooms, food flavorings such as soy sauce equivalents, coconut-based yoghurt and the traditional rice wine of the Mountain Provinces. Other studies on microbial system applications are on the production of feed components (e.g., protein enrichment of root crops and farm wastes, lysine and methionine, and feed enzyme), use of mushroom compost as feed component, animal antibiotics (tylosin) and probiotics. Applications of enzymes/cells focused on reducing toxicity of aflatoxin and sweet potato weevil metabolites, on food processing such fruit juice clarification, on improving digestibility of copra meal, on farm waste management and on producing vaccines against hemorrhagic septicemia in cattle and carabao. ELISA-based diagnostic kits for *Pasteurella multocida* and *P. hemolytica* were developed based on antigens from microbial cells and cell derivatives. Similarly, production of these agents uses conventional fermentation processes.

Tissue culture methods were developed for (1) micropropagation; (2) plant breeding; and (3) metabolite production by cell cultures. Micropropagation techniques using meristem and shoots were applied for native cultivars of bananas, potato, ubi, shallots, garlic, cassava, sweet potato, abaca, papaya, strawberry, durian, mangosteen, passion fruit, rambutan, pummelo, avocado, Derris, Mussaenda, orchids and other ornamental crops. Somatic embryogenesis was used for banana, calamansi, papaya, longan, lychee, avocado and coconut. In-vitro selection methods were developed for tomato, rice, corn, calamansi, kalanchoe, banana and sugarcane. Haploid cell regeneration was developed for coconut and rice and embryo rescue techniques, for macapuno (mutant coconut) and wide crosses of papaya. Cell regeneration techniques essential in plant genetic engineering were developed for coconut, rice, mungbean, mothbean, orchids, tobacco and ramie. As of today, PhilRice scientists have improved the traditional rice variety, wagwag, by another culture.

Monoclonal antibody techniques were applied to produce vaccine against hemorrhagic septicemia caused by *Pasteurella multocida* and diagnostics for the red toxin in mussels and for plant pathogens. The DNA markers are used to assess genetic variation in rice, mango and coconut;
characterize rice, mango, coconut cultivars, zooxanthellae of the giant clam and tuna; diagnose the tungro virus; detect food and water contaminants; analyze the coconut genome; determine the origin of local rice cultivars; and aid in selecting and mapping resistance genes in rice, mungbean and potato.

**Direction in agricultural biotechnology**

Apparently, the direction of agricultural biotechnology research was determined by how the research system defined the scope of biotechnology. The nature of biotechnology research reflected the national policy directions of the early 1980s, when the emphasis was to develop technologies for import substitution. Hence, projects on biocontrol and soil inoculants were welcomed because they meant savings in pesticide and chemical fertilizer, both of which are important commodities. Feed components such as protein-enriched root crops or banana peelings were proposed to substitute imported soybean and fish meal. Other microbe-derived feed additives such as lysine and tylosin were to be locally produced rather than imported. Also, BIOTECH was established when biotechnology was a newly emerging industry. At that time, the trend was on the development of fermentation systems for genetically modified microorganisms. Hence, the emphasis was on fermentation systems and the development of technologies that could be commercialized.

The nature of biotechnology research reflected the expertise, level of funding, facilities and infrastructure support available during this period. Fifty-three of the 59 senior scientists involved in these projects were trained in the agricultural sciences (Table 4). The size of the funding was a factor, too. Research using microbial and plant tissue culture techniques was several times cheaper compared with the reagents needed for DNA manipulations. In fact, until 1997, many projects at BIOTECH were funded at the rate of P12,000 per year—just enough to buy one or two of the multitude of reagents needed for DNA manipulations.

Infrastructure support was very poor. Frequent electrical outages killed mammalian cell cultures and DNA libraries. Essential reagents took months to procure or lost their efficacy at the Bureau of Customs. Prior to 1995, only the Natural Sciences Research Institute had the facilities to undertake rDNA work with nonpathogenic organisms. Despite all these, the scientific community was very responsive to policy directions. BIOTECH researchers developed 14 technologies for commercialization (Table 5). Also, nine technologies were awarded patents and seven more had patents pending (Table 6).
The current size of human and physical resources for modern agricultural biotechnology is modest but managed to produce significant work. There are 50 Ph.D. holders trained in DNA manipulations and 15 others trained in biochemical and serological methods. They are connected with 13 institutions in various parts of the country (Table 7). However, only seven of these institutions are equipped for DNA work, were only three had a microprojectile bombardment equipment for plant cell transformation. Only the Philippine Carabao Center is equipped for invitro fertilization studies and the National Institute of Molecular Biology and Biotechnology (MBB)-UP Diliman, for animal cell culture studies.

The proposed national biotechnology research and development program for agriculture, forestry and environment

In 1996, PCARRD initiated the formulation of a national biotechnology program for agriculture, forestry and environment. The program was developed along seven criteria: Science and Technology for National
Development priorities, application of modern biotechnology (70%), accommodation of domestic concerns and basic sciences (30%), market rather than supply orientation, environmental concerns, availability of human resource and infrastructure and provisions for social marketing and technology transfer. The general objectives were to apply biotechnology for the improvement of present yields of selected crops, trees and livestock and the quality of products (e.g., delayed ripening of mango and papaya) and the bioremediation of the environment; to develop policies; and apply social

Table 5. Technologies developed at BIOTECH, UP Los Baños, 1979-98

<table>
<thead>
<tr>
<th>Commercial Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MYCOVAM</td>
<td>Mycorrhizae tablets for reforestation replaces 60-85% fertilizer requirements Licensed to Los Banos Biotechnology Corp. Remits P10-15,000/month royalty to BIOTECH</td>
</tr>
<tr>
<td>2. MYCOVAM</td>
<td>Powder containin mycorrhizal fungi for reforestation, agricultural and fruit tree crops P25/kg, Licensed to Los Banos Biotechnology Corp.</td>
</tr>
<tr>
<td>3. BIO-GREEN</td>
<td>Bio-organic fertilizer with Trichoderma sp. and Azotobacter, P175/50 kg bag, Licensed to 5 private companies</td>
</tr>
<tr>
<td>4. NITROPLUS</td>
<td>Bio-organic fertilizer for legumes with Rhizobium and replaces 30-50% N-requirement at 4 packs/ha of peanut P25/pk</td>
</tr>
<tr>
<td>5. BIO-N</td>
<td>Biofertilizer for rice and corn, with Azopirillum P25/pk, licensing under negotiations</td>
</tr>
<tr>
<td>6. BACTROLEP</td>
<td>Bioinsecticide, Bacillus thuringiensis preparation, effective against corn borer and diamondback moth of cabbage</td>
</tr>
<tr>
<td>7. PELMICTROL</td>
<td>Bioinsecticide, Bacillus thuringiensis preparation against mosquitoes</td>
</tr>
<tr>
<td>8. COCOGROE</td>
<td>Plant growth hormone preparation from coconut water, P250/L</td>
</tr>
<tr>
<td>9. Plant diagnostic kits</td>
<td>Monoclonal antibodies for plant virus diagnosis</td>
</tr>
<tr>
<td>10. HEMOSEP</td>
<td>Pasteurella vaccine against the deadly hemorrhagic septicemia in cattle and carabao, P10/dose</td>
</tr>
<tr>
<td>11. LYSINE</td>
<td>Feed additive, an amino acid (lysine) preparation nutritional supplement</td>
</tr>
<tr>
<td>12. TYLOSIN</td>
<td>Feed additive, antibiotic preparation, therapeutic and growth promotant</td>
</tr>
<tr>
<td>13. MANNANASE</td>
<td>Enzyme preparation for conversion of copra to produce high quality feed supplement</td>
</tr>
<tr>
<td>14. YEAST strains</td>
<td>Improved yeast strains for higher alcohol production</td>
</tr>
</tbody>
</table>

Source: Dela Cruz 1996
Table 6. Technologies patented or patents applied for by BIOTECH, UP Los Baños, 1979-98

<table>
<thead>
<tr>
<th>Patent No</th>
<th>Inventor</th>
<th>Title</th>
<th>Date filed</th>
</tr>
</thead>
<tbody>
<tr>
<td>14067</td>
<td>EJ del Rosario</td>
<td>An apparatus for the continuous flow tower fermentation of sugar into</td>
<td>Dec. 26, 1979</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ethanol by a flocculant yeast with automatically controlled feeding of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>sugar and yeast</td>
<td></td>
</tr>
<tr>
<td>15246</td>
<td>JC Mamaril</td>
<td>Process of producing rhizobial inoculum</td>
<td>Sept. 3, 1982</td>
</tr>
<tr>
<td></td>
<td>RB Aspiras</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15247</td>
<td>LE Padua</td>
<td>Bacterial insecticide, its composition and use</td>
<td>Sept. 3, 1982</td>
</tr>
<tr>
<td>15248</td>
<td>PC Sanchez</td>
<td>Process of producing mungbean sauce</td>
<td>Sept. 3, 1982</td>
</tr>
<tr>
<td>15444</td>
<td>RE dela Cruz</td>
<td>Process of producing mycorrhizal inocula</td>
<td>Sept. 3, 1982</td>
</tr>
<tr>
<td>26413</td>
<td>CB Pham</td>
<td>Process of producing animal feed from cassava fiber residue</td>
<td>Feb. 17, 1992</td>
</tr>
<tr>
<td>27274</td>
<td>CB Pham</td>
<td>Bioprocessing of agricultural crop residues</td>
<td></td>
</tr>
<tr>
<td>27995</td>
<td>CB Pham</td>
<td>Microbial production of L-lysine using homoserine auxotrophic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>mutants and repeated batch fermentation</td>
<td></td>
</tr>
<tr>
<td>29753</td>
<td>JC Mamaril</td>
<td>Process for producing concentrated plant growth hormone and</td>
<td>Nov. 16, 1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>regulators from coconut water</td>
<td></td>
</tr>
<tr>
<td>Patents pending</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47313</td>
<td>FS Maslog</td>
<td>Production and development of monoclonal antibodies against</td>
<td>Nov. 12, 1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>hemorrhagic septicemia</td>
<td></td>
</tr>
<tr>
<td>47312</td>
<td>BM Espiritu</td>
<td>Bio-organic fertilizer, special compost</td>
<td>Nov. 23, 1993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>inoculated with beneficial molds and nitrogen fixing bacteria</td>
<td></td>
</tr>
<tr>
<td>49333</td>
<td>ES Paterno,</td>
<td>Use of coconut shell charcoal as carrier materials of powdered and</td>
<td>Nov. 9, 1994</td>
</tr>
<tr>
<td></td>
<td>FG Torres</td>
<td>granular</td>
<td></td>
</tr>
<tr>
<td>49334</td>
<td>ES Paterno,</td>
<td>Inoculants</td>
<td>Nov. 9, 1994</td>
</tr>
<tr>
<td></td>
<td>FG Torres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49470</td>
<td>AK Raymundo,</td>
<td>Use of soil and charcoal and wood ash</td>
<td>Nov. 29, 1994</td>
</tr>
<tr>
<td></td>
<td>TO Zulaybar,</td>
<td>mixture as carrier for microbial inoculant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ES Luis, RD Ayo</td>
<td>Bioprocess of local tylosin production for feed additive</td>
<td></td>
</tr>
<tr>
<td>49471</td>
<td>GD Reyes</td>
<td>A process to produce biodegradable plastic from Bacillus species</td>
<td>Nov. 29, 1994</td>
</tr>
<tr>
<td></td>
<td></td>
<td>isolated from soil</td>
<td></td>
</tr>
<tr>
<td>53009</td>
<td>SM Mercado</td>
<td>Process for the production of microbial rennet</td>
<td>May 8, 1996</td>
</tr>
<tr>
<td></td>
<td>RR del Rosario</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Dela Cruz 1996

marketing and technology transfer. To fasttrack results, strategies include
the direct transfer of available foreign technology, procurement of gene
constructs through material transfer agreements, development of own
technologies and gene constructs, when feasible, and adoption of foreign technologies, when feasible.

The comprehensive agricultural biotechnology program for agriculture, forestry and environment approved in 1998 has five components: crop biotechnology, livestock biotechnology, forest biotechnology, microbial biotechnology, and policy and social marketing. It has a proposed 10-year budget of P2.310 billion from the DOST and PCARRD. The biotechnology component gives priority to seven crop commodities: coconut, fruits (mango, banana, papaya, durian and pili), ornamentals, rice, corn, cotton and abaca. Livestock biotechnology prioritizes cattle, carabao, goat, sheep, swine and poultry. Microbial biotechnology focuses on biofertilizer, biocides and bioremediation. The budget is allocated as follows: 32.2 percent for crop biotechnology; 23.4 percent for livestock biotechnology; 21.2 percent for microbial biotechnology; 19 percent for forestry biotechnology and 4.2 percent for policy/social marketing component. Since the microbial biotechnology program addresses mainly crop production, the total proposed budget for

### Table 7. Research resources for crop biotechnology

<table>
<thead>
<tr>
<th>Institution</th>
<th>Facilities available for Mol. markers</th>
<th>Transformation</th>
<th>No. of Ph.D with training in DNA</th>
<th>Biochemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>UPLB BIOTECH</td>
<td>X</td>
<td>-</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>IPB</td>
<td>X</td>
<td>-</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>IBS</td>
<td>X</td>
<td>-</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>D Plant Path</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>D Horti</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Inst Chemistry</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>NCPC</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>UP Diliman</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>MBB</td>
<td>X</td>
<td>X</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>MSI</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>NSRI</td>
<td>X</td>
<td>-</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>PhilRICE³</td>
<td>X</td>
<td>X</td>
<td>8</td>
<td>nk</td>
</tr>
<tr>
<td>VISCÁ</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>nk</td>
</tr>
<tr>
<td>PCA Albay</td>
<td>X</td>
<td>-</td>
<td>1</td>
<td>nk</td>
</tr>
<tr>
<td>CRDI</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>nk</td>
</tr>
<tr>
<td>CLSU</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>nk</td>
</tr>
</tbody>
</table>

1 Molecular markers
2 Some are also trained in DNA manipulations.
3 Sebastian 1999
crops is about 53.4 percent. However, only P5 million of the P60 million needed for the first year of implementation has been allocated, which was all expended on the crop biotechnology program.

In the prioritization of projects, heavy emphasis was placed on the application of modern biotechnology, which is in line with the DOST’s policy to promote advanced sciences. In crop biotechnology, the probability of success, availability of external funding and collaboration with foreign research groups were also considered. Still, the program was too broad and all encompassing.

Similar to past experiences, the program is limited by the existing manpower resources in modern biotechnology techniques. Hence, positions for post-doctoral candidates have been opened although with the devaluation of the peso, it is doubtful that the program will attract relatively well-trained individuals. There is a need to fasttrack a manpower development program in modern biotechnology and at the same time create conditions that will attract trained individuals to stay, considering that the high demand for well-trained individuals abroad is a force to reckon with. Since offering a good compensation package alone could not be as equally attractive, programs that keep experts in contact with the international scientific mainstream might help.

Assistance in developing local capability can be accessed from international biotechnology initiatives. Of the 43 international biotechnology initiatives, about 20 can be tapped by the Philippines to serve as an important source of support and collaboration for biotechnology planning and implementation. Assistance can also be expected from the governments of Japan (such as the Japan Society for the Promotion of Science and the Japan International Research Center for Agricultural Sciences) and Germany as well as from the International Foundation for Science of Sweden.

