JARQ 49 (2), 103 - 109 (2015) http://www.jircas.affrc.go.jp

# Farmer Perceptions and Management of Rice Planthoppers in Cambodia

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## Abstract

Solving big problems requires accurate information. Rice in the area of Cambodia near Vietnam was extensively damaged by the brown planthopper (BPH) from 2007 to 2009, with all districts in Takeo province in the area of Cambodia near Vietnam severely affected. How did farmers learn of methods to protect rice plants? This study seeks to reveal how methods to control the BPH were diffused in Cambodia through interviews with farmers, local governmental officials, and village chiefs in the target province. The farmers stated that they controlled the BPH with nets and beating as physical controls and spraying mixed oil & ash and chemical pesticides as chemical controls. They tended to source their own information and experiences of neighbors, government officials, and pesticide sellers, while farmers in three communes very severely affected by the BPH infestation followed the advice of sellers in employing pesticides. Further, most local government officials and village chiefs recommended using nets and spraying oil mixtures and chemical pesticides. The flow of information from the resource to individual farmers seemed to be linked to the level of BPH infestation.

**Discipline:** Insect pest
**Additional key words:** brown planthopper, control, flow of information

## Introduction

The brown planthopper (BPH), *Nilaparvata lugens* (Stål) is one of the most destructive pest insects in Asian countries (Denno & Roderick 1990, Dyck & Thomas 1979). When heavy infestations occur, the BPH, by sucking sap, can cause rice plants to dry out and wilt completely, as in hopper-burn. Moreover, the insect can work as a vector for plant pathogen viruses, which exacerbate losses (Hibino et al. 1985, IRRI 1983).

To counter the BPH, useful and effective information must be conveyed to individual farmers to control the pest in fields. The importance of knowledge diffusion dynamics in developing economics has been recognized (World Bank 1999), although such knowledge is often unequally distributed within a nation (Morone & Taylor 2004). For example, although farmers have solved problems on their own to some extent when cultivating crops, they have achieved only low yields (Huis & Meerman 1997). To produce high and stable yields, it is important for each farmer to learn better methods by transmitting information. Farmer field school (FFS) has been utilized for this purpose in tropical Asian countries. It plays an important role in the pesticide-use of farmers, since this learning process has been integrated into the pest-management (IPM) program of the Food and Agricultural Organization of the United Nations (FAO); farmers trained in FFS succeed in disseminating fewer pesticides than other farmers (Heong & Escalada 1998, Yorobe et al. 2011). Moreover, ecological engineering projects are conducted in Vietnam and Thailand to reduce the yield losses of rice pests (Gurr et al. 2011, Nootjarin 2012)

Cambodia is one of the rice-producing countries in Southeast Asia. Eighty percent of its population live rurally and 51% of total employment is agricultural (World Bank 2012), with most farmers cultivating rice for a living. Though its yields of rice are now higher than previously (FAO 2012), farmers still lack proper pest control knowledge, particularly in using pesticides (Sylviane et al. 2002). From 2007 to 2009, local government official farmers in national provinces producing high volumes of rice detected the BPH infestation in their rice fields in the area of Cambodia near Vietnam (Matsukawa et al. 2014), but were unsure how to control and manage the BPH problem or trace

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Received 17 March 2014; accepted 20 August 2014.

the source of their information. Accordingly, this study aims to reveal (1) the methods that Cambodian farmers employed to control BPH and (2) the main information route via which these methods were transmitted.

## Material and methods

### 1. Study area

Takeo province is one of the great rice-producing provinces of Cambodia. Five of its ten districts were selected as a study area, namely the Treang, Tramkok, Kirivong, Koah Andaet, and Prey Kabbas districts. Further, one commune from each district was selected as a workshop-style interview site: R, CT, PR, PK, and PP communes (Fig. 1).

### 2. Workshop-style interview with farmers

In 58 of 64 villages in five communes, workshop-style interviews were conducted with rice-cropping farmers in 2012. Through a village chief, 10 to 15 farmers participated in each workshop and photos, illustrations, and figures were used in the workshop to reduce misunderstanding. The farmers responded to questions by sticking colored papers on large-sized craft papers with questions; multiple answers were allowed for all questions.

According to the result of a previous survey, the methods used to control the density of the BPH population included dispersing nets, beating infected plants with sticks, spraying a mixture of oil & ash, spraying a pesticide, spreading additional fertilizer, removing the BPH from infected plants, and employing fluorescent lights to collect BPH. These methods were depicted to the participants with explanations, and farmers were asked to place stickers on the column that conformed to their practices.

