# STATUS OF HERBICIDE UTILIZATION AND ITS ECONOMICAL ASSESSMENT IN THE PHILIPPINES

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## Abstract

Herbicide use for weed control in the Philippines has already been accepted in the production technology but has yet to be promoted for wider use by the small farmers. Herbicide recommendations are available for 18 crop species or categories approved by the Fertilizer and Pesticide Authority (FPA).

Research on weeds started 68 years ago; the bulk of the early work during the first 33 years was devoted to species identification and weed biology. Herbicide research started in 1948, and it became institutionalized when a weed control program was developed by the Department of Agricultural Botany, College of Agriculture, University of the Philippines.

Although the herbicides 2,4-D, monuron and diuron were found effective for weed control in the late 1950s, there were probably very few small farmers, if any, who used them until the 1960s. The food production program of the government triggered the use of herbicides on rice and other food crops. In general, 2,4-D and butachlor are the most important herbicides in rice. Other herbicides used for the crop are trifluralin, oxadiazon, and thiobencarb. Bormacil, glyphosate, paraquat, dalapon, atrazine, and diuron are used for plantation crops.

The small farmers are not ready to use herbicides due to the lack of cash and other factors related to high yield production technology. Nevertheless, it is expected that in the next five years, more herbicides will be used in rice as farmers in irrigated areas shift from transplanting to direct-seeding method of planting. Intensified production of high valued crops such as garlic, onion, cotton, African oil palm, rubber, banana, and sugarcane will also require the use of herbicides.

Weed science research in the country is constantly developing techniques for managing weeds but there is little work on the economics of weed control practices. Nevertheless, research is relatively advanced and there are available data developed by researchers which indicate that there is a bright prospect for herbicide use in the Philippines.

## Introduction

Herbicide use for weed control in crops is accepted as an effective tool in production technology in the Philippines but is yet to reach the majority of our farmers. Efforts are being made to encourage the use of herbicides to free the farmer from the burden of handweeding. However, current economic situation, production technology, and the farmer's knowledge and attitude present barriers to the immediate attainment of this goal. This paper reviews the general trend of research and use of herbicides and presents survey data on the recommended herbicides and their corresponding market potentials in the country.

In the Philippines, research on weeds started about 68 years ago, when Quisumbing and Ocfemia (1914) published their study on the chemical and bacteriological effects of clearing grasslands by burning. The research work conducted in the next 33 years was devoted to weeds of rice (Cabailo, 1925), pasture (Babaran, 1939; Zuniga, 1947), seed viability and germination (Garcia, 1931; Juliano, 1940), root excretion effects (Peralta and Estioko, 1923), and the biology of noxious weeds such as *Marsilea* (Quisumbing, 1924) and *Monochoria* (Juliano, 1931), and *Lantana* (Gonzales, 1937).

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In 1948, Capinpin and Ocfemia published the first study on the use of the herbicide 2,4-D against various weed species in lawns, vacant lots, and pastures. This was followed by the work of Vega (1954) on 2,4-D for the control of weeds in lowland rice. Thus, at this time, the weed control program which revolved around herbicides was finally developed at the Department of Agricultural Botany, College of Agriculture of the University of the Philippines at Los Baños (Vega, 1979).

Herbicide research in the Philippines was intensified with the establishment of the International Rice Research Institute (IRRI) in 1962, because it was recognized that the full potential of the rice varieties could be achieved better with appropriate weed control techniques. There were other events which led to increased efforts in herbicide research. These were the organization of the Weed Science Society of the Philippines (WSSP) in 1968 (Vega, 1979), the holding of the second conference of the Asian-Pacific Weed Science Society (APWSS) at the University of the Philippines at Los Baños (UPLB) and IRRI in 1969, and the establishment of the Philippine Council for Agriculture and Resources Research and Development (PCARRD) in 1972 and the National Crop Protection Center (NCPC) in 1975. Furthermore, the Fertilizer and Pesticide Authority (FPA) which governs the fertilizer and pesticide industry was created in 1979. This agency specifically regulates the registration and use of pesticides and promotes their proper use by commercial operators, farmers and the general public. Likewise, plantation companies on banana, pineapple, and sugarcane as well as the pesticide companies also established crop protection research and development programs which included herbicides. Results of their studies are usually presented at the annual conferences of the Pest Control Council of the Philippines (PCCP) and/or published in the Philippine Journal of Weed Science.

## Comparative use of herbicides in the world

On a worldwide basis, pesticide use by category is: 43% herbicides, 35% insecticides, 19% fungicides, and 3% other compounds (Magallona, 1980). The United States consumes 45% of the total available pesticides, followed by Europe (25%) and Japan (12%), while other countries have a total share of only 18%. It will be noted that in the industrialized countries where agriculture is capital intensive and highly mechanized, the use of herbicides as a measure to reduce the cost of farm labor is high (Shetty *et al.,* 1977). For example, herbicide application in ricefields is 200% in Japan (2.5–3.0 million/ha), 91% in Taiwan (0.74–0.78 million/ha), and 70% in Korea (Chisaka, 1981).

Kim (1981) estimated that rice fields in Korea will be treated with herbicides up to 150% within the next 10 years. The main reasons for high usage of herbicides are: high labor cost *vs.* herbicides, farmers' sense to perfectly remove weeds from the fields, and the need to control perennial weeds by sequential application of herbicides (Chisaka, 1981).

