PESTICIDES IN BRAZILIAN AGRICULTURE

José Tadashi YORINORI*

Abstract

Favored by a climate that allows production all year-round, Brazilian agriculture requires a considerable effort in pest control. With one of the largest areas of arable land and with only about 6% (*ca.* 47 million hectares) of the country's area being used for crop production, Brazil is probably the largest potential market for pesticides. In 1981, 143 thousand tons (*ca.* 833 US$million) of commercial pesticides were used, of which, 50.6% was represented by insecticides, 30.9% by herbicides and 18.5% by fungicides. In 1975 the National Agricultural Pesticide Plan (PNDA) was established for stimulating the national production of pesticides. In 1974, 77.3% of all pesticides were imported but in 1981, import volume fell to 35%. During the last decade, the use of pesticides increased at an average rate of 9%/year. As a result, it boosted the agricultural production to a record high but it also brought about a series of negative effects: higher production cost; environmental pollution; and animal and human poisoning were multiplied many fold. Public and government awareness of the harmful effects of pesticides has resulted in new laws regulating the registration and use of pesticides. Research on pest management and biological control of insects has received high priority and is routinely used in cotton, soybean, sugarcane and wheat farms. The recently created National Pesticide Research Center, focusing on the synthesis, efficiency, toxicological, environmental and economical aspects of pesticides will bring new dimensions to pesticide use and research in Brazil. With the development of several programs by the government for the exploration of the new frontiers of Central and Northern Brazil, involving millions of hectares of untouched land, the demand for more pesticides in the years to come should be greatly increased.

Evolution of the pesticide situation in Brazil

Favored by a climate that allows crop production all year-round, Brazilian agriculture requires a considerable effort in pest control. With one of the largest areas of arable land and with only about 6% (*ca.* 47 million hectares) of the country's area being used for crop production (SEAG, 1982), Brazil is probably the world largest potential market for pesticides.

In 1979 Brazil was the third largest pesticide consumer, behind the United States and France (IBE, FGV, 1981). In 1981, 143 thousand tons of pesticides were commercialized (Table 1), corresponding to approximately 832.8 US$million (Table 2). The national production represented 64.8% of the total (Table 3) (SINDAG/ANDEF, 1982).

In the 1970s, the consumption of pesticides increased at an annual average rate of 9% (IBE, FGV, 1981). In 1974, 77.3% of the country's need was imported. In that year, the apparent consumption (importation + national production − exportation) was record high, reaching over 100 thousand tons. The largest share of the 32.9 tons of imported fungicides was used for controlling coffee rust (Table 3) (SINDAG/ANDEF, 1972–82). Of the total pesticides used in 1972, 57.3% was represented by insecticides but in 1981 it dropped to 28.9%, showing a considerable increase for fungicides and herbicides (Table 3). The apparent consumption of fungicides jumped from 22.3 thousand tons in 1972 to 36.5 thousand tons in 1980. In 1981 it decreased to 22 thousand tons, probably due to the reduction in the use of fungicides on wheat which was affected by drought and frost.

Brazil has been dependent upon imported pesticides for many decades. In order to stimulate the national production of pesticides, the National Agricultural Pesticide Plan (PNDA) was established in 1975. As a result, importation of pesticides, especially fungicides and herbicides was

* José Tadashi Yorinori, Plant Pathologist, Centro Nacional de Pesquisa de Soja (CNPSo) EMBRAPA, Caixa Postal 1061 – 86.100 – Londrina, Paraná, Brazil.

Table 1 Amount and percentage of the total commercial pesticides sold in Brazil during 1976–81[1].

Pesticides	Amount (1,000 tons)					
	1976	1977	1978	1979	1980	1981
Insecticides	136.3 (72.2)[a]	135.8 (70.2)	113.6 (67.8)	129.2 (63.0)	100.8 (55.5)	72.3 (50.6)
Fungicides	23.9 (12.7)	28.4 (14.7)	25.9 (15.5)	35.9 (17.5)	36.6 (20.1)	26.4 (18.5)
Herbicides	28.5 (15.1)	29.3 (15.1)	27.9 (16.7)	40.1 (19.5)	44.3 (24.4)	44.1 (30.9)
Total	188.7 (100.0)	193.5 (100.0)	167.4 (100.0)	205.2 (100.0)	181.7 (100.0)	142.8 (100.0)

[1] Source: SINDAG/ANDEF, 1982.
[a] Percentage of the total sales in each year.