The factors determining which methods were used against the BPH included the availability of informational resources and the level of BPH infection. Farmers were asked to record the resources for each method with a table. The farmers chose from options including their own experiences; those of their families, neighbors, and farmers in other villages; and information of government officials (GO), non-governmental organizations (NGOs), pesticide sellers, and others. Further, the farmers were also asked whether they recognized BPH infection in their rice fields from 2006 to 2011. Photos of the BPH and hopper-burn were shown with explanations to prevent any misunderstanding of the symptoms caused by other insects or disease pests.

### 3. Interview with key persons

Interviews were conducted with officials of district agricultural offices (DAO) in five districts and with village chiefs of 58 villages to determine the recommended methods of controlling the BPH population density.

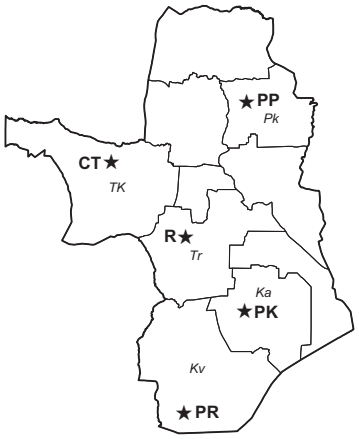


**Fig. 1. Map of Takeo province and target communes of workshop interviews**
District names: *Tr*: Treang; *Tk*: Tram Kak; *Kv*: Kiri Vong; *Ka*: Koah Andaet; *Pk*: Prey Kabbas, names of target communes: R, CT, PR, PK, PP.

### 4. Data analysis

For the control method and their information resources, individual answers (Yes=1, No=0) were calculated as a percentage of the total number of farmers in each commune and the statistical significance of differences among the control methods in each commune was calculated using the Steel-Dwass test. The result among the resources of each method was also calculated by the same test in each commune, while data were analyzed with Excel statistical analysis add-in software (Excel statistic 2012; Social Survey Research Information Co., Ltd., Tokyo, Japan). The same letters in tables indicate no significant differences ($P < 0.05$).

## Results

From the workshop interviews, we obtained 655 valid answers (R, 110; CT, 179; PR, 127; PK, 130; PP, 109) from 799 participants (82.0%). Further, we also acquired answers from key person interviews; five from the officials of DAO and 57 from village chiefs respectively.

### 1. BPH management conducted by farmers during the infection

The control methods conducted on farmers were as follows: (1) nets -- 2 persons holding the end of a big net and walking in the field to catch the BPH; (2) beating -- beating the infected rice plants with a stick; (3) oil & ash -- a mixture of machine oil & ash/sand was sprayed onto fields; (4) pesticides -- spraying chemical pesticides; (5) removal -- removing the damaged rice plants from the field; (6) fertilizer -- adding fertilizer; (7) light traps -- turning on fluorescent lights or making fires in fields to catch the BPH. Some farmers utilized other methods, such as natural pesti-

cides, repellent plants, water controls, and allowing ducks and cows to graze in fields. Almost all farmers chose a combination of multiple such methods mentioned above.

In R commune, 20-30% of the farmers used nets, beating, oil & ash, pesticides, and fertilizer, with no significant differences among these methods. Seventy-four percent of the farmers from the CT commune sprayed a mixture of oil & ash; net-use and beating were conducted by about 45% of farmers. Oil & ash were effective in controlling the numbers of the BPH, according to the participants. In comparison, about 90% of the farmers in the PR, PK, and PP communes sprayed chemical pesticides during the BPH infection, although they also used nets, beating, and oil & ash. Ten percent of farmers in R commune and 3.9% in CT commune did not use any method during BPH infestation (Fig. 2).

**2. Information resources**

To consider the flow of information in the study area, farmers were asked from whom/where they had learned control methods (multiple answers were allowed). The information resources of each method are shown in Table 1. Farmers tended to obtain information on net-use from other persons (including families, neighbors, and other villagers) or governmental officials (including provincial and district offices of agriculture) in CT, PR, PK and PP, while in R commune, other persons followed after the government and farmers' own experiences. Beating was derived mainly from personal experience or from other persons, but 16 farmers in CT commune and a few farmers in other communes obtained details of the same from governmental officials. Further, farmers in all communes learned about the oil-mixture method from other persons, following governmental officials and their own experiences. Pesticide information resources tended to vary among R and CT communes and PR, PK and PP communes. In R and CT communes, the resource tended to be other persons or governmental officials, while conversely, for farmers in PR, PK, and PP communes who sprayed pesticides during BPH infestation, their information resources tended to be pesticide sellers, though some obtained details from other resources (Table 1). Some of the farmers in R and CT communes obtained some information from NGOs, showing that the action area of NGO might be restricted, although this was not confirmed in this study.