The experience of Japan, Taiwan and Korea in herbicide use is unique. In 1967, Chang observed that the majority of rice farmers in Taiwan own only small farms with sufficient family labor, for which reason he believed that ". . . there is no urgent necessity to rely on chemicals for weed control in paddy fields." Thus, he predicted that it would take a long time for herbicides to be accepted in Taiwan and for handweeding to remain as the dominant field practice. But industrialization came in very fast which lured farm labor to the factories, and the increased mechanization, high cost of labor, and high income enabled the farmers to afford herbicides as labor-saving and cheaper tools for weed control.

The East Asia situation is entirely different from the experience of most of the South and Southeast Asian countries such as the Philippines, Thailand, Indonesia, Malaysia, India, Bangladesh and Pakistan. Although several experimental data show that in many instances herbicides are cheaper as against manual and mechanical weeding, the average farmer does not have the cash to buy herbicides due to low productivity and low income (Shetty *et al.,* 1977). Thus, he still resorts to manual and mechanical weeding which is inefficient and slow in many ways. Some exceptions may be cited where herbicides are used extensively as in the following plantation crops: banana and pineapple in the Philippines, rubber and African oil palm in Malaysia and Indonesia, and tea in India and Indonesia. De Datta (1981) reported that there is a considerable use of herbicides in rice in the Philippines (1.2 million/ha rice fields treated out of 3.4 million/ha or 35.3% during the wet season but only 23.5% during the dry season). There are no figures for Malaysia, Thailand and Indonesia but De Datta mentioned that herbicides are used only to a limited extent in these countries.

## Herbicide use in the country

According to Capinpin (1975), the British engineers of the Manila Railways were the first to use herbicides successfully in the Philippines in the early 1930s, when arsenical salts were applied to control weeds on railways. However, this practice was discontinued because the salts also poisoned goats and carabaos that fed on the grass. The second compound to be used was a concentrated activated diesel emulsion (CADE), introduced by American Factors of Hawaii against weeds in sugarcane. However, its "burning" contact effect was undesirable and it is only in the late 1960s that Victoria Milling Company revived its use.

Although research on the phenoxy herbicides was intensified in the early 1950s, there were probably very few small farmers who used them until the early 1960s. At the same time, research on the substituted ureas such as monuron and diuron also started, and in the late 1950s the s-triazines became available for testing on corn and sugarcane. Then in the early 1960s, propanil was tested against *Echinochloa* and other grass weeds in rice. The number of herbicides tested thereafter are too numerous to be mentioned here, but the more prominent ones included bromacil, butachlor, chloramban, dalapon, glyphosate, paraquat, pendimethalin, thiobencarb, and trifluralin.

Before the 1970s, there were probably very few small farmers, if any, who used herbicides on crops other than rice. In fact, the launching of the intensified Masagana 99 rice production program in 1973 was probably the one most important event which triggered the use of herbicides on a staple food other than the plantation crops.

Herbicide sales in the country registered a generally increasing trend from 1970 to 1981, although there was a slight drop in 1976 (Fig. 1). For example, the sale was US$1.2 million in 1970, US$4.8 million in 1975, US$8.2 million in 1980, and US$11.3 million in 1981. Likewise, importation of both finished products (formulated) and technical materials in 1977 to 1979 increased with a total value of US$7.505 million, excluding those products sold directly to plantations and institutions valued at US$0.91 million (Table 1). The amount doubled from 1977 to 1979. There was also a rise in the volume of herbicides formulated locally as granules, emulsifiable concentrates, and wettable powder in that order of importance (Table 2). The total volume was 12,217 metric tons for the 3-year period (1977–1979), over half of which was formulated in 1979 with total market value of US$12.816 million. Recent trade statistics showed that stock sale in 1981 was US$11.261 million which was 39% higher than that of 1980 valued at US$8.189 million (Table 3). Similarly, indent and export sales increased by 47 and 25%, respectively.

As mentioned earlier, integration of weed control as a component of the Masagana 99 rice production package is one explanation for the increased herbicide use in the country. This is indicated by the rise in sales shortly after the launching of the program. The subsequent implementation of other food programs such as the Masaganang Maisan corn program and the Gulayan sa Kalusugan vegetable program also contributed to the increased use of herbicides. Moreover, the establishment or expansion of plantation crops such as banana, pineapple, rubber, African oil palm, and sugarcane had resulted in more markets for herbicides.

During the last five years, the area cultivated in the country has expanded. In 1981, the Bureau of Agricultural Economics placed the total area devoted to the various agricultural crops

