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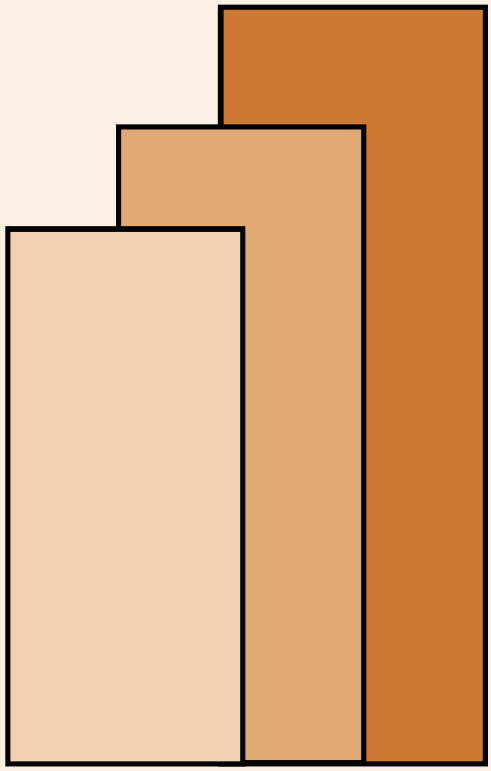
Saturnina C. Halos

DISCUSSION PAPER SERIES NO. 99-18



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PHILIPPINE INSTITUTE FOR DEVELOPMENT STUDIES
AND THE
DEPARTMENT OF BUDGET AND MANAGEMENT

AGRICULTURAL TECHNOLOGY ACQUISITION, DEVELOPMENT AND DISSEMINATION IN THE PRIVATE SECTOR
(FINAL REPORT)

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AGRICULTURAL TECHNOLOGY ACQUISITION, DEVELOPMENT AND DISSEMINATION IN THE PRIVATE SECTOR

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Summary

This study is an attempt to characterize agricultural technology acquisition, development and dissemination in the private sector. The results were based on data available from relevant government offices and results of a survey and interviews. The survey is limited. Of fifty private organizations claiming to undertake R & D activities, only 10 agreed to participate in the survey. Interviews were also conducted with the same number of former and current employees as well consultants to agricultural firms. Other firms were reluctant to participate in the survey citing time constraints and need to protect proprietary information. The research programs of two foundations, one established by the coconut industry and the other by the sugar industry are studied in more detail as they represent contrasting approaches to R & D program formulation and management.

Many extensively used agricultural technologies such as pesticides, growth regulators, fertilizers, feed formula, vaccines, therapeutics, seeds, chicken strains, hog breeds, farm implements, processing methods for crops and livestock and processing machineries are introduced. The major technology source is the United States. It has the most number of patents and supplies the highest number of available chicken strains, hog breeds and vegetable varieties imported into the country. These technologies are introduced either through established subsidiaries of multinational companies, joint venture agreements, technology transfer tie-ups or outright sale. Sale of technology often accompanies free information on other aspects of production.

R & D is market-driven. Most agricultural research and development activities are adaptive in nature and are associated with the introduction of new technology. The major purpose of the R & D is the fine tuning of the imported technology to suit local conditions in terms of technical efficiency, affordability and cultural acceptance,

thereby assuring/expanding/maintaining a market. Furthermore, since the R & D is specific to the particular technology, any advantage is gained exclusively by the seller and user of the technology. Most R & D are therefore undertaken by firms that sell or use foreign-developed technologies such as agrichemical companies, animal breeders, poultry integrators, and others mentioned above. Most firms do not maintain a separate R & D division but some of the production or marketing staff double as researchers. While some maintain their own laboratories and research stations, some depend upon researchers and facilities in the public sector. In agrichemical registration especially, the guidelines stipulate that data about the product should be gathered by accredited public institutions.

R & D is seldom undertaken to locally develop new technologies that opens up new business opportunities. One small company has ventured into this approach but this could be due to the fact that the founders were trained in developing the appropriate technology. Accordingly, the technology development took about 15 years using whatever resources was available to them. This company has for the past few years been a regular supplier of a supermarket chain. The technology is kept from the public eye and plant visits are highly restricted. A foundation established by a group of companies in hog breeding and rearing is developing modern hog raising method for small growers.

The contrast in the approach of developing and managing a R& D agenda by the coconut research foundation and the sugar research foundation bears watching. Whereas the latter is intent on accessing and rapidly developing new technology of immediate use to sugar farmers, the other is engaged in a technical survey of possible novel processes for the coconut. Also, the coconut foundation has established its own research facilities and hired full time research staff whereas the sugar foundation has resolved to remain a funding and policy making body with a very lean administrative staff. The sugar foundation has established linkages with existing research institutions to carry out the research program and is providing common facilities for the dissemination of new technologies to mill district development committees. The sugar foundation thus see the need to strengthen the capability of the public sector to undertake research.

The data on research expenditures is very limited. However, other indications suggests that there has been a considerable reduction in R & D investments. Notable is the contraction of R & D personnel of multinational pesticide companies. The exceptions are in the sugar and coconut industries where research funds have been mandated by government.

Introduction

The private sector is the major source of novel agricultural technology. Commercial production systems for banana, poultry, hog and recently cutflowers have all been introduced by private firms and so are production tools such as pesticides and agricultural machineries. The introduction of these technologies often require adaptive research. As of 1986, research in the private sector accounted for about 36% of total research expenditure in the country (Pray, 1986), 50% of this having been spent by multinational companies. Major research activities include plant breeding (hybrid corn with downy mildew resistance, selections of cocoa, sugarcane, rubber, coconut), pesticide research (bioefficacy of new chemicals and process innovations to adapt domestic production to local input supply), agricultural machinery innovations and animal feed and husbandry. Five factors were cited as responsible for this growth of private sector investment (Umali, 1990). One, expanding markets increased the demand for the products of the input, seed, plantation and livestock sectors which subsequently spurred research into technologies that would increase productivity. Two, agriculttural research by the government, private foundations led to methods of controlling a major corn disease which led to private corn breeding programs. Three, presence of agricultural scientists enabled companies to use local staff rather than expatriates thereby further research costs. Four, a strong patent system allowed firms to retain exclusive rights to their research output. And five, the government pursued a series of policies which strengthened private sector incentives to invest in agricultural research.

In the US, private sector investments in agricultural research is increasing. As of 1992, about 60% of the US$ 6,329 expenditure in agricultural research was spent by the private sector (Fuglie, et al. 1996). One major reason cited is the policy that allows patenting of life forms developed through biotechnology.