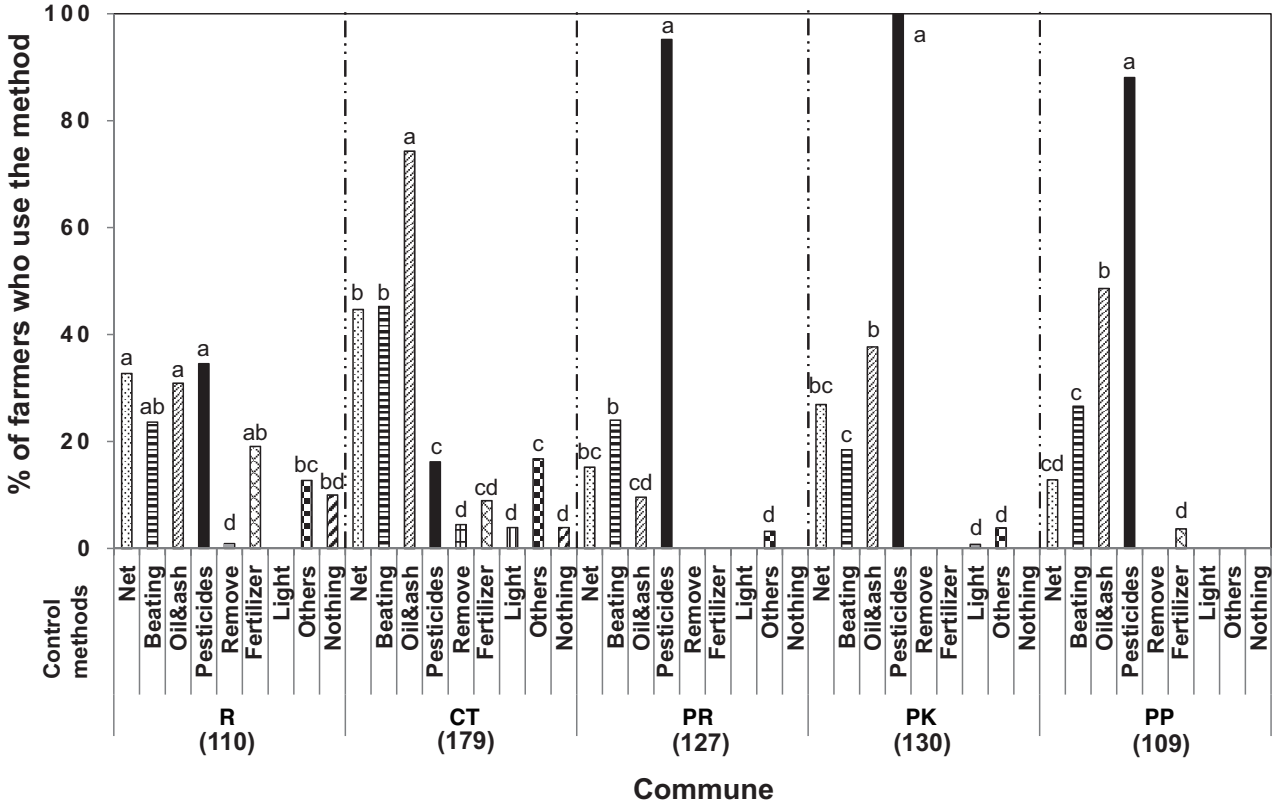


**Fig. 2. The control methods used by farmers during the BPH devastation in five communes**

Parentheses show the number of participants in R, CT, PR, PK, and PP communes. The user percentages were calculated by the numbers of farmers that conducted each method, divided by the number of participants. The same letters mean no significance ($P < 0.05$).