Table 2 Value (US$) of pesticides sold in Brazil during 1976–81[1].

Pesticides	Value (US$ 1,000.00)[a]					
	1976	1977	1978	1978	1980	1981
Insecticides	145,686	191,304	163,290	196,163	268,034	244,400
Fungicides	56,912	79,888	57,756	71,524	149,355	133,687
Herbicides	184,482	162,748	123,259	164,475	334,707	454,800
Total	387,080	433,940	347,165	435,022	752,096	832,687

[1] Source: SINDAG/ANDEF, 1982.
[a] Dollar (US$) values were calculated from Brazilian currency (Cr$) using the approximate exchange rate (Cr$: US$) for each year: 1976 = 10 : 1; 1977 = 15 : 1; 1978 = 25 : 1; 1979 = 40 : 1; 1980 = 55 : 1, and 1981 = 96 : 1.

significantly reduced. In 1972, only 19.4% of all the fungicides was produced in the country whereas in 1981 the national production amounted to 86.8% (Table 3). Until 1972 all the herbicides were imported. National production began in the following year and over half of the 25.6 thousand tons consumed in 1981 was produced in the country. During the last decade (1972–81), the herbicides had the highest average annual increase, followed by the fungicides. Following the National Agricultural Pesticide Plan in 1975, there was a substantial decrease in imported herbicides and fungicides, with little change for the insecticides, showing that the country is still largely dependent on importation (Table 3). Though a significant growth of the national pesticide industry occurred in the past five years, the variety of active ingredients of each pesticide is still very limited. Out of more than 30 insecticides used in the country, less than half (14) is nationally produced (Table 4). Of more than 24 fungicides only seven are produced

Table 3 Apparent consumption (importation + national production – exportation) (formulated and concentrated) of pesticides in Brazil during 1972–81 and percentage of importation and national production in 1981 [1].

Pesticides	Apparent consumption (1,000 tons)										
	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	% (81)
Insecticides											
Imported	25.0	18.2	30.8	26.2	20.8	23.8	22.8	21.1	19.3	8.6	44.2
National production	14.0	16.3	14.4	15.6	7.7	10.0	19.9	17.7	12.9	10.8	55.8
Sub-total	39.0	34.5	45.2	41.8	28.5	33.8	42.7	38.8	32.2	19.4	100.0
Fungicides											
Imported	20.0	26.1	32.9	5.0	7.3	12.7	7.8	10.5	8.7	2.9	13.2
National production	4.3	6.3	7.6	9.2	9.3	11.9	15.2	14.9	27.8	19.1	86.8
Sub-total	24.3	32.4	40.5	14.2	16.6	24.5	23.0	25.4	36.5	22.0	100.0
Herbicides											
Imported	4.7	7.9	14.1	29.7	22.8	15.6	17.3	10.5	12.8	12.1	47.1
National production	0.0	0.5	0.8	1.7	1.5	4.3	5.5	9.6	15.5	13.5	52.9
Sub-total	4.7	8.4	14.9	22.4	24.3	19.9	22.8	20.1	28.3	25.6	100.0
Total											
Imported	49.7	52.2	77.8	51.9	50.8	52.1	47.9	42.1	40.8	23.6	35.2
National production	18.3	23.0	22.8	26.6	18.6	26.3	40.6	42.3	56.3	43.4	64.8
Total	68.0	75.2	100.6	78.5	69.4	78.4	88.5	84.4	97.1	67.0	100.0

[1] Source: SINDAG/ANDEF, 1982.