The commercialization of locally developed technologies
Of the various locally developed biotechnologies, micropropagation of banana, orchids, abaca and white potato have became routine procedures in commercial and government service laboratories. This reflects the success of training courses in banana and orchid tissue cultures mainly at various units of UPLB, Bureau of Plant Industry-Davao Station and the Natural Sciences Research Institute, UP Diliman. Also, BIOTECH has inked agreements with individual entrepreneurs in the commercialization of its technologies. Despite aggressive efforts at BIOTECH to find entrepreneur-partners for its commercialization efforts, only three of the 14 identified
technologies have been assigned to private groups. These have yet to develop into sustainable commercial operations. To date, only one group pays royalty to BIOTECH.

Junne (1990) cites common characteristics of start-up companies and research groups in developing countries that make commercialization difficult. Among these are ventures normally centered around a few bright scholars with fresh ideas; ventures lack adequate funding; the research groups have little experience in scaling up and commercializing the product; individuals have difficulty defending their patents; and home markets are too small to make production economical.

These situations apply in the Philippines as well. Commercial agreements between UPLB and private entities cover only a single product, hinging the success of the company to this particular product. If the product is an unknown one, the private entity will often lack the marketing experience. Worse, there had been a case where a start-up company assigned to commercialize a particular technology went on to develop its own equivalent product. Since most technologies focused on traditional fermentation, such require considerable capitalization. The high cost of money, unstable supply, high cost of electricity, poor communications infrastructure and shaky marketing strategy can all make commercialization difficult to sustain.

Another reason commercial operations cannot be sustained are the technical problems often associated with a new technology. For instance, microbial-based technologies offered by BIOTECH for commercialization often needs further development (De la Cruz 1999). The stages in the development of a fermentation technology includes first a laboratory scale test, followed by a bench scale test, a pilot plant scale and finally, the commercial scale. Most of the technologies for commercialization have yet to go through pilot scale tests since this portion is hoped to be partly funded by the private sector. However, the private sector has misgivings on investing heavy on research. From their perspective, the private sector has to compete with public agencies, which sometimes provide the product free.

Commercialization also often does not happen because of researchers’ tendency to develop a complete technology by themselves, refraining to involve individuals with the appropriate expertise. This stems from the incentive system that gives recognition and award to individuals rather than to research groups. For example, in the case of a microbial-based technology, the efficacy of the organism for a particular process is discovered by a microbiologist. However, to produce the organism in commercial quantities, a fermentation engineer should come into the picture and conduct the
appropriate studies. Unfortunately, this seldom happens. Likewise, no mechanism is in place to ensure that research results are submitted and/or reviewed by a peer group. Most of the information is in the form of research abstracts found in programs/proceedings of scientific meetings. Only about one-tenth of results of completed research projects are published in peer-reviewed journals.

This lack of an automatic review process may also explain the low rate of adoption of technologies. For example, previous studies on the effect of organic fertilizer or compost-to-corn production indicate that organic/compost fertilization may or may not increase yields. Hence, the current recommendation to use organic fertilizers in the *Masaganang Maisan* Program does not appear to have a well-grounded, scientific basis.

Upon transfer of the technology, no research fund is granted for further improvements on the technology based this time on feedback from the user. In general, the flow of information from research to extension to technology user has been one way. Only the actual training of users is funded. This often assumed that the technology initially recommended by the researcher needs no further improvement. Nor are users generally taught on how they can improve the technology by themselves or perhaps identify causes of technical failure. Farmers are often the ones made to feel responsible when a technology fails to deliver the expected improvements.

The observed adjustments were often on the recommended processes. In Davao, a commercial organic fertilizer producer refrains from composting crop residues because of the possibility of transmitting diseases and uses the *Trichoderma* technology developed for crop residues to rapidly compost cattle dung. In Manila, another organic fertilizer producer composts chicken dung for similar reasons aside from the difficulty of composting variable materials. Also, the quality of organic fertilizer is best with cow dung and chicken dung is better than crop residues.

Another hindrance in commercializing of biotechnology is the lack of funding on biosafety testing of local isolates in actual environments. To date, only the testing on new species is funded. Testing of local isolates is important because when a living organism is introduced into an environment in quantities beyond the normal, there are possible risks. For instance, the organism is capable of changing population structures. Furthermore, biological agents often elicit allergic reactions and other unwanted effects of microbial agents. One farmer claimed that the *Trichoderma* inoculum he used for composting degraded his house’s wood, a scientifically valid effect.
Still another aspect that deter commercialization is the level of competitiveness of locally developed technologies versus imported counterparts. Often, local researchers appeal to the patriotic sense of entrepreneurs for the adoption of local technology. However, one needs a novel, effective technology with a tremendous commercial potential to penetrate the international market. Given that foreign companies have several decades headstart with a technology, the limited experience and studies conducted by local scientists on, say, the fermentation technologies for tylosin or lysine, puts the latter at a disadvantage. Furthermore, when dealing with micro-organisms, the production of such and their products is sensitive to economies of scale. This means local researchers must go beyond the Philippine market if they were to make profit.

Outfits that develop basic ideas and techniques from the laboratory into commercially feasible technologies are few in the Philippines. These are either small companies or entrepreneurs with limited capitalization or farmer cooperatives. Hence, they have not much resource to sustain a long gestation period. This reality must be analyzed vis-à-vis the international trend in the commercialization of biotechnology. Previously, small start-up companies developed technologies and tried to market their products directly. Today, these companies either sell the technology, form joint ventures, assign the commercialization of or sell outright the technology to a large, established company.

Local entrepreneurs with limited capitalization can still thrive, as indicated by the experience of a small tissue culture laboratory (produces 3,000 banana plantlets/month) in Mindanao. In this case, the market for the product is already established, the supply of raw materials available and the technology reliable and relying mostly on nontechnical labor. Technical manpower cost is minimized by employing daily, contractual labor rather than monthly wage earners. This operation also relies on family labor, which helped to further bring down costs.

There are biotechnologies that, by their site- and variety-specific nature, must be produced in the country. These are the soil inoculants and biocontrol agents. Organic fertilizer must also be produced in the country because it is needed in bulk. Hence, it is imperative to develop suitable technologies that can be transferred and their operations sustained by the business sector. Because farmers play a role here, the country must deal with how to give small, resource-poor farmers access to such biotechnologies. Past experiences teach researchers some lessons. In the Masaganang Maisan and Masaganang Ani Programs for corn and rice, the farmers were unable to use the recommended biocontrol agent, Trichogramma, and organic
fertilizer because of lack of reliable supply. Also, small banana growers in Luzon and Visayas (unlike their counterparts in Mindanao) do not have ready access to tissue-cultured banana. In contrast, tissue-cultured banana plants are regularly produced in government and private laboratories in Mindanao. Their large private laboratories, such as that of a Stanfilco subsidiary, produce only for their own plantations while smaller laboratories sell to the public in nurseries that they maintain. It thus appears that for banana tissue culture to become a commercial venture in Luzon and the Visayas as well, efforts must be directed toward making tissue-cultured plants preferred and affordable to their small farmers.

To commercialize locally developed technologies, there are questions that are best answered even before starting the research. Will the technology pay? How much will the development cost be? Do we have the market? The capital? Will the technology be marketable? If the technology produces new products, how will these be marketed? If the market does not yet exist, can we develop the market? Who pays for market development? Can it compete with an alternative technology? Can we make it available? How do you make it available? How will its production affect the environment? How will the product itself affect the environment/farm workers’ health/consumers’ health?

**Regulatory issues**

A regulatory framework is essential in the development of biotechnology to enable locals to legally acquire and safely release biotechnology products in the environment. Three regulatory regimes are required in the Philippines: biosafety, IPR and commercial product regulation, which could be under the jurisdiction of the Fertilizer and Pesticide Authority (FPA) and/or the Bureau of Food and Drugs (BFAD) as far as organic fertilizers, biocontrol agents and plants expressing pesticidal genes (e.g., Bt genes) are concerned.

**Biosafety**

Maredia (1998) argued that biosafety regulations can be economically justified by the benefits that accrue from its implementation. These benefits include lesser human and environmental risks of biotechnology products and "accidental" costs to society; more predictable timelines and costs for a research organization to get a new product into the market; and certainty and stability to the social framework necessary for the development of R&D activities. Biosafety regulations can also have their downside. They can increase research lag, production costs, transaction costs and marketing
costs to research organizations and opportunity costs to society due to the diversion of technical, human and physical resources needed for productive endeavors. Thus, a country has to balance the potential benefits with the increased tangible costs of biosafety regulations.

The Philippines is the first country in Southeast Asia to adopt biosafety regulations when the NCBP, a multisectoral body overseen by the DOST, was constituted by Executive Order No. 430 on October 15, 1990. The NCBP formulates and oversees implementation of five biotechnology policies:

- No work on biological and chemical warfare be allowed;
- Only genetic engineering work and the introduction of new species are covered;
- Any work covered by the guidelines must be approved first by the NCBP;
- Enforcement of the guidelines rests with the institutions and scientists involved; and
- Monitoring is the institution’s responsibility.

There are three sets of guidelines. The first covers the conduct of smallscale laboratory research. The second covers large-scale contained work and glasshouse trials. The third tackles planned release of GMOs and potentially harmful exotic species (NCBP 1998). Certain regulatory functions overlap with that of other agencies such as on quarantine. Hence, the apparent position taken by the Committee is to regulate only GMOs while the regulation of non-GMOs is left to the bodies under various line agencies.

The review further stressed the need to critically assess the NCBP’s structure and provide a clearer definition of its relationship to existing regulatory bodies to ensure proper implementation of guidelines and administrative expediency.

Improving quarantine facilities was also pointed out. The expressed need for better coordination is partly justified by the fear that experiments not acceptable in other countries might be relocated to the Philippines.

The current guidelines still have vague provisions such that applications for field testing have not yet been approved. Whether risks assessment will be tested on a select list of model organisms and what these model organisms will be are still subjects of debate. Also, there is no program to support full implementation of the NCBP’s mandates. These mandates include establishing the appropriate facilities required for research, developing the scientific capability for risk assessment and funding biosafety research. For the meantime, research institutions have to request funding
elsewhere to support this type of work. The issue with funding could be another reason no genetic engineering work in the country was made before 1996. Also, the delayed release of clear guidelines in the field release of GMOs and the lack of facilities could also explain why, to this day, no field release of GMO has been approved.

The cost and benefit of the biosafety guidelines in the Philippines are two areas that need to be compared. Compliance to Philippine biosafety regulations requires a lot of documentation, long waiting period and more research data than those required by other countries (Sebastian 1999). With the size of the Philippine market, private seed producers may not be able to recoup their investments in biosafety compliance alone. Given the experiences of other countries, there is a need to examine whether all of the provisions of the Philippine guidelines apply. How much will the proper implementation of biosafety regulations cost vis-à-vis its perceived benefits? For pharmaceutical products, it is reported that about 90 percent of the total cost of product development goes to research to comply with regulatory requirements. Biotechnology products for agriculture would probably require less, but the time needed to produce the required data is substantial.

The Philippines can perhaps learn a lesson or two from China’s case. China started without formally adopting biosafety policies until it has gained some experience in developing and handling GMOs. Although genetic engineering work started in 1986 and commercial planting of its own transgenic tobacco was done in 1992, the drafting of biosafety guidelines started only in 1994 (Jia 1997). Four principles guided the draft:

- The guidelines should facilitate rather than hamper biotechnology development while ensuring human health and environmental protection;
- A science/product-based regulation system rather than technology/process based should be followed;
- Risk assessment should be conducted on a case-to-case basis; and Guidelines shall be revised step-by-step as experience is gained as well as information from other countries builds up.

Thailand, on the other hand, is proceeding with caution on the Bt gene due to its possible deleterious effect on silkworm for its silk industry. An awareness campaign launched by well-funded groups eschews the European stand on GMOs. Few seem aware that the soybean and corn imported into the country most likely contain GMOs, coming as they are from the United States, where about 80 percent of soybeans and 30 percent of corn are GMOs. Hence, the early morning taho and the tofu in the local
market come from these soybeans. Also, the potato fries in fastfood chains, soya and corn oil in processed foods such as common snack foods and directly imported food items are partly derived from GMOs, which the English have called Frankenfoods. Furthermore, these imported feed corn and soybean may have the antibiotic-resistance genes that are feared of being transferred into gut bacteria and then into the environment.

Notable is the Philippine Rice Research Institute’s (PhilRice’s) stand on developing its own GMOs. To avoid the controversy of introducing genes of nonfood organisms, they are using wild rice genes to enhance the rice plant’s resistance to pests and are using herbicide resistance genes as selectable markers to avoid the antibiotic-resistant controversy. The Institute of Plant Breeding is more or less dependent on its collaboration with foreign institutions under international programs, using genes isolated in or by these institutions.

**IPR issues**

The Philippines, being a signatory to the World Trade Organization-TRIPs agreement, must harmonize its IPR laws with provisions of the agreement. Recently approved is an Intellectual Property Code (Republic Act 8293), whose implementing guidelines the DTI is actively disseminating. A pertinent provision is the patentability of life forms that specifically excludes plant varieties, animal breeds, and essentially biological processes in the production of plants and animals but allows patenting of micro-organisms, nonbiological and microbiological processes. Hence, under this provision, transgenic plants and animals or processes for the production of metabolites, or human proteins from plant or animal cell cultures will have difficulties in obtaining patent protection. Approval of patents will apparently depend upon the interpretation of the term "essentially biological processes" or whether in-vitro manipulation of DNA and cells of higher organisms shall be considered nonbiological.

Other provisions of the Code that directly affect biotechnology development are the first-to-file rule and the 20-year patent protection period. The first-to-file rule is clearer than the superseded first-to-invent rule. The 20-year protection starts from the date of filing of application, which is consistent with the TRIPs agreement. This also addresses complaints from local inventors who claim that the former rule of extending patent protection from the date of issuance of patent leaves room for the piracy of ideas especially since the period from filing to issuance takes as long as three years.
The University of the Philippines promotes patenting of technologies developed by its staff. The DOST has a program with similar intent. The university has established IPR offices in its campuses. Scientists are assisted by the various councils of the DOST in patent applications. The PCASTRD provides funds for patenting technologies developed from its own research programs, whereas the Technology Application and Promotion Institute (TAPI) provides funds to other scientists. Hence, most biotechnology researchers are aware of IPR and have patents to show. However, because most of these technologies are developed from commonly-used protocols, there has developed within the science community a practice of withholding information. The growth of the science is retarded because researchers refrain from publishing results. This also increases the potential of research being inadvertently duplicated or redundant.

World trends show that the main source of expense involving IPRs are litigation on patent infringements or challenges to broad patents. In the Philippines, policies to help protect patents held by scientists and inventors are needed. There have been at least two separate cases of violation of commercialization agreements between the university and the private sector, both of which are similar in circumstance: The University had earlier assigned the commercialization to a company, which then started production using the patented process. Midway, the company began to develop its own process and eventually left out the university. In these cases, two companies—one Filipino and one Australian—were involved.

Currently, access to genes and other biotechnology tools for R&D is being provided through IRRI for rice breeding, CYMMIT for corn breeding, INIBAP for banana and ACIAR for papaya. In these collaborations, research institutions need to develop expertise in analyzing potential limitations of these agreements and to inform staff of their implications. Researchers sometimes freely exchange materials and may unknowingly break certain provisions of the agreements.