This study was done in conjunction with a study on public expenditures in agricultural research. It attempted to characterize agricultural technology acquisition, development and dissemination in the private sector. The results were based on data available from relevant government offices and results of a survey and interviews.

Survey results obtained for actual research expenditure was too limited and was not included.

The private sector as source of agricultural technologies

The provision of technologies for agricultural production, postharvest treatment and primary processing is a major industry in the Philippines. These technologies include pesticides, growth regulators, fertilizers, feed formula, vaccines, therapeutics, chicken strains, hog breeds, seeds, farm implements, processing methods for crops and livestock and processing machineries. Majority of these technologies are introduced. These technologies are brought into the country either through the establishment of a subsidiary by a multinational company, as part of a joint venture in production, through technology transfer tie-ups or outright sale. Few technologies are developed locally.

The monopoly of the imported technology is protected either inherently and by patents. Technologies such as pesticides, growth regulators, fertilizers, feed formula, vaccines, therapeutics, implements and process and machineries are covered by patents. More than 73% of patents granted between 1948 - 1995 covered the active ingredient, formula and manufacture of agricultural chemicals (Table 1).

Table 1. Patented agricultural technologies [1]

	1948-65		1970-79		1980-89		1990-95		Total	
	F	L	F	L	F	L	F	L	F	L
Agrichemicals[2]	48	3	613	9	811	4	184	8	1656	24
Agricultural gadgets / machineries	17	59	81	47	62	10	6	14	166	130
Animal husbandry[3]	18	7	118	1	10	1	0	0	146	9
Agroprocessing[4]66	31	118	33	68	4	34	12	286	80	
Total	149	100	930	90	951	19	224	34	2254	243

[1] F- foreign, L- local, [2]Pesticides, growth regulators, fertilizers; [3]Feed formula, vaccines, therapeutics, implements; [4] Manufacturing process and machineries Source: Bureau of Patents

Majority of patent holders of agricultural technologies are foreign companies whereas locally owned patents are wholly owned by individuals. Hence, the low proportion of Filipino-owned patents indicates the low level of research and development among Filipino-owned firms. On the other hand, some have expressed

mistrust on the patenting system. Some inventors have claimed that an application for patenting opens their invention to copying before their patents could be granted.

Most patents awarded to Filipinos are in agricultural machineries and gadgets indicating that most innovative activities are in this area. These are mostly utility patents providing a 7 year protection to improvements of an existing technology. This could be due to a shorter period and thus lower cost of development of such improvements.

There has been a slackening of patenting from 1990 across all technologies. This could be due to mergers and restructuring of transnationals, new directions in technology generation and crop production brought about by the novel, *in vitro* methods of crop manipulation (biotechnology) and concern for the environment. In crop protection, the same multinational companies selling pesticides are developing novel pest resistant crops through biotechnology. Pesticidal genes and/or crops could eventually replace chemical pesticides as the marketable technology. These genes and the method of developing the new crop or variety are being patented in developed countries. A very generalized method for breeding (haploid and doubled haploid angiosperms) has been granted a patent to a foreign company in the Philippines in 1989.

A look at about half of the patent holders from 1948-95 show that about 82% of patent-holders are based in the USA, Germany or Japan with 38% based in the USA (Table 2). This however represent the few companies that hold multiple patents especially on agrichemicals. These same companies established subsidiaries in the country.

Table 2. Country origin of patent holders[1] (1948-95)

Country	Agrichemicals	Machineries	Animal husbandry	Processing	Total
USA	413	17	4	40	474 (38%)
Germany	275	4	1	11	291 (24%)
Japan	197	36	0	17	250 (20%)
United Kingdom	78	1	0	8	87 (7%)

Holland	38	1	0	2	41 (3%)
France	35	0	0	4	39
China	17	1	0	0	18
Italy	6	1	0	1	8
Australia	6	0	0	0	6
Switzerland	6	0	0	0	6

[1]Hungary, New Zealand, Panama with one patent holder each; Source: Bureau of Patents

In animal husbandry, the new systems of production have inherent capacities for protection. Chicken strains and hog breeds imported into the country can not be developed by local breeders because the parentals needed to develop the strains or breeds are kept by the exporting entity. Small hog raisers can not breed their own stock mainly due to the huge capital costs (A minimum of P10 Million has been cited.) needed to set up individual breeding farms and thus must rely on local commercial breeding farms. On the other hand, most accompanying technologies for poultry and hog production require sophisticated infrastructure for mass production. Imported feed formula includes veterinary products also developed and produced in an industrial scale by the patentee.

All commercially grown poultry and hog breeds are imported (Table 3). Chicken strains are imported from 14 countries and hog breeds from 8 countries. There are 28 chicken strains grown in the Philippines in 1994-97. Most of these strains (11 out of 28 strains) originally came from the USA. Some of these are produced in Thailand, Malaysia and Taiwan (Table 4). These latter became major suppliers of chicken breeds during the past few years. There are 19 hog breeds grown between 1994-1997 (Table 5). Similarly, most of these are from the USA.

Table 3. Importation of commercial poultry and hog breeds for production purposes (No. of heads) by country of origin (1994-97)

Country	Chicken	Hog
Australia	0	3,072
Belgium	0	2,313
Canada	116,000	398
Denmark	30,000	0
France	84,000	195
Germany	62,000	0
Ireland	78,000	408

Israel	86,000	0
Korea	29,000	0
Malaysia	711,000	0
Netherlands	400,000	0
New Zealand	35,000	0
Taiwan	560,000	170
Thailand	331,000	0
United Kingdom	732,000	1,001
United States	1,112,000	1,029

Source: Bureau of Animal Industry, Animal Health Division

Table 4. Country source of chicken strains commercially grown in the Philippines

Strain/breed	Country source
Anak, Anak 2000	Israel
Arbor Acres	Thailand, United Kingdom, USA
Avian	United Kingdom, Malaysia, Netherlands, Thailand, USA Korea
Babcock	USA
B300	USA
Cobb	USA, United Kingdom, New Zealand, Denmark, Netherlands
Cobb-Vantress	United Kingdom, USA
DeKalb XL	Thailand
DeKalb-Beta	USA
H & N Nick Chick	USA
Hubbard	Taiwan, Netherlands, United Kingdom, USA
Hybro	Ireland, Netherlands
Hybro G	Netherlands
Hyline	USA
Isa Color/Isa 30	France
Isa-Vedette/ Vedette	France
Lohmann	Germany
Kabir	Israel
Peterson	Malaysia, Taiwan, Thailand, United Kingdom, USA, Korea
Peterson Avian	Malaysia, Taiwan
Peterson/Hubbard	Taiwan
Pilch	Malaysia, Netherlands
Ross	United Kingdom, Taiwan, USA
Ross 208	United Kingdom, Taiwan
Starbro	Canada, France
Shaver Starbro	Canada
Shaver Starcross	Canada
Vedette	France