Table 4 Amount of imported and nationally produced insecticides during 1979–81.[1]

Insecticides (Common name)	Imported (tons)			Nationally produced (tons)		
	1979	1980	1981	1979	1980	1981
Aldicarb	2,046	1,055	1,006	–	–	–
Aldrin	962	1,026	725	–	–	–
B. thuringiensis	177	279	17	–	–	–
BHC	–	–	–	3,230	4,099	2,070
Carbaryl	1,955	1,438	276	–	–	–
Carbofuran	440	396	433	–	–	–
Carbophenothion	205	140	189	–	–	–
Camphechlor	–	–	–	3,893	–	595
Chlorpyrifos	411	513	421	–	–	–
DDT	–	–	–	4,444	2,752	1,818
Diazinon	144	122	134	–	–	–
Dichlorvos	100	70	190	–	–	–
Dicrotophos	–	–	–	450	462	190
Dimethoate	1,025	210	40	20	373	225
Disulfoton	478	220	314	–	–	–
Endosulfan	1,050	1,200	307	–	–	–
Endrin	1,474	459	215	–	–	–
Parathion	255	–	–	347	224	96
Fenthion	140	95	20	–	–	119
Heptachlor	339	259	379	–	–	–
Malathion	–	–	–	1,170	364	787
Demeton-methyl	145	272	–	–	–	158
Parathion-methyl	3,484	2,871	1,507	3,484	2,871	1,507
Mineral Oil	3,018	2,500	–	–	529	1,514
Monocrotophos	–	–	–	2,200	2,396	938
Omethoate	85	143	140	–	–	–
Phorate	145	76	198	–	–	–
Phosphamidon	240	110	80	–	–	–
Trichlorfon	668	464	183	653	1,126	891
Wettable sulfur	2,223	2,682	239	–	225	2,325
Other	36	83	81	–	–	–
Total	18,795	16,165	5,945	19,891	15,421	13,233

[1] Source: SINDAG/ANDEF, 1982.

Table 5 Amount of imported and nationally produced fungicides during 1979–81.[1]

Fungicides (Common name)	Imported (tons)			Nationally produced (tons)		
	1979	1980	1981	1979	1980	1981
Benomyl	115	67	50	–	–	–
Captafol	461	415	304	–	–	–
Captan	160	163	241	–	–	–
Chlorothalonil	510	599	230	–	–	–
Copper oxychloride	30	50	–	8,313	10,646	8,198
Copper sulfate	1,796	1,242	400	–	7,410	4,053
C.s. pentahydrated	–	–	–	–	–	196
Cuprous oxide	–	–	–	3,880	4,480	1,590
Dithiocarbamates	487	269	431	340	13,196	12,136
Dodine	5	4	36	–	–	–
Edifenphos	70	107	90	–	–	–
Kasugamycin	1	2	2	–	–	–
Kitazin®	90	216	225	–	–	–
Thiophanate-methyl	186	304	91	–	–	–
Mineral Oil	4,527	3,750	–	–	794	2,271
Oxycarboxin	–	4	26	–	–	–
Quintozene (PCNB)	280	144	188	–	–	–
Thiabendazole	81	127	119	–	–	–
Triadimefon	86	128	187	–	–	–
Triforine	18	55	66	–	–	–
Triphenyltin acetate	63	45	57	–	–	–
Streptomycin sulfate	24	32	11	–	–	–
Wettable sulfur	741	894	79	–	75	775
Other	436	83	81	33	–	–
Total	9,876	8,737	2,914	21,573	36,421	29,219

[1] Source: SINDAG/ANDEF, 1982.

nationally (Table 5). The proportion is the same for herbicides (Table 6).

In 1979 the United States was the largest supplier of pesticides to the Brazilian market (68.2%), followed by the Federal Republic of Germany (10.6%) and Switzerland (7.8%). In the same year Brazil exported US$22.4 million worth of pesticides, mainly to Argentina (18.9%), Puerto Rico (18.9%), Tanzania (11.1%) and Hungary (5.1%) (IEA, 1982).

The increase in the amount of herbicides used in the past five years may be a direct result of (i) the severe frost in 1975, destroying most of the coffee plantations in Southern Brazil, and the

Table 6 Amount of imported and nationally produced herbicides during 1979–81.[1]

