# A SURVEY ON THE SAFE AND EFFECTIVE USE OF PESTICIDES IN CUT FLOWER PRODUCTION : THE CASE OF HIGHLANDS OF NORTHERN THAILAND

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## SUMMARY

To compete with the income gained from opium cultivation, cut flower growing has been introduced in the highlands of northern Thailand. High-value produce whose the physical appearance is essential to secure high market prices, cut flowers require intensive pesticide use. Farmer's practices in cut flower production raise, however, various problems related to pesticide overuse and misuse, leading to potential health hazards. To gain clear understanding of pesticide use practices and identify the main factors contributing to pesticide exposure, this survey was conducted on 50 cut flower growers. A semi-structured personnal questionnaire was designed to collect information on pesticide characteristics, their conditions of storage, dosage and application as well as the safety precautions taken by farmers during mixing and spraying pesticides. Relating the results of this survey, 28% of farmers store pesticides at home, in the living room ; 32% apply dosages higher than recommended on the label while 36% overdose or underdose the spray solution according to pest infestation level. Mostly all farmers apply pesticide cocktails without knowledge about chemical compatibility. During mixing, 94% of farmers wear boots, 80% wear gloves, 42% wear special work clothing and only 18% of farmers wear face mask and 6% face shield. Farmer's wives and contract workers involved in pesticide application face higher pesticide exposure as they do not take safety precautions when spraying. After spraying, 98% of farmers wash themselves, 84% wash their work clothing and only 26% dispose of empty containers. This survey achieved in assessing the main risk factors of pesticide contamination and implementing appropriate safe use trainings in the context of farmer's perceptions and knowledge.

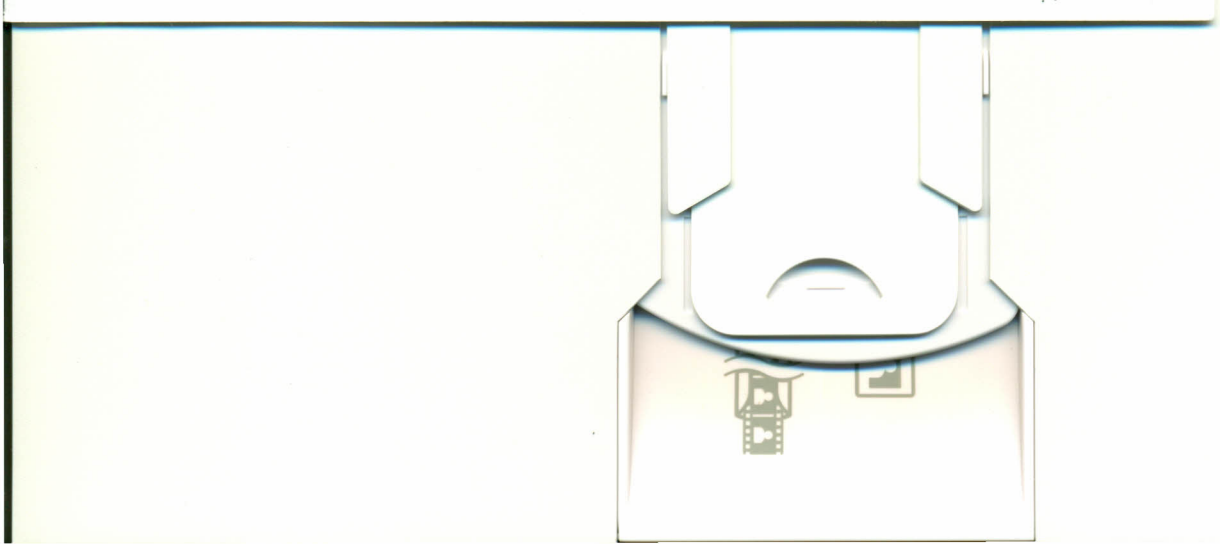
## INTRODUCTION

From several decades, the production and consumption of opium were widespread in Thailand, especially in the highlands of northern country. Thailand was, indeed, facing as one source of the vast opium crop emerging from the infamous triborder area known as the Golden Triangle. Because of the concept which claimed that there is no crop that can compete with the income gained from opium growing, the Royal Project Foundation decided to promote crops suitable for the cooler climate of highlands of northern Thailand. In this context of opium substitution, cut flowers growing has been introduced by the Royal Project Foundation.