Source: Bureau of Animal Industry, Animal Health Division

Table 5. Country source of hog breeds commercially grown in the Philippines

Breed	Country source
Babcock	USA
Dalland	France

Duroc	Canada
Duroc/Yorkshire	USA
D/Y/L	USA
Landrace	Canada
Large White	France, Ireland, United Kingdom
LR/LW/D	Belgium
L/L Hybrid	Australia
L/L/H	Australia
L/L/Hyson	Ireland
L/L/D/Pacher	Belgium,Australia
L/L/Pietrain	Belgium, Ireland
Large White/Landrace	France, Belgium, Ireland, UK, USA, Australia
Pietrain/Landrace	Belgium
Pot Belly Pig	USA
Seghers	Belgium, Netherlands
Yorkshire	Canada,
Yorkshire/Hampshire	USA

Source: Bureau of Animal Industry, Animal Health Division

There are 322 registered feedmills in 1997 (Table 6) of which 75% (242) are located in Central Luzon (82), Southern Tagalog (81) and the National Capital Region (79). Of the 311 that indicated their milling capacities, about 76% are small with capacities of 1-10 tons per day, 11-30 tons per day and 31-50 tons per day. Only 2 mills registered capacities of more than 1,000 tons per day, one in Pangasinan (San Miguel Foods) and the other in Bulacan (Vitarich). However, in terms of presence throughout the country and total milling capacity, Swift Foods has feedmills in 10 regions and a total capacity of about 1,500 tons per day. San Miguel on the other hand has 11 plants producing its brand (B-Meg) through franchising.

Table 6. Number of feedmills according to production capacity (tons/day)

Size	Number of mills
1-10	109
11-30	84
31-50	45
51-100	38
101-200	22
201-500	9
601-800	2
>1,000	2
Total	311

Source: BAI, Livestock Development Council, DA

Automated feed mills are imported systems introduced either as a subsidiary of a foreign feeds company or through a technology transfer tie-up. Feedmills are either owned by single families/individuals, cooperatives or public corporations. All registered feedmills are required to have a consultant who serves as one source of technology and innovations. Hence, in addition to the availability of locally fabricated feed milling components, this allowed for the wide variation in size and spread of the technology in the country. Only 272 mills indicated their dates of first registration. According to this record, the earliest feedmill registered in 1959 is the Vigo Feeds Milling Corp with a capacity of 10 tons per day (Table 7), the smallest mill built before 1970. Most feedmills are relatively new having been built after 1990 and those built after 1980 were the smaller sizes (<30 tons/day). This trend coincided with the availability of credit facilities, locally assembled small mills and mixers, and locally available raw materials.

Table 7. Feedmills classified into their milling capacities (tons/day) and year first registered with the Bureau of Animal Industry

Year first registered	1-10	11-30	31-50	51-100	101-200	201-500	601-800	>1000
Before 1970	1	4	2	3	0	1	1	1
1971-80	2	5	8	5	5	3	0	0
1981-90	31	6	14	15	7	2	0	0
1991-date	69	41	18	15	8	3	1	1

BAI, Livestock Development Council, DA 1997

It has been said that the best extension worker is the agrichemical supplier who provide not only advice on the use of his product but also on other farm practices. Similarly, animal husbandry suppliers usually provide free technical advice in areas where their products would sell. An importer for hog/poultry husbandry gadgets and equipments may provide for free the design for housing. An integrator provides free technical assistance for all the information in management from housing to health care in exchange for buying the inputs from them and for assurance of continuous supply of poultry.

Seeds of mostly semi-temperate vegetables are imported from 17 countries with majority being supplied by Japan, Thailand, Vietnam and mostly USA. (Table 8).

Table 8. Vegetable seed importation (kgs.) 1993-97

Species	Weight	Country source
Onions	79,510	USA*, Israel, Italy, South Africa
Carrot	26,692	USA, Japan*, Australia, Netherlands, Germany
Pepper	17,420	Vietnam*, USA, Japan, Taiwan, Australia, Netherlands, Denmark
Radish	10,237	Thailand*, Japan, China
Cabbage	10,515	USA, Japan*, Netherlands
Cauliflower	8,286	USA*, Japan, China
Melons	7,760	USA*, Japan
Others	8,483	USA*, Japan, Netherlands, Singapore, Pakistan, Thailand, India, Korea, Denmark, Taiwan, Australia

Source: Bureau of Plant Industry, Quarantine Division

On the other hand, a notable restructuring has emerged in the cutflower business. When previously, the local cutflower supply business is dominated by small growers, today major suppliers have corporate structures using turnkey technologies of cutflower production imported from the Netherlands and Israel. The turnkey cutflower technology is a controlled-environment production system comprising of housing, irrigation system, varieties and production management and postharvest handling practices and requires capitalization in million of pesos. Technical assistance is provided with the technology. A few companies have foreign principals to supply an export market. A state university is studying the technology to develop a design affordable to small farmers.

The objectives and nature of R & D in the private sector

Of the 300 or so firms concerned with agricultural production, only 46 have R & D (Table 9) activities. Add to this are four research foundations, one set-up by a multinational firm, one by a group of companies in hog breeding and rearing, one funded by COCOFED and the other by the sugar industry. Most of the agrichemical firms and banana growers are subsidiaries of multinational corporations.

Table 9. Types of agricultural firms conducting R & D

Type	Number
Agrichemicals producer	9
Animal breeder	7
Banana/fruit producer	5

Poultry integrator	4
Seed producer	4
Organic fertilizers producer	4
Animal health product producer	4
Feed producer	3
Hog grower	3
Machinery fabricators/assembler	1
Grain producer	1
Ornamental plant grower	1
Research foundations	4

Market is the major consideration in undertaking R & D by the private sector. Outfits appear to differ in their method of reading their market and what it needs. Some outfits hire marketing consultancy firms to read their market for them. Others depend upon their marketing/production staff and/or technical consultants. In drawing up the research agenda, some firms involve the top management, research arm, marketing/production staff and/or technical consultants. Subsidiaries must have their research plan finally approved by the regional/main office. The head of an individually/ family owned small firm generally makes all the decision.

