The Oil Palm Industry's approach to the use of pesticides in Papua New Guinea

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Introduction to the Oil Palm Industry in PNG

Oil palm is a perennial tree crop that produces two types of vegetable oil; crude palm oil and palm kernel oil. It is one of the world's main sources of vegetable oil and has many food and non-food uses.

The oil palm is grown mostly within 5-10 degrees north and south of the equator. It needs a high but evenly spread rainfall of between 1800 to 5000 mm per year, requires over 2000 hours of sunshine per year and prefers to grow below 500m. The centres of oil palm growing in PNG (Hoskins, Bialla, Popondetta and Milne Bay) are all to be found in the coastal areas, which satisfy these requirements.

Oil palm is grown by both smallholders and plantations. In PNG, it is produced under what is known as a Nucleus Estate/Smallholder model. The plantation companies provide the milling, transport and export marketing functions for their own and the smallholders' crop. The Palm Oil Producers Association (POPA) represents the country's plantation/milling companies. The Oil Palm Industry Corporation (OPIC) is the industry's smallholder extension service, and the Oil Palm Research Association (OPRA) provides research, advice and technical assistance to the whole industry. Together these three organisations look after the nation's oil palm industry. Issues concerning SHE (Safety, Health and Environment) are foremost in the industry's thinking and all companies that make up POPA have embraced the International Standards Organisation Environmental Management System and for the first time ever in the history of oil palm, an entire country's industry has achieved ISO 14001:2004 accreditation.

The area of oil palm in PNG has been slowly but consistently growing since the last new project development in the late 1980's. This growth has been achieved in the main by establishment of Customary Land Development (CLD) associated with existing oil palm projects. The current area of oil palm is shown in Table 1 where the CLD figures are shown in the Smallholder column and also includes data from the Community Oil Palm Development (COPD) at Bialla. It can be seen that nearly half of the country's oil palm is located in West New Britain with the rest spread between Milne Bay, Oro and New Ireland Provinces. The total area of 120,000 ha may seem high, however this is less than that of the country's other main export-crops.

AREA OF OIL PALM 2004 (hectares)

Project Area	Province	Plantation	Smallholder	COPD	Total
Hoskins	West New Britain	30,447	23,233	0	53,680
Bialla	West New Britain	6,315	10,227	4,614	21,156
Popondetta	Oro	9,007	14,515	0	23,522
Milne Bay	Milne Bay	12,431	1,394	0	13,825
New Ireland	New Ireland	5,812	2,233	0	8,045
TOTAL		**64,012**	**51,602**	**4,614**	**120,228**

Table 1. Areas under oil palm cultivation in PNG

For the last 25 years, PNG's palm oil exports have continued to increase. Looking at the trends in export tonnage rather than export value, the effects of world prices are removed and a clearer picture of the changes in each industry is revealed. The upward trend of oil palm production is relatively constant whereas the other major exports have remained static or even declined (Fig 1).