**Table 1. Numbers of farmers who received information on each resource**

| Methods | Resource *2 | R (110) *1 | | CT (179) | | PR (125) | | PK (130) | | PP (109) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Net | Self | 16 | a *3 | 12 | b | 1 | b | 6 | - | 0 | |
| | Other persons | 9 | ab | 36 | a | 14 | a | 12 | - | 8 | - |
| | GO | 17 | a | 34 | a | 4 | b | 11 | - | 6 | - |
| | NGOs | 6 | ac | 17 | b | 0 | | 0 | | 0 | |
| | Mass media | 0 | | 0 | | 0 | | 6 | - | 0 | |
| | Sellers | 2 | bcd | 0 | | 0 | | 0 | | 0 | |
| Beating | Self | 15 | a | 26 | ab | 6 | b | 10 | a | 0 | |
| | Other persons | 4 | b | 39 | a | 19 | a | 13 | a | 20 | a |
| | GO | 0 | | 16 | b | 5 | b | 1 | b | 2 | c |
| | NGOs | 7 | ab | 4 | c | 0 | | 0 | | 0 | |
| | Mass media | 0 | | 0 | | 0 | | 0 | | 7 | b |
| | Sellers | 0 | | 0 | | 0 | | 0 | | 0 | |
| Oil & ash | Self | 6 | ab | 14 | c | 0 | | 6 | b | 4 | b |
| | Other persons | 16 | a | 88 | a | 10 | a | 38 | a | 30 | a |
| | GO | 11 | ab | 33 | b | 2 | b | 6 | b | 18 | a |
| | NGOs | 3 | b | 6 | c | 0 | | 0 | | 1 | b |
| | Sellers | 0 | | 0 | | 0 | | 0 | | 0 | |
| Pesticides | Self | 3 | b | 3 | b | 0 | | 1 | c | 0 | |
| | Other persons | 21 | a | 16 | a | 33 | b | 18 | b | 4 | b |
| | GO | 17 | a | 8 | b | 12 | c | 8 | c | 10 | b |
| | NGOs | 0 | | 0 | | 0 | | 0 | | 0 | |
| | Sellers | 2 | b | 2 | b | 96 | a | 124 | a | 82 | a |
| Remove | Self | 1 | | 7 | - | 0 | | 0 | | 0 | |
| | Other persons | 0 | | 0 | | 0 | | 0 | | 0 | |
| | GO | 0 | | 1 | - | 0 | | 0 | | 0 | |
| | NGOs | 0 | | 1 | - | 0 | | 0 | | 0 | |
| | Sellers | 0 | | 0 | | 0 | | 0 | | 0 | |
| Fertilizers | Self | 13 | a | 16 | | 0 | | 0 | | 0 | |
| | Other persons | 1 | b | 0 | | 0 | | 0 | | 4 | |
| | GO | 6 | ab | 0 | | 0 | | 0 | | 0 | |
| | NGOs | 1 | b | 0 | | 0 | | 0 | | 0 | |
| | Sellers | 0 | | 0 | | 0 | | 0 | | 0 | |
| Light | Self | 0 | | 1 | - | 0 | | 0 | | 0 | |
| | Other persons | 0 | | 1 | - | 0 | | 0 | | 0 | |
| | GO | 0 | | 4 | - | 0 | | 1 | | 0 | |
| | Village chief | 0 | | 1 | | 0 | | 0 | | 0 | |
| | NGOs | 0 | | 0 | - | 0 | | 0 | | 0 | |
| | Sellers | 0 | | 0 | | 0 | | 0 | | 0 | |
| Others | Self | 13 | - | 23 | a | 2 | - | 5 | | 0 | |
| | Other persons | 9 | - | 6 | b | 1 | - | 0 | | 0 | |
| | GO | 0 | | 0 | | 0 | | 0 | | 0 | |
| | Village chief | 0 | | 0 | | 1 | - | 0 | | 0 | |
| | NGOs | 0 | | 1 | b | 0 | | 0 | | 0 | |
| | Sellers | 0 | | 0 | | 0 | | 0 | | 0 | |

*1 Numbers in parentheses indicate the number of farmers in R, CT, PR, PK and PP communes.
*2 Self; own experience, other persons; family, neighbors, other villagers, GO; governmental officials (Provincial and district agricultural offices), NGOs; non-governmental organizations, sellers; pesticide sellers.
*3 Different letters (a-d) show significant differences at an 0.05 level among the information resources of each method in each commune. Minus (-) shows no significant difference at an 0.05 level.