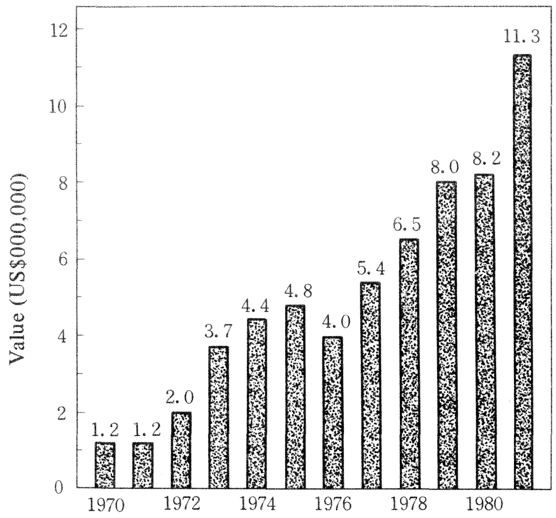


**Fig. 1 Herbicide sales in the Philippines, 1970–1981.**
(Data from the Agric. Pest. Inst. Philipp., 1982)

**Table 1 Total importation of herbicides by category in the Philippines (adapted from Magallona, 1980).**

| Category | 1977 | 1978 | 1979 | Total |
|---|---|---|---|---|
| 1. Finished quantity (metric tons/kl) | 604 | 588 | 946 | 2,138 |
| 2. Products (C and F) ($000) | 1,650 | 1,594 | 1,925 | 5,169 |
| 3. Technical quantity (metric tons/kl) | 156 | 246 | 561 | 963 |
| 4. Material (L and F) ($000) | 377 | 494 | 1,465 | 2,336 |
| 5. Indent sales ($000)* | 683 | 108 | 119 | 910 |

* Direct sales to plantations and institutions. No volumes are reported.

**Table 2 Volume and market value of herbicides formulated locally in the Philippines (adapted from Magallona, 1980).**

| Formulation | Volume (metric tons) | | | | Market value ($000) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1977 | 1978 | 1979 | Total | 1977 | 1978 | 1979 | Total |
| Granules | 3,392.0 | 5,318.4 | 9,773.6 | 18,484.0 | 1,734.4 | 2,739.2 | 5,779.2 | 10,252.8 |
| Wettable powder | 127.2 | 199.44 | 366.51 | 693.15 | 65.04 | 102.72 | 218.72 | 384.48 |
| Emulsifiable concentrate | 720.8 | 1,130.16 | 2,076.89 | 3,927.85 | 368.56 | 582.08 | 1,228.08 | 2,178.72 |
| Total | 4,240.0 | 6,648.0 | 12,217.0 | 23,105.0 | 2,168.0 | 3,424.0 | 7,224.0 | 12,816.0 |

Table 3 Herbicide trade statistics in the Philippines (US$) (adapted from Magallona, 1980).

| Sale category | 1980 | 1981 | % Increase |
|---|---|---|---|
| Stock sales (computed at P7.50/US$) | 8,189,164 | 11,361,410 | 38.74 |
| Indent sales (US$ C and F value) | 290,672 | 426,643 | 46.78 |
| Export sales (US$ FOB value) | 445,140 | 556,000 | 24.90 |
| Total | 8,924,976 | 12,344,053 | |

to over 11.937 million/ha compared to 10.640 million/ha planted in 1977, indicating an increase of 12.19% (Table 4). Among the crops grown in the country, about 50% of the total herbicide sales of US$8.2 million in 1980 was used on rice (Table 5). Pineapple and sugarcane which were grown in much lesser areas accounted for 22 and 15% of the whole herbicide market, respectively. Banana, rubber, and other crops had a share of 13% of the sale (US$1.1 million). Generally, herbicides are a component of the whole weed control system.

It will be noted that in 1974, Maramba projected that importation of herbicides would be about 2,472 metric tons in 1977–1979; but the actual amount was 12,217 metric tons (Table 2). He also projected that 15% of the rice fields would be treated with 2,4-D and MCPA in years 1979 to 1981. According to De Datta (1981), 35.3% of the rice fields received herbicide treatments during the rainy season and 23.5% during the dry season or an average of 29.4%. Thus, the projection of Maramba is probably correct if we assume that half of the rice fields was treated with butachlor and other herbicides.

Table 4 Area planted to major crops (ha) that have potential for herbicide use (source: Bureau of Agricultural Economics, 1981 and 1982).

| Crop | 1977 | 1981 |
|---|---|---|
| Rice | 3,547,500 | 3,459,130 |
| Corn | 3,320,000 | 3,426,000 |
| Coconut | 2,714,000 | 3,936,580 |
| Sugarcane | 567,200 | 420,630 |
| Banana | 299,300 | 311,830 |
| Vegetables (leafy, legumes, potato, onion, garlic, etc.) | 133,500 | 290,800 |
| Pineapple | 36,700 | 67,000 |
| Citrus | 22,100 | 25,150 |
| Total | 10,640,300 | 11,937,120 |

Table 5 Estimated value of herbicides used in selected crops in 1980 (source: Agricultural Pesticide Institute of the Philippines, 1981).

| Crop | Value (US$000,000) | % of Total |
|---|---|---|
| Rice | 4.1 | 50 |
| Pineapple | 1.8 | 22 |
| Sugarcane | 1.2 | 15 |
| Banana | 0.6 | 7 |
| Rubber | 0.3 | 4 |
| Others | 0.2 | 2 |
| Total | 8.2 | 100 |

## Economics of herbicide use

Weed science research in the country is constantly developing techniques for managing weeds especially among major crops. Promising methods are continuously being identified and evaluated in terms of their efficacy and profitability.