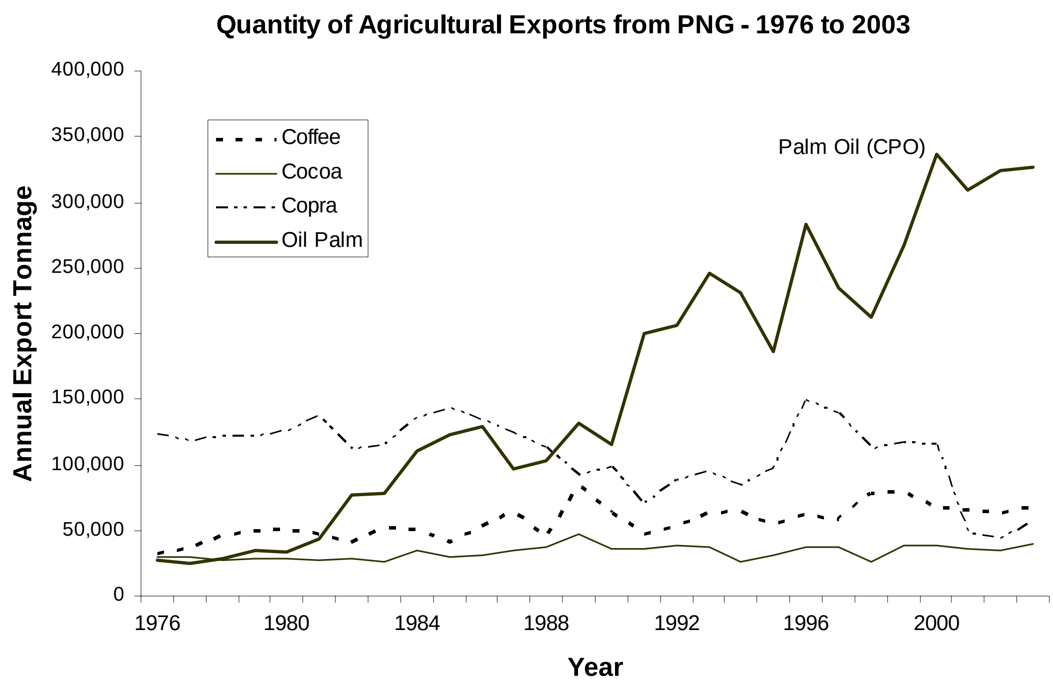

Figure 1. Palm oil production in relation to other major agricultural exports from PNG

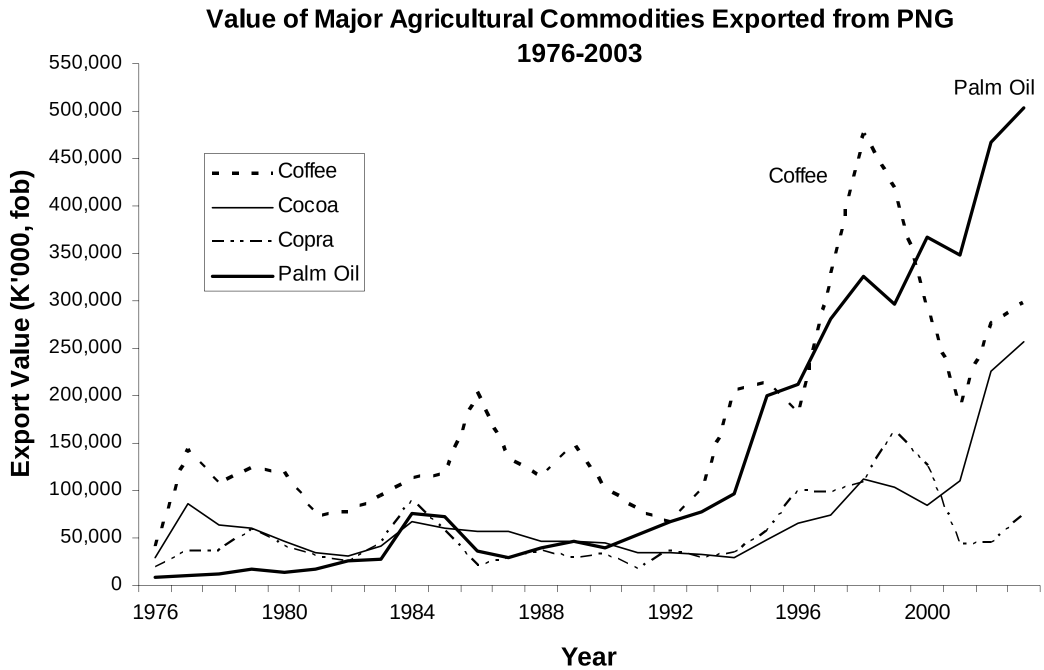

Figure 2. Palm oil export value in relation to other major agricultural exports from PNG

Fig. 2 shows the value (in Kina) of the country's main export crops since 1976. It can seen that the growth in export revenue from oil palm has increased dramatically in the last 15 years and this despite 14-year-low world CPO prices in the last few years, oil palm is now PNG's largest export crop.

The life cycle of the crop

The germinated seeds are placed into professional nurseries on the plantations, kept under shade and well watered so that the young seedlings flourish. At 12 weeks the seedlings are transferred to larger bags and placed into the main nursery. Here the seedlings stay for 9 months before being planted out by either the smallholders or the plantation companies.