However, the introduction of cut flower production with high quality requirements made adoption of pesticides a cost-effective choice. Pesticides still have a high reputation in their relevance for securing high-grade produce and increasing yield. In addition to pesticide overuse, some studies concluded, that even though farmers state their concern about possible health hazards, their behaviour in spraying, mixing, handling pesticides and pesticide disposal indicates a lack of real knowledge or a unawareness of actual danger (Jungbluth, 1996).

In order to improve the safe and effective use of pesticides, the Asia-Pacific Crop Protection Association (APCPA) was asked to implement safe use training for farmers. This study aims at providing qualitative data on pesticide use in cut flower production to APCPA in order to set up appropriate training. It was, therefore, essential (1) to gain a clear understanding of farmer's practices regarding pesticide use, (2) to assess the major risk factors of pesticide exposure, (3) to investigate farmer's perceptions of pesticide toxicity and hazards.

The study was based on a survey conducted in the north of Thailand. Data were obtained using a semi-structured personal interview combined with observations during pesticide operations. The scope of the study was limited to 50 chrysanthemum growers, selected as primary sample frame. The questionnaire was elaborated to collect data on the characteristics of pesticides, the conditions of



pesticide storage, the dosage and application of pesticides, the safety precautions during mixing and spraying as well as the no-chemical pest management practices. The main factors of pesticide exposure and possible health disorders related to pesticide use have been considered in order to minimize pesticide hazards.

## METHODOLOGY OF THE STUDY

### Study area: Doi Inthanon

Doi Inthanon is located on the flanks of Thailand's highest mountain, after which it is named and rises to some 2.565 metres. It belongs to Chiang Mai province in the north of Thailand. Prior to the establishment of the Royal Project station, in 1979, the Doi Inthanon massif, covering a total area of 482 $km^2$, has been designated a national park. Nevertheless, since 1979, the forests on the flanks of the massif had been severely denuded by over 50 years of clearance for shifting cultivation by hilltribemen, latterly for opium growing. Two ethnic groups, named Hmong and Karen live in this area. Thanks to its physical and climate characteristics, Doi Inthanon offers the possibility of growing a wide range of temperate climate crops. Indeed, a large spectrum of fruits including strawberries and apples, vegetables and cut flowers are grown in Inthanon area. Although fruits and especially strawberries provide high income to farmer families, it is the production of cut flowers which is the most popular in Inthanon area. Four major varieties have been introduced and promoted from Royal project: chrysanthemum, carnation, gerbera and gypsophila (United Nations Environment Programme, 1988).

### Characteristics of chrysanthemum farming system

With an average temperature of 17.5°C, Inthanon area is suitable for producing high quality chrysanthemums. In this area, chrysanthemums are grown under plastic film covered structures which provide in every way a more suitable growing environment than outdoors growing. In fact, so different is this environment that the protected chrysanthemum is a different and higher value product than the outdoors one. In addition to that, plastic covers enable the installation of incandescent bulbs intended to create artificial long day periods and then prevent immature flowering.

### Selection of the sample

Chrysanthemum growers were employed as the primary sampling frame and 50 were interviewed. Chrysanthemum is the major cut flower production in Inthanon area, so that chrysanthemum growers are representative of the way pesticides are used in cut flower growing.

### Data collection

The survey was conducted during two months (June and July 1997) in Inthanon area. Data on farmer's practices were obtained using:
(a) a semi-structured personal interview based on a questionnaire designed for the purpose.
(b) observations, included pesticide application ranging from spray mixture preparation to safety precautions taken after spraying, and discussions with the farmers.
Spray application techniques and protective measures were examined to understand which factors could lead to exposure and possible illness.

### Questionnaire design

To investigate deeply farmer's practices in the context of their attitudes and knowledge about pesticides, the questionnaire was divided in four parts:

- Socio-economic characteristics of respondents (10 questions)
- Production and marketing aspects (15 questions)
- Pest management and safe use practices (26 questions)
- Major problems in chrysanthemum growing (tables to complete)

## RESULTS OF THE SURVEY

### Part 1: Socio-economic characteristics of respondents

#### *Farmer's characteristics*

All interviewed farmers were male farmers. The average age of the entire sample was 33 years with 34% of respondents between 15 and 25 years old. Most respondents (46%) completed between 4 and 6 years of compulsory education (P4-P6) until they were 10-12 years old ; 38% of respondents have an education level inferior to P4 and 10 farmers reported they were illiterate. The average family size is six persons composed of the two parents and four children. The main source of income is chrysanthemum growing.