Herbicides (Common name)	Imported (tons)			Nationally produced (tons)		
	1979	1980	1981	1979	1980	1981
Alachlor	1,301	2,149	2,131	–	–	–
Bentazone	571	803	1,173	–	–	–
Benthiocarb	450	686	1,001	–	–	–
Blazer®	90	186	162	–	–	–
Butachlor	32	260	355	–	–	–
Cyanazine	13	98	129	–	–	–
Dalapon	130	391	517	–	–	–
Diuron	–	–	–	1,301	1,389	2,574
Glyphosate	771	–	–	90	2,194	1,332
MCPA	27	97	182	–	–	–
Metalachlor	1,148	2,701	2,034	–	–	–
Metribuzin	707	561	771	–	–	–
Oryzalin	238	667	561	–	–	–
Paraquat	–	152	–	572	1,285	952
Penoxalin	295	485	589	–	–	–
Picloram	360	514	164	–	–	–
Propanil	–	–	40	1,427	1,549	1,914
Tebuthiuron	220	204	335	–	–	–
Triazine herbicides	1,472	2,469	1,432	336	1,974	1,437
Trifluralin	–	–	–	5,962	4,662	3,564
Thiocarbamates	499	–	–	–	690	1,257
Urea herbicides	60	47	84	–	–	–
Other	840	304	467	–	–	–
Total	10,367	12,774	12,127	11,857	18,293	17,690

[1] Source: SINDAG/ANDEF, 1982.

change from coffee to highly mechanized annual crops, such as soybeans; (ii) the scarcity of hand labor due to rural exodus; and (iii) the expansion of sugarcane plantations for fuel alcohol.

The pesticide sales in 1981 decreased 11.45% compared to 1979. This reduction was associated with the decrease (44%) in the sale of insecticides. The insecticides represented 50.6% of the total commercial pesticides sold in 1981, followed by herbicides (30.9%) and fungicides (18.5%) (Table 1) (SINDAG/ANDEF, 1982).

Among the factors that promoted the use of pesticides in Brazilian agriculture, the financial credit with lower interest for pesticides provided by the government may have been the greatest incentive to the farmers. The amount of credit remained relatively stable for most of the period

Table 7 Amount of financial credit (US$) for pesticides and percentage of the total credit allocated each year for the major crops during 1976–80.[1]

Crops	1976		1977		1978		1979		1980	
	US$1,000[a]	%	US$1,000[a]	%	US$1,000[a]	%	US$1,000[a]	%	US$1,000[a]	%
Soybean	134,367	34.7	126,821	35.5	119,592	33.8	184,644	37.2	130,071	24.8
Coffee	4,282	1.1	6,149	1.7	7,858	2.2	17,692	3.6	84,671	16.1
Wheat	49,719	12.9	77,737	21.8	69,992	19.8	91,736	18.5	66,901	12.8
Cotton	51,052	13.2	35,121	9.8	27,062	7.7	40,851	8.2	44,663	8.5
Sugarcane	22,245	5.8	13,172	3.7	14,344	4.1	16,988	3.4	29,305	5.6
Rice	43,294	11.2	32,259	9.0	25,725	7.3	28,568	5.8	27,352	5.2
Fruit crops	12,405	3.2	12,955	3.6	17,490	4.9	23,782	4.8	26,478	5.0
Corn	9,694	2.5	7,356	2.1	7,248	2.0	12,656	2.6	19,270	3.7
Horticultural crops	5,458	1.4	5,325	1.5	7,465	2.1	9,754	2.0	12,880	2.5
Other crops	54,192	14.0	39,915	11.2	57,102	16.1	69,856	14.1	82,556	15.8
Total	386,708		356,810		353,878		496,527		524,076	

[1] Source: Banco Central do Brazil, Credito Rural, 1976–80.
Inst. Econ. Agricola, SP – Prognostico 81/82. p. 40.

[a] Cr$: US$ exchange rate: 55:1

Table 8 Annual percent increase of pesticide price paid by the farmers in the state of Paraná. Period 1977/81.[1]

Pesticides	Year				
	1977	1978	1979	1980	1981
Herbicides	10.03	12.60	57.51	78.64	87.23
Insecticides	13.17	21.24	35.78	81.17	65.13
Fungicides	17.99	14.23	25.64	100.89	81.60

[1] Source: SEAG, 1982.

between 1972 and 1978 but increased considerably in 1980, with a 48% increase over 1978 (Table 7) (Central Bank of Brazil, 1980). This was mainly due to the higher price of pesticides paid by the farmers (Table 8) as a consequence of the higher cost of petroleum, copper compounds for fungicides and other active ingredients that were imported and, especially, due to the maximum devaluation of the Brazilian currency in 1979.