Available economic data on weed control on some crops show that handweeding is more time-consuming and more expensive than other methods which include herbicides. For example, in a survey conducted in 1981 among onion farmers in the province of Nueva Ecija in Central Luzon, Belen (pers. comm., 1982) estimated that sole handweeding of unmulched onion was more expensive than the use of herbicides plus handweeding (Table 6). He found that

Table 6 Economics of farmers' weed control methods for transplanted onion. Nueva Ecija, 1981 (unpublished data by Mr. Emmanuel Belen, Rohm and Haas, Philippines).

| Weed control method* | Herbicide rate | Labor input (man-days/ha) | Cost of Herbicide (P/ha) | Labor cost (P/ha) | Total cost of weed control (P/ha) |
|---|---|---|---|---|---|
| Handweeding | – | 125 | – | 1,500 | 1,500 |
| Chemical + hand-weeding | Maximum | 18.5 | 350 | 222 | 572 |
| Chemical + hand-weeding | Minimum | 60 | 175 | 720 | 895 |

* Labor input = P12/man-day; labor cost includes man-days in herbicide application.

the total cost of handweeding was P1,500/ha (125/man-days at P12/man-day). On the other hand, the cost of handweeding was reduced to 18.5 man-days at maximum herbicide rate and 60 man-days at minimum herbicide rate. The corresponding total cost of weed control (herbicide + hand-weeding) was P572 to P895, or a reduction of about 3 to 2 times the cost of handweeding alone. The comparative cost for mulched garlic may be estimated from the time spent in handweeding (40–90 man-days/ha), although mulching with rice straw is also expensive in both the material and labor (Tabbada, 1982).

In coconut nursery, Abad and San Juan (1981) reported that manual weeding of *Cyperus rotundus* and other weeds was more expensive and more time-consuming than the use of herbicides in two trials (Table 7). Weeding with the use of chisel-shaped bolo (machete) was done

**Table 7 Economics on the use of herbicides and manual weeding for control of *Cyperus rotundus* L. and other weeds in a coconut nursery (adapted from Abad and San Juan, 1981).**

| Weed control method* | Glyphosate rate (kg/ha) | Herbicide cost (P/ha) | Labor requirement per operation (man-days/ha) | Total labor cost (at P10/ man-day) | Total cost (P/ha) |
|---|---|---|---|---|---|
| Trial I: | | | | | |
| Monthly manual weeding with a chisel-shaped bolo | – | – | 132 | 15,840 | 15,840.00 |
| Biweekly manual weeding with a scythe | – | – | 45 | 10,800 | 10,800.00 |
| Glyphosate fb paraquat | 1.64 | 3,011.20 | 6 | 420 | 3,431.20 |
| Glyphosate fb paraquat | 2.46 | 3,552.60 | 6 | 420 | 3,972.60 |
| Glyphosate fb paraquat | 3.28 | 4,384.80 | 6 | 420 | 4,804.80 |
| Glyphosate fb paraquat | 4.10 | 5,217.80 | 6 | 420 | 5,637.80 |
| Glyphosate fb paraquat | 4.92 | 6,049.00 | 6 | 420 | 6,469.20 |
| Trial II: | | | | | |
| Monthly manual weeding | – | – | 128 | 15,360 | 15,360.00 |
| Glyphosate fb paraquat | 1.64 | 3,011.20 | 7 | 490 | 3,501.20 |
| Glyphosate fb paraquat | 2.46 | 3,552.60 | 7 | 490 | 4,042.60 |
| Glyphosate fb paraquat | 3.28 | 4,384.80 | 7 | 490 | 4,874.80 |
| Glyphosate fb paraquat | 4.92 | 6,049.20 | 7 | 490 | 6,539.20 |

* Glyphosate was applied three times at bimonthly intervals. fb paraquat = followed by four monthly applications of paraquat at 1.32 kg/ha.

monthly. The two trials had an average weeding time of 130 man-days/mo (1,500 man-days/yr), compared to 6–7 man-days for those treated with glyphosate followed by paraquat. The cost of manual weeding was 5 times higher than the most effective combination of glyphosate and paraquat.

To mention other studies, Sabio *et al.* (1981) found out in direct-seeded upland rice that the application of herbicides followed by handweeding gave higher net income than the other systems without the chemical component (Table 8). In transplanted lowland rice, Navarez *et al.* (1981) observed that 2,4-D at 0.5–0.8 kg/ha and butachlor at 1.0 kg/ha gave economic benefits; but lower herbicide rates with or without handweeding gave a net return lower than handweeding alone (Table 9).

De Datta and Barker (1975) made the most extensive documentation of the economics of modern weed control techniques in rice. But since then, however, no follow-up of similar impact has been published. Furthermore, no other crop has been studied as thoroughly as rice to also document the economic advantage derived from herbicide use.

While it is recognized that economic data are needed in support of the use of herbicides in any crop or in any agricultural activity, ". . . there is little serious or concentrated work being done to look at the economics of weeds and of different weed control practices" (Vega, 1979). For example, among 14 papers presented during the 10th anniversary of the Weed Science Society of the Philippines (WSSP, 1979) none dealt with the economics of weed control. Comparison of yields of weeded and unweeded plots, losses due to weeds, weight of weeds, and other data on length of weed competition were presented, but the actual economic benefit resulting from weeding by manual, mechanical and chemical methods was not discussed.