#### *Farm size and Land ownership*

The average chrysanthemum growing area is 1.24 rais (1 rai = 0.16 ha). The lowest and highest are respectively 0.25 and 4 rais with 48% of farms ranging from 0.5 to 1 rai. The physical characteristics of Inthanon area as well as the high labour requirements of chrysanthemum growing contribute to develop a small-scale farming system. The characteristics of land ownership indicate that the majority of respondent families own their growing land (94%).

### Part 2: Production and marketing aspects

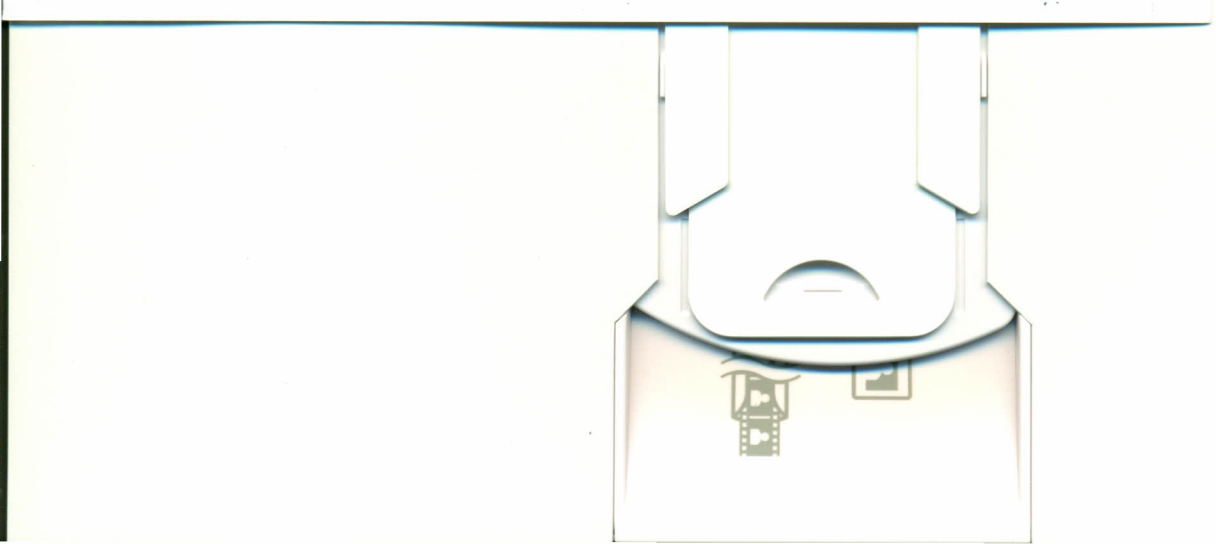
Chrysanthemum growing is an intensive crop with high labour requirement The average number of family members working on the farm is four persons in addition to the two parents. Family labour is used for weeding, pruning, trimming, harvesting as well as packing flowers. Except farmer's wives, family labour are not involved in pesticide operations. Considering the high labour requirement of chrysanthemum growing, 36% of farmers reported they hire contract workers in addition to family labour ; 33 % of contract labour are hired for pesticide application.
Some marketing aspects and farmer's income have been investigated but will not be presented in this paper.

### Part 3: Pest management and safe use practices

#### *Characteristics of pesticides used in chrysanthemum production*

**Type of chemicals**

The main group of pesticides used are insecticides that make almost 58% of chemical sprays. Fungicides are also necessary to control disease particularly during the rainy season and constitute



nearly 40% of used pesticides. Herbicides are used by 24% of farmers in order to cope with the increasing difficulties to hire workers. 35% of pesticides are organophosphate and carbamate compounds, chemical families identified as being related to most pesticide poisoning.

**Brand name**

Chrysanthemum growers use 33 different brand names. Among these 33 pesticide brand names, farmers rely on a limited number of chemicals applied repeatedly. Four pesticides are widely used : mancozeb, methomyl, propargite and hexythiazox which are used respectively by 84, 64, 46 and 34% of farmers. Paraquat is the only one for chemical weed control. Two of the most hazardous pesticides are registered under different brand names: methyl-parathion used by 10% of farmers is sold under 2 different brand names; monocrotophos under 3 brand names. Currently, there are 298 active ingredients registered in Thailand, which sum up to a several time higher number of product names (2258 names in 1991) and the trend is still rising (Grandstaff, 1992). This confusing number of trade names in the pesticide sector makes market transparency nearly impossible for users and contributes to widespread pesticide use.