**Regulation of final commercial products**

The Department of Agriculture Administrative Order No. 8, Series of 2002, which was signed in April 2002 after more than two years of consultation, regulates the import and release into the environment of plants and plant products derived from modern biotechnology. The Cartagena Protocol on Biosafety defines modern biotechnology as the application of in-vitro nucleic acid techniques, including rDNA and direct injection of nucleic acid into cells or organelles or fusion of cells beyond the taxonomic family. Genetically
modified plants are thus covered by this order. This guideline requires risk assessment and risk mitigation as the instruments that ensure the safety of any GMO used in the country, whether imported for contained use, directly for food, feed and processing uses, or used for propagation.

Learning from the experience of the NCBP, the Order’s guideline has clearly defined the procedures, timeliness and actors in the application process to obtain importation permits for GMOs. The permit obtained under this guideline declares the safety of the article for its intended use and to the environment if approved for field trials or propagation.

The Order provides that before any GMO is to be planted in the Philippines, it must have undergone testing in contained conditions and in field trials in the country so that country-specific safety issues are addressed. Mainly, these issues concern bioefficacy and unintended effects on the local environment.

The Order is also consistent with all existing guidelines developed by experts convened by the Organization for Economic Cooperation and Development, World Health Organization/Food and Agriculture Organization, Codex Alimentarius, and the provisions of the Cartagena Protocol on Biosafety.

The cost of modern biotechnology development
The government’s stand on biotechnology has been clearly enunciated by various DOST secretaries. The previous direction of development has been on novel uses of micro-organisms. However, there is a need to take a critical look at how the Philippines should join the modern biotechnology revolution, particularly in crop biotechnology. Maredia et al. identified five progressive steps in crop improvement where biotechnology could come in, and analyzed the cost and benefit of adopting investment options according to an economic framework. Considerations are the cost of the research, the value of research spill-ins, the value of the benefit from the research result and the size of the market for the research output. The first step does not cost anything since this involves the spontaneous diffusion of imported technologies without the benefit of local R&D (Table 8). From the second to fifth steps, the cost increases with the introduction of sophisticated biotechnology tools. For example, Step 3 has added the cost of a conventional breeding program to Step 2.

Modern biotechnology development requires large investments in physical, human, institutional and organizational infrastructure in research and regulatory capabilities. The local cost of establishing a molecular marker technology laboratory is between US$100,000 (manual) to US$200,000
Maintenance cost at maximum capacity is about US$100,000, the amount granted by the Rockefeller Foundation to the PhilRice’s rice biotechnology program. The cost of establishing a genetic engineering laboratory would require 50 percent more (US$200,000-US$400,000) because of biosafety requirements. Maintenance cost would be similar. These costs are comparable to costs reported elsewhere.

Personnel cost includes the cost of training scientists with at least Ph.D degrees, well-grounded in the foundation sciences, skilled in the required laboratory techniques and capable of maintaining their creativity in a research laboratory where basic reagents may be not readily available, where the electricity may fail anytime and where other unforeseen problems may arise due to poor infrastructure support for advanced research. Studies toward the Ph.D degree is better done abroad because of the rapid pace in molecular biotechnology. Current estimates range from US$100,000 to US$150,000 per Ph.D graduate. Technicians trained in molecular techniques are also needed. An excellent curriculum for training such technicians is the BS Molecular Biology and Biotechnology at UP-Diliman. The total cost of training is about P300,000 per graduate. Depending upon the management capability of a scientist, four to eight full time technicians are needed to optimally exploit the research creativity of the senior researcher.

Establishing and implementing the regulatory framework adds cost to biotechnology R&D. The formulation and implementation of biosafety guidelines involve research cost as well as personnel responsible for implementing at the national and institutional levels. These personnel must be able to assess risks of GMOs and their products with different features

Table 8. Five steps in a conventional crop improvement program

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Spontaneous diffusion of imported technologies without the benefit of local R&amp;D;</td>
</tr>
<tr>
<td>2.</td>
<td>Direct transfer of technologies after testing and screening by local R&amp;D programs for adaptability to local environments;</td>
</tr>
<tr>
<td>3.</td>
<td>&quot;Adaptive&quot; transfer of technologies whereby finished technologies from elsewhere are subject to local adaptation before local release (e.g., the use of imported varieties as parents of local breeding programs).</td>
</tr>
<tr>
<td>4.</td>
<td>Comprehensive applied research where imported knowledge from basic research is utilized in local applied research programs to produce home-grown technologies.</td>
</tr>
<tr>
<td>5.</td>
<td>Comprehensive basic and applied research that utilizes imported knowledge but also has the ability to conduct own basic or pretechnology research.</td>
</tr>
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(automated).
Special Issues in Agriculture

(insect protected, virus protected, delayed ripening) and of different species (transgenic plants, recombinant vaccines, recombinant microbes). Currently, no field of specialization exists to build up on this capacity but expertise can be developed by closely working with experienced scientists from developed countries. Cost is also incurred when building special biosafety features of the research laboratory, adding infrastructure needed for contained trials and for field testing and generating the required data for compliance. Opportunity cost is incurred in the time lag from application to approval at various stages (laboratory research, contained trials, field trials, commercialization). The formulation of and advocacy for IPR protection systems, the acquisition of biotechnology products and processes and the protection of locally owned IPR involve cost. So do measures taken to allay food safety concerns such as research on and formulation of food safety policies on food testing and standards.

Finally, there is the cost of technology diffusion that depends mainly upon the biotechnology product itself, the user’s prior knowledge and familiarity with it, and the cost of adoption.

**Strategic plan for biotechnology development**

Modern biotechnology R&D requires higher investment than conventional R&D as the former includes not only expenditures for building and maintaining competitive research capability but the cost of instituting and implementing the regulatory framework as well. Given the low level of research investments in agricultural research, limited manpower and facilities and multitude of problems requiring technological solutions, there is a need to identify the best mode of investing scarce research resources and of prioritizing research programs. In biotechnology, it is important to consider first the role of the private sector in accessing the technology since this sector is more efficient in commercializing new technologies. Policies to promote private sector research should be adopted. Apparently, policies will have to be specific since there are different biotechnology products. Also, existing policies should be reviewed to determine if they inadvertently hinder (rather than facilitate) the private sector’s foray into research.

A second consideration is the uniqueness of the technological problems to the country and its economic impact. Technological problems in coconut and abaca production could be considered unique since the Philippines is the number one producer of these crops and that the size of the market for the research output would be considerably bigger than anywhere else in the world. In this case, other countries cannot be expected
to solve the problem for the country since the Philippines is likely to be the only one experiencing such problem at a significant level.

A third consideration is the applicability of biotechnology to the problem at hand and the availability of alternative technologies. There has to be a comparison between cost and benefit that includes relative time lags between development, relative probabilities of success, regulatory framework and commercialization modes. For example, early programs in nitrogen fixation pertain to the transfer of the nitrogen fixing genes to common crops. However, years of research has yet to bear success on this strategy. On the other hand, there already is a wealth of data and experience on the use of nitrogen fixing organisms to promote growth and reduce N-fertilizer needs.

Field reports indicate that the country should pursue research on bio-organic fertilizers. Davide’s work with resource-poor corn farmers indicate the efficacy of nitrogen fixers as substitute for inorganic fertilizers in marginal lands. PhilRice has validated the use of a 1:1 ratio of organic fertilizer and inorganic fertilizer in the exogenous supply of nitrogen. Also, what with the current European hysteria against GMOs and the trend toward organic/natural foods, the country’s use of nonmodified biological control agents and organic fertilizers on fruit crops give local farmers that advantage in the international market.

Finally, with the antibiotechnology groups’ strong lobbying efforts in Congress and the media blitz, it will be prudent to start with a project that is of urgent need and attracts the least controversy—one which the private sector may not be interested in investing but has a high degree of success. Of the various possibilities, the development of a bunchy top resistant abaca is the most attractive. The above considerations should be factored in the economic framework developed by Maredia and Byerlee (1999).

**Conclusion: integrating biotechnology into the agricultural research agenda**

The Bureau of Agricultural Research is in the right direction in requiring the integration of commodity-specific biotechnology projects within commodity Research Development and Extension (RDE) programs. Biotechnology is a tool rather than an end in an agricultural research agenda. Successful applications in genetic improvement or breeding work, in the development of safer, more effective vaccines and reliable diagnostics and in the development of new production systems are now aplenty. However, since funds will always be limited despite the limitless
biotechnology possibilities, there is a need for project prioritization. The Agriculture and Fisheries Modernization Act (AFMA) has already set the minimum limit to biotechnology research investments at 4 percent of research expenditures.

Prior to project prioritization, the Bureau of Agricultural Research should decide how much of its funds should go to support DA development projects and where should it go. Previous dispensations have used substantial research funds to establish demonstration plots in support of DA programs. Although external evaluators have been hired to find out how effective the programs are in transferring technology to farmers, a more critical look is needed to determine whether the money invested in demo trials could be better spent in research for technology development or whether a more cost-effective alternative for technology transfer could have been adopted.

Biotechnology prioritization within a commodity RDE should be based on how critical the problem needs to be solved and how cost-effective the biotechnology research will be. Hence, alternative technologies should not be discounted outright but rather, compared with a possible biotechnology intervention. Although it may seem prudent to use less expensive research techniques such as microbiological systems rather than DNA manipulations, previous experiences fail to show its wisdom. Also, there is a need to focus and take a risk on a particular research approach. The past practices in developing research programs are akin to that of a small farmer who plants as many crops as he can in his farm so that if one crop fails he still has some left. This analogy compares with researchers who present donor agencies with a long list of projects, who in turn take their pick of projects according to their own priorities.

Furthermore, there is a need to be more realistic in choosing projects that are doable or in trimming down expectations from the project. Given the existing biosafety policies, it might take the country more than 10 years to develop its own transgenic crop from scratch. Hence, there is an immediate need to start testing the applicability of the guidelines to allow its evolution into a more realistic one. It does not help to have very stringent biosafety guidelines that are difficult to follow and consequently, would just retard biotechnology development.

Aside from determining specific critical problems where biotechnology applications will be most cost-effective vis-à-vis alternative technologies, the following principles should be adopted.

1) Molecular marker studies should be linked with breeding programs;
2) The Philippines, being the major source of coconut in the world,
should lead in the applications of crop biotechnology in coconut improvement;

3) As much as possible, international programs as well as private counterpart funds should finance biotechnology projects of the Philippines’s own choice. Otherwise, inclusion in international programs that not necessarily aligned with the Philippines’s development plans will only divert what little resources the country has.

4) Access to critical technologies as well as transgenic crops suitable to local farming conditions should be facilitated.

Risk assessment studies should take priority to enable the country to access already existing biotechnology products. The IRRI is ready to disseminate for field testing its transgenic rice such as Bt rice and a variety resistant to bacterial blight. The INIBAP has available banana bunchy top virus-resistant and fungal-resistant clones. Field testing of Bt corn with private seed companies should also be facilitated.

A decision also has to be made whether BAR should take a more active role in the design of development programs that the DA will pursue. Such a program should have a reliable, scientifically-tested technology as its core. Presently, an opportunity exists in the fruit industry. Trends in the epidemiology of the greening disease of citrus and several diseases of banana indicate a decline in these crops unless disease management programs are adopted by tapping on communities, provinces and individuals in their own capacities. This type of program substantially reduces pest management costs that are otherwise expensive to small farmers working on their individual capacity.

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IV
Property rights reform in Philippine agriculture: framework for analysis of recent experiences

by Rochlano M. Briones

Introduction

In traditional and modern economies, an essential element of the resource allocation mechanism is the property rights system. Flaws in the underlying property rights system may lead to misallocation of resources. The related problems of mass poverty, sluggish growth and rapid resource depletion in many developing countries suggest a need for all-encompassing property rights reforms.

The Philippines exemplifies these problems: the official poverty headcount in 1997 was 37.5 percent, with a far larger magnitude (51.2%) in rural areas, where land ownership inequality is common. Deforestation and overfishing remain critical: in 1991 to 1996, the average annual rate was 1.52 percent. The forest cover was 5.54 million hectares, down from 10.8 million hectares just three decades before 1968. Meanwhile, municipal fisheries have experienced an average annual output decline of 2.8 percent in the 1990s. The agriculture and natural resource sectors have therefore been the subject of extensive property rights reforms.

The Comprehensive Agrarian Reform Program (CARP) began in 1988 to implement RA 6657 (the Comprehensive Agrarian Reform Law, or CARL), a culmination of several decades of land reform efforts. These efforts include the land reform code (RA 3844) of the 1960s, which prohibited share tenancy and the 1972 Presidential Decree No. 27, which covers rice and corn lands. Meanwhile, policies on property rights in the uplands and coastal areas have been implemented to arrest resource degradation, including the introduction of tenure instruments and the recognition of community-based management.
In the past decade, studies on these initiatives have burgeoned. This paper reviews these studies using an analytical framework focusing on efficiency and equity. Interpreted broadly to include intergenerational welfare, these criteria subsume the issue of sustainability. Economic analysis typically focuses on efficiency, for which its analytical tools are well suited. The equity criterion, while important, involves a nearly intractable web of social justice issues. This review finds that focusing on the efficiency criterion is fruitful for evaluating property rights reform. Equity nevertheless remains integral to the discussion; as one can see later in this discussion, recent theories hypothesize complementarity (rather than tradeoff) between efficiency and equity.

Evaluating efficiency involves a comparison of benefits and costs. The challenge to an efficiency analysis is in identifying and valuing such benefits and costs of reform. Given the volume of relevant existing literature, this paper devotes the most attention to the CARP, which is the Philippines’ premier property rights reform program.

**Analytical framework for land rights**

**Property rights systems**

Property rights determine how persons may or may not behave with one another, with respect to the use of resources. A system that assigns property rights confers obvious benefits to society as a whole. First, in the absence of such a system, a destructive “state of nature” may prevail, wherein individuals and groups engage in conflict to appropriate one another’s possessions. Second, the property rights system enables a reward-and-penalty scheme to operate, motivating persons to employ resources toward productive ends.

On the other hand, property rights systems also impose costs. At the very least, there are transaction costs in setting up and maintaining the system. For example, resources are used when demarcating and defending boundaries and establishing a mechanism to settle conflicts and adjudicate disputes.

**Private property**

The most familiar property rights system is that based on private property. In this system, property is defined in terms of residual rights,¹ which permit the rights holders to take actions not otherwise prohibited within the system. Discretionary use, within explicit restrictions, is the most natural way of

¹The term is appropriated from incomplete contracts literature; see Grossman and Hart (1986) and Hart and Moore (1990).
understanding the term "right." An obvious example is the ownership of livestock with prohibitions on cruel treatment. In addition to assigning residual rights, the system allows the transfer of these rights. Transferability is a critical feature of the private property system, as this permits the operation of markets (which are simply institutions for the orderly exchange of rights).

The formation of markets is explained by the evolutionary theory of property rights (Fields 1989; Platteau 1996). The classic statement of the theory is attributed to Demsetz (1967): "Property rights develop to internalize externalities when the gains of internalization become larger than the costs of internalization. Increased internalization results from changes in economic values." He cites as an example the development of land rights for Labrador Peninsula Indians: with increased fur trading came the formation of a property system in forestland.

The evolutionary theory also appears in Boserup (1965). The author identifies population pressure with technological change leading to settled agriculture as factors that help define private property rights more accurately. A more recent illustration of the theory is the case of Thailand, where the opening of the Kingdom to international trade in the 1800s increased demand for rice land, thus ushering in a formal land registry system (Feeny 1982, as cited in Deininger and Feder 1998.)