### 3. Extending control methods by governmental officials and village chiefs

The officials of district agricultural offices (DAO) explained BPH control methods to village chiefs (VC) and farmers. The plus-mark in Table 2 shows the method recommended by the DAO. Though the recommendations differed slightly among districts, net-use and spraying oil & ash mixtures and chemical pesticides were offered to farmers by DAO officials in four of five districts. In Treang district meanwhile, including R commune, both net-use and oil

**Table 2. Village chiefs' and DAO's recommendation of BPH control methods**

| District | Treang | | Tramkok | | Kirivong | | Koah Andaet | | Prey Kabbas | |
|---|---|---|---|---|---|---|---|---|---|---|
| Commune (# of chieves) | R (11) | | CT (16) | | PR (11) | | PK (10) | | PP (9) | |
| Recommended by | DAO [*1] | % of VC [*2] | DAO | % of VC | DAO | % of VC | DAO | % of VC | DAO | % of VC |
| Net | + | 90.9 | - | 87.5 | + | 90.9 | + | 60.0 | + | 77.8 |
| Beating | - | 9.1 | - | 31.3 | - | 27.3 | - | 20.0 | - | 11.1 |
| Oil & ash | + | 90.9 | + | 100.0 | - | 18.2 | + | 50.0 | + | 44.4 |
| Pesticides | - | 72.7 | + | 37.5 | + | 81.8 | + | 60.0 | + | 88.9 |
| Light | - | 0.0 | - | 31.3 | + | 0.0 | - | 0.0 | - | 0.0 |
| Others | - | 18.2 | - | 37.5 | + | 27.3 | + | 20.0 | - | 22.2 |

[*1] Plus indicates methods recommended by the DAO (district agricultural office).
[*2] Percentage of village chiefs who recommended each method.
[*3] Other methods; BPH-resistant rice variety, water control, removing infected plants and spraying natural pesticide.

& ash was recommended by DAO and 90.9% of VC, while pesticide was recommended by 72.7% of VC, but not DAO. In Tramkok district, including CT commune, the use of a net was recommended by 87.5% of VC without offering DAO, while oil & ash was offered by both key persons strongly. Pesticide-use was only recommended by DAO and 37% VC. In Kirivong district, including PR commune, both net and pesticide-use were recommended by both DAO and more than 80% of VC. In Koah Andaet and Prey Kabbas districts (including PK and PP communes in each case), both DAO and VC recommendations to farmers were almost uniform for nets, oil & ash, and pesticides. Beating was offered by VC in all communes, while a light trap was only recommended by 31.3% of VC in CT communes and Kirivong-DAO. The other methods recommended by DAO included cultivating resistant varieties, water control, duck eating, removing damaged plants and treating with natural pesticides.

### 4. BPH infection

To understand how the BPH infestation relates to the actions of farmers, we asked whether they had observed BPH damage in their fields. Figure 3 shows the percentage of farmers having recognized BPH damage in their fields in five communes from 2006-2011. In 2006, 50% of farmers from the PK commune had recognized the damage, but fewer were familiar with it in the other four communes. The number of farmers having recognized BPH damage increased in all communes until 2009, whereupon farmers from PR, PK, and PP communes tended to observe the damage until 2011, while those who did so in the R and CT communes decreased (Fig. 3).

## Discussion

The farmers in the study area imposed physical and chemical controls during the BPH infestation (Fig. 2). As BPH physical control, farmers used nets to remove and beat the plants to fly away. Spraying oil & ash mixtures as one of the chemical controls resembles the traditional use of whale and plant-derived oils from Edo times to the postwar-era in Japan and may be equally effective. Oil films prevent the BPH from jumping from the surface of water, which means they die due to lack of air (Okamoto 1992).

Farmers employed chemical pesticides as another form of chemical control. The farmers in PR, PK, and PP communes where BPH damage was recognized more than the other two communes, employed pesticides but tended not to

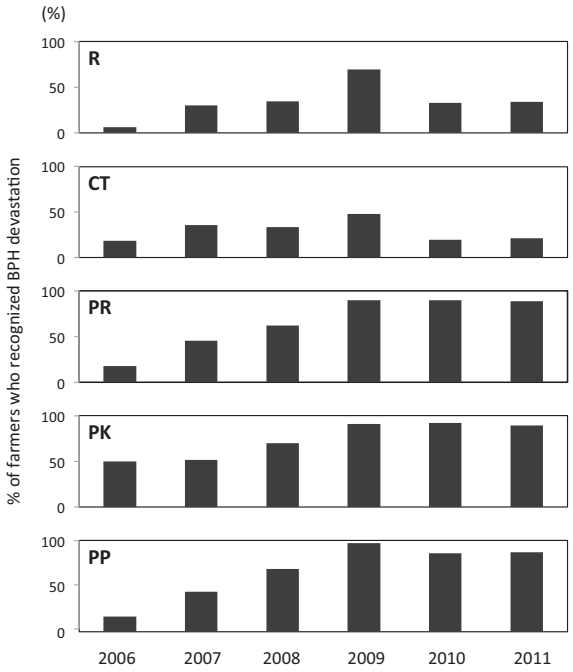


**Fig. 3. The farmers' perception of BPH devastation in their paddy fields from 2006-2011**
The percentages of farmers who recognized BPH devastation were calculated by the numbers of farmers who recognized BPH devastation, divided by the number of participants in each commune.