**Formulation**

Nearly 67% of pesticides used in chrysanthemum production are emulsifiable concentrate (EC), 21% wettable powder (WP), 9% suspension concentrate (SC) and 3% soluble powder (SP). Farmers don't know the different risks of each pesticide formulation but they do know what kind of formulation is easier to handle, to dose or to mix. Farmers prefer to use EC formulations because it is easy to handle, transport and store. On the contrary, farmers find WP formulation less useful when pouring and mixing the concentrated powder.

**Toxicity**

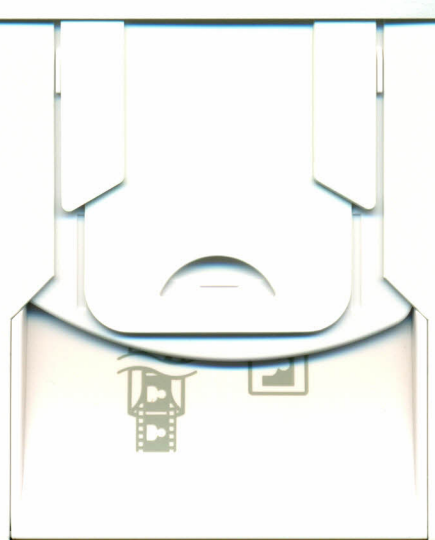
According to the WHO classification (WHO, 1995), 27% of the active ingredients used by farmers belong to the classes Ia (extremely hazardous) and Ib (highly hazardous). Among them, methomyl represents the most used insecticide by farmers.

**Label content**

More than half pesticides belonging to the classes Ia and Ib don't provide neither colour band corresponding to toxicity classification nor safety pictograms. These incorrect labelling practices are a serious problem in Thailand and contribute to increase the risk of farmer's exposition to pesticides. These basic safety information are, indeed, the primary point of contact with users to promote the safe and effective use of pesticides. In Thailand, false and inaccurate labelling of pesticides is widespread as the large number of formulating and repacking plants makes impossible an effective control. In addition, illegal imports of Chinese or Indian products providing label instructions in their own language incomprehensible by Thai people are also a factor of pesticides misuse.

### *Pesticide selection*

97% of farmers select pesticides according to the price and advice given to them coming from three main sources: pesticide retailers, Royal project extension staff and neighbouring farmers. The impact of the retailer on farmer's pest management decisions is therefore of high relevance and should be considered as a way to transfer information about safe use of pesticide to farmers.



### *Pesticide storage*

28% of farmers store pesticides at home, in the living room, directly accessible to children while only 10% of them store pesticides in a general locked farm store; 4% of respondents store pesticides under a black sheet in field and 8% hang them outside house. In addition to the risk of accidental ingestion, this storage conditions, exposing pesticides to heat and moisture, can affect the stability and quality of products.

### *Dosage of pesticides*

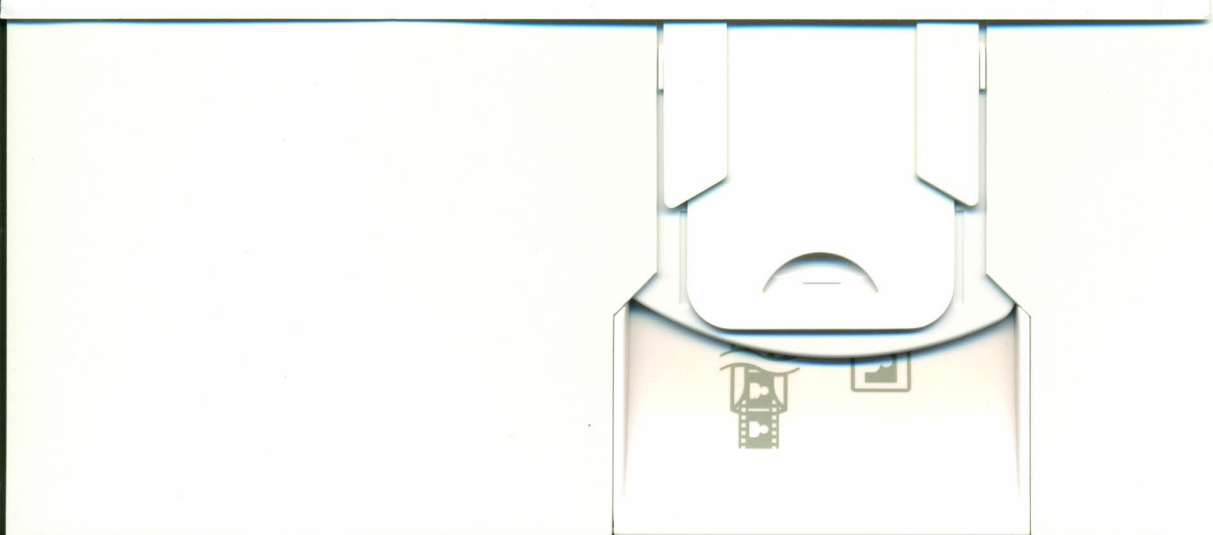
- 32% of respondents mix higher dose rate than label recommendations
- 36% overdose or underdose the spray solution according to the infestation level in field
- 32% reported they abided by the dose rate recommended on the label