The implementation of land rights has a growing effect on investment (Deininger and Feder 1998). In China, the shift from collective farming to individual land rights raised agricultural productivity (Lin 1992). Case studies of a communal forestland show that the establishment of individual land rights motivated agro forestry investment (Otsuka 1998). Active participation of farmers in Cameroon in land titling programs is additional confirmation of the incentive effects of land rights (Firmin-Sellers and Sellers 1999).

Agricultural land under a private property system: Allocation and welfare
The following now clarifies the criteria to be used in assessing social welfare and then identifies the welfare implications of the operation of a land market.

Evaluation criteria
A widely used (and fairly innocuous) standard for evaluating alternative allocations is the Pareto criterion. The criterion states that a reallocation makes society better off if it harms no one, but improves someone’s well being. Social welfare is maximized if no further Pareto improvements are possible,
in which case the allocation is characterized as Pareto optimal. This implies that the allocations that maximize welfare may not be unique; rather, that there may be a range of optima corresponding to a range of possible initial allocations of individual well-being.

A more useful but far more controversial standard is the criterion of potential Pareto improvement. According to this standard, reallocations that harm another person makes society better off if there is a compensation scheme financed by beneficiaries such that nobody ends up being worse off. As with the Pareto criterion, optimality is defined as exhausting all such improvements and a range of welfare optima exists consistent with alternative initial distributions.

The controversy surrounding this criterion is due to the purely hypothetical nature of the compensation. Payment is seldom made given the costs of actually setting up a compensation scheme. Despite this difficulty, the standard is widely used in normative analysis and is employed in this paper.

Land use under perfect markets

This section now clarifies in a more precise manner the benefits that arise from the private property and exchange system. The benchmark case of perfect markets is first examined. As defined in neoclassical theory, this case refers to an idealized state where transaction costs and externalities are absent, agents behave competitively, entry and exit choices are unconstrained and information is equally distributed across economic agents.

Two major propositions may be stated for this case. First, market equilibrium is optimal. Optimality of land use may be understood in both a static and dynamic sense. From a static viewpoint, payment for land services would be the same for all transactions at equilibrium and would equal the marginal product value in all uses. Hence, no reallocation of land can increase aggregate output. Other factors are priced and employed in the same way. From a dynamic viewpoint, landowners will make optimal choices on land improvement (or preservation of land value) as they undertake land investments until the point where the rate of return equals the opportunity cost of capital. Moreover, the price of the land capitalizes the present value of its income stream.

Second, any optimal allocation corresponds to some market equilibrium. That is, the attainment of a Pareto optimum does not depend on the distribution

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2These are of course the two fundamental welfare theorems.
of property rights. The implication is that a preferred outcome, based on a more restrictive welfare criterion (e.g., one that emphasizes equity), may be reproduced as a market equilibrium starting from some appropriate endowment. To reach this appropriate endowment, some authority may have to undertake redistribution aimed at endowment values or individual assets as a whole; land commands no special attention as a store of wealth.

The caveat is that redistribution must be costless. Of course, this is rarely true; those harmed by redistribution may expend resources to oppose the move, as well as make choices that would be otherwise be unprofitable in the absence of intervention. That is, the intervention can introduce distortions. For example, a tax-transfer system may reduce labor supply of both contributors and recipients. Because of these costs, a move to a greater equity may face the efficiency-equity tradeoff.

Land use in the real world

In reality, markets, particularly in agriculture, are far from perfect. Transaction costs abound; contract enforcement may be ineffective; information is asymmetric; competition is imperfect; and some markets may be absent. Agriculture is moreover subject to seasonal fluctuations and random shocks that exacerbate these problems.

In the presence of such market failures in agriculture, the foregoing propositions are no longer valid. Market equilibrium need not be efficient and the attainment of a Pareto optimum may actually depend on the initial endowment. The inapplicability of the second proposition above requires a new approach toward the analysis of efficiency and equity. Instead of a potential efficiency-equity tradeoff, the simultaneous improvement of efficiency and equity may be possible. Theoretical explanations for the equity-efficiency link in land distribution may be the following:

1. imperfections in credit markets
2. agency relations in land cultivation
3. localized linkages for income diversification

The efficiency-equity link: imperfections in related markets

Failures in the operation of land markets may arise from imperfections in related markets, particularly the credit market. Credit constraints are the most commonly-cited and convincing argument for the inefficiency of skewed land ownership (Deininger and Squire 1998; Aghion, Caroli and Peñalosa 1999). The credit problem is the consequence of asymmetric information and weak contract enforcement.
An investment project always involves risks exogenous to the credit market (e.g., pest infestation or steep price declines). Inadequate project returns are also related to the behavior of the borrower, who may decide to default, take excessive risks or fail to exert the effort needed to ensure a profitable return. Such behavior may be the result of the inherent individual characteristic: reliability. The "reliable" and "unreliable" types have a known distribution in the population, although information on the type of a particular borrower is not known to the lender. When the interest rate is a signal of the type of borrower, credit may be rationed in equilibrium (Stiglitz and Weiss 1981). The problem of price being related to quality (i.e., interest rate on a loan with the assurance of repayment) is referred to as adverse selection. On the other hand, default or the potential to default may be the borrower’s choice and therefore not an external cause. Information regarding the choice taken is asymmetric. This problem is referred to as moral hazard.

Market adjustments to these problems are evident in the agricultural sector. Credit constraints artificially raise factor supply for activities that generate immediate cash flows; for example, farm households allocate labor supply away from own-farm labor to off-farm labor, leaving part of their cultivated area idle (Alwang and Siegel 1999). In the formal sector, the collateral system is a common response, with land as the favored form of collateral given its immobility and relative ease in ascertaining property rights and its transfer. However, actual land prices will probably be pushed above the capitalized net yield of the land because of its collateral service (Binswanger, Deininger and Feder 1995). In the informal sector, credit may be tied in with other transactions, such as the purchase of harvest (Floro and Yotoupoulos 1991).

With imperfect credit markets, households can easily fall into "poverty traps." This is exacerbated by the presence of random shocks on assets (e.g., crop loss, medical emergencies) to which the household is vulnerable under credit rationing and in the absence of insurance markets. Once the household falls into the poverty trap, they are unable to obtain financing for the investment whose returns could pull them out of the trap.

A simple model proposed by Banerjee and Newman (1994) illustrates how constraints to investment credit can generate such traps. The model generates credit rationing given the moral hazard problem. Suppose only one good is produced, according to a production function \( f(k) \), where \( k \) is the amount of capital; as usual, \( f' > 0, f'' < 0 \). To purchase \( k \), the individual borrows the amount, pays the interest rate equal to \( r \) and puts up his current wealth \( w \) as collateral. The borrower may, however, abscond, forfeiting \( w \). If
he evades creditors, the person keeps $f(k)$; if he is caught, he gets nothing. The probability of being caught is where $\pi(k)$, $0 \leq \pi(k) \leq 1$ is nondecreasing in $k$. The agent is risk neutral; hence, he seeks to maximize expected profit.

Incentive compatibility requires

$$f(k) - (k - w)r \geq [1 - \pi(k)] f(k).$$

Optimal borrowing, denoted as $k^*$, is at $f'(k^*) = r$. Then solve for critical wealth $w^*$ that just provides a repayment incentive at the optimal investment:

$$w^* = k^* - \frac{\pi(k^*)}{r}.$$

If $w$ falls below $w^*$, then the lender does not lend the optimal investment level. The reason is that there is a lower bound (zero) on the borrower’s punishment. As the poor are already near zero wealth, then they are less deterred by the prospect of being caught. Note that if an individual has an endowment greater than $w^*$ and another slightly below it, then a reallocation of capital or wealth from the former to the latter in the current period will increase aggregate output. Information and enforcement problems prevent the market from making this reallocation.

**The efficiency-equity link: agency relations in land cultivation**

Another source of failure in land markets arises through agency relations in land cultivation. When ownership of land is skewed, the owner inevitably delegates production tasks to agents. Two options are available: first, the owner hires and supervises wage labor; second, the owner delegates operations to a tenant-cultivator.

For the first option, the difficulty lies in the high cost of supervising wage labor (Family labor requires less supervision but of course is in limited supply). The transaction cost of using wage labor is the generally explanation behind the pattern of declining yield that accompany farm size increases (Faruque and Caree 1997).

Doubts have been raised against the robustness of this stylized fact. For example, Benjamin (1995) suggests that the pattern may be partly due to the omission of variables such as soil quality. The relationship is reasserted by Heltberg (1998). Hayami, Quisumbing and Adriano (1990) confirm the
absence of clear empirical evidence regarding economies of scale in agriculture. In the case of plantation agriculture, the apparent scale economies can be attributed to coordination problems at the processing and distribution stage, and not from increasing returns at the production stage.

The second option, which is to delegate operations to a tenant-cultivator, takes the form of either fixed rent or sharecropping. Sharecropping, however, faces an incentive problem if the agent receives earnings that are lower than the marginal product value of the land. In contrast, the cultivator under leasehold receives this marginal product value. The "Marshallian inefficiency" hypothesis posits that the effort of the agent is lower under sharecropping than under leasehold. Share tenancy is regarded as a feudal vestige to be superseded by leasehold as the countryside begins to progress economically.

However, the prevalence and persistence of share tenancy has brought forth theories that examine its basis in rational contracting. Tenancy contracts must combine work incentives with risk-sharing. If the agent shirks from working due to high transaction costs involved in the monitoring process, any output losses from such shirking (a form of moral hazard) cannot be distinguished from those due to environmental factors. Sharecropping, on the other hand, may be used as incentive to workers who also share the risks in agriculture (Stiglitz 1974; Newberry and Stiglitz 1979; Otsuka and Hayami 1988).

An interesting suggestion by Eswaran and Kotwal (1985) distinguishes two types of moral hazard: in addition to shirking by the cultivator, the landowner may also shirk in providing managerial services to production. This provides an additional justification for the share contract. In their model, depending on the specific set of local conditions and agent preferences, sharecropping may be Pareto superior to leasehold.

Instead of moral hazard, another form of asymmetric information that could lead to sharecropping is adverse selection (Hallagan 1978; Muthoo 1998). Own skill or ability may be the private knowledge of a farmer; hence, the contract offers are designed to screen farmers based on skill. However, the adverse selection explanation for sharecropping does not seem to jibe with evidence that finds information regarding skill to be public knowledge within a village (Lanjouw 1999). Moral hazard is deemed to be the more likely explanation for share tenancy.

The concept of sharecropping also came about as an outcome of an imperfect labor market (Ray 1999). In this interpretation, share tenancy is
a form of strategic delegation undertaken by competing landowners. The model is set up as follows:

(1) The landlord can either operate the farm and hire workers, or delegate operation to a share tenant.

(2) The structure of competition is such that when one farm reduces its wage, a rival farm must also reduce its wage.

(3) The decision to hire a tenant is construed as a *credible commitment* that a lower wage will be paid, because the tenant is given only a partial output incentive. This view is hospitable to the thesis of Marshallian inefficiency.

A survey of the empirical literature by Hayami and Otsuka (1993) nevertheless yields little evidence for Marshallian inefficiency. Agrarian contracts are found to adapt to real world enforcement problems; hence, share tenancy is more frequently observed in cases where monitoring is less costly, that is in closely-knit communities and families. A study for the Philippines confirms that share tenancy contracts between kin did not weaken production incentives (Sadoulet, de Janvry and Fukui 1997). There seems to be no compelling reason to attribute production inefficiency to sharecropping.

There are on the contrary, good reasons to believe that sharecropping promotes efficiency, based on the foregoing. It permits cultivation by family labor, reduces reliance on hired labor, spreads risk between tenant and landlord and provides incentives for landlords to supply managerial input. Sharecropping also mitigates credit problems, as sharing of output is often accompanied by sharing of cost outlays. Often, landowners purchase fertilizers, pesticides and other inputs, and share their cost (Otsuka 1999). Moreover, the harvest rights acquired by the tenant upon gaining access to land opens up credit opportunities from moneylenders and traders. These advantages imply that share tenancy promotes equity. Given the traditional criticism of sharecropping as a brutal form of exploitation, the revisionist view of modern economic theory is quite remarkable.

**The efficiency-equity link: localized linkages in income diversification**

The final argument regarding the inefficiency of inequality rests on the potential for localized linkages to promote rural industries when incomes

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3In a rural setting, linkages are conceptualized in a Keynesian type framework, and are quantified by computing localized multipliers. This approach, however, lacks micro foundations (as does the macro model from which it derives), and its appropriateness for explaining *development per se* is suspect. See Briones (2000).
are evenly distributed. "Localized" is used here to distinguish this from the traditional view that sees land reform as a means to indirectly promote national industrialization. According to this argument, industrialization is precluded by the excessive diversion of productive capital into relatively unproductive assets of the landed class (see e.g., Cornista et al. 1989). There is no coherent framework to account for this persistently inefficient and perhaps irrational behavior, nor is there persuasive evidence to show that urban-based industrialization requires liquidation of the landed class’ assets.

A localized linkages framework on the other hand uses the following argument: Consider a rural economy divided into a household and a production sector. The latter is further subdivided into agriculture and manufacturing. The development of rural manufacturing is initially dependent on strong local demand, both from the agricultural and household sectors. The distribution of household incomes may be a determinant of this demand when nonfarm goods are income elastic. The argument is most applicable to an agriculture-dependent region where the greater bulk of the population is poor, and land ownership is highly skewed. Agricultural development and asset redistribution may be the impetus for rural growth linkages (Ranis and Stewart 1993). The importance of income equality in promoting local linkages is echoed by Park and Johnston (1995) in the case of Taiwan.

The concept of linkages can make sense by relating it to the concept of scale economies (Krugman 1993), assuming a case of perfect markets. Fafchamps and Helms (1996) construct a formal model of local linkages, summarized as follows: consider a village whose transactions with the outside world are costly. Suppose rural manufacturing is characterized by increasing returns; moreover, the proportion of manufactures in total expenditure rises with income (i.e., preferences are nonhomothetic). A multiple equilibrium situation is possible, with some levels of Pareto equilibrium dominated by others. In a low-level equilibrium, village manufacturing is underdeveloped because of low demand for its output—but demand is low precisely because incomes are low in the absence of highly productive manufacturing activities. Under these circumstances, how a costless asset redistribution affects the size of the rural manufacturing sector depends on the composition of output demand as income varies. In one of their

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4The equity-growth view is not without its detractors. Li and Zhou (1998) argue that, if public consumption goods are financed by a growth-reducing tax, then majority voting leads to a distortionary regime when inequality is low. A regression of GDP growth on past values of the Gini co-efficient confirms the hypothesis.
simulations for Guatemalan villages, the researchers of the study found that redistribution efforts meant to reduce asset inequality could trigger rural small-scale industrialization.

These arguments hint that the industrialization and development process is dynamic. Likewise, the efficiency-equity link model can be completed only by looking at its dynamic aspect.

**Dynamic version of the efficiency-equity link**

The dynamic version of the model of Banerjee and Newman (1994) concludes that a one-time wealth redistribution can alter the equilibrium path and lead to higher rates of long-run growth. That is, redistribution increases the wealth of the poor and permits them access to credit markets, which increases the over-all rate of capital accumulation.