Agricultural R & D is associated with the introduction of foreign technology except in vegetable and corn breeding, coconut and sugarcane research. The major purpose is the adaptation of the technology to suit local conditions in terms of technical efficiency, affordability, and cultural acceptance. Companies with significant research activities are the pesticide companies, banana growers, poultry integrators, hog breeders, vegetable and corn seed producers. Pesticides and their formulations are all developed abroad like the Cavendish banana variety and its management. All commercial breeds of chicken and hogs and their management systems including housing design and gadgets are also of foreign origin.

Most adaptive researches being of specific nature benefit mostly the seller in terms of an expanded/stable market and the buyer of the technology in terms of affordability and product efficiency. Hence, most pesticide companies have their research activities done by their marketing staff just as banana growers, hog breeders

and poultry integrators have theirs done by production and marketing staff. Only a handful have separate R & D staff.

Pesticide companies whose research is also done by their marketing division undertake experimental field and farmer's field testing and improving application regimes. Those with separate R & D staff undertake screening of new products from the home office for general biological activity, conduct laboratory and screen house testing against common pests and diseases in the region and often contract out experimental field trials in various locations to university researchers. Both activities also generate the data required by the Fertilizer and Pesticide Authority for registration. A continuing research concern of banana growers is pest and disease management due to the genetic malleability of insect pests and pathogens and concern for worker's safety (A company has started paying workers for damage due to pesticide usage). Other concerns include fertilization, irrigation, and postharvest handling. Results from these researches help the company maintain its production targets within manageable cost ensuring its capacity to meet its contract to supply a particular market.

Agricultural machineries are also of foreign origin and local inventors have been very active in introducing many innovations. These innovations are done mostly by individual inventors and innovators, some of whom has established their own small manufacturing concerns. Many innovations on machineries have been granted utility patents (About 449 between 1973-79). Further support for inventions is provided for in RA 7459 (Inventors and Inventions Incentives Act, 1994), the implementation of which is overseen by the Dept. of Science and Technology. As of 1997, 41 inventors with 107 inventions have been endorsed to the Bureau of Internal Revenue for tax exemption privileges and 18 request for duty exemption have been endorsed to the Dept. of Finance. Not all these inventions are agriculture-related, however (TAPI Report, DOST).

Since feeds include locally available raw materials, formulation is based on data obtained by local researchers funded by public funds on nutrient composition of available raw materials, minimum nutrient requirements of farm animals grown under

Philippine condition, palatability and limits of a particular raw material to the feed formula. Such information is available in the publication, Philippine Nutrient Standards. The formulation may be aided by computer programs developed by various individuals and available in the market. The consultant to the mill is expected to develop and further improve upon the formula. Quality assurance of raw materials is a major concern both among feed millers and meat producers. Whereas data exist and is used on the nutritional value of feed ingredients, the presence of toxins has to be monitored for each batch of material procured. Toxicity testing of raw materials is done as a service by government laboratories.

Integrators such as San Miguel undertake in-house research to refine their production technology suited to the strains/breeds of animals they contract out or sell. These refinements include feed formulation for various growth or physiological stages, feeding regime, housing and health protection. Research and development is closely linked to production and no separate research staff exists for R & D alone.

On the other hand, the INFARMCO group of companies has set up a foundation solely to undertake R & D allotting about 2 % of their gross income into the activities of the foundation. A major research activity is to miniaturize hog farming. Accordingly, 90% of locally supplied hog meat comes from small farms. The objective of their major research program is to develop cost-effective technologies for the small farmer, e.g. feed concentrates to supplement farm-supplied feed ingredients in place of complete feed formula. This of course will expand their market for hog feed supplements as well as piglets since the INFARMCO is mainly into hog breeding. In addition, the Foundation is actively sourcing locally developed technologies for commercialization.

Seed producers introduce new foreign varieties of semi-temperate vegetables as well as breed new varieties of local vegetables like tomato, sitao, upo, ampalaya, squash, sorghum and corn. Foreign varieties undergo adaptability trials. New varieties are bred for taste, look and other properties acceptable to the market in addition to the usual agronomic properties of high yield and resistance to pests and diseases. Only two vegetable seed companies develop new varieties and produce some of their own seeds. One indicated, however, that their major source of revenue is actually seed

importation. Apparently, the local market is too small to support a breeding program and they are into breeding only for the love of it. This company has sent staff abroad for training in crop biotechnology in order to position the company upon the acceptance of this trend in the country. The market for local vegetable seed is not lucrative yet demanding but breeders are not much concerned about variety protection. Corn breeding produces seeds for sweet and field corn. The major target is resistance to downy mildew. Corn seed producers produce double hybrid seeds whose seeds if used for the next cropping cannot produce equivalent yield performance. Corn seed producers are very aware of this advantage that they have been wary to adopt the new strategy of producing single cross hybrids because of the possible extraction of the single cross parent. However, this new breeding strategy is a faster method of producing new hybrids. By planting more hybrid types, insect pests and pathogens are prevented from developing more infectious biotypes.

Seldom is R & D done to develop new business opportunities. Development of organic fertilizers has been an active area of research that spawned small companies. Basic studies and inoculants is being provided by the DOST and university researchers. A new, small biotechnology company, Novatech Agri-food Industries, established by two individuals trained in industrial biotechnology is engaged in manufacturing fermentation products with technologies they themselves developed.

Novatech Agri-Food Industries is a pioneering biotechnology company manufacturing fermented food and beverages, organic fertilizer, biotreatment for chicken manure, organic soil conditioner and biologicals for feed supplementation. The company is a single proprietorship established in 1991 with a capitalization of about P500,000 for its agricultural-veterinary division which has now grown to about P10 Million. All of its 5 products, their components, manufacturing processes, plant design and manufacturing equipment have been isolated/developed by the proprietor with a friend who has since died. The proprietor holds a B.S Agriculture and M Sc. Enzyme technology with Ph.D units and the deceased friend, Ph.D. in Enzyme technology, M Sc. Enzyme technology and BS Agriculture. Currently, the company has one other technical personnel, a B.S. Chemistry.

Previous to establishing the company, the proprietor and the friend had since 1974 been experimenting on their own, spending their own money to develop the products they have today. No record exists on their research expenditure but according to the proprietor this could run to about P1.5 million through the years. The proprietor used to work with the Sarmiento Group which has exposed him to the poultry and hog industries, enabling him to study this market. He has a continuing program of R & D that includes improving product performance, developing new products, testing new products in the market, developing new formulations, improving the manufacturing process, testing/identifying new components and gathering data for regulatory requirements. This latter is subcontracted to university researchers, recently with UPLB, BSU and MMSU professors. Previously, no separate accounting has been maintained for R & D expenses. However, starting 1998, 2% of gross revenue or about P100,000 per month shall be set aside for R & D.