The observation of 26 farmers during the mixing of spray solution, showed that the majority of farmers who didn't follow label instructions, didn't use any calibrated utensils to measure the dose rate.
59% of respondents make higher dose rate to improve pesticide effectiveness. This lack of pesticide effectiveness may be caused by:

- the poor quality of pesticides. One problem associated with pesticide production in Thailand is the insufficient quality of the products. Quality tests conducted by the Department of Agriculture (DOA) indicate that a high amount of pesticides do not fulfil minimum standards. Expired or deteriorated products can be found in numerous retail shops (Grandstaff, 1992).
- nearly 27% of farmers believe that high level of infestation requires higher amount of pesticide to ensure a good control.
- nearly 12% of respondents make higher dose rate to overcome what they perceive as "pest resistance". As the same products are intensively used at different concentrations, by all farmers in Inthanon area, conditions are conducive to a rapid occurrence of resistance build-up to new pesticide products. Additionally, the heavy use of pesticides, killing the population of natural enemies and beneficial insects, leads to pest resurgence and severe outbreak. Finally, pesticide overdosage, intended to prevent pest outbreaks, contribute to create new problems and leave the farmers in the so-called "pesticide spiral".

**Pesticide cocktail**

98% of farmers apply an average of 5 chemicals, four pesticides and one liquid fertilizer. They use mixtures of chemicals from liquid and powder formulations, dissolved in water in the mix tank. Pesticides are mixed without relation or knowledge about effectiveness or combination possibilities. The observations during mixing process showed the formation of excessive foam and problem of sedimentation at the bottom of the tank. The reasons for application of pesticide cocktails was to save time and the common belief that pesticide mixture, increasing broad spectrum activity, were more effective than a single pesticide. This practice of pesticide cocktails leads to severe overdosage and risks of phytotoxicity if two pesticides with similar mechanisms of action are used at once (carbamates or organophosphates, for instance) or when pesticides under different brand names are mixed together.



## *Pesticide application*

### Spraying operators

- 88% of farmers apply pesticides by themselves
- 44% of farmer's wives spray pesticides
- 12% of farmers stated they hire professional sprayers. Farmers reported they employed contract labour because of poisoning experience and thus felt afraid of pesticide hazards.

### Maintenance of spraying equipment

Among the 26 observations of pesticide spraying, 10 are made with leaky equipment : leakage and dribbling were observed around plugs in the nozzle, lance-tap and hose, causing fluid leakage along the plunger rod. The poor quality of spraying equipment leads to great dermal exposure especially when farmers don't wear gloves to protect their hands. It is important to stress that farmers don't wear additional protective clothes even if leaks occur.

### Spraying frequency

In chrysanthemum production, the average of spray operations is one a week ; a spray operation includes the application of one pesticide or a mixture of several pesticides. Discussions with farmers indicate they believe frequent application of pesticides are necessary to kill all pests and to avoid blemishes on flowers.