The efficiency-equity link may be stated in dynamic terms as the growth-equity hypothesis: a more equal asset distribution leads to higher future growth rates. In contrast, the traditional view is expressed by the Kuznets hypothesis: as an economy grows, inequality at first rises before declining. Recent evidence tends to support the equity-growth hypothesis (Alessina and Rodrik 1994; Clarke 1995).

In particular, Deininger and Squire (1998) zero in on land inequality as a determinant of future growth. The distribution of operational landholdings is a proxy for asset distribution. Using a pooled time-series and cross-section country data (characterized as a "high quality" data set), they find little evidence for the Kuznets hypothesis; instead, there is a strong negative relationship between inequality and growth. Moreover, weak income growth tends to be concentrated at the lower end of a skewed income distribution.4

The theory and available evidence seem to favor a one-time redistribution of assets for an economy with marked inequities and feeble growth. Where landholding is an important store of wealth and favored collateral form, redistribution may be targeted at landowning.

However, this one-time redistribution of land may not lead to a permanent reduction in land inequality once risk is introduced into the analysis. Random shocks on individual wealth holdings, when credit and insurance markets are imperfect, may result in widening gaps between the lucky and the unlucky over time. Covariation of shocks, localization of land markets, and the absence of nonfarm employment reinforce these distributional trends. Land sales tend to be concentrated in periods of adverse natural or economic conditions (e.g., drought or low prices), where "distress sales" within an area (e.g., stricken by a common shock) force
land prices down. Land buyers, on the other hand, possess financial assets. Hence, there may be a secular tendency for land ownership to continue to be concentrated (Binswanger and Deininger 1997; Carter and Zimmerman 1998).

This consideration may justify complementing land redistribution with programs that offset adverse shocks such as credit support. The following section therefore now examines the case of the CARP in the Philippines, which combines land redistribution with support service provision.

The Comprehensive Agrarian Reform Program
The CARP is arguably the most ambitious program for property rights reform in the Philippines. In principle, the CARP encompasses all agricultural lands. The actual coverage is estimated at 8.06 million hectares, or around 83 percent of agricultural lands. Of these, 4.32 million hectares (around 54%) are private lands, government lands and resettlement areas, all falling under the jurisdiction of the Department of Agrarian Reform (DAR). The remainder (3.74 million ha.) consists of public agricultural lands, including public alienable and disposable lands and some forest lands, falling under the Department of Environment and Natural Resources (DENR).

The CARL sets a 5-hectare ceiling on private land ownership. An additional 3 hectares for each of the landowner’s children may be retained for owner-cultivation. Land sizes exceeding these retention limits are acquired by the Land Bank of the Philippines (LBP). Landowners must be paid a "just compensation" to be determined in the course of implementation. Up to 35 percent of the compensation may be given in cash, with the remainder in the form of government financial instruments and LBP bonds. The yield is set by the 91-day T-Bill. Landowners may also opt for "voluntary" sale or transfer.

Ownership of acquired land is then transferred to cultivators. Persons prioritized to receive transfers are tenants, followed by regular farmworkers, seasonal farmworkers, other farmworkers, tillers of public land and other cultivators. Agrarian Reform Beneficiaries (ARBs) are entitled to no more than 3 hectares of land. In the case of acquired private land, ARBs are required to pay 30 annual amortizations to the LBP at 6 percent interest.

Exempted from coverage are lands for public use, livestock and poultry farms, prawn farms and fishponds, and lands converted to nonagricultural use. The last exemption has gained notoriety, given the Local Government Code provision that authorizes local governments to reclassify up to 15 percent of agricultural land in their jurisdiction. In addition, compulsory
acquisition of commercial farms will be deferred for 10 years after the validity of the program. For commercial estates, CARP provides alternative arrangements for asset reform such as stock distribution and profit-sharing.

Land acquisition and distribution (LAD) is scheduled by the CARL as follows:

**Phase 1** (1988-1992): Rice and corn lands under PD 27, idle lands, private lands under voluntary sale or transfer and government lands;

**Phase 2** (1988-1992): Public alienable and disposable lands, resettlement areas and private agricultural lands in excess of 50 hectares;


Other features of the program include prohibitions against sharecropping as well as rental ceilings for leasehold, which are carryover policies of previous land reform legislations. Moreover, land transactions are effectively frozen: land covered by CARP cannot be sold while distributed land cannot be transferred for the next 10 years. (The exceptions are transfers to the government or the LBP, or transfers by inheritance.)

Finally, the CARP seeks not only to redistribute land but raise agricultural productivity by providing support services to ARBs as well. These services include the provision of credit, infrastructure, technical assistance and community organization. To operationalize beneficiaries’ development, the CARL also provides for the creation of Agrarian Reform Communities (ARCs). These are each composed of a barangay or a cluster of barangays and "primarily composed and managed" by ARBs. In each area, a farmer’s organization or cooperative will be identified to take the lead in the agricultural development of the locality. The ARC em bodies in principle the development approach anchored on participation, local empowerment and area integration.

The DAR is assigned as the lead agency for CARP implementation. Support services are shared with the Department of Agriculture (DA), the Department of Public Works and Highways (DPWH) and the Department of Interior and Local Governments (DILG), in cooperation with Local Government Units (LGUs). The law also mandates the creation of coordinating bodies at the national, provincial and barangay levels. Members in these bodies include representatives of landowners, farmers and beneficiaries.
Accomplishments and administrative costs

Official figures on accomplishments regarding land acquisitions and distribution are shown in Table 1a. Not surprisingly, redistribution is most successful for government-owned and public lands as well as land under voluntary sale or transfer. The exception is public alienable and disposable land although the Integrated Social Forestry program (under the DENR) performs well. Least successful is land under compulsory acquisition, which can be readily attributed to landowners’ resistance. Such lands represent a fifth of CARP’s coverage. Contrary to popular impression, the worst record for compulsory acquisition is held not by those owning the largest areas under CARP coverage but rather, by those belonging to the smallest land category.

An oft-cited cause of delay in the implementation of LAD is the disagreement with landowners over land valuation. Land Bank’s formula is

Table 1a. Accomplishments of land acquisition and distribution, by land type (1972-December 1999)

<table>
<thead>
<tr>
<th>Land type</th>
<th>Scope (% of total)</th>
<th>Distributed (% of Scope)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Private Land</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenanted rice and corn (P.D. 27)</td>
<td>7</td>
<td>87</td>
</tr>
<tr>
<td>Voluntary sale or transfer</td>
<td>8</td>
<td>100*</td>
</tr>
<tr>
<td>Compulsory acquisition</td>
<td>19</td>
<td>10</td>
</tr>
<tr>
<td>By size category (as of 1996)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - 24 ha.</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>24 - 50 ha.</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>over 50 ha.</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>53</td>
</tr>
<tr>
<td><strong>Government-owned and Public Land</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under DAR jurisdiction**</td>
<td>16</td>
<td>100*</td>
</tr>
<tr>
<td>Public alienable and disposable land</td>
<td>31</td>
<td>46</td>
</tr>
<tr>
<td>Integrated Social Forestry Areas</td>
<td>16</td>
<td>90</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>63</td>
<td>73</td>
</tr>
<tr>
<td><strong>Total land (8,061,764 ha.)</strong></td>
<td>100*</td>
<td>65</td>
</tr>
</tbody>
</table>

*Actual distribution in excess of coverage

**Includes land owned by government financial institutions, KKK lands, settlements, and landed estates

SOURCE: PARC Secretariat
based on a weighted average of the price from comparable sales, capitalized net income and market value based on tax declaration. Unfortunately, reliable information on capitalized net income and comparable sales are usually unavailable. In the case of sales figures, CARP regulations are part of the reason for data unavailability (Bravo and Pantoja 1998). Low assessment values also preclude reliance on the tax declaration. In the absence of clear information on land values, fiscal constraints probably lead to the landowner’s systematic undervaluation of their compensation. Adriano (1994), meanwhile, notes that measures undertaken to prevent corruption (to which land redistribution programs are especially vulnerable) have created a multilayered, horizontally coordinated system, further slowing down implementation.

Another problem with LAD is its tendency to perform poorly in regions where land is more inequitably distributed (Table 1b). Consider the two worst performers in LAD, Regions V and VI. Based on the 1991 Census of Agriculture, the Gini ratio of landholding inequality in these regions is 0.81, compared to the national average of 0.57. These two regions account for 23.6 percent of the national CARP coverage. Over-all, it seems that land reform has managed to redistribute land only in places where it was relatively better distributed from the start (World Bank 1999).

Table 1b. Accomplishments of land acquisition and distribution, by region: 1972-December 1999

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage of Total Scope</th>
<th>Percentage Distributed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Mindanao</td>
<td>4.4</td>
<td>103</td>
</tr>
<tr>
<td>Northern Mindanao</td>
<td>4.2</td>
<td>97</td>
</tr>
<tr>
<td>Cagayan Valley</td>
<td>7</td>
<td>95</td>
</tr>
<tr>
<td>CAR</td>
<td>1.8</td>
<td>89</td>
</tr>
<tr>
<td>CARAGA</td>
<td>4.7</td>
<td>85</td>
</tr>
<tr>
<td>Southern Mindanao</td>
<td>6.7</td>
<td>85</td>
</tr>
<tr>
<td>Central Luzon</td>
<td>9.2</td>
<td>84</td>
</tr>
<tr>
<td>Ilocos Region</td>
<td>3.3</td>
<td>80</td>
</tr>
<tr>
<td>Eastern Visayas</td>
<td>9.6</td>
<td>68</td>
</tr>
<tr>
<td>Central Mindanao</td>
<td>13.3</td>
<td>66</td>
</tr>
<tr>
<td>Southern Tagalog</td>
<td>9</td>
<td>63</td>
</tr>
<tr>
<td>Central Visayas</td>
<td>3.9</td>
<td>53</td>
</tr>
<tr>
<td>Western Visayas</td>
<td>13</td>
<td>45</td>
</tr>
<tr>
<td>Bicol Region</td>
<td>10.6</td>
<td>42</td>
</tr>
<tr>
<td>Total Lands (8,061,764 ha.)</td>
<td>100</td>
<td>65</td>
</tr>
</tbody>
</table>
Meanwhile, Table 2 details CARP accomplishment by support service type. Credit provision (mostly channeled through the Land Bank) to ARBs reaches a sizeable number of farmers, while total releases average nearly P7 billion annually in nominal terms. Infrastructure provision is unimpressive while no quantifiable benefits from farmer training are available. Finally, it is unclear whether CARP made a substantial difference in the quantity of services being delivered (given that these services are standard fare of government development programs) or in the targeting of these services (i.e., specifically toward new land awardees).\(^5\)

Implementation of the CARP is financed by a special fund,\(^6\) whose breakdown is shown in Table 3. These are again nominal figures spanning a 12-year interval. Total cost averages less than P5 billion a year, which is only one-fifth of average public agriculture and natural resource expenditures per annum from 1989-1998 (based on data from David and Inocencio 2000). Landowner compensation takes up less than a third of total cost, which is expected given the low rates of accomplishment in distributing private lands. Nearly a quarter of administrative cost is taken up by personnel services, in contrast to the 12 percent allocation for infrastructure, a highly capital-intensive activity. The administrative demands of the program under the over-all fiscal bind can explain this seemingly lopsided allocation.

**Field evidence on CARP implementation**

Official statistics mentioned earlier present accomplishments on a highly aggregated basis. This section presents findings on the progress of CARP

**Table 2. Accomplishments of CARP support services (1987-July 1999)**

<table>
<thead>
<tr>
<th>Support Service Component</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Credit</strong></td>
<td></td>
</tr>
<tr>
<td>Loans released (P million)</td>
<td>82,290.50</td>
</tr>
<tr>
<td>Number of small farmers benefited</td>
<td>6,153,380</td>
</tr>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Completed roads (km)</td>
<td>5,639</td>
</tr>
<tr>
<td>Communal irrigation service (area, ha.)</td>
<td>67,380</td>
</tr>
<tr>
<td><strong>Extension</strong></td>
<td></td>
</tr>
<tr>
<td>Number of farmers trained</td>
<td>2,767,348</td>
</tr>
<tr>
<td>Number of farmers provided technical assistance</td>
<td>1,739,457</td>
</tr>
</tbody>
</table>

SOURCE: PARC Secretariat
implementation at the farm level. This discussion starts off by identifying and describing several "major data sets" specifically designed for CARP evaluation. Most of these data sets are the main vehicle for this study’s agrarian reform impact assessment.

Except for the panel study conducted by the World Bank (Deininger et. al. 1999), which is based on village surveys, the major data sets emanate from the following nationwide surveys:

1. The Benchmark Survey (covering crop year 1989-1990)
2. The ARB Performance Monitoring and Evaluation System (PMES)
   - Phase 2 (crop year 1994-1995)
   - Phase 3 (crop year 1996-1997)
3. The Benchmark Survey of ARCs (crop year 1993-1994)
4. MODE Impact of Agrarian Reform Survey (crop year 1996-1997)

Except for the fourth, which was undertaken by a nongovernmental organization, MODE Inc., these surveys were commissioned by the DAR to the Institute of Agrarian and Rural Studies (IARDS), formerly the Institute of Agrarian Studies (IASt) at the University of the Philippines in Los Baños. These surveys have different sampling frames (i.e., even PMES 3 differs from PMES 2); the closest to a time-series survey is the Benchmark Survey-MODE Survey comparison, although even here significant noncomparables should be noted. Further details regarding these data sets are available in the Appendix.

Table 3. Administrative costs of implementing CARP (1987-1999)

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount (P million)</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landowner compensation</td>
<td>15,685</td>
<td>28.4</td>
</tr>
<tr>
<td>Other activities</td>
<td>5,690.70</td>
<td>10.3</td>
</tr>
<tr>
<td>Credit (LBP)</td>
<td>2,768</td>
<td>5</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>6,707.10</td>
<td>12.1</td>
</tr>
<tr>
<td>Extension</td>
<td>2,056.90</td>
<td>3.7</td>
</tr>
<tr>
<td>Others</td>
<td>3,583.10</td>
<td>6.4</td>
</tr>
<tr>
<td>Personnel services</td>
<td>13,465.50</td>
<td>24.4</td>
</tr>
<tr>
<td>Other items</td>
<td>5,362.20</td>
<td>9.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55,318.50</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

SOURCE: PARC Secretariat
Accomplishment of agrarian reform based on the nationwide studies

The PMES Surveys describe the average ARB as similar to the typical farmer. The head of the household is usually male, married and in his 50s, with three to four children, and has received little more than primary education. Other surveys with a broader class of respondents do not deviate much from this characterization. The portrait of the beneficiary as a smallholder is justified: according to the PMES 2, average farm size of the ARB is only 2.41 hectares. The MODE Survey estimates average farm size at 2.6 hectares. Similarly, the 1991 Census of Agriculture and Fisheries estimates the average farm size in the country at 2.2 hectares.

Table 4 shows the distribution of farmers by type of tenure. Sharecropping, an illegal arrangement, accounted for a quarter of the sample in the 1989 Benchmark. The MODE survey shows that, despite six years of CARP implementation, practically the same proportion (25%) of farmers remained as share tenants. Likewise, there is no recorded increase in the proportion of owner-cultivators.

Meanwhile, the PMES Surveys, along with the ARC Survey, report a low incidence of sharecropping among ARBs. All of the surveys, though, report higher proportions of amortizing owners compared to the Benchmark 1989 figure. In a separate report, the MODE Survey shows only a minimal change in the number of owners. It further states that only 8.2 percent of owner-cultivators claim to have received their land from the CARP; in contrast, 58 percent inherited their land while 32 percent purchased it outright.