The Philippine Sugar Research Institute Foundation (PHILSURIN)

Industry update

Ledesma (1997) recently gave an overview of a Philippine sugar industry on the decline. From the world's fourth largest exporter of sugar in the early eighties, the Philippines has today become an importer of sugar. A major reason could be the decrease in hectarage from 553,333 has. producing 2.9 million MT sugar in 1975-76 to 370,000 has. producing 1.8 MT sugar in 1993. Furthermore, domestic consumption has risen since 1996 and has outstripped production because sugar consumption grew by 3.4 % whereas production remained constant. The total requirement in 1998, including the US export quota and two months buffer stock is 2.5 Million MT much larger than the expected production of 1.9 million MT. This challenge has led the Philippine sugar industry to study the steps needed to increase productivity.

Studies were made to identify constraints in production. Compared with some major sugar-producing countries, the productivity of the Philippine sugar industry is low (Table 10) both in terms of ton cane harvest per unit area and sugar recovery per ton cane.

Table 10. Cane production areas and productivity in selected countries (1995-96)

Latitude	Philippines 5 ^{o} - 20^{o} N	Columbia 3^{o}S - 12^{o}N	Thailand 5 ^{o} - 20^{o} N	Indonesia 10^{o}S - 5^{o}N
Area harvested (1000 has)	385	129	980	375
Ave. Yield (TC/ha)	55	136	55	75
Ave. sugar yield (TS/ha)	4.68	16.05	5.82	5.87
Recovery rate (%)	8.6	11.8	10.6	7.8

Source: PHILSURIN Update, Vol.1(2) Aug. 1996

In a historical perspective, productivity of the sugar industry have also declined (Table 11) in terms of sugar yield per hectare even with an increase in ton cane harvest per hectare. Major reasons cited for the decline in sugar recovery are the delay in the delivery of the canes from the farms to the actual milling process, milling inefficiencies due to outdated equipments and process and varietal breakdown. It has been noted that the PHILSUCOM years had negative impact on productivity and that of the PHILSUGIN years positive.

Table 11. Productivity performance of the sugar industry

Years	Agency	TC/ha	MT Sugar/ha	%Sugar recovery
1933-34	_	45.41	5.05	11.13
1947-53	_	45.80	5.16	11.27
1954-74	PHILSUGIN	53.45	5.62	10.51
1975-86	PHILSUCOM	50.76	4.94	9.73
1986-94	SRA	57.53	5.14	8.93

Source: SRA as reported by Ledesma, 1997.

Uncertainties due to the Agrarian Reform Law appears to have aggravated this problem of low productivity. Smaller landholdings on the average gave lower yields compared with large landholdings (Table 12). However, the size of the farm per se is not the cause of lower productivity but the inability of small farmers to provide the necessary inputs for optimum yields. Production loans are denied by banks who are reluctant to asssume ownership of land which they still have to pay for from uncertain profits. As of 1995, 79% of all sugar farmers operate farms, 5 hectares and below. The full implementation of the law will transfer full ownership of some 10.9 million hectares to 3.9 million farmers within ten years.

Table 12. Sugar productivity by farm size

Farm size (ha)	TC/ha	MT Sugar/ha	%Sugar recovery
5 & below	42.16	3.75	8.89
5.1 - 25	48.17	4.17	8.66
25.1 - 50	56.76	4.81	8.47
50.1 - 100	57.79	4.74	8.20
100 & above	62.22	5.33	8.57

Source: SRA as reported by Ledesma, 1997

Significant differences in yield in different locations have also been noted (Table 13). Of the various regions, Panay sugar farms gave the lowest yields whereas Negros farms yielded the most in ton cane per hectare and Mindanao gave the best sugar recovery indicating that Negros farms have the best agricultural practices. The higher sugar recovery reported for Mindanao could be because their mills are built later than those in other locations.

Table 13. Sugar productivity by geographical location (1993-94)

Location	TC/ha	MT Sugar/ha	%Sugar recovery
Luzon	53.89	4.73	8.78
E. Visayas	59.00	4.30	7.29
Panay	47.20	3.40	7.20
Negros	66.36	5.08	7.66
Mindanao	49.81	4.72	9.48
Philippines	59.69	4.77	7.99

Source: SRA as reported by Ledesma, 1997

The new R, D & E system for the sugar industry

The Philippine Sugar Research Institute Foundation (PHILSURIN) , was organised in 1995 by the National Council of Sugar producers in response to Executive Order No. 18 of May 18, 1986 which declared that:

It shall be the policy of the State to promote the growth and development of the sugar industry through greater and significant participation of the private sector and to improve the working conditions of laborers.

PHILSURIN was organized to advance the Philippine sugar industry to a sustainable, globally competitive position by providing planters and millers with appropriate and cost-effective technologies through improvement in sugar research, development and effective delivery of extension services(PHILSURIN Annual Report,

1996-97). It was organized by four national organizations in the sugar industry namely, the Philippine Sugar Millers Association,Inc., the Association of Integrated Millers Associations, the Confederation of Sugar Producers Associations and the National Federation of Sugarcane Planters.

PHILSURIN is a nonstock, nonprofit organization governed by a Board of Trustees, whose members represent the above four organizations with the administrator of SRA and the director-general of PHILSURIN as ex-officio members. The executive committee is the Sugar Development Council consisting of representatives of planters (2), millers (2), research bodies (PCARRD, UPLB, SRA, one each) and the Director General, PHILSURIN. The PHILSURIN has institutionalized the MDDC to implement its action programs at the local level. The MDDC or mill district development committee is a body organized by the associations of sugar farmers and millers in a milling district. The MDDC serves as the focal point in addressing all local issues related to sugar production carrying out the R, D & E program at the local level especially at the areas of extension and applied research whereas PHILSURIN is responsible for preparing the R & D plans and programs with inputs from the MDDC, raises and allocates funds for the program and monitors and assesses the results of on-going projects. The MDDC operationalizes the active participation of the private sector funding the mill district development plans and projects which government cannot provide. The liaison between PHILSURIN and the MDDC is a coordinator, a professional hired specifically for the purpose by PHILSURIN. The MDDC Coordinator is accountable and responsible to PHILSURIN in achieving local goals determined by the respective mill district (PHILSURIN Update. Vol.1, May, 1996).

PHILSURIN is supported by a lien of P2.00 / LKG-bag on all sugar production representing both planters and millers share and established as per Sugar Order No. 2 Series of 1995-96, Sugar Regulatory Administration. This lien is expected to generate P76 Million annually based on an average production of 1.9 MT (PHILSURIN Update, May, 1996). For 1996 and 1997, remittances were P41 and P30 Million, respectively. These remittances are expected to increase with the increasing number of sugar mill districts joining PHILSURIN. As of March 23, 1998, 21 of the 28 mill

districts all over the country has agreed to remit the liens to PHILSURIN (Leon Arceo, Personal comm).