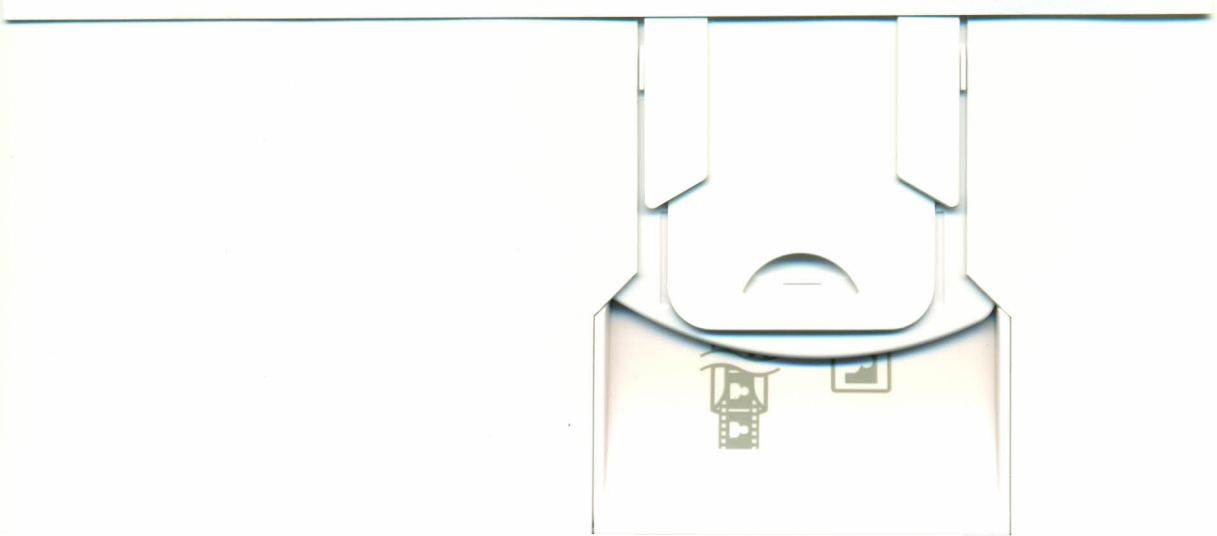
## *Safety precautions*

### Before using pesticides

Before mixing pesticides, 80% of farmers stated they read label recommendations. Concerning the awareness of safety pictograms, 92% of farmers know the meaning of the five pictograms, which have been shown to them. On the contrary, only 4% of farmers know the meaning of colour band on pesticide label. They are completely unaware of the relation between the colour band coding system and the toxicity class of the pesticide.

### When mixing pesticides (Figure 1)

Mixing procedures are always carried out by farmers because they don't feel confident to get the correct dose rate when other person(s) prepare pesticides for spraying.



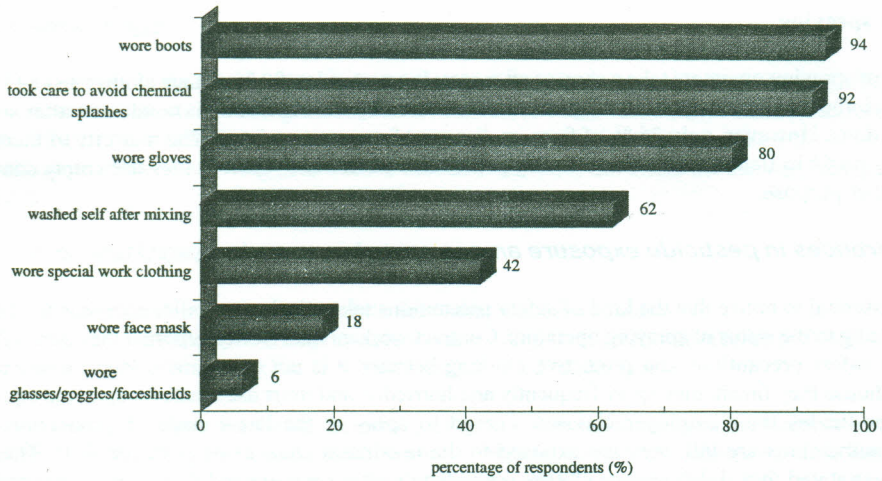



**Fig. 1** : Safety precautions taken when mixing

## When spraying

With reference to the distribution of age of respondents, farmers can be divided in two groups : those who are less than 35 years old (31 farmers) and those who are more than 35 years old (19 farmers).