remember the product names or active ingredients. This might be due to the pesticides being imported, with instructions written in foreign language. Recently, the import of pesticides has been soaring in Cambodia (FAO 2000-2012); mainly from neighboring countries, such as Vietnam and Thailand (JICA-Cambodia 2012, Sylviane et al. 2002), which implies that most farmers handled them without understanding their proper uses. Improper use of pesticide may not only risk farmers' health but also the outbreak of pesticide-resistant BPH. Excessive use of pesticide has seen a resistant BPH population start to emerge in Asian countries (Matsumura & Sanada-Morimura 2010, Sukanya et al. 2013). To manage the use of agricultural chemicals, including pesticides and fertilizers, legislation was enacted by the Cambodian government in December 2012 (JICA-Cambodia 2012). Clear instructions might help farmers use pesticides suitably and avoid such problems.

Information resources in the study area seemed to be divided into two trends. Farmers in the R and CT communes obtained information from those around them or local government officials to learn about nets and oil mixtures to control BPH. Further, the key actors, both local government and village chiefs, also recommended these methods (Table 1-2). In developing countries meanwhile, farmers tend to gain pest control information from their own experiences and the opinions of neighbors, extension services, the media, and pesticide sellers (Heong et al. 2013, Jintana et al. 2012, Nicholas et al. 2003, Paul et al. 2001, Stephanie 2008, Williamson et al. 2003). Farmers in PR, PK, and PP communes used pesticides depending on sellers' opinions in purchasing chemical pesticides, although both key actors recommended the use of nets, oil mixture and pesticides to farmers. The ADB (Asian Development Bank) reported that 20 to 80% of the rice farmers in ASEAN (Association of South-East Asian Nations) relied on local insecticide sellers for pest-management information, advice, and recommendations (Heong et al. 2013). Although knowledge of a new product starts with the seller, diffusing new knowledge requires farmers in the community to exchange their experiences (Ryan & Gross 1943) The flow of information seems consistent with BPH damage. It seems the level of BPH infestation may be a factor in choosing control methods, and pesticides might be used as a last resort to control heavy infestation. The main information resources were their own experiences, governmental officials, and pesticide sellers (Fig. 4). Farmers seemed to favor using pesticides more through sellers than local government officials when BPH heavy infestation occurred, compared to traditional pest controls like using net or oil & ash based on VC advice or farmer's experiences. There is a need to establish a tried and tested route, which can provide information to all farmers in the community.

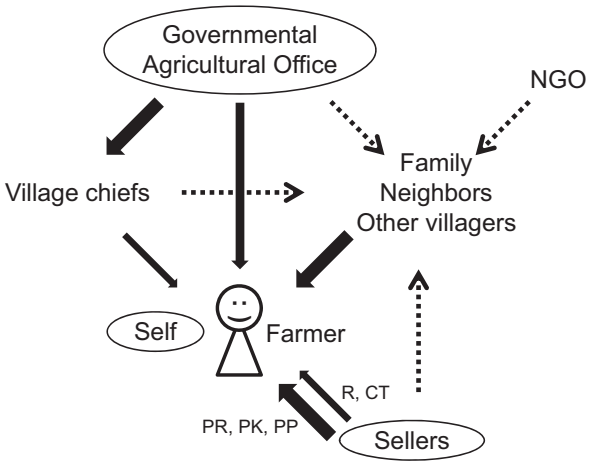


**Fig. 4. Flowchart of information from government to individual farmers**

The magnitude of the arrow indicates the frequency of information access. The dotted line indicates the suspected flow of information.

## Acknowledgments

We thank Drs. Preap Visarto of the GDA and Ho Van Chien of the Southern Regional Protection Centre in Vietnam for providing useful information and advice. We also thank Ms. Hing Thida and Messrs. Var Sophal, and Yam Vin of the Royal University of Agriculture for their translations during the survey. Additionally, we thank all the participants of this study.

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