Table 8 **Comparison of yield, total income, total weeding cost, and net income per hectare for various weed control methods under improved C-22 rice practices. Lalaan, Silang, Cavite, 1979 wet season (adapted from Sabio, Fisher and Pastores, 1981).**

| Weed control method* | Yield (kg/ha) | Total income (P/ha) | Labor time (man-hr/ha) | Total weeding cost (P/ha) | Net income (P/ha) |
|---|---|---|---|---|---|
| 1. Two HW by farmer | 1,920 | 2,496 | 664 | – | 2,496 |
| 2. 1st HW by farmer, 2nd HW hired | 1,920 | 2,496 | 664 | 332 | 2,164 |
| 3. 1st HW hired, 2nd HW by farmer | 1,920 | 2,496 | 664 | 913 | 1,583 |
| 4. Two HW hired | 1,920 | 2,496 | 664 | 1,245 | 1,251 |
| 5. Butachlor 2.00 kg a.i./ha, HW by farmer | 2,490 | 3,237 | 186 | 213 | 3,024 |
| 6. Butachlor 2.00 kg a.i./ha, HW hired | 2,490 | 3,237 | 186 | 562 | 2,675 |
| 7. Butachlor 1.33 kg a.i./ha, HW by farmer | 2,330 | 3,029 | 208 | 142 | 2,887 |
| 8. Butachlor 1.33 kg a.i./ha, HW hired | 2,330 | 3,029 | 208 | 532 | 2,497 |
| 9. FP, cultivation and HW by farmer | 1,650 | 2,145 | 489 | – | 2,145 |
| 10. FP, cultivation by farmer, HW | 1,650 | 2,145 | 489 | 876 | 1,269 hired |
| 11. FP, cultivation and HW hired | 1,650 | 2,145 | 489 | 958 | 1,187 |

* HW = handweeding; fb = followed by; FP = farmer's practice; total income = grain yield × P1.30/kg; labor time = handweeding, 'lithaw' and 'suyod' cultivations (8 man-hours/day); cost of butachlor (60 EC) = P60.50/quart; handweeding cost = P15.00/day; cultivation cost = P30.00/day for man plus animal; first handweeding = 177 man-hours/ha; second handweeding = 487 man-hours/ha.

Table 9 Economics of farmers' weed control methods for rainfed transplanted rice. Alcala-Amulung, Cagayan, 1980 wet season (adapted from Navarez, Estano and Moody, 1981).

| Weed control method* | Herbicide rate (kg/ha) | Labor-input (man-hr/ha) | Cost of herbicide | Total cost of weed control | Grain yield | Gross value of crop (P) | Return to weed control (P) |
|---|---|---|---|---|---|---|---|
| 2,4-D G | 0.8 | 5 | 75 | 80 | 3.3 a | 4,290 | 700 |
| 2,4-D EC | 0.5 | 8 | 53 | 61 | 3.1 a | 4,030 | 459 |
| Butachlor G fb handweeding | 1.25 | 202 | 150 | 352 | 3.3 a | 4,290 | 428 |
| Butachlor EC | 1.0 | 8 | 117 | 125 | 3.1 a | 4,030 | 395 |
| 2,4-D EC fb rotary weeding | 0.25 | 261 | 26 | 287 | 3.2 a | 4,160 | 363 |
| Butachlor EC + 2,4-D EC | 0.5 + 0.25 | 8 | 84 | 92 | 2.9 a | 3,770 | 168 |
| Butachlor EC fb 2,4-D EC | 0.5 fb 0.4 | 16 | 100 | 116 | 2.9 a | 3,770 | 144 |
| Two hand-weedings | – | 417 | – | 417 | 3.1 a | 4,030 | 103 |
| Unweeded check | – | – | – | – | 2.7 a | 3,510 | – |
| Butachlor EC fb handweeding | 0.5 | 225 | 58 | 283 | 2.8 a | 3,640 | 153 |
| 2,4-D EC fb handweeding | 0.25 | 139 | 26 | 165 | 2.5 a | 3,250 | 425 |
| Two rotary weedings | – | 155 | – | 155 | 2.4 a | 3,120 | 545 |

* fb = followed by; G = granular; EC = emulsifiable concentrate. Cost of herbicide: 2,4-D = P75/25 kg, 2,4-D EC = P40/liter, butachlor G = P120/20 kg, butachlor EC = P66/liter. Wage rate = P1.00/hr. Price of rice = P1.30/kg rough rice; return to weed control = gross value of crop – total cost of weed control – gross value for the unweeded check.

## Training and extension programs on pesticide use

Like most small farmers in other parts of the world, the Filipino farmer, in general, does not have adequate knowledge on herbicides – the benefits derived from them and how they are used efficiently and effectively without harm to his crops, neighbors, work animals, and other living organisms useful to him. This situation, together with the availability of family labor for handweeding and the cost of spray equipment and herbicides are some reasons why a farmer still sticks to the traditional methods of weed control.

To support government food production programs, the FPA, NCPC, Ministry of Agriculture, and other government research agencies conduct training and extension programs designed to instill awareness of the proper use and safe handling of pesticides and management of poisoning cases. Among the participants or beneficiaries of such programs are farm technicians, farmers, pesticide dealers, and medical as well as paramedical personnel. The information and training given to farmers have contributed to the increasing use of herbicides in the country.