The selected seedlings are transported to the field and planted at about 128 palms per hectare. Growth is rapid and the palms quickly establish themselves, so by 24 months after planting the palms are beginning to bear fruit. In the first year of harvest a hectare of palms may produce 10 tonnes. Growth continues and yields steadily increases. Average yields in the industry as a whole are typically 19 t / ha, but some material, bred specially in PNG, is achieving 35 t/ha. The life span of the oil palm in commercial terms is 20 years

Pesticide management

Pesticides are only used during the crop growing process, i.e. between seedling production in the nurseries and crop production. Pesticide residue analysis is carried out as a standard routine by the oil buyers and in over 30 years of exporting oil to Europe no single batch of oil has been rejected.

Although individual companies vary in detail, the approach is similar and pesticide management has been the first area to be brought into line with ISO 14001 principals. The approach by New Britain Palm Oil Ltd (NBPOL) is typical and is here used as an example. After an initial base line survey to determine pesticide use within the company, guidelines for the use of all pesticides in the plantations and nursery were drawn up through a consultative process involving all levels within the organisation.

The application of pesticides is always a planned process. The decision to spray and the choice of pesticide follows on from a 3-step field assessment:

1. The field conditions and deciding if pesticide spraying is required.
2. Decide from the assessment which pesticide to use.
3. Prepare an estimate of how much pesticide is required.

The Guidelines also cover the responsible handing of pesticides, the appropriate uniforms and Personal Protective Equipment (PPE) to wear, chemical storage and pesticide disposal. They guide a sprayer, supervisor and Assistant Manager through the entire spraying process starting with how to read labels and Material Safety Data Sheets (MSDS) and ending with the importance of washing both the spray clothing and the operator.

In a typical plantation company (and these figures and all future figures have been provided by NBPOL) the volume of pesticides applied can be broken down as follows. By far and away the largest usage are herbicides, which account for 91% of all chemicals used (Fig. 3). A long way behind is insecticides, which account for about 8%, but these can be subdivided into those used for malaria control (2.4%, net dipping and wall spraying) and those applied in the plantation 5.7%. Fungicides and rat baits, or rodenticides, typically account for less that 1% each. Breaking this down to individual chemicals we can see that just 2 herbicides make up 70% of all pesticides used (Table 2).

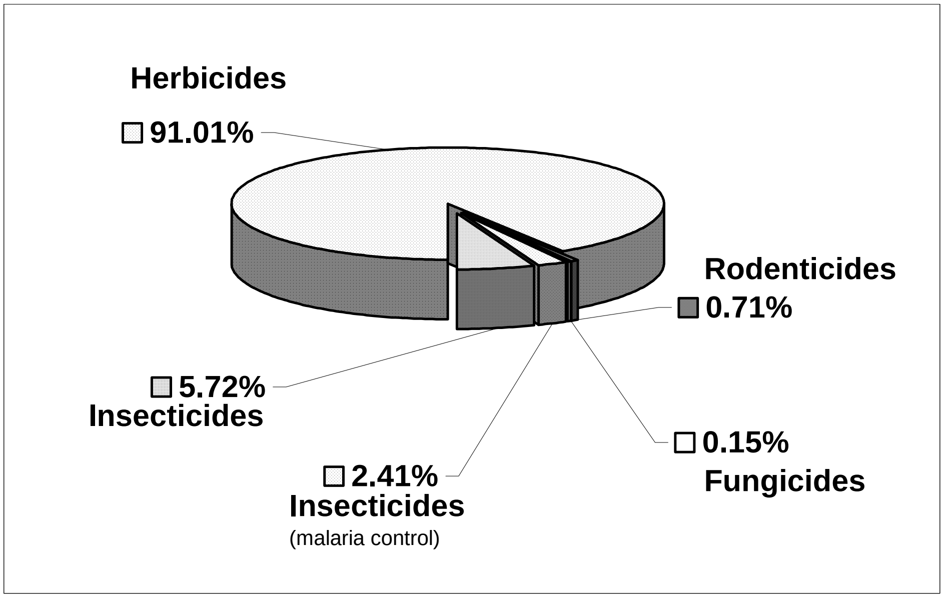

Figure 3. The proportion of pesticides used by NBPOL

TYPE	VOLUME (L) USED/YEAR	% of all pesticides
Glyphosate	34,500	42
Paraquat	23,300	28
Totals	57,800	70

