



**United Nations  
Environment Programme**



**Food and Agriculture Organization  
of the United Nations**

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Distr.: General  
7 February 2006

English only

**Rotterdam Convention on the Prior Informed  
Consent Procedure for Certain Hazardous  
Chemicals and Pesticides in International Trade  
Chemical Review Committee**

Second meeting

Geneva, 13–17 February 2006

Item 5 (b) of the provisional agenda\*

**Inclusion of chemicals in Annex III of the Rotterdam Convention:  
review of notifications of final regulatory actions to ban  
or severely restrict a chemical: Endosulfan**

## **Endosulfan– Additional Supporting Documentation – Thailand**

### **Note by the secretariat**

1. Annexed to this note is a translation of the additional supporting documentation provided by Thailand in support of their final regulatory action on endosulfan.

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\* UNEP/FAO/RC/CRC.2/1.

Annex:

**Report on  
Survey on the use of endosulfan for controlling Golden Apple Snail in  
the Paddy fields**



**By**  
Rice Research Institute, Department of Agriculture  
Toxic Substance Division, Department of Agriculture  
Office of Agricultural Regulatory, Department of Agriculture  
Entomology and Zoology Division, Department of Agriculture  
Planning and Technical Division, Department of Agriculture  
Thammasat University  
Agreevo (Thailand) Ltd.  
Muctasim Chemical Work Ltd. (Israel)

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## Introduction

Golden Apple Snail was originated in South America. It was taken from Japan and first brought to Thailand for petting or controlling of algae in fresh-water fish tank during 1982-1983. Golden Apple Snails were then exported to Japan for consumption. Due to its resistance to waste water and aridity, the reproduction is rapidly increased. As a result, an incredible amount of golden apple snails widely spreads into rivers, and canals as well as becomes a significant pest to paddy field particularly after flooding period during 1994-1995. It is reported that the outbreak of golden apple snails is rather severe in 43 provinces throughout the Kingdom. Currently, it is expected that the golden apple snails are widely distributed into more than 65 provinces throughout the country. The golden apple snails, when observing with nagged eyes, can be divided into 2 groups. The first group has yellow-brown shell with yellow tentacles while the second group has a dark-green shell, a light black strip across the body as well as light brown tentacles (Chompoonuch and et al., 1991). The golden apple snails basically destroy rice plant in the sprout stage and seeding stage. The beginning of the stem, which is normally sunk below surface water, is the first place destroyed by the golden apple snails followed by leaves. There are various methods to control golden apple snails. These are such as the use of material to prevent water flowing onto paddy field; the destruction of snails' adults and eggs; the control of water level and the use of chemicals. The most effective method to control the golden apple snails is a combination of all methods. The use of chemicals in controlling of golden apple snails is currently increasing. Department of Agriculture realized that many farmers apply endosulfan in their rice fields to control the golden apple snails, which may cause adverse effects to aquatic animals and the environment. Since the use of endosulfan is not recommended in the paddy field, the data collection and research on the impact of endosulfan are needed.

## Objectives

To learn from farmers concerning;

1. The actual scenario of the use of endosulfan to control the golden apple snails in paddy fields.
2. Method and frequency of the use of endosulfan
3. The effects of the use of endosulfan post to farmers and living organisms including surface water in paddy fields and other natural water ways.

## Task Team

Rice Research Institute, Department of Agriculture  
Toxic Substance Division, Department of Agriculture  
Office of Agricultural Regulatory, Department of Agriculture  
Entomology and Zoology Division, Department of Agriculture  
Planning and Technical Division, Department of Agriculture  
Thammasat University  
Agreevo (Thailand) Ltd.  
Muctasim Chemical Work Ltd. (Israel)

## Operators

Agriculture Scientists of Rice Research Center, Pathum Thani

## Methodology

1. Meeting among the task team, formulate the questionnaires, aiming at gathering data on the use of endosulfan including its adverse effects post to farmers and the environment in both paddy field and natural surface water.