## Prospects for herbicide use

There is plenty of room for improvement in Philippine agriculture which must be directed towards higher yield per unit area with a more efficient use of resources. There are examples in rice and plantation crops which show that herbicide use is economically more advantageous than handweeding. Research is relatively advanced in the country, and there are several herbicides recommended for most of the crops grown (Table 10). This list was obtained through a survey

Table 10 Recommended herbicides in the Philippines: result of surveys among pesticide companies, plantation managers and government institutions, June 1982.

| Crop species/ category | Herbicide: Common name | Herbicide: Trade name | Rate of application (kg a.i./ha) |
|---|---|---|---|
| 1. Rice | 2,4-D | (Many) | 0.6 – 1.8 |
| | MCPA | Agroxone | 0.75 |
| | Butachlor | Machete 5G, 600 EC; Lambast | 0.75 – 2.1 |
| | Bentazon | Basagran | – |
| | Butachlor + 2,4-D | Rogue EC | 0.75 – 0.5 |
| | 2,4-D + Piperophos | Rilof H 4.2 G, 500 EC | 0.63 – 1.0 |
| | Molinate | Ordam 90 EC, 10 G | – |
| | Oxadiazon | Ronstar 12 L, 2G, 25 EC | 0.4 – 1.0 |
| | Trifluralin | Treflan EC; Triflurex | – |
| | Trifluralin + MCPA | Treflan 12 Granule | – |
| | Nitrofen | Agchem X - 55WP, 25 EC | – |
| | Thiobencarb | Saturn EC; Saturn S | – |
| | Thiobencarb + 2,4-D | Saturn D | – |
| | Glyphosate | Roundup | 2.16 – 2.88 |
| | Pendimethalin | Herbadox 330 EC | 1.0 – 1.25 |
| | Paraquat | Gramoxone | – 0.5 |
| 2. Corn | 2,4-D | (Many) | 0.6 – 1.8 |
| | Atrazine | Atranex 80 WP; Gesaprim | 0.72 – 2.4 |
| | MCPA | Agroxone | 0.75 |
| | Pendimethalin | Herbadox 330 EC | 1.0 – 1.25 |
| | Ametryn | Ametryn WP; Ametrex, Gesapax 80 WP | – |
| | Ametryn + Atrazine | Gesapax Combi | – |
| | Glyphosate | Roundup | 2.16 – 2.88 |
| 3. Sugarcane | 2,4-D | (Many) | 0.75 – 1.0 |
| | Asulam | Asulox 40 | 1.12 – 3.36 |
| | Atrazine | Atrazine; Atranex 80 WP, Atradex 80 WP; Gesaprim 80 WP; Atred 80 WP; Gesaprim 500 WP, Bentrazine 800 WO; Premox 80 WP | 0.72 – 2.4 |
| | Ioxynil + 2,4-D | Actril DS | 1.0 |
| | MSMA | Herbicane | – |
| | Pendimethalin | Herbadox 330 EC | – |
| | Diuron | Planters Diuron; Karmex, | – |
| | | Diuron 80 WP | 1.6 – 2.0 |
| | Paraquat | Gramoxone | 0.36 – 0.48 |

| Crop species/ category | Herbicide: Common name | Trade name | Rate of application (kg a.i./ha) |
|---|---|---|---|
| 3. Sugarcane | Dalapon | Dowpon; Bastapon; Gramevin, etc. | 1.3% |
| | Fenac/Chlorfenac | Fenac | – |
| | Ametryn | Gesapax 80 WP | 1.6 – 2.4 |
| | Ametryn + Atrazine | Gesapax Combi 80 WP | 1.2 – 2.4 |
| | TCA | Nata WP 92–95, C 92–95 | – |
| | Diuron + Paraquat | Tota-Col | – |
| | Linuron + 2,4-D | Wegard | – |
| | Metribuzin | Sencor | – |
| | Atrazine | Gesaprim 80 WP; Atranex 80 WP | 1.6 |
| 4. Coconut | Glyphosate | Roundup | 1.4 – 1.8 |
| | Diuron | Karmex | – |
| | Paraquat | Gramoxone | 0.72 |
| | Diuron + Paraquat | Tota-Col | – |
| 5. Pineapple | Bromacil | Hyvar X Weedkiller | 1.6 |
| | Diuron | Planters Diuron; Karmex | 0.5 – 3.0 |
| | Atrazine | Gesaprim 80 WP, others | 1.2 – 2.4 |
| | Ametryn | Gesapax 80 WP | 2.4 – 4.0 |
| 6. Banana | Paraquat | Gramoxone; Planters Paraquat | 0.36 – 0.48 |
| | Atrazine | (Many) | – |
| | Ametryn | Ametryn WP/Ametrex; Gesapax 80 WP | 2.4 – 4.0 |
| | Glyphosate | Roundup | 2.16 – 2.86 |
| | Ametryn + Atrazine | Gesapax Combi | – |
| 7. Citrus | Bromacil | Hyvar X Weedkiller | 1.2 |
| | Dalapon | Dowpon | 1–3% |
| | Diuron | Karmex, Diuron 80 WP | – |
| | Glyphosate | Roundup | 2.16 – 2.88 |
| | Paraquat | Gramoxone | 0.5 |
| 8. Rubber | Ametryn | Gesapax 80 WP | 2.4 – 4.0 |
| | Paraquat | Gramoxone; Planters Paraquat | 0.5 |
| | Glyphosate | Roundup | 2.16 – 2.88 |
| | Dalapon | Dowpon | 1–3% |
| 9. Onion and Garlic | DCPA | Dacthal 75 WP | – |
| | Prometryn | Gesagard 80 WP | 1.0 – 1.6 |
| | Nitrofen | Agchem X-55 WP, 50 WP, 25 EC | |