In 1980 the crops that demanded more financial credit for pesticides were soybeans (24.8%), coffee (16.1%), wheat (12.8%), cotton (13.2%), sugarcane (5.7%) rice (5.2%) fruit crops (5.0%) corn (3.7%) and horticultural crops (2.5%), making up to 84.2% of the total credit. In 1977 the same crops were responsible for 86% of the financial credit provided by the government. In 1980, there was a significant decrease in financial credit for soybean and wheat compared to 1979 (Table 7). This was due to the decrease in acreage of wheat and the lower application of insecticides to soybeans. The latter was mostly due to the use of integrated pest management by a larger number of farmers.

The subsidized credit for pesticides used by the farmers is concentrated in a small number of crops and mainly in the southern states of Paraná (33.7%), Rio Grande do Sul (32.9%), and São Paulo (19.4%) (Central Bank of Brazil, 1980).

The volume of pesticides used in a particular year is often dependent upon a number of factors, either related to agricultural performance itself (lower incidence of pests, adverse climatic conditions, crop failure, lack of incentive for expansion of area, lower price of agricultural products, and increased cost of pesticide application) or related to the pesticide industry and market competition (SINDAG/ANDEF, 1982). In recent years the volume of insecticides sold has decreased due to (i) the development of more concentrated formulation; (ii) the restriction in the use of highly toxic compounds; (iii) the development of integrated pest management programs; (iv) decrease in the level of incidence of insect pests, and (v) the natural competition in the insecticide market.

The fungicides are showing an increasing marketing volume with the expansion of their use in various crops such as potato, wheat and in apple orchards. Production of apple and other crops has grown in importance in the past four to five years. But probably the major reason for the increased consumption of fungicides is the recovery and restoration of coffee plantations for which the coffee rust is the limiting factor, requiring continuous fungicide protection. The most substantial increase in consumption in recent years has been shown by the herbicide market. Its total sale value in 1980/81 (Table 2) surpassed that of insecticides. Soybean crop is by far the largest consumer of herbicides and insecticides.

Regulations on pesticides

Any pesticide to be commercialized and used in Brazil must be registered and licensed at the Division of Phytosanitary Products (DIPROF) of the Ministry of Agriculture (MA, 1979, 1980).

The registration is done through the Section of Registration and Records (SEREC) which after examining the information on the pesticide grants the Certificate of Registration and Licence, valid for a period of five years and subject to renewal. During the registration process, the chemical, physical, phytosanitary and toxicological characteristics of the pesticide are evaluated in order that it can be safely released to the market. The analysis carried out by DIPROF evaluates the effect of the pesticide in relation to the crops, the insects, weeds, diseases, man and the environment.

When a new product or a new recommendation is to be added for a pesticide already registered it must be accompanied by complete experimental data from an official research institution attesting to the recommendation and dosage to be used.

Once the product is approved by DIPROF, based on its phytosanitary properties, the request for registration is sent to the Ministry of Health where the Working Group on Pesticide Residues (GT-2) examines the toxicological aspects concerning public health in accordance with standards established by the Experts on Pesticide Residues of the FAO/WHO Joint Committee.

When these evaluations are completed, the Food Technical Chamber (CTA) publishes a resolution in which the residual tolerance and pre-harvest intervals for the different crops are established (Stellfeld *et al.*, 1981).

The whole file is then sent back to DIPROF for the final approval and issuance of the Certificate of Registration and Licence.

Once the pesticide registration is granted, renewed, extended or cancelled, a specific resolution is published in the Official Diary of the Union and the information is made public.

Periodically the Ministry of Agriculture publishes the Catalog of Agricultural Pesticides listing the pesticides (formulations or active ingredients) registered for use in agriculture (MA, 1980).

Once the pesticide is released to the market, it is continuously inspected for quality control by the state and federal inspectors. The inspection procedures and penalties are indicated in the Handbook for Agricultural Pesticide Marketing Inspection (MA, 1979).

Every pesticide dealer (private or cooperatives) must be properly registered and authorized by the Agricultural Inspection Service of the Federal Agricultural Division at each State.