2. Determining the target area by considering the following reasons; the area where farming occurred, which are located in three major basins, Tajeon River, Chao Pra Ya River, and Bang Pra Kong River; data shown that there are significant use of endosulfan; the area connected to natural surface water.
3. Pre-testing and editing of the questionnaires as well as training the team on how to collect the data.
4. Launching at least 200-250 questionnaires to farmers in the target area.
5. Gathering, analyzing, and summarizing the data by using the data obtaining from interviewing of farmers and then estimating the result in forms percentage of farmers in each area

## Study areas

1. Pathum Thani
2. Supan Buri
3. Nontha Buri
4. Nakorn Pathom
5. Cha Choengsao

## Duration of work

March 1999 – April 2000

## Result

1. The main data obtaining from questionnaire are history of farmers; how they found golden apple snails; the method used to control the golden apple snails; the use of endosulfan and its effects.
2. By using the map of Department of Land Development, the study areas are classified as follows;
  1. Pathum Thani i.e. Lad Lum Kaew District, Sam Kok District and Lam Luk Ka District
  2. Supan Buri i.e. Derm Bang Nang Boach District, Samchuck District, and Sri Pra Jan District
  3. Nakorn Pathom i.e. Bang Len District, and Nakorn Chaisri District
  4. Nontha Buri i.e. Bang Bua Thong District, and Thrai Noi District
  5. Cha Choengsao i.e. Meung District, Bang Num Prew District and Bang Poo District
3. The questionnaires were tested with 10 farmers in Lam Luk Ka District, Pathum Thani Province and found it is generally effective. However, there are some questions need to be improved. After improvement of questionnaires, 12 revised questionnaires were then re-tested.
4. After testing the questionnaires, the actual investigation was conducted. The questionnaires were replied by 234 farmers. Of which, 45 of them are from farmers in Pathum Thani, 74 from Supan Buri, 46 from Nakorn Pathom, 29 from Nontha Buri and 40 from Cha Choengsao.
5. Data gathering from questionnaires are presented as follows;

## History of Rice Growing

1. Experience of Rice Growing

The majority of farmers (43%) in Pathum Thani have experienced in paddy field for 21-30 years while the number of the farmers who have experienced in paddy field for 1-10 years, 11-20 years and 31-40 years are in the range of 14% -19%.

The majority of farmers (37.8%) in Supan Buri have experienced in paddy field for more than 40 years while the number of the farmers who have experienced in paddy field for 1-10 year, 11-20 years and 31-40 years are in the range of 13.5% -16.2%.

The majority of farmers (39%) in Nakorn Pathom have experienced in paddy field for 11-20 years while a very few farmers have experienced in paddy field for more than 40 years (9%).

The majority of farmers (34.5%) in Nontha Buri have experienced in paddy field for 11-20 years while the number of the farmers who have experienced in paddy field for 21-30 years and more than 40 years are 27.5% and 24.1% respectively.

The majority of farmers (30%) in Cha Cheongsao have experienced in paddy field for more than 40 years, while the number of the farmers who have experienced in paddy field for 1-10 years, 11-20 years, 21-30 years and 31-40 years are in the range of 15% -20%.

Comparing in province level, it is found that Supan Buri and Cha Cheongsao's farmers have the highest experience in paddy field (more than 40 years), and higher than other provinces (30-37.8%). On the other hand, farmers in Nakorn Pathom and Nontha Buri have less experience in paddy field. They have experienced in paddy field for 11-30 years, in the range of 39% and 34.5 % respectively. The majority of Pathum Thani's farmers have experienced in paddy field for 21-30 years.

On average, it is found that majority of farmers have experienced in paddy field for more than 10 years and 23.5% of farmers have experienced for more than 40 years. The minority of farmers, (less than 14.5%) have experienced in paddy field for 1-10 years and all of them did not feed fish in the paddy fields.

2. Frequency of rice growing per annual

According to the survey, farmers in Pathum Thani, Supan Buri, Nakorn Pathom and Nontha Buri grow rice in their fields more than one cycle each year while 12.5% of Chacheongsao's farmers grow rice in their fields only once a year.

3. land ownership

The majority of farmers in Pathum Thani, Nontha Buri and Chacheongsao own approximately 11-20 Rai (1 acre = 6.25 rai) of land but the percentage of land ownership in each province varied. The farmers owning 11-20 Rai of land in Pathum Thani, Nontha Buri and Chacheongsao are accounted for 24.5%, 34.5% and 32.5% respectively while the farmers owning 21-30 Rai of land in Supan Buri and Nakorn Pathom are accounted for 33.8% and 32.6% respectively. On average, the percentage of farmers in target areas owning 11-20 Rai and 21-30 Rai of land are accounted for 29.5% and 26.5% respectively.