| Crop species/ category | Herbicide: Common name | Herbicide: Trade name | Rate of application (kg a.i./ha) |
|---|---|---|---|
| 10. Sorghum | 2,4-D | 2,4-D Amine, EC; Weedtrol EC | 0.75 – 1.0 |
| | Atrazine | Gesaprim 80 WP | 0.72 – 2.4 |
| 11. Coffee | Paraquat | Gramoxone; Planters Paraquat | 0.5 |
| | Glyphosate | Roundup | 2.16 – 2.88 |
| | Diuron | Karmex; Diuron 80 WP | – |
| 12. Oil palm | Paraquat | Gramoxone | 0.5 |
| | Glyphosate | Roundup | 2.16 – 2.88 |
| | Dalapon | Dowpon | 1–3% |
| | MSMA/DSMA | – | |
| 13. Vegetables/ Legumes | Prometryn | Gesagard 80 WP | 0.8 – 1.6 |
| | Glyphosate | Roundup | 2.16 – 2.88 |
| | Paraquat | Gramoxone | 0.5 – |
| | Trifluralin | Treflan EC | 1.0 – |
| 14. Cotton | Glyphosate | Roundup | 2.16 – 2.88 |
| | Prometryn | Gesagard 80 WP | 0.8 – 1.6 |
| | Trifluralin | Treflan EC | 1.0 |
| 15. Grapes and Ornamentals | Terbacil | Sinbar | – |
| 16. Brush Weeds in Pasture | Picloram | Tordon | – |
| 17. Growth Retardant | Maleic Hydrazide | MH 3D | – |
| 18. Non-Crop/ General Weed Control | Bromacil | Hyvar X | – |
| | Bromacil + Diuron | Krovar I Weedkiller | – |
| | Diuron | Karmex; Diuron 80 WP | – |
| | Diuron + Paraquat | Tota-Col | – |
| | Fenac/Chlorfenac | Fenac | – |
| | Glyphosate | Roundup | – |
| | Paraquat | Gramoxone; Paraquat 24%, Paraquat plus; Pared | – |
| | Picloram | Tordon | – |
| | TCA | Nata WP or G 92–95 | – |

among pesticide companies, plantation managers, and government institutions. The table shows the herbicides (common name, trade name) used in 18 crop species or categories with the range of the recommended rates per hectare. All these compounds at the formulations and rates indicated have been registered for use with the FPA.

The launching of intensified corn production (Maisagana 77 and 99) in late 1981 is expected to generate interest in herbicide use. The most limiting factor in corn production in Mindanao, center of the production program, are weeds particularly *Rottboellia exaltata*, which would require the use of herbicides for timely weed control. This requirement would be critical and most attractive among farmers who use hybrid seeds, high fertilizer rates, and cultivating areas of 5 ha or more. Of the total area for corn (3,267 million/ha), 45% is in Southern Mindanao or 57.5% for the whole of Mindanao and 10.6% in the Cagayan Valley (Pamplona and Madrid, 1979). For the Maisagana corn production program, the input allocation is 11.47% for weed control, 20% for insecticides, 59.47% for fertilizers, and 6.80% for seeds.

There is potential for herbicides in onion and garlic which are high valued crops planted to over 10,000 ha in 1981–1982. Mulching and herbicides could reduce their cost of weeding. Cotton production which is expected to reach an area of over 100,000 ha in 10 years or less will require herbicides for cotton planted early (August to September) when there is still some rain.

The establishment of African oil palm, rubber, and hybrid coconut plantations will also require considerable use of herbicides. However, the use of legume cover crops could reduce herbicide use towards the late growth stages of these crops.

Sugarcane has traditionally been a high user of herbicides (Obien and Baltazar, 1979). But improved tillage and timely hilling-up or inter-row cultivation have also reduced weed infestations. This is complemented by the fact that seed pieces are planted during the dry months and weed growth is minimal. When the seedlings are knee-high these are hilled-up to cover the weeds at the base of the seedlings. Since moisture is low at the soil surface, weed germination and growth is also low, but the canes which are planted deep and well fertilized, could grow fast and shade the remaining weeds.

A survey of the market for 1981 and in the next 5 years gives some idea on the prospect of continued use of herbicides as viewed by the pesticide companies (Table 11). At present, 2,4-D and butachlor are the most important herbicides as shown by the volume sold locally amounting to over 2,000 metric tons/yr for each of these two compounds. Pendimethalin, paraquat, MCPA, dalapon, bromacil, atrazine, diuron and glyphosate are also used by various special sectors of the industry.

The most promising compound to increase in volume of use in the next five years is pendimethalin for weed control in corn, but there will also be substantial increases for paraquat, diuron and 2,4-D. It will be observed that although a compound is registered in the country, data on current use as well as the future volume needed are not always available to the researcher. There is need to have accurate monitoring of market statistics and it is hoped that FPA will be able to gather these in the future.

Expansion of herbicide use is not easy, but this could be increased through the following measures:

1. intensified supervision of farmers by extension technicians, coupled with farm demonstration and training in order to make farmers understand the advantage of herbicide use and proper application techniques;
2. provision of sufficient loans so that farmers could buy the materials for their crops; and
3. organized marketing of farm products so that farmers get the best price and could pay for their loans and save enough for future use.