Prior to PHILSURIN, sugarcane research in the private sector was carried out by 3 corporations: Victorias Milling Corporation which used to have the most active group, Hacienda Luisita and Ledesma Foundation (Pray, 1986). In addition to research, VMC used to provide technology such new varieties and information free to its contract growers and for a fee to other sugar millers and planters. This may explain the higher productivity of sugar farms in Negros where VMC is located. On a countrywide basis, the lone agency mandated to provide R, D & E is the agricultural research division of the SRA. As presented earlier, the system has not effectively addressed the technical issues of low productivity.

Sugar R&D Action Plan 1996-2000

The planning process

Ledesma (1997) noted that causes of low sugar yields have existed and has not been resolved over a hundred years. As early as 1877, Creps cited the following causes: poor sugar yield, presence of pests and periodic locust infestation and lack of sufficient capital in exploiting the industry. Demeterio and Atienza, 1980 gave the following : recurrent occurrence of typhoons and droughts, expansion into marginal areas, delay in milling and processing of cane, improper use of fertilizer and inadequate provision of other inputs, failure of many farmers to absorb a satisfactory level of transfer of technology and low level of mechanization. MADECOR in a study of the state of R & D in sugarcane commissioned by the National Council of Sugar Producers in 1995 cited the following reasons: inability of the farmers to grow a good ratoon crop due to RSD (ratoon stunting disease) and poor ratooning ability of planted varieties, considerable delay between cutting and milling of canes, harvesting immature and unripened canes and improper fertilization, presence of pests and non-adoption of proven agronomic practices.

The usual practice of inviting researchers to develop a research program was tried and found ineffective (Arceo, personal comm). The current R, D & E program was developed through a series of studies and consultations. The results of the review

made by MADECOR was verified through field visits to various mill districts as per request of PHILSURIN by the Sugar Commodity Research Team of PCARRD with members coming from UPLB, PCARRD, SRA, PHILSURIN and Victorias Milling Corporation. Three more studies were commissioned by PHILSURIN in aid of developing an action plan: Internal assessment of sugarcane breeding in the country to UPLB; Evaluation of fertilization recommendation in sugarcane to Dr. W. Espada and Handling and transport of sugarcane to Sugar Knowledge International Limited.

The action plan

The action plan for the next 5 years is based on the finding that there are available scientific information and technologies that if adopted immediately by the majority of sugarcane farmers would significantly increase productivity, such as the VMC HYVs, existing information about RSD, etc. Hence, the action plan is largely an applied research and extension program at the mill district levels with a set of doable and clear objectives with realistic goals and strategies as follows:

1. Accelerate the full adoption of a selected high yielding variety (HYV) by reducing the time lag between introduction and full adoption. Use rapid multiplication and propagation techniques such as micropropagation. Increase the number of micropropagation nurseries to cover all mill districts.

2. Strengthen extension services. Strengthen the extension arm of the industry and intensify its activities. Conduct a massive campaign for an industry wide adoption of proven agronomic practices to optimize yield and maximize returns.

3. Reduce delays from cutting to milling by establishing systems to synchronize harvesting with milling operations.

4. Support a R & D program that addresses specific problems of production: RSD, other pests and diseases, new and better varieties and inappropriate fertilizer recommendations.

His action plan has set very specific goals for the next five years:

1. The newer HYVs to account for 50% of the total area planted to canes.

2 The L-kg/TC to go up in the next 3-5 years, based on the adoption of better HYVs.

3. The average yield in terms of ton sugar per hectare to increase from 5.5 in 1995 to 6.3 in the year 2000.

4. Seed certification for disease free planting stocks

The above action program is being implemented in a decentralized fashion. The MDDCs are responsible for the propagation and dispersal of HYVs, dissemination, extension and adoption of technologies to increase sugarcane productivity, development of appropriate and cost-effective technology for sugarcane and reduction of postharvest losses. The SRA is expected to assist implement the breeding program, help develop methods to control pests and diseases and assists in disseminating technical information.

PHILSURIN in cooperation with the MDDCs is establishing common facilities to accelerate the distribution of disease-free HYV stocks to participating planters such as micropropagation laboratories with suitable irrigation system for field nurseries, farm tools, seed boxes and watering /misting facilities, hardening greenhouses and water treatment facilities for removing plant pathogens carried by the seed pieces. Applied research implemented at the mill districts will follow experimental designs provided by PHILSURIN and results will be analyzed in a central computer facility. Specific goals for the MDDCs are set annually, for 1997-98 are as follows:

1. To increase the tons sugar yield per hectare. The percentage of increase varies from a low of 5% to as high as 15% as set by each MDDC. Use of HYVs, proper fertilization, improved cultural practices, and reduced damage due to pests and diseases are the programs designed to meet the goal.

2. To provide solutions to field problems in sugarcane by pursuing problem-oriented research projects aimed at improving varieties, pests and disease control, fertilization, and transfer of technology to the users.

3. To increase the remittances due to Philsurin through a focused and aggressive campaign.

Effective July 1, 1997, PHILSURIN leased the research facilities of the Victorias Milling Corporation agreeing to pay royalty to any VMC varieties planted to at least 2, 000 has and took over the VMC Sugarcane breeding project. The goal of

the project is for PHILSURIN to develop new varieties, the earliest to be released by 2005. Varieties will be developed to improve yields for different growing conditions with the following goals: for premium growing conditions from 85 to canes/ha or 8.5 ton sugar /ha to 120-180 ton canes/ha or 14.4 - 23.4 ton sugar/ha; for intermediate growing conditions, from 65 tons cane/ha or 5.2 tons sugar/ha to 100-119 ton canes/ha or 11 - 14.3 ton sugar/ha and for marginal conditions, from 45 tons canes/ha or 3.6 ton sugar/ha to 70 - 99 ton canes/ha or 7 - 10 ton sugar/ha. Other research and extension projects have been contracted out to other agencies (Tables 14 and 15) where expertise exists.