## History of finding of golden apple snails

1. Duration of golden apple snails causing problems

66.6% of farmers in Pathum Thani and 66.2% of farmers in Supan Buri have been facing with golden apple snail's outbreak for more than 5 years while 93.1% of farmers in Nontha Buri have been facing with the outbreak for about 4-5 years. 71.5% of farmers in Nakorn Pathom have been facing with the outbreak for 3-4 years while certain of them (22%) have been facing with the outbreak for more than 5 years. In Chacheongsao, the outbreak was drastically diverse, however, 26-30% of farmers have been facing with the outbreak for 2-3 years while 20%, 12% and 12% of them have been facing with the outbreak for 4, 5 and more than 5 years respectively. On average, 29.5% of farmers have been facing with the outbreak for more than 5 years followed by 5 years (21.8%), 4 years (20.1%), 3 years (18.8%), 2 years (7.7%) and 1 year (1.3%).

2. Frequency of finding of golden apple snails

According to the survey, farmers are facing with the severe outbreak of golden apple snails in each rice crop season. 37.8% of Pathum Thani's farmers and 20% of Chacheongsao's farmers are facing

with the outbreak only in the rich-grade paddy field. On average, the majority (80%) of farmers are facing with the outbreak in both rich-grade and poor-grade paddy field.

### 3. Duration of damage

The damage made by golden apple snails begins after transplanting stage, ranging from 37.5%, 55.4%, 36.9%, 51.7% and 58% in Pathum Thani, Supan Buri, Nakorn Pathom, Nontha Buri and Chacheongsao respectively. The destruction is then occurred in seeding stage up to 7 days and 7-14 days respectively. On average, most of the rice (48.3%) was damaged at the beginning of sowing stage followed by seeding stage up to 7 days (21.8%) and from 7 to 14 days (17.9%).

### 4. Rice species grown in the paddy field

Rice species grown in paddy fields vary from province to province. However, Supan Buri no.1 is the most popular species grown in Pathum Thani while Rice no. 35 is the most common species (37.8%) grown in Supan Buri. Similarly, rice no. 35 is a majority species (82.8%) grown in Nontha Buri. Paungthong is a majority species (36.8%) grown in Nakorn Pathom. Chacheongsao grows Supan Buri no.1 up to 35%. There is no correlation between rice species and the outbreak of golden apple snails, which means the pest damage all species of rice grown in the study area.

## Method used to control golden apple snails

### 1. destruction of eggs

A very few farmers apply this method to destroy the golden apple snails. Only 10.8% of Chacheongsao's farmers apply this method. On average, only 2.2% of farmers apply this method to control the snails.

### 2. destruction of snail adult

60%, 49.2%, 63.9% and 55.1% of farmers in Pathum Thani, Supan Buri, Nakorn Pathom and Chacheongsao apply this method to control the snails on both a permanent basis and temporary basis. On the other hand, a few farmers (17.2%) in Nontha Buri apply this method. However, On average, farmers in all mentioned provinces apply this method on both permanent basis (22.2%) and temporary basis (23.1%), combining of 45.3% in total.

### 3. Use of net preventing the water flow (screening trap)

Few farmers in the study area apply the net to prevent to golden apple snails floating over the surface water into the paddy fields especially there is no record of using this method in Nontha Buri. On average, only 3% of farmers apply this method permanently while 5.6% of them apply temporarily.

### 4. Duck pasturing

The way of feeding the duck with golden apple snails basically benefits the farmers. After harvesting or before starting the next rice growing crop, duck feeder will come to the farmers and request to release their duck into the paddy fields at the land preparation stage. 66.7%, 56.8% and 45.6% of farmers in Pathum Thani, Supan Buri and Nakorn Pathom release the ducks into paddy fields to control the golden apple snails while only 24.1% and 17.2% of farmers in Chacheongsao and Nontha Buri apply this method. On average, 13.2% of farmers apply this method permanently while 31.8% of them apply temporarily, combining of 44.8% in total.