Table 2. Herbicide usage in NBPOL plantations

As part of weed management, a vigorous leguminous cover crop is used to out-compete weeds and provide nitrogen fixing in the soil. This cover crop also reduces soil erosion while the oil palms are young. Herbicides are used to keep circles around the palms free from weeds. This allows the loose fruit, which is an indicator of bunch ripeness, to be clearly seen and is the catalyst for timely harvesting. Paths are kept clear to assist with inspections and to allow the harvesters easy access to the palms. For each stage in the life history of the palm, the chemical, its frequency of use and the equipment used to apply it are specified. In this regimented way strict controls of herbicide usage are maintained.

By strictly controlling the use of herbicides, it has been possible for NBPOL to consistently reduce the quantities used over the last few years. The graph in Fig. 4 shows the amount of herbicide (formulated product) applied annually by NBPOL expressed over the total planted hectarage. The graph shows the annual decline in use and indicates a 53% decline in usage over a six year period despite an increase in 41% of cultivated land over the same period

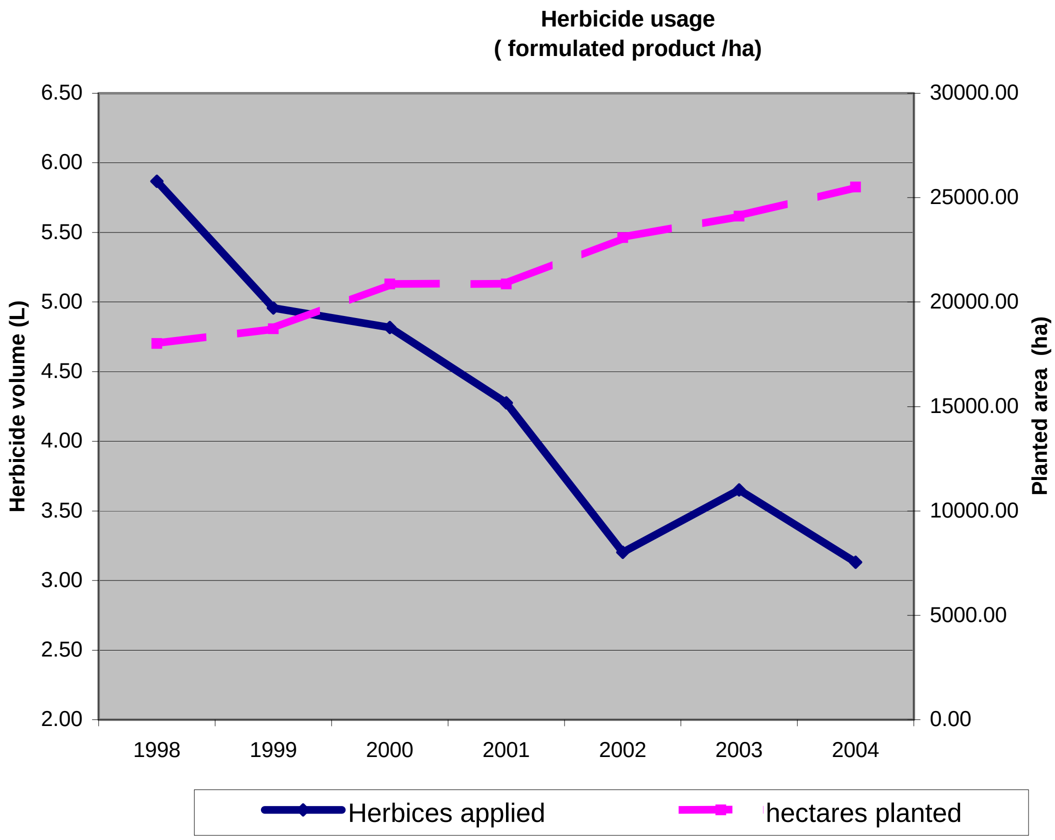

Figure 4. Amount of herbicide used per hectare by NBPOL over time

The herbicides and insecticides used are rapidly deactivated by or in soils (Table 3). Persistence is not an issue with the chemicals routinely used in the industry, as environmentally persistent chemicals are avoided. What does concern the industry is the inherent risk of using hazardous chemicals who's toxicity rating is higher than average for example methamidophos, a systemic insecticide used in the treatment of some of the main insect pests of oil palm, which has both a low LD50 and a high WHO rating (Table 3).