Table 14. Projects contracted out to expert groups in public institutions

Activity	Contracting party	Cost
Collection, characterization, evaluation and conservation of sugarcane germplasm	IPB, UPLB	P978,000
Integrated management of sugarcane ratoon stunting disease (RSD)	IPB, UPLB	P3,900,000
Development of sustainable pests and disease management for sugarcane	NCPC, UPLB	P1,253,000
Formulation and validation of fertilizer management package for sugarcane	SRA/PCARRD	P968,000
Information and technology packaging and dissemination for sugarcane	PCARRD	P327,000
Handling and transport of sugarcane	SKIL	P2,000,000

Source: PHILSURIN

Table 15. Facilities established/equipment procured by PHILSURIN and MDDC

Type of facility	Number established	Funding agency	Agency to maintain facility
Computer		PHILSURIN	
Micropropagation lab	8	PHILSURIN	MDDC
Farm tools		PHILSURIN	MDDC
Seed boxes		PHILSURIN	MDDC
Watering /misting facilities		PHILSURIN	MDDC
Irrigation system for field nurseries		PHILSURIN	MDDC

Water treatment facility		PHILSURIN	MDDC
Quarantine greenhouse	1	PHILSURIN	BPI
Hardening greenhouse	21	PHILSURIN	MDDC
Photoperiod house chamber	1	PHILSURIN	LGAERC, SRA
Small farm tractor		MDDC	MDDC
Utility vehicle		MDDC	MDDC
Tool shed		MDDC	MDDC

In terms of expenditure, most of the PHILSURIN funds are currently spent for the mill districts to build greenhouses, micropropagation laboratories, hire and pay for MDDC coordinators and strengthen the participation of planters and millers in R, D & E planning and implementation. It is expected that initially many MDDCs will receive more funds than they remitted, with large producers subsidizing small producers. Eventually, of the total funds remitted by the mill district, 80% will go back to support their activities and 20% will be used to support national activities of common interest. On the whole, the objective of management is to keep administrative support expenses to the minimum (Arceo, Personal comm). As of 1997, about 30% is spent for administrative support services.

The PHILSURIN seems set in achieving a full integration of research, development and extension where goals are translated into increases in productivity at the farm level. This is achieved with adequate funding completely under the control of the affected sectors, a leadership that understands the problems involved and a flexible organizational structure that avoids a heavy bureaucracy and that places more emphasis on accessing the appropriate resources such as expertise wherever it is strongest and avoids the pitfall of creating institutional mandates, a major weakness of the PCARRD-DOST system.

PHILSURIN appears to be the appropriate R & D vehicle for the sugar industry. To further support this system, Sugar Executive Order No. 2 should be further strengthened to make the lien and participation by all sectors of the sugar industry mandatory. A study should be made on the advisability of turning over the

research resources of the SRA to PHILSURIN and devolve extension personnel to MDDCs. The present implementation system of PHILSURIN necessitates the strengthening of the research infrastructure of public research institutions such as upgrading laboratories and research personnel. PHILSURIN is also set in improving research personnel by providing scholarship funds for postgraduate studies. Crop biotechnology (genetic engineering) has been specifically mentioned as our weakest field and should be strengthened.

The Philippine Coconut Research and Development Foundation

Seed oils like coconut oil in the world market are to a certain degree interchangeable in utilization. Previously, coconut oil has the advantage of having high lauric acid and has its own niche in the seed oils market. However, the advent of a high lauric acid rapeseed variety developed through genetic engineering has posed a threat to this traditional market of coconut oil. Traditional breeding, genetic engineering and a short maturity period has increased the food and nonfood uses and production of rapeseed oil which has enjoyed tremendous growth in the world market. For the period, 1962 - 1992, rapeseed oil trebled its share in the total world oils and fats production from 3.8% to 11.2% whereas, coconut oil has reduced its share from 6.1% to 3.5%. In addition, despite the tremendous growth of the world seed oils production (Fig 1), Philippine production of coconut has decreased from 1986-1995 (Fig 2). Of these two major problems, shrinking world market share in lauric acid and decreasing coconut production, the private sector through the Philippine Coconut Research and Development Foundation, Inc. (PCRDF) has decided to focus on new commercial uses for the coconut.

The PCRDF is a duly registered non-profit, non-stock science foundation established in July 15, 1975 by 12 individuals representing various sectors of the coconut industry. The Foundation was conceived as a mechanism to institutionalize research and industry development -free from bureaucratic and vested interests but attuned to the needs of the separate entities that make up the industry- and assume a catalytic role in promoting a systematic and wide-ranging program of research , manpower training, technology transfer, rural community development and policy-oriented studies (PCRDF: the First Decade-1975-85). Its policy-making body is a

Board of Trustees which until 1980 have members drawn from various organizations and individuals directly or indirectly involved in coconut R & D. Currently, the Board members represent various sectors of the coconut industry and nominated by the Philippine Coconut Producers Federation (COCOFED). Its initial funds came from COCOFED whose donation amounted to P21 Million in 1978. This fund although mandated as a trust fund was invested in real estate. Since the money was not spent for research, the Foundation was penalized by the Dept. of Science & Technology in 1986 and as penalty was required to support scholarships at the baccalaureate and masteral levels. Judicious management of the real estate properties raised P100 Million in 1995 which has since been kept in trust generating between P13- P17 Million in annual interest earnings and currently used to fund the research program of the Foundation. This is a tremendous increase over the amount of P 38 Million spent for research and development for the period, 1975-91.

In 1994, 20 years of research (1974-94) supported by the Foundation was reviewed. The verdict was not good. These research were too academic and too little was of use to the industry. The quality was poor, research results were not properly reviewed, and reviews often resulted to individual conflicts between researchers and reviewers, lacks the multidisciplinary approach to technology development, and some vital information were deliberately left out in project reports. Hence, research management was changed. A limited degree of duplication is allowed for validation purposes. A peer-review system was put in place, either an open review where reviewers and proponent come together in a meeting to thresh out differences or a written one. A policy of assigning basic research to academe was adopted, coconut production research to the Agricultural Research Bureau of the Philippine Coconut Authority whereas research with commercial applications is directly implemented by the research personnel of the Foundation and supported by researchers from other agencies if needed.

The research resources of the Foundation includes a central laboratory of about 360 sqm consisting of 5 suitably equipped laboratories: microbiology and biotechnology, product research and development, production technology: agricultural R & D - macapuno and tissue culture, analytical laboratory- wet chemistry and

instrumental laboratory and a pilot plant. The PCRDF Central Laboratory conducts scientific work in coconut directed towards producing new materials, products and processes with the application of/and modern technologies; provides technical assistance to the different PCRDF satellite COCOLABS of which there are 5 and other sectors of the coconut industry through product and process development, analytical services and R & D training and foster closer collaboration with both local and foreign agencies for the exchange of technical information and expertise.