### 5. Animal feeding

None of farmer or a very few farmers feed the animal with the golden apple snails as it is not convenient and they are afraid of chemical used to kill the snails. On average, only 3.4% of farmers feed the animals with the snails on a permanent and a temporary basis.

#### 6. Selling

No golden apple snail selling activity occurs in the study area due to no market share for this kind of snails.

#### 7. Snail-eaten Bird

Snail eaten Bird or so-called “Open-billed Stork” normally consumes the golden apple snails and the snail is partly controlled by the birds particularly in Pathum Thani. It is reported that 60% of the farmers in Pathum Thani temporarily find snail-eaten birds while 22.2% of them permanently find the case. Open-billed Stork is considered insignificant in other provinces in case of reducing the golden apple snails.

#### 8. Application of chemical

According to the survey, it is found that 97.8%, 100%, 97.8% 93.1% and 82.8% of farmers in Pathum Thani, Supan Buri, Nakorn Pathom,, Nontha Buri and Chacheongsao apply a chemical to control the golden apple snails in their paddy fields. On average, 94.1% of the farmers apply chemical in their fields.

#### 9. Consumption of Golden Apple Snail Meat

Consumption of golden apple snail is not popular among farmers. According to the survey, only 2 farmers (2.7%) used to temporarily consume the golden apple snails.

## **Reasons and duration of the application of endosulfan (table 4)**

### 1. Reasons of endosulfan application

The main reason of applying endosulfan is its characteristic in destroying the snails. 60%, 63.5%, 76.1% and 72.5% of farmers in Pathum Thani, Supan Buri, Nakorn Pathom, and Chacheongsao have been applying endosulfan in their fields according to its destroying characteristic. The second reason encouraging farmers to apply endosulfan is the recommendation made by chemical dealers and neighbors. 37.8% of farmers in Nontha Buri apply endosulfan due to its destroying characteristic and the advice made by chemical seller (34.5%) and neighbors (37.8%). On average, farmers widely apply endosulfan under the reason e.g. destroying characteristic (63.7%), advice made by chemical dealers (31.2%) and neighbors (27.8%) as well as its cheap cost (12.8%). It is observed that a very few government agencies have given the advices to the farmers on safe application of endosulfan, which is particularly found in Nontha Buri (6.9%), accounted for only 0.9% of overall surveyed farmers.

### 2. History of the endosulfan use

A number of years for which farmers have been applying endosulfan varied from province to province, however, the trend is consistent with the outbreak of golden apple snails occurring in the area. 33.3% and 37.8% of farmers in Pathum Thani and Supan Buri have been applying endosulfan for 5 years, which is consistent with the finding of snail in the afore-mentioned provinces; 5 years or more than 5 years. In Nakorn Pathon, farmers applying for 3 and 4 years are accounted for 56.5% and 23.9% respectively. The snails have also been found for 3-4 years in this area. In Nontha Buri, farmers

applying endosulfan for 4, 5 and more than 5 year, are accounted for 24.1%, 31% and 27.6% respectively. Concurrently, snails were found in this area for 4-5 years. Chacheongsao trend is also similar to others. Farmers applying endosulfan for 2 and 3 years are accounted for 35% and 27.5% respectively. At the same time, the snails were discovered for almost same years. On average, majority of farmers (27.4%) have been applying endosulfan for 3 years, followed by 5 years (23.5%), and 4 years (19.2%).

## **Trade name and transportation cost accounted by farmers (table 5)**

There are 23 trade names of endosulfan distributing throughout the country, however, the most popular trade names are Guardner, Thiodan, Eto, Nokdai and endosulfan.

Almost all types of endosulfan being used by farmers are in Emulsifiable concentration form (EC) containing in bottle except for the one being used in Nakorn Pathom (13%) and Nontha Buri (34.4), which are in Granule form. Endosulfan is generally sold at the price of 201-300 baht (1 USD = approx. 40 baht) per unit in most market (73.9-84.4%). In Nontha Buri, however, 48.3% of farmers are able to purchase at the price of 201-300 baht per unit (EC) while 34.5% of farmers are able to purchase at the price of 301-400 per unit (granule).