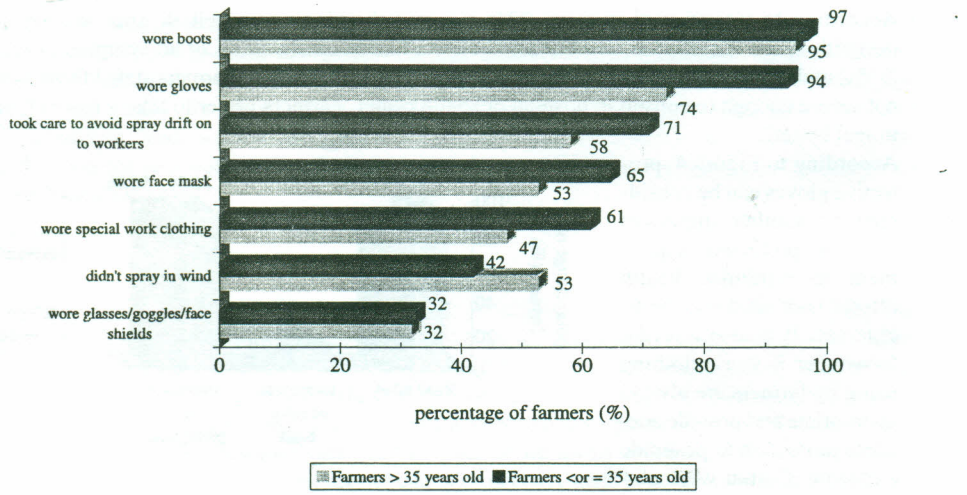



**Fig. 2** : Safety precautions taken when spraying according to farmer's age.

**After spraying**

98 % of spraying operators take a shower after spraying pesticides, 90 % change clothes and 84 % wash their clothes immediately. These figures are confirmed by the observations conducted after spraying operations. However, only 26 % of farmers dispose of empty containers. The majority of them leave empty packs in fields, without any rinsing procedures but no one reported they use empty containers for other purpose.

### *Differences in pesticide exposure among spraying operators*

It is essential to notice that the kind of safety precautions taken during and after spraying are different according to the status of spraying operators. Contract workers interviewed reported they don't take care about safety precautions and protective clothing because it is not convenient. Paid on basis of the greenhouse they finish, they spray frequently and hurriedly, and must use whatever spraying equipment and pesticides their employer chooses. Forced to spray at the latest stage of production, when chrysanthemums are tall, they are exposed to the maximum chances of pesticide drift. These two workers stated they didn't change clothes immediately after spraying and they even didn't wash their clothes after every pesticide applications, so that inner pesticide residues remain into jacket and trousers, generating an important risk of dermal absorption.
The second pesticide operators who are greatly exposed to pesticides are farmer's wives : 44 % of them spray pesticides usually without any protective equipment. They are also exposed to pesticides through pesticide spray drift as they used to work in the greenhouse when her husband spray pesticides.

### *Possible health disorders related to pesticide use.*

According to interviewed farmers, 72% reported they have ever felt ill after mixing or spraying pesticides. The main symptoms are acute effects like headache (95% of all symptoms) and dizziness (33%) and usually appear one to two hours after spraying operation. Farmers stated these symptoms are not severe enough to consult in hospital or health center. Farmers prefer to take a rest at home waiting to feel better.
According to Figure 4, protective gloves can be considered as another important item of protective equipment to minimize health effects associated with pesticide use. It is also relevant to wonder if work clothing using by farmers are always appropriate and provide adequate protection to pesticide exposure. Cotton work clothes worn by most of farmers may be composed of thin materials, which absorb easily pesticide spray solution, leading to greater dermal exposure through inner pesticide residues.

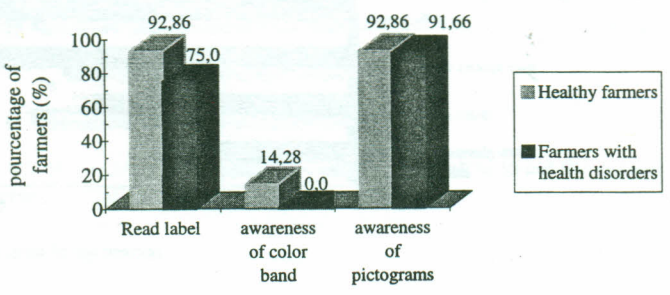
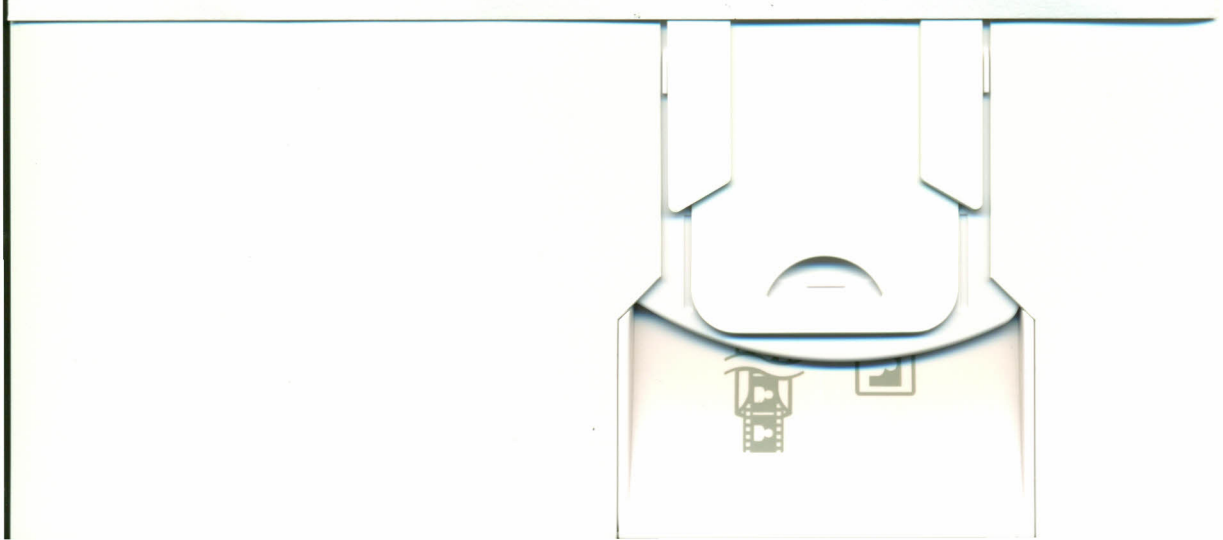