Note that the rice and corn are the major crops raised by ARBs (57% according to the PMES 3). Rice and corn are the main crops of all

### Table 4. Distribution of respondents’ parcels by tenure by survey (in %)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Share tenant</td>
<td>25</td>
<td>9</td>
<td>26</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Leaseholder</td>
<td>19</td>
<td>8</td>
<td>15</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Owner</td>
<td>6</td>
<td>29</td>
<td>11</td>
<td>18</td>
<td>10</td>
</tr>
<tr>
<td>Owner-cultivator (awaiting certificate)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landless worker</td>
<td>35</td>
<td>32</td>
<td>34.5</td>
<td>23</td>
<td>33</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>-</td>
<td>5.7</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8</strong></td>
<td><strong>22</strong></td>
<td><strong>14</strong></td>
<td><strong>38</strong></td>
<td><strong>35</strong></td>
</tr>
<tr>
<td></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
respondents in the ARC survey while rice is planted by over 60 percent of respondents in the Benchmark and MODE surveys. The bulk of the reported LAD accomplishments among rice and corn farmers may actually be due to the implementation of PD 27, even prior to CARP.

The data in Table 5 regarding support services is not very encouraging. The PMES reports that even among the ARBs, a substantial minority (33%) does not recall receiving assistance from any government agency or unit. Naturally, in the non-PMES surveys that included non-ARB respondents, the proportions of those receiving assistance is much lower than those reported in the PMES. The PMES 3 Survey is more upbeat: 63 percent of ARBs recall receiving government assistance. In this survey, assistance is classified by activity, namely: training (39%), fertilizer dispersal (9%), animal dispersal (7%), seed dispersal (11%), infrastructure (27%), technology transfer (31%), postharvest facilities (4%), marketing assistance (1%) and crop insurance (2%).

Agrarian reform accomplishment based on the panel study

The panel study observes that, consistent with the findings of nationwide surveys, a decade of CARP implementation failed to eliminate share tenancy even in rice farms. Only 12 percent of the sample in 1985 are share tenants, which was the result of aggressive implementation of PD 27 before CARP; in 1988 share tenants still account for 8 percent of the sample.

A more alarming trend is the simultaneous increase in landlessness in the surveyed villages. Owners comprised a quarter of the sample in 1985; 38 percent in 1998. Meanwhile, an additional 5 percent of the sample

<table>
<thead>
<tr>
<th>Availment</th>
<th>PMES 1994</th>
<th>ARC 1993</th>
<th>MODE 1996</th>
</tr>
</thead>
<tbody>
<tr>
<td>With assistance</td>
<td>67</td>
<td>42</td>
<td>-</td>
</tr>
<tr>
<td>Source of assistance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DA</td>
<td>67</td>
<td>24.9</td>
<td>41.6</td>
</tr>
<tr>
<td>DAR</td>
<td>33</td>
<td>49</td>
<td>28.3</td>
</tr>
<tr>
<td>DENR</td>
<td>-</td>
<td>0.8</td>
<td>9.5</td>
</tr>
<tr>
<td>DPWH</td>
<td>31</td>
<td>0.3</td>
<td>-</td>
</tr>
<tr>
<td>LGU</td>
<td>11</td>
<td>10</td>
<td>-</td>
</tr>
<tr>
<td>Others</td>
<td>-</td>
<td>42.6</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 5. Distribution of respondents by availment of support services (in %, multiple responses)
became landless. This is probably still an underestimate figure, given the possible out-migration activities.

Movement up the "agricultural ladder" therefore seems to have slowed down during the CARP period. While there is an increasing share of owner-cultivators (i.e., more and more families reaching the top of the ladder) there is also an increasing landlessness (i.e., more and more families failing to get on the first rung). Former share tenants and landless workers comprised 82 percent of the new owners in 1988 (compared to 1972), but accounted for only 20 percent of the new owners in 1998 (compared to 1985). A probit estimation confirms the observation. This evidence suggests that while PD 27 had been targeted for the poor, the CARP’s aimed at other land reform objectives. Apparently, DAR focused on completing the granting of land ownership to leaseholders and awardees of the Certificate of Land Transfer under PD 27.

The success of the PD 27 program, in contrast to the laggard CARP, has been largely attributed to the coincident onset of the Green Revolution (Otsuka 1991). Effectively, PD 27 maintained the land incomes and values of the landowners at the pre-reform levels, defusing their opposition. Leaseholders and land awardees, meanwhile, received the income gains from the introduction of modern varieties. There is evidence to suggest that payments of leaseholders are only half that of share tenants precisely because of these lease controls (Otsuka, Cordova and David 1992).

**Hypotheses regarding impacts of reform**

An earlier section of this study hypothesized that asset inequality is negatively related to future growth, hence measures intended to reduce inequality such as agrarian reform may promote growth later. For the Philippines, however, no study regarding the link between asset inequality and growth has yet been conducted. Balisacan (1999) investigates the link between initial landholding inequality and subsequent regional poverty and finds a strong positive relationship. Quite possibly the causation runs from equality to growth to poverty reduction, although further study is needed to finalize this claim.

Another possibility is wealth equality’s impact on promoting local consumption linkages, which consequently expands rural industries. Only one study (Ranis, Stewart and Reyes 1989) explores the inequality-rural industry link for the Philippines but even this fails to assemble evidence from village data. Hence, the inequality-rural industry link remains an unsubstantiated, although interesting, conjecture. Focus is therefore shifted on the more specific hypotheses regarding CARP impacts.
Expected CARP impacts

According to the framework, the land distribution component of the program may enhance economic efficiency. In the case of public land transfer, and perhaps even for government-owned lands, beneficiaries may in most instances be the current occupants. Hence, the transfer essentially formalizes land rights, thus, establishing tenurial security. Given that the bulk of CARP accomplishment in LAD falls under this category (63%, excluding forestry areas which account for another 16%), this is expected to be currently the major source of CARP redistribution benefits. However, note that no studies have been conducted on the productivity gained by awardees of government and public property as an offshoot of the tenure formalization under CARP. This study will hence redirect focus on the impacts of CARP on private nongovernment lands.

Credit services supporting CARP also serve to overcome market failures. Meanwhile, infrastructure, technical assistance and even community organizations may be means to give farmers access to public or quasipublic goods, which their markets are ill-equipped to supply. These complementary services are perhaps essential to breaking the dynamic pattern of inequitable land distribution and its accompanying efficiency losses.

On the other hand, the program does undermine efficiency in other ways. Some of its features introduce distortions in agrarian markets. Tenancy regulation induces owner cultivation with hired labor, which may be less efficient. On the other hand, the permitted tenancy contract (the leasehold) exposes the tenant to more risk. The regulation of land markets further suppresses their development for land rights. Even as the program aims at expanding an ownership base, nonowners’ access to land is restricted.

These regulations can further fragment the fragile credit market. In the informal sector, the shift to owner-cultivation and leasehold may sever landlord-tenant ties that are characterized by interlinked credit and cost-sharing. Restrictions on land access may also constrain the credit ties with other lenders (i.e. traders, input dealers, etc.) who typically practice informal lending where the farmer’s share in the produce is used as collateral.

In the formal sector, lenders such as banks may experience a dramatic climb in the transaction cost of agricultural lending, as a burgeoning mass of owner-cultivators apply for small loans. In addition, and perhaps most importantly, landowners may find themselves rationed even more severely in the credit market, as the collateral value of their land vanishes in the face of restrictions on land transactions.

The protracted and unpredictable implementation of the program is another source of distortion. CARP weakens incentives to invest in land
improvements during its implementation phase. Moreover, given that only agricultural lands are covered, a common criticism of the Program (aired especially by vocal farmer groups) is its failure to address evasive land conversion.

In sum, these hypotheses summarize the foregoing discussions:

1. **Credit, investment, and CARP beneficiaries.** Land awardees obtain more credit and accumulate more assets without the program.

2. **Land access and CARP.** The program restricts access to land, thereby suppressing upward mobility of the rural poor.

3. **Credit, investment and landowners.** The program reduces landowner’s investments in land improvements.
   - The program reduces aggregate investments due to the diminished collateral value of agricultural land and to scale diseconomies in smallholder lending.

4. **Land use and CARP.** The program introduces inefficient land use practices due to uncertainty in land rights and excessive regulation of land markets.

**CARP impacts on landowners and land use**

The incentive effects of CARP on land investment are uncertain. A survey made by of the Management Association of the Philippines in 1990 found that over 60 percent of 39 respondents (farming over 72,000 ha.) either reduced their investments or shelved expansion plans (Llanto and Estanislao 1993). Even granting that this survey is credible, the only other evidence remains anecdotal. Meanwhile, the erosion in the collateral value of land has been looked into by Llanto and Dingcong (1994). They gathered data on borrowings by landowners and agrarian reform beneficiaries and using logit regression, concludes that the probability of being rationed does not depend on the size of agricultural land, which suggests that such property has lost its collateral value. However, the magnitude of the implied credit reduction is unclear.

Clarete (1992, as cited in Llanto and Estanislao 1993) has attempted to quantify the welfare losses arising from the loss of collateral value of land, using Computable General Equilibrium (CGE) methods. He estimates the productivity of farming and other primary sectors to fall by 4.7 percent and 3.7 percent respectively as a result of this effect. The annual decline comes to around P2 billion a year. These simulations are indicative of the orders of magnitude associated with these losses.
Some evidence on rising transaction cost has been gathered by Casuga (1994). Based on her sample of 64 formal sector creditors, she measured the transaction cost in 1986 (before CARP) as 4 centavos per peso loan for rural banks. Three years later (after one year of CARP implementation), the transaction cost grew to 9 cents per peso. However, she rightly cautioned against attributing this increase to the program.

Likewise, little can be said about the actual land use distortions inadvertently imposed by CARP. Land conversion, a hotly disputed issue in land use, does not appear to reach alarming proportions; approved conversions totaled only 1.2 percent of DAR coverage in 1997, and only 1.3 percent of total rice areas. Even taking into account illegal conversions, such behavior cannot on the whole be seen as endangering CARP objectives. Nevertheless, the future potential for expanded land conversion is a cause of concern, as 88 percent of municipalities lack a land use plan (Gordoncillo et al. 1998).

In sum, there is a mild confirmation of hypotheses 3 and 4 but no hard evidence regarding the gravity of the hypothesized welfare losses.

**CARP impacts on actual and potential beneficiaries**

To determine the impacts of CARP on actual and potential beneficiaries, this section examines issues of credit, capital accumulation and land access. As a prelude, the following reviews existing data on productivity and incomes.

**Production and earnings**

Yield comparisons by crop are presented in Table 6. The ARBs produced approximately the same yields as the average farmer. The only serious difference is the estimate for rice yield from the MODE Survey. Smaller surveys also suggest that yields of CARP-affected farmers are similar to national yields, for example, Geron (1994).

Table 7 presents the magnitude and sources of income. Poverty incidence of families among ARBs is over 60 percent. According to the

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<tbody>
<tr>
<td>Rice</td>
<td>2.9</td>
<td>2.8</td>
<td>2.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Corn</td>
<td>1.8</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
</tr>
<tr>
<td>Copra (annual)</td>
<td>1.2</td>
<td>1.3</td>
<td>1.2</td>
<td>1.4</td>
</tr>
</tbody>
</table>
MODE Survey, around 70 percent of respondents were poor (using a slightly higher poverty line than that employed in the PMES). Note though that, except for the PMES 3, surveys compute sample poverty using total household incomes, hence, requiring the imputation of a family poverty line (unadjusted for household size). These figures are higher than official figures on rural poverty of households (44.4% in 1997). The appropriate data that can be compared with that on ARBs are the poverty rates in agricultural households, for which no figures are available in 1997. Previous studies suggest that agricultural poverty is higher than rural poverty.\(^7\)

Income from farming accounts for less than half of total household income—a fact corroborated by three surveys conducted in the mid-1990s. Meanwhile, off-farm incomes accounts for only 5 percent to 10 percent of household income; nonfarm income accounts for a large share in earnings. The surveys covering 1996 show that over half of family income is from nonfarm sources. In the ARC Benchmark Survey, nonfarm incomes were apparently the source of inequalities as some of these are OCW remittances; in the PMES 2, however, the distribution of the share of nonfarm income in total income did not vary much across income deciles (Bravo and Pantoja 1999).

Household income figures, however, may not be fully comparable across surveys. Consider the net farm income per hectares (gross of rent): the MODE Survey has the figures P17,942 for rice, P6,892 for corn, and P3,830 for coconut. Contrast this with the corresponding PMES 3 estimates: 35,718

<table>
<thead>
<tr>
<th>Sources of income (%)</th>
<th>ARC 1993</th>
<th>MODE 1996</th>
<th>PMES 1994</th>
<th>PMES 1996</th>
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</thead>
<tbody>
<tr>
<td>Farm</td>
<td>51.939</td>
<td>46.6</td>
<td>47.9</td>
<td>42.8</td>
</tr>
<tr>
<td>Off-farm</td>
<td>54.5</td>
<td>71.7</td>
<td>-60</td>
<td>62.8</td>
</tr>
<tr>
<td>Nonfarm</td>
<td>8.9</td>
<td>4.9</td>
<td>5.5</td>
<td>2.7</td>
</tr>
</tbody>
</table>

Table 7. Income, poverty, and income sources of respondents by survey

\(^7\)If Balisacan’s (1997) calculations are extrapolated to estimate the divergence between national poverty and poverty among agricultural-dependent households, the resultant figure is closer (58.5%) to rural poverty of households.
pesos, 12,801 pesos, and 2,508 pesos, respectively. The divergences are perhaps too large to be accounted for simply by the profit edge of ARBs.

Credit

According to the MODE survey, 47 percent of respondents are dissavings. The PMES 3 reports that 54 percent of ARB respondents made borrowings, a figure close to the 56 percent of the MODE Survey. According to the latter, a greater proportion of ARBs and leaseholders are borrowers, compared to other respondents. Table 8 details the sources of credit. The PMES Surveys seem to show a large increase in credit access. This is due to the unusually low proportion of respondents (30%) who claimed to have borrowed in 1994.

Borrowing from formal sources appears quite limited. Instead, respondents who borrowed relied mostly on informal credit. Contrary to popular impression, moneylenders are not the main source of informal credit. Surveys show an important role played by credit coming from buyers (MODE) and suppliers (PMES 3). Credit sourced from buyers is probably an interlinked scheme while the credit from suppliers is probably trade credits from fertilizer, pesticide and seed dealers. Informal lenders demanded collateral only from a few of the borrowers (27%, according to the MODE Survey).

The PMES surveys contain data on ARB amortization compliance. A little more than a tenth of ARBs were irregularly paying amortization in 1994. By 1996, this proportion reached one-fifth of ARBs. While the survey

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<tr>
<td><strong>Formal sources</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooperative</td>
<td>6.9</td>
<td>7.6</td>
<td>6.4</td>
</tr>
<tr>
<td>Other formal sources</td>
<td>2.2</td>
<td>5.9</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Informal sources</strong></td>
<td>21.5</td>
<td>40.5</td>
<td>-</td>
</tr>
<tr>
<td>Traders</td>
<td>6.7</td>
<td>13.5</td>
<td>21</td>
</tr>
<tr>
<td>Input dealers</td>
<td>2.5</td>
<td>15.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Moneyleaders</td>
<td>6.9</td>
<td>6.5</td>
<td>5.5</td>
</tr>
<tr>
<td>Relatives and friends</td>
<td>5.3</td>
<td>15.7</td>
<td>11.4</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>2.7</td>
<td>6.7</td>
</tr>
</tbody>
</table>
rules out ARB default on a massive scale, no information is available regarding the severity of the default threat among irregular payers. Nor have any studies been conducted on the measures taken by Land Bank to deal with these cases, particularly with ARBs who ceased repayment (7% in 1994).