## **Amount and methods of the use of endosulfan to control golden apple snails (table 6)**

### **1. amount used per rai per application**

According to the survey, it is found that; endosulfan is applied at a concentration as follows;

- less than 50 c.c. per rai per application is only found in Pathum Thani (20%) and Nakorn Pathom (10.9%)
- 50-100 c.c. per rai per application is mostly found in Pathum Thani (51.1%), Supan Buri (36.5%), Nakorn Pathom (56.5%), and Chacheongsao (40%). However, few farmers (10.3%) apply this concentration in Nontha Buri.
- 101-150 c.c. per rai per application is found in all provinces, which are Pathum, Thani (22.2%), Supan Buri (21.6%), Nakorn Pathom (17.4%), Nontha Buri (10.3%) and Chacheongsao (17.5%).
- 151-200 c.c. per rai per application is found in all provinces, which are Pathum, Thani (4.4%), Supan Buri (18.9%), Nakorn Pathom (13%), Nontha Buri (27.6%) and Chacheongsao (30%).
- more than 500 c.c. per rai per application is only applied in Supan Buri (12.2%) and Nontha Buri (24.2%)

On average, endosulfan (EC) is applied at a concentration of 50-100 c.c. per rai per application by 40.6% of farmers while concentration of 101-150 and 151-200 are applied by 18.8% and 17.9% of farmers respectively. The use of endosulfan (granule form) at the ratio of 1-3 kg per rai is done by 27.6%, 2.2%, and 2.2% of farmers in Nontha Buri, Nakorn Pathom and Pathum Thani respectively.

### **2. Frequency of application per rice crop**

According to the survey, farmers in Pathum Thani, Nakorn Pathom, Nontha Buri and Chacheongsao apply endosulfan in each rice crop accounted for 38.9%, 63%, 62.1% and 62.5% respectively. However, certain amount of farmers apply endosulfan twice in each rice crop, accounted for 20%, 28.3%, 37.9% and 27.5% respectively. In Supan Buri, 47.3% of farmers apply twice while 33.8% of them apply only once in each rice crop. On average, 57.4% of farmers apply only once in each crop while 33.5% and

10.3% of them apply twice and three times each crop. Only three farmers in Supan Buri apply up to four and seven times each crop, accounted for 0.9% and 0.4% respectively.

### 3. Duration of application

Duration of application vary from place to place. Some farmers apply endosulfan before sowing stage while some apply after. Some farmers apply more than once both before and after sowing stage. On average, it is found that most farmers (82.1%) tend to apply after sowing stage while 47.4% of them apply before sowing stage. The percentage of application of endosulfan after sowing stage as compared to before sowing stage in each province are as follows;

- Pathum Thani	71.1 : 37.8
- Supan Buri	82.4 : 66.2
- Nakorn Pathom	82.6 : 30.4
- Nontha Buri	82.8 : 37.9
- Chacheongsao	65 : 50

### 4. Methods

#### **Mixing with water and spray;**

The major mode of application of endosulfan is to mix it with water and spray over the paddy fields. The majority of farmers in Pathum Thani (53.3%), Supan Buri (58.1%), Nakorn Pathom (41.3%), Nontha Buri (51.7%) and Chacheongsao (62.5%) apply spraying method.

#### **Mixing with water or oil and drop;**

The second mode of application of endosulfan is to mix it with water or oil and gradually drop into the paddy fields which allows the droplet to disperse into swamp area. The detail of mixer vary from place to place though, 31.1% and 22.5% of farmers in Pathum Thani and Chacheongsao apply the mixing of endosulfan with oil and drop into the fields while 20% and 10% of farmers in the the mentioned provinces apply the mixing of endosulfan with water and drop into the fields. Supan Buri and Nontha Buri prefer the mixing of endosulfan with water rather than oil while Nakorn Pathom prefers no mixing, mixing with water and mixing with oil at the range of 26.1%, 17.4% and 15.2% respectively. By looking at overall application, the method being applied is obtained in order such as spray (53.9%), mixing with water and dropping (20.5%), mixing with oil and dropping (16.7%) and no mixing (11.1%).