On January 13, 1981, the Ministry of Agriculture established that all pesticides should be classified into products of general use, of controlled use and those of restricted use, according to the toxicological class defined by the Ministry of Health. Those formulations bearing the toxicological class I (highly toxic) and II (moderately toxic) would have their sale and use strictly controlled. Those of toxicological class III (low toxicity) and IV (practically non toxic) would not be restricted for sale but would have to comply with the law that regulates the proper labelling of the presticides. In addition to the information that is normally displayed on a pesticide label it should also (i) specify the toxicological class expressed in one of four colors: red for toxicological class I; yellow for toxicological class II; blue for toxicological class III; and green for toxicological class IV.

These colors should appear as a continuous 2.5 cm wide band around the bottom of the label. The rest of the label should have a white background and all the printed information should be in black; (ii) specify the crops and the target pests according to their common or scientific names; and (iii) specify the dosage for each pest and the pre-harvest interval for each crop.

Following the regulations that established the toxicological classes for the pesticides, the Pesticide Prescription Act (Decree No. 007 of January 13, 1981) was signed by the Minister of Agriculture. This Act prohibited the sale of pesticides of classes I and II without a written prescription by an agronomist who should be officially registered at the Regional Council of

Engineers (CREA) and have a BS degree in Agronomy. This new law imposes restrictions for both the users (farmers) and the pesticide dealers. A pesticide of toxicological class I or II cannot be used by the farmer nor sold by a commercial dealer without a prescription signed by an agricultural specialist in which the crop, the target pests, the dosage and mode of application should be clearly stated.

A severe penalty is also imposed upon a farmer when an employee becomes poisoned due to mishandling or for lack of proper protection. At present, only few states are being able to properly enforce the rules. Nevertheless, in the short period since the laws were enacted it has been possible to assess the extent of the problems related to agricultural pesticides.

With the recent requirements for the pesticide registration, the Prescription Act, and the standard lay out of pesticide labels, there has been a great progress in the enforcement of the rules for pesticide marketing and use. Any failure in compliance with the existing rules is subject to penalty or seizure of all the stock until the correction is made.

In 1974 the federal government established the Special Secretary for Environmental Protection (SEMA) with the responsibility of studying the problems related to environmental protection. At the State level, the environmental protection services are carried out by the Superintendence of Water Resources and Environment (SUREMA). A recent act by the state of Parana established the rules that regulate the environmental pollution by pesticides. According to this act, is considered as pollution by pesticides any release of this product to the environment that results in the disturbance of the normal dynamics of the ecosystem.

The act regulates the use and handling of pesticides, their storage and transportation, the disposal of pesticide containers, the source of water used in the pesticide application, cleaning of equipment and the mode of application (whether aerial or surface). Any failure to comply with the rules is subject to severe penalties (Strambi, 1982).

Problems with pesticides

There is a worldwide concern about the inadequate use of pesticides and the problem is particularly serious in developing countries where control on the introduction, marketing and use is lacking or very poor.

Water pollution by pesticides resulting in death of farm animals, birds, fishes and occasional human casualties is a serious problem during the height of the crop season in many parts of the country. Environmental pollution and poisoning with organochlorine insecticides are particularly serious where intensive cropping is done with cotton and soybean. Only in recent years, with the establishment of the Special Secretary for Environmental Protection (SEMA), has there been more attention focused on pesticide pollution problems (Strambi, 1982; Streitemberger *et al.*, 1977).

Mercuric compounds are still used for treating sugarcane pieces for planting and also for seed dressing of wheat, rice cotton and some horticultural crops. In April 29, 1980 a decree established strict regulations concerning the use of mercuric compounds, recommending their adequate use and that their application should be done only by the manufacturers or importers of the registered trade marks but this is rarely observed. New registration is prohibited but those trade marks that are presently registered are allowed to be commercialized until their licence expires within the next two or three years (IBE, FGV, 1981).

Considering the difficulty in enforcing the regulations in a vast country like Brazil, it can be expected that mercuric compounds and other hazardous pesticides will be used for many years to come. One exception to this is the State of Parana where since 1975 the State Secretary of Agriculture is strictly enforcing the use of pesticides with seizure of chemicals that are marketed or used without strict compliance with the regulations established by the Division of Phytosanitary Products of the Ministry of Agriculture. Until July 1979, two thousand tons of pesticides had been confiscated in the State of Parana for lack of compliance with the regulations (Jacob, 1979).

In general, there is also lack of coordination among the various levels of decision-making areas of the government, industry, commerce, extension, research, farmers and consumers.