It is partly for this reason that much effort has gone into establishing a good Integrated Pest Management system for the control of weed and insect pests and reducing the use of pesticides where possible.

PESTICIDE	TYPE	TOXICITY RATING LD 50	WHO	RESIDUAL
Glyphosate	Herbicide	5600	III	14 days
Gramoxone	Herbicide	157	II	Deactivated in soil
Methamidophos	Insecticide	20	Ib	Applied by trunk injection and not exposed to soils & non-targets. Breaks down rapidly in soil.

Table 3. Toxicity ratings of the main pesticides used by the PNG oil palm industry

Integrated Pest Management (IPM)

There are three major principles used in IPM:

1. Keeping pests below economically damaging levels.
2. Relying, wherever possible, on non-chemical measures to keep pest populations low.
3. Selecting and applying pesticides in a way that minimizes adverse effects on beneficial organisms, humans and the environment.

IPM emphasises biological control, plant resistance, planting practices and other non-chemical methods and requires a broad understanding of the pest to be managed (Fig 5)

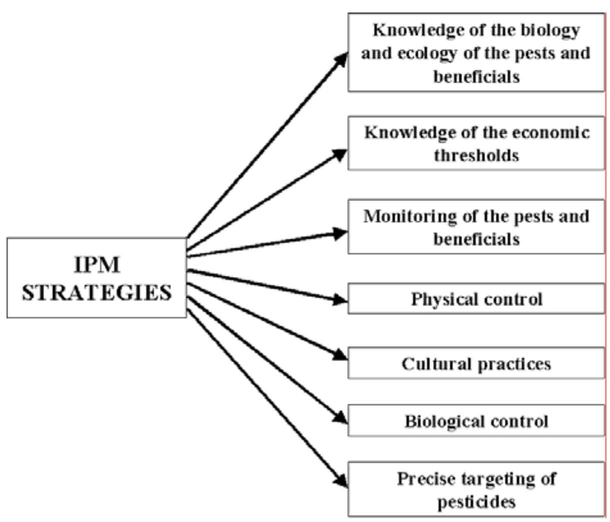

Figure 5. IPM strategies used within the PNG oil palm industry

For specific weed control, IPM strategies are used for the control of Mimosa, *Mimosa diplotricha* (= *invinsa*); Siam Weed, *Chromolaena odorata*, and, more recently, Mikania spp. Stem galling flies, *Cecidochares connexa*, are being used as biological control agents of *Chromolaena*, and have been introduced, and successfully spread, into various parts of PNG. Psyllid bugs, *Heteropsylla spinulosa*, are used to suppress mimosa on the mainland of PNG and are distributed into oil palm areas where mimosa is observed to be building up.

An example of using IPM strategies for the management of an insect pest are the grasshoppers called, collectively, sexava. These are a group of long-horned grasshoppers (Tettigoniidae), which can defoliate oil palm in large outbreaks and can cause serious economic damage. By applying the strategies laid out in Fig. 5 useful information can be accumulated to understand the best ways of controlling the pest. The relevant knowledge and non-chemical control information are shown in Tables 4 and 5. It can be seen that much of the non-chemical control is based on the knowledge of the pest.