The chosen combination of inputs is determined by their relative prices while the total expenditure on weed control is determined by its effectiveness and cost relative to the total value of the crop (De Datta, 1981). High yields result from high technology used under good conditions, and high prices of produce will enable the farmer to put in high inputs to his production budget. But farmers will tend to neglect weed control, by herbicides or even mechanical/manual methods, if the level of technology gives low yields.

Thus, it will take some time before ordinary famers accept herbicide technology. But there is great potential of herbicide use in high valued crops and this has been seen in the trend in

**Table 11 Volume of imported, manufactured locally, marketed locally, and estimated future volume of herbicides in the Philippines: result of surveys among pesticide companies, June, 1982.**

| Herbicide | | Volume | | | Estimated volume in the next five years |
|---|---|---|---|---|---|
| Common name | Trade name | Imported | Manufactured locally | Sold locally | |
| 1. Ametryn | Gesapax 80 WP | – | – | – | – |
| 2. Asulam | Asulox 40 | – | – | – | – |
| 3. Atrazine | Gesaprim | – | – | – | – |
| | Atranex 80% WP | 7 metric tons (1981) | – | 5 metric tons (1981) | 60 metric tons (1981) |
| 4. Atrazine + Ametryn | Gesapax Combi 80 WP | – | – | – | – |
| 5. Bromacil | Hyvar X | 8 metric tons | – | 8 metric tons | 12 metric tons |
| 6. Butachlor | Machete 5G | – | – | 2,000 metric tons/yr | – |
| | Machete 600 EC | – | – | 200 metric tons/yr | – |
| | Lambast | – | – | – | – |
| 7. Butachlor + 2,4-D | Rogue EC | (1st year of introduction only) | – | 78,0001 | 120,0001 |
| 8. Dalapon | Dowpon | – | – | – | – |
| | Dalapon 85 WP | – | – | 15–20 metric tons | – |
| 9. DCPA | Dacthal 75 WP | – | – | 2–3 metric tons | – |
| 10. Diuron | Planters Diuron | 20 metric tons | – | 20 metric tons | 200 metric tons |
| 11. Glyphosate | Roundup | – | – | 4.5 metric tons a.i. (100%) | 75 metric tons a.i. (100%) |
| 12. Ioxynil + 2,4-D | Actril DS | – | – | – | – |
| 13. MCPA | Agroxone | (none) manufactured locally | – | 78,0011 | 120,0001 |
| 14. Oxadiazon | Ronstar | – | – | – | – |
| 15. Paraquat | Planters Paraquat | 100,0001 | – | 100,0001 | 1,000,0001 |

| Herbicide | | Volume | | | Estimated volume in the next five years |
|---|---|---|---|---|---|
| Common name | Trade name | Imported | Manufactured locally | Sold locally | |
| 16. Pendimethalin | Herbadox | 150,000 l (1981) | 125,000 l (1981) | 125,000 l (1981) | 1,200,000 l |
| 17. Picloram | Tordon 101 | – | – | – | – |
| 18. Piperophos + 2,4-D IBE | Rilof H 4.2 G | – | – | – | – |
| | Rilof 500 EC | – | – | – | – |
| 19. Prometryn | Gesagard 80 WP | – | – | – | – |
| 20. Trifluralin | Treflan EC | Negligible | None | Negligible | – |
| 21. 2,4-D | Planters | – | – | 2,000 metric tons/yr | 20,000 metric tons |
| | 2,4-D Amine EC | – | – | 225 metric tons | 550 metric tons |
| | Weedtrol G | – | 3,000 metric tons | – | 5,000 metric tons |
| | Weedtrol EC | – | 165 metric tons | – | 330 metric tons |
| | Hedonal Liquid | – | – | 40 metric tons a.i. (100%) | 250 metric tons a.i. (100%) |
| Total | | 35 metric tons 250,000 l | 3,165 metric tons 125,000 l | 4,481 metric tons 225,000 l 44.5 metric tons a.i. (100%) | 26,152 metric tons 2,420,000 l 325 metric tons a.i. (100%) |

rice and plantation crops. This is exemplified by the increasing number of rice farmers in Nueva Ecija and Bulacan in Central Luzon who are planting rice by the direct-seeding method and are therefore using herbicides for weed control, because of the increasing cost of labor in the last two years. Thus, the increasing cost of farm labor is viewed as a key towards a shift to labor-saving weed control techniques such as the use of chemicals either solely or in combination with other methods.

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## Discussion

**Sundaru, M.** (Indonesia): Undoubtedly the use of herbicides in rice fields in the developing countries for the last 2–3 years has been effective in the control of annual weeds. How is it possible to solve the problem of perennial weeds? Have you any clue in this regard?

**Answer:** Post-harvest plowing can control many of the perennial grass weeds such as *Paspalum* and *Cynodon* and some of the sedges. Application of glyphosate and paraquat could also help reduce the population when applied before planting rice. Bentazon is recommended against *Scirpus maritimus* which often escapes treatments with butachlor and late application of 2,4-D. There is really no simple solution to the problem of perennial weeds: combination of good cultivation practices and timely/sequential application of pre- and post-emergence herbicides should gradually reduce the population of perennial weeds. There are several species of perennial weeds and this complicates the problem. The introduction of biological control measures could perhaps play a significant role in the control of perennial weeds.