### 5. Water drainage after application of endosulfan

After applying endosulfan, limited water flow out of the field. 55.4% of Supan Buri farmers drain water out of the filed while 17.8%, 18%, 13.8% and 20% of water in Pathum Thani, Nakorn Pathom, Nontha Buri and Chacheongsao was drained. On average, according to the survey 29.5% of water was drained while the rest (70.5%) was not.

### 6. retention time of inlet after application

Among the group of farmers whose paddy-field inlet was released after application of endosulfan, it is found that the retention time of inlet varied from province to province as follows;

- Supan Buri: 54% of Supan Buri farmers released the inlet out of the paddy field within 1-3 days.
- Pathum Thani: 11.1% of farmers released the inlet out of the paddy filed within 6-7 days, 4.5% within 1-3 days and 2.2% within 4-5 days.
- Nakorn Pathom: each of 7% of farmers released the inlet out of the paddy fields within 1-3 days and more than 7 days.
- Nontha Buri: 10.3% and 3.4% of farmers released the inlet out of the paddy fields within 1-3 days and more than 7 days respectively.
- Chacheongsao: None of the farmers released the inlet out of the paddy fields within 1-3 days, while 11%, 3% and 6% of farmers did it within 4-5 days, 6-7 days and more than 7 days respectively.

On average, the majority of farmer (20.5%) released the inlet out of the paddy fields within 1-3 days. Other retention time periods were not significant (2.6-3.4%). However, releases of inlet is considered minimal as compared to no releases (close-system) (70.5%).

#### 7. Outlet receiver

Outlet water from Pathum Thani (11.1%) and Supan Buri (33.7%) are direct into irrigation canals rather than other pathways. On the other hand, farmers in Nakorn Pathon (12%), Nontha Buri (10.3%) and Chacheongsao (14%) released the outlet into rivers and canals. On average, 14.5% farmers released the outlet into irrigation canals while 11.1% of farmers released into rivers, and canals.

## Effects after the application of endosulfan

### 1. Effects of application

It is observed by most of the farmers (75-89%) that the use of endosulfan causes the death of non-target organisms such as fish, frog and snake. Certain farmers observed the death of shrimp, crab, rat, eel, and toad after the use of endosulfan. On average, 84.2%, 62.4%, 60.7%, 15.4%, and 12.4% of farmers reported the death of fish, snake, frog, bird, and shrimp respectively while a very few farmers (0.4%-1.7%) reported the death of crab, rat, eel and toad.

### 2. Effects to users

43.2-65.5% of farmers reported that the side-effect of the use of endosulfan was not clearly discovered. The rest of farmers found some side-effects and these varied from person to person. However, the common symptoms found in every province are headache (24.1-39.2%), nausea (6.9-14.9%). On average, 54.7% of farmers confronted with no side-effect, 34.2% headache, 11.1% nausea, and few of them confronted with respiratory problem, limb numbness, weakness, irritated eyes, and irritated skin.

### 3. awareness of the farmers

85.1-100% of farmers in all provinces are aware that endosulfan is harmful to the environment except for Nontha Buri, of which only 69% of farmers are aware. Farmers who are not aware of the effects of endosulfan post to the environment are accounted for 7.6% (Pathum Thani), 12.2% (Supan Buri), 10.3% (Nontha Buri) and 12.5% (Chacheongsao). Moreover, farmers who are unconcerned about the effects of endosulfan are accounted for 2.7% (Supan Buri) and 20.7% (Nontha Buri). However, on average, 88% of farmers are aware of those effects, 8.5% are unaware and only 3.4% are not sure.

### 4. Death of fish after the use of endosulfan

70.4%, 64.9%, 83% and 65.5% of farmers in Pathum Thani, Supan Buri, Nakorn Pathom, and Nontha Buri reported that they observed the death of fish in rivers and canals after the use of endosulfan while a minority of farmers is not known. However, 60% of Chacheongsao farmers have never observed the case. On average, 65.4% of farmers observed the case.

### 5. recommendations of the use of endosulfan in the next rice crop season

91.1%, 87.8%, 97.8%, 69% and 80% of farmers in Pathum Thani, Supan Buri, Nakorn Pathom, Nontha Buri and Chacheongsao strongly confirm that they will apply endosulfan in the next rice crop season even though they are aware that it is toxic to human health and the environment. The main reason of this, is that endosulfan effective substitute is not currently available. Only minority of farmers are thinking about stop using the endosulfan. 5.4% and 24.1% of farmers in Supan Buri and Nontha Buri are still not

sure. On average, 86.8% strongly confirm that they will continue using endosulfan while 8.5% will stop using, and 4.7% are still not sure.