Biology and ecology	• Long life cycle (8-10 months) • Poor mobility limits outbreaks • Females may lay 100 eggs or more • Most eggs deposited in the ground, • Egg diapause broken by high rainfall • Often move from natural host plants on to palms • Several known parasites and predators (beneficials)
Economic thresholds	• Thresholds based on defoliation levels not pest numbers. Light defoliation (<10%) used as the threshold • Light defoliation tends to develop into moderate to severe damage • Moderate to severe defoliation reduces yield by up to 50% for two years • Defoliation of upper fronds particularly damaging
Monitoring	• Outbreaks initially monitored and reported by harvesters, pruners and field supervisors • Damage levels assessed, defoliation maps and recommendations produced • Beneficials also monitored

Table 4. IPM: knowledge of Sexava

Physical	• Hand collecting of sexava adults and nymphs from affected areas, particularly from young palms.
Cultural	• Natural host plants can be removed from the vicinity of oil palm growing areas • Preference for shade means that it is important that oil palm is well pruned and kept free of old fronds that tend to hang down from the central cluster
Biological: Egg parasitoids	• Hymenopteran egg parasitoids reared in sexava eggs, then released into oil palm growing areas where low-level sexava populations are present • Several million of these egg parasitoids are released into the field each year • Can be combined with cultural and physical control methods to provide long-term regulation of low-level populations of sexava
Biological: Internal parasitoids	• *Stichotrema* is an internal parasite found to infect *Segestidea novaeguineae* on mainland PNG • Able to reproduce parthenogenetically • Nymphs of *S. defoliaria* and *S. decoratus* are infected with *Stichotrem*a in the laboratory, then are released into suitable areas in West New Britain • Indications are that this method of biological control has been successful
Biological: Biodiversity management	• Planting and/or encouragement of vegetation to sustain beneficial species of predators and parasitoids (i.e. the adults of the egg parasitoids)

Table 5. IPM: non-chemical control of sevava

The control methods described above will help to suppress upsurges of sexava. However the eggs can accumulate in the soil during extended dry periods because they go into arrested development (diapause). When the rains come they all hatch at about the same time producing a large increase in population, which the parasitoids cannot catch up with initially. Such outbreaks will therefore require chemical control. By monitoring an outbreak, the area in which damage is occurring can be delineated (based on leaf damage). This allows the precise targeting of the systemic insecticide using trunk-injection in the area where damage is occurring. 10ml of methamidophos is applied per tree into a single 1.5cm diameter hole, 15cm deep and drilled at a 45° angle into the trunk, 1m above ground. The hole is plugged with a square ended hardwood peg to avoid bacterial, viral or fungal infections getting into the palm and any dangers of contamination to the environment. By confining the insecticide to the palm, there is no impact on other non-target organisms. The treatment is repeated after 16 weeks to control any sexava nymphs that have emerged from the ground after the effectiveness of the insecticide has waned (around 60 days).

Similar IPM approaches are used for other oil palm pests such as rhinoceros beetles, which bore into the growing crown causing damage, and bagworms that, like sexava, cause defoliation. For rhinoceros beetles physical control can be affected by hand picking, ensuring that breeding sites such as decaying trunks are disposed of rapidly and, in the case of outbreaks of *Oryctes rhinoceros*, the use of a synthetic aggregating pheromone. No insecticidal control is required. For bagworms control measures can include: hand collection from young palms, removal of natural host plants from the vicinity of oil palm growing areas, maintenance of good ground cover within the plantation (for beneficials) and precise targeting of insecticide by trunk injection (using one treatment only). Bagworms are particularly vulnerable to parasitoids, so biodiversity management is important in suppressing outbreaks.

Conclusion

The industry (POPA) is ensuring its continued commitment to the environment and has actively sought ISO 14001 accreditation. Most of the industry has now been accredited. This is the International Standards Organisation’s Environmental Management System, which commits the industry to a reduction in pollution and a continued improvement in its environmental performance. In essence it provides a structure to progressively lessen the footprint of the industry on the land it occupies, the water that runs over it and the air above it. In practical terms this means adopting a planned approach to pesticide usage through structured herbicide use and biologically sound IPM strategies.

Since its inception, the oil palm industry in PNG has adopted an integrated pest management approach to its pest problems. IPM approaches provide long-term solutions to pest problems and can considerably reduce the incidence of outbreaks. Such an approach also allows the oil palm industry to minimise and target pesticide usage thus avoiding pollution of the environment.

The planned approach is the safest, most efficient and environmentally responsible way of using pesticides and has become one of the main pillars of ISO 14001 commitment by the oil palm industry in PNG as a whole.

Further Reading

PNG Oil Palm Research Association Annual Reports 2000-05
NBPOL Management Guidelines -pesticides