These data show that ARBs are no less productive than average small farmers and even slightly poorer than the typical agriculture-dependent household. There is a significant dependence on nonagricultural earnings, and there are indications that such dependence is growing. Many ARBs borrow, but mostly from the informal sector, where fixed asset collateral is seldom required. Note that the agrarian reform regulations preclude even full-fledged owners-beneficiaries from using the awarded land as collateral for at least ten years upon the awarding. Nor can government credit be expected to substantially offset this, given weak availment rates of cooperative credit, which is the main channel of such credit support.

The major question, of course, is whether CARP or agrarian reform in general positively affected productivity and income. The question cannot be answered using the available nationwide studies for two reasons: First, the issue of causation, which can be most effectively addressed by regression analysis, is not covered by any nationwide studies. Second, sampling frames differ across surveys, making intertemporal comparison difficult, if not impossible.

**Capital accumulation**

The panel study yields productivity and income trends that suggest improving households’ circumstances due to agrarian reform. Average household incomes in real terms rose by 46 percent between survey rounds; by 1998, average household expenditure was above the World Bank poverty line. There is, however, no trend found in terms of more diversity of income sources. Agriculture continues to provide the bulk of household earnings.

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8. Of course, regression analysis does not establish causation *per se* but can substantiate the magnitude of an assumed causation. Justification of the assumed causation requires appeal to principles or evidence other than the regression analysis itself.

9. An example of a pitfall in the use of these surveys can be seen in the report of Garilao (1998), which alleges that ARB income increased, by comparing average income of farmers from the Benchmark Survey (P47,884) and that of the ARBs from the PMES 2 Survey (P56,646). The comparison is obviously faulty given that only nominal incomes have been measured, and that any number of other factors may have led to an income change. In addition, it is difficult to compare households composed of affected farmers in a broad sense (Benchmark Survey) with ARBs in the narrow sense (PMES Survey).
This study used multivariate regression analysis to isolate the contribution of agrarian reform to the trends. The method consists of regressing (in differenced form) an outcome variable against household attributes, time trend and a reform beneficiary dummy. The study found that ARBs were able to provide education to their children as well as accumulate more assets. That is, agrarian reform increased investments in human and other capital. The magnitude of the welfare gains is significant by any standard, as land reform beneficiaries earn 30 percent more than the national per capita income.

This study explains these wealth effects based on the idea that an asset transfer lends to growth by encouraging investments and easing credit constraints. The study, however, gives no direct evidence regarding agrarian reform’s impact on credit.

Land access
Nationwide studies are largely silent about land access. Village surveys over the last two decades have on the other hand substantiated the notion that agrarian reform restricts access to land. The direct evidence takes the form of tenant eviction: this may have befallen one-fifth to one-half of tenants in Central Luzon and Panay, going by the findings of a survey of five villages conducted in 1986 (Otsuka 1991).

The emergence of permanent labor contracts is a persuasive circumstantial evidence regarding the decline of land access opportunities. A new kind of labor contract in Central Luzon, called the kasugpong, is probably substituting for the prohibited tenancy contracts (Hayami and Otsuka 1993). The proportion of permanent laborers versus landless workers in some Central Luzon villages has increased from virtually zero to around 30 percent by the 1980s, after two decades of PD 27 implementation. Under this permanent labor contract, a worker receives a fixed amount of paddy rice or a small proportion of harvest in exchange for services throughout the cropping season. However, by the fixed nature of the payment to these workers, labor requires constant supervision and is prone to shirking. In the Central Luzon farms, the residual profit from kasugpong farms is around a quarter below those of family-operated farms.

More direct evidence on the reform-land access link is given by the panel study. A nonparametric regression finds that ownership of land is strongly related with size of landholding, whereas under a healthy rental market no such relationship could be found. A parametric regression confirms that area cultivated is strongly affected by size of owned land. The welfare impact of restricted access could be substantial: the consumption of
the landless who later successfully gained land access was 30 percent greater than those who failed.

On the whole, the negative impact may well have exceeded the benefits of agrarian reform. Prohibitions on share tenancy as well as rent controls deny the landless the opportunity to rise in the "agricultural ladder." Adverse equity and efficiency consequences are expected to the extent that poverty is concentrated in this sector, as is the finding of income studies (Balisacan 1993; David and Otsuka 1994).

**Implications for policy**

If the hypotheses mentioned earlier hold for the Philippines, then the policy prescriptions for changing course in agrarian reform become clear. The experience of World Bank-supported land reform programs may be used to enumerate a set of broadly stated best practices (Deininger and Binswanger 1999). The World Bank policy agenda proposed in the mid-1970s were focused on the following desirable goals: owner-operation, active land markets and egalitarian asset distribution. Their merit has been largely confirmed over a quarter of a century. Add to this a few more hindsight/ideas. One is that land transfers should be accompanied by broader efforts to improve related markets and infrastructure. Another is that the reform process should take into account the considerable potential of markets for land rentals and sales in promoting land access and egalitarian land distribution.

Restrictions on tenancy and land markets must therefore be lifted (Otsuka 1999). A recommendation is to shift away from crudely coercing land distribution and toward the more subtle form of coercion, land taxes. Progressive taxes on land, and taxes on idle land are highly favored as relatively efficient instruments for indirect land redistribution (Hayami, Quisumbing and Adriano 1991). The revenue potential from progressive land taxes is respectable, judging from the CGE simulations of Habito (1989).

The administrative demands of levying such taxes are however daunting, particularly at the national level. First, landowners would be likely to misdeclare land ownership and quality. Second, land taxes encounter considerable coordinated opposition from landed interests, particularly when they see it as an pure tax burden, whereas the constituency for such taxes are poorly organized (Skinner 1993).

An emerging consensus on land reform is to back up tax instruments with "negotiated" solutions and implement in a decentralized fashion with reliance on beneficiary participation (Deininger 1999). This strategy is
counter to the "voluntary" nature prevailing in the CARP. Deininger et al. (1999) suggests that the opposition may be mitigated by tying revisions in the tax regime with the lifting of restrictions on land markets or even of ownership limits. While other analysts refrain from recommending a repeal of retention limits (as advocated by Hayami, Quisumbing and Adriano), there is a broad consensus among economic analysts regarding the "reform of land reform."

**Research issues: agrarian**

This summary recapitulates the general link between equity and growth in the Philippines as well as the impacts of agrarian reform on landowner investment and intended beneficiaries.

First, the positive relationship between land ownership equality and future growth is yet to be convincingly established from Philippine experience. It is a fact, however, that asset equality is positively related to future poverty reduction. Because of this and other considerations, there are good reasons to expect the posited relationship to hold. The requisite test is not too demanding; one only needs to conduct an analysis, perhaps on a regional level, and compare area growth rates with some measure of initial asset inequality. The available measure pertains to operational landholdings (available from the Census of Agriculture and Fisheries).

A more demanding but still feasible exercise may be to use as a measure the inequality of land ownership. It is possible to work on the existing DAR and Land Registration Authority records to assemble a database on recent land ownership patterns by region, and compare this with subsequent growth rates. In this vein, much work still needs to be done on the relationship between income inequality, local linkages and the growth of rural-based industries. Data from ARCs can help frame this particular thrust.

Second, evidence concerning foregone landowner investment due to agrarian reform remains little more than anecdotal. An intensive data gathering—from landowners, banks to other financial intermediaries—is recommended to quantify the investment losses attributed to agrarian reform. Preliminary efforts based on rapid appraisal methods will be a good start.

Third, there are yet no nationally valid evidence on the contribution of agrarian reform to incomes and assets of beneficiaries of private land redistribution. Data gathering should focus not merely on ARBs but rather on representative samples of the rural population; data should focus on production, income, credit, assets and education. If possible, impacts from various agrarian reform interventions should be isolated. Moreover, nationwide surveys of rural households should be undertaken repeatedly and consistently. The
past decade has seen several lost opportunities for a time-series study that tracks trends for beneficiaries and nonbeneficiaries.

Fourth, the implications of land market regulation on land access, equity and poverty should be quantified at the national level. Findings on land access trends based on village studies need to be integrated at the national level; this is a must since out-migration may conceal the magnitude of rental market suppression. Hence, these nationwide studies must be representative enough to include a sufficient proportion and number of the landless. The existing nationwide surveys nevertheless can be mined for further information, if not about trends, at least about the link between land access and ownership. Moreover, a well-rounded analysis should include those on agrarian contracts that may arise to circumvent the land market restrictions. Research should proceed beyond the already well-researched villages and provinces and into other informal rural markets all over the country.

Fifth, practically no work has been done regarding the productivity and welfare impacts of providing tenurial security to occupants of government and public lands. The gap in agrarian reform research is striking, given the concentration of land distribution accomplishment in government and public lands only. Research specifically intended at quantifying CARP impacts only (i.e., not the cumulative effects of all land programs undertaken in the country) should probably take this issue as a starting point.

Sixth, policy research may begin to seriously investigate tax-oriented, and otherwise noncoercive schemes for agrarian reform. While evidence on the harmful effects of current land reform efforts is yet to be finalized, the implementation roadblocks currently being encountered pose strong objections to the drive to complete CARP within its current set-up. Innovative approaches to rural land markets should now begin to draw the attention of policy analysts and policymakers.

Property rights reforms in fishery and forestry
There are three reasons why the current fishery and forestry use tends to lead to excessive extraction. The first two are static allocation problems, while the third refers to dynamic tradeoffs between current and future uses of a resource. The following incorporates standard textbook treatment of these issues (e.g., Johansen and Lofgren 1985).

Open access
Fishery and forestry resources are regarded as common pool resources (CPRs) that are subject to multiple use, difficulty in exclusion and rivalry in the extracted resource, i.e., fish catch or logs (Ostrom, Gardner and
Walker 1994). The problem of the "commons" (i.e., an open access problem) was pointed out in a seminal paper by Hardin (1968). Consider a resource stock that yields a homogenous harvest to users upon application of effort. Suppose the cost of each unit of effort and the price of the harvest are constant. Also assume the set of users is the industry, and industry effort is subject to diminishing marginal product. In the region of diminishing returns at the margin, average product exceeds marginal product and is falling.

Open access implies free entry; hence, equilibrium is reached when the marginal user earns zero profit. This implies equality between average product and marginal cost of effort. The optimum though is at the point where marginal product equals marginal cost. The equilibrium effort implies over-harvesting of the resource. A user is unable to take into account the external effect of his/her own effort on the harvest of others.

**Offsite services**

Natural resources such as forests provide a wide range of environmental services (watershed maintenance, erosion control, wildlife preservation, etc.). When forests are felled, the loss of these services involves a cost above that of the extractive activity itself (e.g., timber cutting and hauling). The extraction cost and offsite cost together comprise the social cost. A private sector firm will extract timber until the marginal cost of extraction equals the unit value of the timber. Since social optimum involves equality of the unit value of the timber with the marginal social cost, the private firm’s equilibrium involves excessive extraction. Take for instance a logging company’s decision that does not consider the costs imposed by downstream siltation of lakes and reservoirs; here, too little forest cover in the end will be maintained.

**Intergenerational concerns**

The foregoing discussions refer to externalities imposed by a user on other current users. There is still a different type of externality imputed to future users. This is the concept of *sustainability*. Consider once again a given resource that yields a homogenous harvest. To isolate the intergenerational aspect of the exploitation problem, consider the case of a privately-owned resource, where extraction involves no offsite costs.

Let the discount rate be \( r \). Various stock levels of the resource are possible, ranging from the minimum threshold to the maximum carrying capacity. Below the threshold, the population declines to zero; beyond the carrying capacity, the stock will also tend to decline. In between the threshold
and the carrying capacity, the stock grows. The growth rate at first increases with the stock level, then decreases to zero as it approaches the carrying capacity.

At equilibrium, the harvest equals the growth rate; hence, the resource stock remains constant. The equilibrium stock is that level where the (positive) change in growth rate equals the discount rate. If the discount rate increases, the equilibrium stock falls (so as to realize greater changes in the growth rate). It is quite possible for the discount rate to be sufficiently high such that the short-term equilibrium stock is set below the threshold level—implying complete extraction of the resource in the long run.

The problem with the equilibrium solution is that the value of the resource and the discount rate are set only by the current generation. Compared to valuation that represents scenarios for future generations of users, the harvest price may be too low or the discount rate too high. The problem becomes more stark when long-run equilibrium entails extinction of a species; the willingness to pay of future generations for some positive population is not captured by the market.

### Regimes for reducing exploitation

#### Regulation and taxation instruments

To correct these externalities, the country should find a cost-effective means of limiting extraction. The most direct method is command and control. However the geographic sprawl of the CPRs as well as the transportation costs have, in many countries, rendered this instrument largely ineffective (Hyde et al. 1996). Another means is to impose harvest fees or taxes. If set at the right rates, taxes and fees can lead to a complete internalization of costs, although their implementation costs may be high or prohibitive.

#### Private (individual) land rights

A recent alternative policy is the promotion of property regimes in CPRs. One option is to confer use rights to individuals. Such an option is feasible for forestland, where numerous titling or other tenure programs have been undertaken in developing countries. (It should be noted that, even in theory, conferment of use rights can be effective only against the open access problem. It cannot be regarded as a means to adequately account for offsite externalities.)

In practice, establishing private property arrangements must contend with the costs of enforcement. The evolutionary theory predicts that, where benefits of internalization exceed costs, private property rights will evolve. The absence of such conditions is prima facie evidence that private property
arrangements are too costly. Forest products have low value as well as low marginal extraction cost, whereas the cost of limiting access even for a private landholder is typically large (Hyde et al. 1996).

Tenurial programs are often coupled with agro forestry projects. In the framework of the evolutionary theory, this is to raise "the benefits of internalization." Internalization of costs can be facilitated by extension efforts and subsidies packaged as conservation programs. So will a titling program.

Successful cost internalization projects suggest that profitability is a critical element; quicker gestation projects are favored by farmers as well. Thus, tenurial security promotes investment and innovation. Interestingly, the greatest threat to security comes from government regulation (Current et al. 1995). For instance, logging restrictions can effectively nullify tenurial arrangements and reduce the incentive to protect the property rights.

Ironically, even if private property rights can be effectively enforced, land titling programs (or even the expectation of such programs) may actually hasten deforestation. The perverse possibility arises because occupancy is usually the criterion for obtaining a title—hence, providing an incentive to undertake clearing activities (Angelsen 1999).

Common property
The third option for CPR management is to promote common (in contrast to private) property arrangements. The durability of common property arrangements, some of them rooted in ancient tradition, has motivated numerous attempts to analyze their effectiveness in resource management. At the simplest level, communal arrangements realize economies of scale in protection activities. In terms of production, however, individual rights are typically bestowed on the basis of land clearing and occupancy. Hence, customary tenure is not exactly inimical to commercial activities such as agro forestry (Otsuka 1998). Collective production is not a common feature of communal arrangements, contrary to popular belief; rather, such arrangements provide public goods, enhance equity, undertake risk-reduction or help break seasonal labor bottlenecks (Deininger and Feder 1998).