**Fig. 3** : Safety precautions taken by healthy farmers and farmers with health disorders before using pesticides



On the contrary, during spraying, work clothing seems to be efficient to avoid pesticide contamination. Farmers believe that pesticide exposure is greater when spraying than when mixing. Therefore, they pay more attention to wear quality work clothing during pesticide spraying than during mixing. In addition to work clothing, the wearing of face mask seems to constitute an important factor of protection. After their first illness experience, farmers usually don't take additional protective measures until they feel severe health disorders.

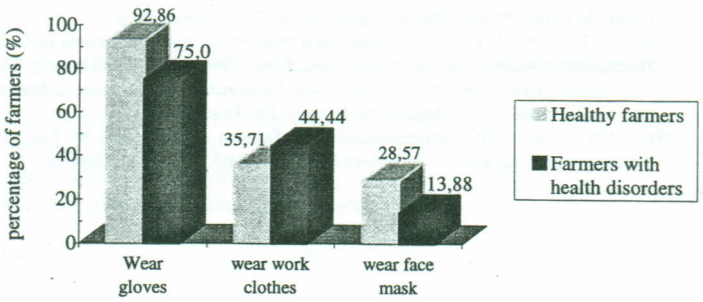



**Fig. 4**: Safety precautions taken by healthy farmers and farmers with health disorders when mixing pesticides

## CONCLUSION

A wide range of cheap and long used pesticide products is still available and widespread in cut flower growing in Thailand. Incorrect labelling, insufficient quality of the products and the unreasonable high amount of trade names contribute to a lack of market transparency and pesticide misuse. Safe use training should focus on the wearing of adequate work clothing and the hazards of pesticide exposition through spray drift. A major problem concerns unawareness of farmer's wives and contract workers involved in pesticide spraying regarding pesticide toxicity. These spraying operators, usually non targeted by extension staff as well as pesticide retailers require particular attention and must be reached by safe use training. Law enforcement of policies for pesticide imports, licensing, registration, control and pricing are therefore essential components to promote an appropriate use of pesticides.

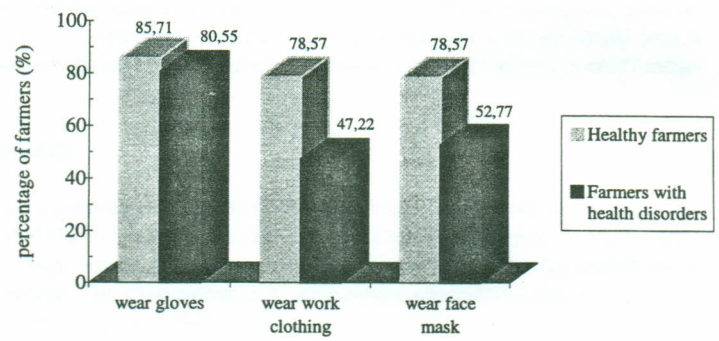



**Fig. 5**: Safety precautions taken by healthy farmers and farmers with health disorders when spraying pesticides

## ACKNOWLEDGEMENT

This survey was conducted with the financial support of the Asia-Pacific Crop Protection Association, regional association of the GCPF (formerly GIFAP).

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