At the government level, the various agencies acting in the area of pesticides are not properly integrated, and often there is overlapping of activities. The industry and pesticide dealers are primarily interested in their profit and price control by the government is often lacking. The personnel involved in the inspection of pesticide products and sanitary education is minimal when compared with the complexity and extent of the problem (Jacob, 1979).

The farmer is often led to use a pesticide before he knows how to handle it, and all the information contained on the label is useless when he cannot read or does not care about it. And finally, the consumer is the victim of the consequences of improper use of pesticides, without any option.

In spite of the existing laws regulating the production and use of pesticides in Brazil, there is still a long way to go until pesticides are properly and safely used.

Outlook on the future of pesticides in Brazil

In recent years there has been an increasing awareness of the harmful effects of pesticides and considerable research effort is being directed to the development of integrated pest management programs and biological control. Soybean, cotton, sugarcane and wheat in Southern Brazil have greatly benefited from the use of pest management and biological control methods (Bleicher *et al.*, 1981; Gallo, 1980; Gazzoni *et al.*, 1981).

It is hoped that chemical pesticides will be used more efficiently and rationally in the future, especially in Southern Brazil.

The recently created National Pesticide Research Center, focusing on the synthesis, efficiency, toxicological, environmental and economic aspects of pesticides will bring new dimensions to pesticide use and research in the country (EMBRAPA, 1981).

Although it is expected that pesticide prices will go up due to the increase of fuel price, higher cost of pesticide research and production, the pesticide industry estimates that expansion in the use of pesticides in Brazil will be greater than in other countries (IBE, FGV, 1981).

With the development of several programs by the government for (i) the exploration of the frontiers of Central and Northern Brazil, (Carajas Project); (ii) the nationwide irrigation projects (PROFIR), and (iii) the projects for the utilization of lowlands (PROVARZEA), involving several million hectares of untouched land, the demand for more pesticides in the years to come will be greatly increased.

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Discussion

Thyagarajan, G. (India): Brazil is one of the world's major producers of cassava. From your experience, is there any need for using pesticides in cassava? It is said that insect attacks are instantly repelled by the release of HCN from the plant by enzymatic action. Could you comment on this aspect?

Answer: Insecticide application is occasionally required to control the cassava caterpillar which causes extensive damage.

Soekarna, D. (Indonesia): What kinds of insecticides are you using on soybean?

Answer: The use of organochlorine compounds has been restricted due to human hazard. Presently we use mostly carbaryl, endosulfan, trichlorfon, azinphos-ethyl, chlorpyrifos, diflubenzuron, dimethoate, fenitrothion, methyl parathion, methomyl, monocrotophos, omethoate, phenthoate, phosalone, phosphamidon, and triazophos.

Singhal, S. (India):1. Can you elaborate on the bad effects of the financial credit allocated by the government to the farmers? 2. You were presenting data on imports and production of pesticides. Is it in terms of active ingredients or formulated products?

Answer: 1. Easy access to subsidized pesticides and machinery increases the demand of these items, resulting in higher cost. On the other hand the price received by the farmers for their products is controlled by the government and the market trends but the government cannot control the price of the chemicals which tends to increase. 2. Chemicals are imported as active ingredients.

Ishikura, H. (Japan): 1. What is the involvement of national and regional agricultural experiment stations in producing the efficacy data (analytical data) of pesticides and who bears the cost? 2. Is the presentation of fish toxicity data compulsory in applications for registration?

Answer: 1. The national and regional agricultural experiment stations are responsible for providing the efficacy data and for indicating the specific target pests and crops for which the pesticide should be registered. At the moment there is no charge for the tests. Efficacy data can also be supplied by the applicants but additional official data are required. 2. Only recently have laws been enacted to control pollution. As far as I know there is no specific requirement to supply fish toxicity data for registration. However the data are usually provided by the applicants through pesticide development research. Efforts are being made to evaluate methods for the analysis of the chemicals present in water and to determine which compounds are the most important in the pollution complex. Also we rely upon data supplied by WHO.

Yang, C.Y, (AVRDC): How are soybeans being utilized in Brazil?

Answer: Of all the soybean production per year in Brazil, two-thirds are for domestic use chiefly for oil extraction and animal feeds and one third is exported.