## Conclusions and recommendations

According to the survey, it is disclosed that most of the farmers in the study area own 11-30 rai of land and almost all farmers have been experiencing in paddy field for more than 10 years and the rice was grown more than one growing cycle a year.

The outbreak of golden apple snails was found in every province and the outbreak has been lasted for at least 3 years and has caused the adverse effects every growing season. The golden apple snails attack the rice plant mostly in the sowing stage. The control of golden apple snails applied by the farmers are destruction of eggs; the use of net, feeding of animals and humans. However, 55-60% of farmers in Pathum Thani, Supan Buri, Nakorn Pathon and Chacheongsao apply the destruction of snail adult while a few of them apply this method in Nontha Buri. Duck pasturing method was applied by farmers in Pathum Thani, Supan Buri, and Nakorn Pathon while a very few farmers in Nontha Buri and Chacheongsao applied this method. Open-billed Stork, a snail-eaten bird, is a natural control of snail, therefore, they have an important role in reducing the number of snail particularly in Pathum Thani. It is reported that 82% of farmers observed Open-billed Stork eating snail in their paddy fields.

It is admitted by 94% of farmers that chemical is still needed to get rid of the snail and endosulfan is well known. Pathum Thani and Supan Buri farmers have applied endosulfan in their paddy fields for 5 years or more. Other provinces' farmers have applied for 3-4 years. Although the reason of the use of endosulfan varied from person to person but they share a common reason, that is endosulfan perform satisfactory characteristic in killing snails. Most of the farmers applied liquid-form endosulfan in Emulsifiable concentration form, while the application of granule form is limited.

Rate and method of application rather vary, however, On average 41% of farmers apply at the concentration of 50-100 c.c. per rai per application. The use of endosulfan at the concentration of 101-150 and 151-200 c.c. per rai per application are equal, 18%. Interestingly, 12% and 14% of farmers in Supan Buri and Nontha Buri apply at the concentration above 500 c.c. per rai per application.

Majority of farmers in the study area except for Supan Buri apply endosulfan once in each rice crop season. Supan Buri's farmers, on the other hand, apply endosulfan twice in each rice crop season. It is also found that some farmers in Supan Buri apply about 4-7 times in each rice crop season.

Farmers applying endosulfan after sowing stage as compared to before sowing stage is accounted for 2: 1 except for Supan Buri and Chacheongsao, in which the ratio before and after sowing stage is similar. On average, 54% of farmers apply a spray method, 20% and 17% of them apply the mixing of endosulfan with water and oil respectively. 11% of Nakorn Pathom's farmers apply endosulfan into the field directly. After applying endosulfan, most of the farmers do not release the inlet water out of their paddy fields except for Supan Buri's farmers in which 50% of farmers release the inlet out of their paddy fields. Moreover, almost all farmers in Supan Buri release the inlet out of their paddy fields within 1-3 days after application, which may be related to the duration of the application of endosulfan before sowing stage.

It is observed by almost all farmers that endosulfan can cause the death of fish, snake, frog, eel, and toad. 50% of farmers observed the side-effects of the use of endosulfan. These symptoms are such as headache, nausea, weakness, and irritated eyes. However, although farmers are aware of the adverse effects caused by endosulfan to human health and the environment, they are strongly admitted and confirmed that they will continue using endosulfan in the next rice crop season due to substitutes of endosulfan or alternative methods are not known.

As to the summary above, it is clearly mentioned that although endosulfan post the adverse effect to human health and the environment, the farmer are thinking of continuing the use of such chemical. In order to

enhance the safer use of chemical to control golden apple snails, the following measures need to be undertaken;

1. Seeking for appropriate and effective substitutes by considering the cost, easy to apply and suitable for farmers.
2. During the research period of finding an appropriate substitute, The instant solution is to encourage the safer application of endosulfan e.g. ratio of application, methods of application, and duration of application including the drainage of inlet out of the field after application.