Only 13 out of 30 full time personnel are doing research. Only the director holds a MS in agricultural chemistry and environment, the 12 hold BS degrees: 1 medical technology, 1 plant pathology, 2 molecular biology and biotechnology, 1 microbiology, 2 food technology, 1 chemical engineering, 3 chemists, 1 agricultural chemistry, 1 horticulturist. Technical assistance is provided by part-time consultants, 2 with Ph.D (Analytical Chemistry, Microbiology) and 2 MS (Emeritus professor in Microbiology, plant tissue culture) with about 20 years experience in their lines of specialization. The Foundation has research tie-up with local, PCA, VISCA, UPLB, UPDiliman, NAFCI, as well as foreign research institutions, Univ. of Maryland, Michigan State University, University of Montreal, Harvard University.

The S & T program of the Foundation (Table 16) is developed together by the technical staff and consultants, R & D Committee, Chief Operating Officer and approved by the Board. There are 13 research projects and 13 B.S. level technical staff.

Table 16. The PCRDF S & T Program

1. Establishment of minicocolabs in strategic locations to do coconut research and showcase various cocotechnologies for countryside livelihood programs (1995-97)
2. Monoacylglycerides (MAG) Program : Feeding program (1996), Antimicrobial/antiviral studies (1996), Pilot production (1996-97), Medical and medical applications (1996-97)
3. Acceptability tests for structured lipids (1995-96)
4. Macapuno program: Mass propagation, Development and mass propagation of self-pollinating/dwarf macapuno (1995-97), Product development and other applications of macapuno (1996-2000)
5. Sugar alcohol and application studies (1996-2000)
6. Product development using coconut sap (1996-97)
7. Coconut methyl ester as fuel using different cuts/fractions (1996-97)
8. $C_6C_8C_{10}$ fractions for solid fuel (1996)

9. Enzyme applications for oleochemicals and coco studies (1996-2000)
10. Young coconut water (buko) product development studies (1996-97)
11. Medium chain triglycerides and SL studies for athletes (1996)
12. Fatty acids/triglycerides profile of developing coconut endosperm
13. Fatty acids/triglycerides profile of various coconut cultivars growing in different locations and harvested at different seasons

Source: PCRDF

The PCRDF S & T program is a forward looking program. Although it is focused on alternatives to the traditional uses of the coconut in response to the threat of laurate canola, the research topics are too many and are treated too lightly. There is no immediate linkage with a user-industry. The funding is inadequate and despite previous observations for the need to have a multidisciplinary approach to technology development, this strategy is also lacking in this new program. There appears a need for a more thorough analysis of the R & D program to look into the total cost of developing each technology being studied, time needed for development, market access and identify who will commercialize the technology.

While the CEO stressed the need to support the one million coconut farmers, not one study appears to address this problem. Previous analysis indicates that the farmer does not improve his income with increased production with copra as the saleable product (Eleazar, 1994). In contrast, the PHILSURIN is addressing immediate problems of production. There could be several reasons for this. The identified beneficiaries (members of the sugar associations) of R,D & E were consulted on whether they agree to the sugar research fund. One association brought PHILSURIN and SRA to court over the legality of the lien but has now withdrawn the case. Presently, 7 mill district associations have balked at participating in PHILSURIN. Intended beneficiaries are actively involved in identifying their technical problems and developing/funding the field based research. Also, the funding of PHILSURIN is an annual fund based on the sugar productivity for the year hence, the contributors must be made aware of where the fund is going and the mechanism allows them to withdraw their support, making the PHILSURIN directly accountable to the sugar producers and millers. The sugar industry is aware of the need and volume of the market which they can easily access. Whereas the coconut farmers have not been consulted yet are supposed to have paid for the PCRDF funds. The annual budget of

PCRDF is the interest of a trust fund which could be augmented by the sale of additional properties long established from contributions of COCOFED. COCOFED has a huge membership and no mechanism exists for the PCRDF to account their activities to the general membership.

R & D Investments

Only a handful of companies were willing to divulge their R & D expenditures (Table 17). Others balked as this may require additional effort to identify such expenditures which may have been accounted with the marketing expense. Other companies were weary that the competition may find ways to use the data. Two company heads cited a figure of 2% of gross income as their regular expenditure for R & D.

Table 17. Annual R, D & E expenditures (In thousand pesos) in some companies

Nature of the company	1997	1996	1995	1994	1993
Sugar foundation	19,000	7,000	NA	NA	NA
Coconut foundation	17,000	14,000	10,000	7,000	6,000
Multinational pesticide	19,000	20,000	19,000	19,000	14,000
Multinational pesticide,seeds	17,000	20,000	18,000	16,000	NA
Local poultry integrator	20,000	20,000	20,000	20,000	20,000
Seed producer	500	300	100	200	200
Local pesticide producer	400	20	15	14	100
Local poultry supplies	-	200	200	200	200
	92,900	81,520	69,315	64,414	57,500

The intensity of research activities by the private sector except in sugarcane and coconut appears to have declined from the 80's level. When previously, a number of multinational pesticide companies used to maintain research groups distinct from the marketing group, only two have remained to do so. The regional research station of a multinational agrichemical firm has reduced not only the number(from 5 to 3) but also the rank of its research staff (from 2 senior to 2 junior level). This reduction in research intensity could have been brought about by mergers among pesticide firms and the future shift from pesticides to biotech products. In banana R & D, a research foundation purposely organized to service the banana industry has also reduced its research activities in banana.

Government policies affecting R & D in the private sector

Government has adopted a policy of promoting local innovations and R & D activities. A major legislation is RA 7459 signed into law April 28, 1992 providing multi-incentives package to encourage the development of inventions and facilitate their commercial applications. The law provides for presidential awards, tax/duty exemptions, loan assistance and invention assistance development in prototyping, piloting, training, study tours, attendance to conferences/seminars and laboratory tests and analyses. Various councils of the DOST provide counterpart R & D funds to private companies. Although respondents agreed that tax exemption for R & D equipment is conducive to their R & D initiatives, interviewees find the availment procedures too cumbersome. Similarly, interviewees find the availment procedures and equity requirements for technology-commercialization loans cumbersome and too steep for small entrepreneurs. Organic fertilizer producers bewail the data required for FPA registration of organic fertilizers which does not apply to inorganic fertilizers and propose that government fully provide for the costs of testing and obtaining evaluation data of their products.

Researchers and entrepreneurs both the see the need for government assistance in the introduction and promotion of locally developed novel technologies such as organic fertilizers. An awareness campaign for the need to protect the soil and more stringent implementation of environmental laws has been suggested. A level playing field should be promoted where government should not compete with the private sector in providing technologies that the latter can produce. An example that has been cited are clean seed potatoes derived through tissue culture and tissue cultured bananas.

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