Factors conducive for a group to govern its members effectively have been compiled in a famous list by Ostrom (1994), which is based on a wide range of case studies. These factors are:

1. exclusion of nonmembers from the resource;
2. appropriateness to local conditions;
(3) membership participation in rule setting;
(4) accountability in monitoring;
(5) application of graduated sanctions;
(6) presence of low-cost conflict resolution mechanisms;
(7) recognition by the formal authority; and
(8) nesting of cooperative groups in large organizations.

Meanwhile a formal approach typically employs game theory. Common property arrangements are interpreted as a cooperative equilibrium achieved by the players. The more appealing models employ repeated interaction, where the central idea is that exclusion from future benefits can lead to noncooperative behavior. For cooperative equilibrium to be possible, the player must perceive the number of interactions to be indefinite, retaliation from other members credible, and the future sufficiently important (Seabright 1993). Unfortunately, as expressed in the Folk Theorem, cooperative behavior is not the only possible equilibrium. Nor is it clear that a cooperative equilibrium is robust to environmental and group change.

One extension of the theory of cooperation is to examine the role of history in the evolution of social norms. Sethi and Samanathan (1996) describes the development of social norms as the evolution of strategies in terms of "replicator dynamics." Strategies are increasingly adopted when their payoffs yield more than the average payoffs. They find that norms of restraint and punishment can be stable, even against the entry of narrowly self-interested players.

Another related theory recognizes that communal arrangements need not fit into a cooperative/noncooperative dichotomy; rather, a wide range of success in various aspects of resource management are possible. McCarthy, de Janvry and Sadoulet (1998) regard cooperation as a matter of degree and subject to variable costs. Their model provides a flexible framework for identifying factors that raise or reduce the equilibrium degree of cooperation.

Programs and reforms in the forestry and fishery sectors
The DENR takes the lead in administering programs and implementing policies for the natural resource sector. For forestry, extraction is regulated under Timber Licensing Agreements. The agency is also implementing several programs to address forest denudation as well as upland poverty. the CARP, too, already has tenure programs in forest land, referred to as
the Integrated Social Forestry Program. Beneficiaries of this program are issued nontransferable Certificates of Stewardship to provide them security of tenure. The oversight of the projects has been mostly devolved to the LGUs since 1991.

The Community Forestry Program, meanwhile, assigns forest protection and management to organized communities. The privilege to use and sell forest products is formalized in a 25-year Community Forest Management Agreement. By 1997, there were 66 such agreements covering 173,298 hectares of land. Other community-based programs are the Forest Land Management Program (covering reforested areas) and the Regional Resources Management Program.

For fisheries, legislation has been consolidated in the Philippine Fisheries Code of 1998. The other important laws are the Local Government Code (LGC) of 1991, and the Agriculture and Fisheries Modernization Act (AFMA) of 1997. The LGC defined the scope of municipal fisheries to cover waters up to 15 kilometers from the coast. Boats above three tons (which are classified as commercial vessels) are not allowed to fish in these areas. It also expanded the authority of LGUs in administering these areas.

The municipal authority was empowered to enforce fishery laws, license municipal fishers, grant privileges to organized fishers in constructing immobile gears and regulate local waters. Meanwhile commercial waters remain the responsibility of the national government, specifically the Bureau of Fisheries and Aquatic Resources.

The Fisheries Code as well as the AFMA explicitly expressed the principle of sustainable development in the management of agricultural and fishery resource (Israel and Roque 1999). For commercial waters, licensing and fishing permits are supposed to reflect resource rents as well as regulate harvests to the maximum sustainable yield level. The code also enumerated various sanctions on illegal fishing gear, exploitation of sensitive resources, catch limits, restricted fish species, etc.

**Evaluation studies for the Philippines**

**Incentives and environmental degradation**

Forest denudation in the country is typically associated with upland migration; estimates of upland population range from one-tenth to one-third of the total population. This suggests "push" factors, given declining person-land ratios and nonfarm employment opportunities in the lowlands (Cruz and Repetto 1992). Upland dwellers as well as coastal fishermen comprise some of the poorest sectors in the country, with subsistence
activities being the norm. Upland poverty itself is sometimes thought to be a contributor to unsustainable land use practices. This notion is, however, not empirically substantiated (Grepperud 1997).

Coxhead and Rola (1998) find that "pull" factors in the form of price incentives are also important, particularly for the spread of erosive farming. Lack of access to credit constrains the adoption of conservation measures. Increasing access to credit has, however, an ambiguous impact on soil erosion as land clearing is also positively related with credit access.

For the fisheries sector, Israel (1997) found that virtually open access regime in commercial waters resulted in fishing effort far in excess of that required for either maximum economic yield or for maximum sustainable yield. In 1994, fishing efforts should have been reduced by about 12 percent to attain the maximum sustainable yield or by nearly half (45%) to attain the maximum economic yield.

Environmental taxes and subsidies
Environmental observers agree that extraction charges are too low, given the rents earned. In the case of forestry, an early calculation (de los Angeles 1989) found that charges extract less than a tenth of resource rent. For fisheries, large resource rents are likewise being earned but the fees have not been adjusted since the early 1980s (Israel and Roque 1998). However, fee increases may meet strong political opposition; Elazegui and Paunlagui (1999) cite an example of a municipality which could not raise fees due to vehement local objections.

Government programs to promote sustainable technology also promote adoption of conservation measures. Adoption rates among cooperators in the Central Visayas Regional Project are higher than that among noncooperators. Moreover, the degree of participation is positively related to the adoption choice. Incomes of cooperators are also shown to be higher than incomes of noncooperators. The former has also increased faster over the program’s eight-year implementation (Francisco 1994).

Tenurial security and property rights
De los Angeles (1994) claims that the link between upland conservation and property rights is "no longer debatable." She cites studies which found that the extent and pace of adoption of conservation measures differ between CSC holders and non-CSC holders. Coxhead and Rola (1998) confirm that less secure tenure in the uplands is associated with the adoption of erosive farming.
As mentioned earlier, tenurial security may be undermined by government regulation. The threat of imposing a total log ban casts a veil of uncertainty over upland property rights arrangements. Most likely, given the enforcement costs, elimination of formal rights will lead to informal encroachment. The *de facto* open access state may therefore reassert itself. Extreme logging restrictions may unintentionally promote forest destruction (de los Angeles and Oliva 1996).

**Promotion of community-based management**

Building community organizations is an important factor in the adoption of agro forestry schemes (Francisco 1994). The promotion of *co-management* (where the State retains ownership of the resource but users also undertake resource management) in fisheries is currently an active research area of the WorldFish Center (formerly the International Center for Living Aquatic Resources Management, or ICLARM). Among the Asian countries considered (Philippines, Vietnam, Thailand, Malaysia, Indonesia and Bangladesh), the Philippines was singled out as having the most experience with community-based management of coastal resources as well as the strongest set of supporting policies and laws.

These studies evaluated the ingredients for sustainable common property arrangements, identified by Ostrom (1990, 1994). As listed in Pomeroy, Katon and Harkes (1999), these are:

1. clearly defined boundaries;
2. clearly defined membership;
3. group cohesion;
4. existing organization;
5. positive net benefits from the member’s viewpoint;
6. participation by those affected;
7. enforcement of management rules;
8. legal rights to organize;
9. community level cooperation and leadership;
10. decentralization and delegation of authority; and
11. coordination between government and community.

Among these, those of "high importance" are numbers 1, 2, 5, 6, 7 and 9. To illustrate: in San Salvador and in Malalison Island in the Philippines, the marine sanctuary was clearly demarcated with buoys. All members of the fisher organization were involved in making and changing the rules. The NGOs devote much time and effort in educating fishers
about the benefits and costs of comanagement. Comanagement was more successful in communities where fishers had positive attitudes toward collective action, and where a strong local leadership was present.

Studies that quantify the benefits and costs of co-management are, however, sparse. Katon et al. (1997) analyzed beneficiary perception of the quality of life improvements in Cogtong Bay, Central Visayas. Comanagement in this area began in 1989, when the national and municipal government, together with local fishers, established a regime of coastal resource management. The comanagement project was found to be successful in promoting positive and statistically significant changes in its performance indicators, except for the household income indicator. Not surprisingly, the most significant changes were observed for indicators related to "empowerment."

As for the cost side, a study by Abdullah et al. (1997) measured the transaction costs of a fishery comanagement project. This study categorized transaction cost as either information, collective decision-making or operational costs. The following are the results of the study (in pesos):

<table>
<thead>
<tr>
<th></th>
<th>Years 1-2</th>
<th>Years 3-4</th>
<th>Years 5-8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comanagement</td>
<td>1,547,272</td>
<td>1,113,250</td>
<td>1,200,200</td>
</tr>
<tr>
<td>Centralized manag</td>
<td>446,895</td>
<td>467,542</td>
<td>2,830,847</td>
</tr>
</tbody>
</table>

Figures on centralized management are derived from key informant interviews and other studies. Its total cost is slightly lower than that of co-management (P3.86 million versus P3.74 million). However, the bulk of the transaction cost of comanagement take the form of initial startup costs.

It may be conjectured that comanagement more than compensates these initial costs by requiring lower outlays in later years. Enforcement costs may eventually be lower as community members are more likely to comply with rules formed under participation, than with rules that are externally imposed.

Research issues: fisheries and forestry

The research issues for CPRs can be divided into three broad categories, namely: the link between property rights and environmental degradation; the transaction costs of establishing property rights; and the appropriate set of instruments, in combination with the property rights regime, for managing CPRs.
The link between conservation practices and tenurial security is well established. What is unclear is whether the promotion of formal individual rights under conventional programs contribute significantly to the control of environmental degradation. Of special concern is whether perverse incentives for land clearing and migration might be created by tenure programs.

Except for a few studies on fishery comanagement, there are no estimates available regarding the benefits as well as costs of establishing property rights regimes. More work needs to be done in this area, especially in terms of evaluating and comparing alternative regimes. Emphasis should be both on generating concrete figures over time for particular cases so as to obtain an idea about orders of magnitude as well as relating costs over time to the locality’s social and physical environment. An interesting hypothesis for research is that community-based management—when compared to centralized management—involves large initial investment but low recurring costs.

Finally, research should also examine further the appropriate combination of other interventions with the promotion of property rights. Consider pricing issues: a criticism is that fees collected for logging concessions and commercial fishing licenses are too low to capture resource rents. The appropriate level and structure of fees as well the system of fee setting are yet to be specified. Further studies should therefore focus on the appropriate level of fees and process of adjustment.

Also, as the Fisheries Code includes a very limited provision on market-based instruments, analysis of policies in this direction will be a valuable input to future legislation. To date, studies that focus on the increasing role of markets in the tenurial and access schemes are a controversial yet poorly-researched area.

The devolution of oversight functions over the ISF Program as well as of municipal waters presents another important issue. While most observers approve the general intent of the Local Government Code, research on the benefits of the changing of hands on uplands and coastal resource management is yet to be rigorously studied. As most recommendations center on improving the capacity of local governments to undertake the environmental protection, research on governance should specifically focus on capacity-building proposals.

**Conclusion**

The agriculture and natural resource sectors in the Philippines have undergone extensive property rights reforms, particularly from the late 1980s.
Recent literature on property rights is replete with empirical evidence across countries and over time, on both favorable and unfavorable efficiency impacts of such reforms. Some carry hypotheses on equity and sustainability and on links between efficiency and equity.

Unfortunately in the case of Philippine agriculture, much of these hypotheses have yet to be established. Findings of past studies are mostly based on case studies, where their applicability over a bigger locality is inconclusive. Greater effort should be directed to achieving wider generality.

Also, nationwide studies for agrarian reform do not permit time-series comparisons. Nor do they address large coverage areas for reform such as occupants of public and government lands. Though opportunities have clearly been missed, these are part of a rich potential for further research. The very slow reform implementation itself consequently permits extended comparisons between beneficiaries and nonbeneficiaries, which is essential for any statistical analysis of causation.

While the literature has indeed burgeoned over time, the absence of a concerted, systematic research aimed at gathering evidence, tracking changes over time, and testing hypothesis arising from a coherent framework is regrettable but not irreparable. By paying heed to what is known and not known about the impacts of property rights reform, further research work can bridge the gap within this decade.
Appendix

The survey frames of the major data sets

The Benchmark Survey, covering crop year 1989-1990, was aimed at providing a basis for comparing the progress of agrarian reform at the farm and household level. Over 8,000 households were drawn from 400 barangays out of 41 provinces having the highest proportions of lands subject to CARP. Sample selection was also stratified by ecological zone (i.e., upland, lowland and coastal zones).

The Benchmark Survey of ARCs, like the Benchmark Survey, included both ARBs and non-ARBs among the respondents. Data pertained to crop year 1993-1994. This survey covered 61 ARCs with 3,656 respondents (approximately 60 each ARB). Within each ARC, barangays were stratified by ecological zone when possible. Selection of ARBs and nonbeneficiaries was done by proportional sampling.

The MODE Impact of Agrarian Reform survey (henceforth the MODE survey) consisted of interviews of a subset of respondents (around 1,500 in all) from the Benchmark survey. Its sampling design hewed closely to that of the Benchmark Survey. Unfortunately, the survey instrument diverged greatly from that used in the Benchmark survey, making the usefulness of the MODE survey for longitudinal comparison limited.

The sample design of PMES was also based on the Benchmark Survey, but its coverage was limited to ARBs under DAR jurisdiction. Phase 2 was a pilot test of the PMES covering 3,411 ARB respondents from 20 provinces. Selection of provinces applied island group stratification (Luzon, Visayas and Mindanao) and size stratification (large and small provinces).

Meanwhile Phase 3 is yet to be finalized, although summary findings are available. This survey is distinguished by its validity for regional analysis as well as its inclusion of ARCs as a distinct domain. The ARBs are first stratified in terms of residence or non-residence in an ARC. The selection of ARC barangays from each included province is based on categories of LAD accomplishment. For non-ARC residents, selection from each included province is based on a subset of municipalities, followed by a subset of barangays and finally a subset of ARBs in the barangay.
Finally, the longitudinal study of Deiniger et al. (1999) utilized villages that had been surveyed by the International Rice Research Institute as well as the International Food Policy Research Institute in 1985, 1989 and 1998. The 1989 survey was able to collect information on inheritances, assets and the history of land transactions. Five villages were covered: two in Central Luzon and three in Panay island. In each area, the sample included one village with irrigated rice land and a favorable agro climatic environment, as well as one village with rainfed production combined with supplemental irrigation. The fifth village (in Panay) had an unfavorable upland environment.
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The agricultural sector is one of the most studied areas in Philippine history. Admittedly, much is yet to be achieved to ensure food security and sustainable competitiveness. However, findings and recommendations from past researches have not been fully utilized. Neither have current programs undergone regular analyses and intensive evaluation.

This book focuses on the field of resource management and sustainability that is critical to agricultural management practices and development. It also gives premium to the institutional issues in the areas of property rights, land, water, fishery, and forestry, including an evaluation of the Comprehensive Agrarian Reform Program (CARP) and other tenure-related government programs. Certainly, the four main papers in this book are significant in that they present the strategies for the policy, regulatory and institutional frameworks crucial not only in promoting but also in enforcing efficient, effective, equitable and sustainable agricultural growth for the country.