Risky rice

Rice farmers’ perceived risk and risk awareness and how it affects the handling of pesticides in the Mekong Delta, Vietnam

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Student
Master Thesis in Science of Environmental Health 15 ECTS
Master's Level
Report passed: XX June 2015
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Acknowledgement

This study was made with financial support from the Minor Field Study (MFS) scholarship.

A special thanks to Mr. Ho Thanh Binh (PhD in Food Technology. Vice Dean at An Giang University) who assisted to the aim and purpose with this thesis. Mr. Binh operated as my supervisor in Vietnam. Mr. Le Ngoc Hiep (M.Sc. Lecturer at An Giang University) and Mr. Pham Xuan Phu (M.Sc. Lecturer. Vice Head of Department) assisted me to conduct the interviews. Thanks to all other persons at An Giang University who greeted me and helped me.

To all the interviewed rice farmers who remain anonymous. Since you letting me conduct my interviews at your farms this thesis was able to be completed. I wish to thank you yet again for your time and effort trying to explain your work.

The companies who showed me their facilities taught me about their organizations so I got a holistic perspective on the rice production chain.

Mrs. Trinh Thi Kim Vô (Communicator at Department of Natural Resources and Environment) for your aid and assistance.

My supervisor Kristin Palmqvist (Professor of Plant Ecological Physiology at Umeå University) who supported and gave me valuable feedback and support during the whole project.

Christian Bigler (Senior Lecturer at Umeå University) who helped me received the scholarship from SIDA and other preparations for the travel.

Gerd Sävenstedt (Head of international relations at Piteå Kommun) and Åsa Wikman (Head of Community Development at Piteå Kommun) who help me start the project and create Vietnamese contacts.

I would like to express my gratitude to the families Xuan/Bui and Ha/Hoang who gave me a warm welcome and let me live together with them. You gave me an insight in the Vietnamese every-day-life and knowledge about your country and culture that I will carry with me my whole life. For that I am grateful.
List of Abbreviations and Acronyms

ADI – Acceptable Daily Intake
Agrichemicals – All chemicals used in agriculture, i.e. fertilizers and pesticides
DDT – Dichlorodiphenyltrichloroethane
FFS – Farmer Field School
GDP – Gross Domestic Product
NES – No Early Sprays
PPD – Plant Protection Department
SIDA – Swedish International Development Cooperation Agency
UNEP – United Nations Environmental Program
WHO – World Health Organization
WHO Ia – WHO classification of chemicals: Extremely hazardous
WHO Ib – WHO classification of chemicals: Highly hazardous
Risky rice - Rice farmers’ perceived risk and risk awareness and how it affects the handling of pesticides in the Mekong Delta, Vietnam

Author: Gustav Roslund

Abstract

Agrichemicals have been misused by rice farmers in Vietnam for a long time. This thesis has studied the rice farmers’ knowledge, risk awareness and risk perception to get an understanding of the rice farmers’ agrichemical management. 15 rice farmers in An Giang province in the Mekong Delta, Vietnam were interviewed in 2015 when the winter-spring rice was cultivated. Field method Contextual Inquiry was used to observe and interview the rice farmers. The rice farmers in Mekong Delta, Vietnam think that they are exposed to a medium risk when handling pesticides. They think that pesticides are the most effective pest controlling method. They do not use any protective gear because the weather is too hot which makes the protective gear uncomfortable to wear, even though the majority of the farmers have experienced health effects. The farmers overuse agrichemicals. The rice farmers can increase their gross income if they start using agrichemical more responsible. The majority of the farmers do not follow recommendations established in research. The Vietnamese government have a big responsibility to implement new laws to create a healthier and more environmentally sound agriculture.

Keywords: Vietnam; Rice farming; Pesticides; Environmental Health; Risk awareness.
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7 Appendix 1: Observation and interview template
1 Background

1.1 General
Rice is the most important staple food worldwide (Mainuddin et al. 2011, Savary et al. 2012) and the rice production affects the world’s largest populations of farmers and consumers (Savary et al. 2012). Any progress towards a more sustainable rice production has major global implications, especially for the poor. A more sustainable rice production may result in considerable reduction in negative health effects related to agriculture (Savary et al. 2012).

Pesticide is any substance or mixture of substances intended to prevent; destroy; repel; or mitigate any pest ranging from insects; animals; weeds; to microorganisms (United States Environmental Protection Agency 2014). Pesticides are referred to by their functional class for the organisms that they are designed to control, such as herbicides; insecticides; or fungicides. (Alavanja et al. 2004). Pesticides are applied in order to control disease, vectors and agricultural pests (UNEP 2014). Pesticides are used because of their toxic properties towards targets species. What makes pesticides effective against disease and pest makes them hazardous to humans and to the environment and therefore cause harm to non-target species (UNEP 2014).

1.2 Vietnam – Mekong Delta
Vietnam consists of 58 provinces that are divided in municipalities and districts (Utrikespolitiska Institutet 2010). The provinces have their own budget and vast liberty in the interpretations of central directives. The laws are often unclear, incomplete and inconsistent (Utrikespolitiska Institutet 2010).

The most important sector in Vietnam is the agriculture industry that stands for 25 % of GDP (Utrikespolitiska Institutet 2010). The chemical industry is of big importance as well. (Utrikespolitiska Institutet 2010). Rice and fish farmers’ stands for 50 % of the nationwide employment (Utrikespolitiska Institutet 2010, Nationalencyklopedin 2014) and 80 % in the Mekong Delta (Agricultural technician, pers. comm. 2015-01-16). 20 % of the farmers live in poverty (Agricultural technician, pers. comm. 2015-01-16).

Vietnam is the world’s second largest export country of rice (FAOSTAT 2011). The Mekong Delta in South Vietnam is producing more than 50 % of the domestic output and 90 % of the exported rice (Berg and Tam 2012) but it only covers 12 % of Vietnam (Berg 2002). The Mekong Delta is one of the most dynamic, productive and diverse river basins in the world (Mainuddin and Kirby 2009, Mainuddin et al. 2011). There are three types of rice grown in the basin: main rainfed rice; upland rice; and irrigated rice (Mainuddin and Kirby 2009). In Vietnam they are called summer-autumn rice; spring-summer rice; and winter-spring rice respectively (Mainuddin and Kirby 2009).

1.3 History
The Vietnamese government has promoted use of pesticides which have resulted in extensive use of pesticides from the 1950s and forward (Dasgupta et al. 2007). Agronomists and farmers had little knowledge of the hazards of pesticide use during that period of time. Pesticide applications were completed by specialized teams who worked with the Plant Protection Department (PPD). The PPD recommended spraying on a calendar basis, with little or no attention to field conditions (Dasgupta et al. 2007).

The Socialist Republic of Vietnam was founded in 1976 when northern and southern Vietnam merged (Utrikespolitiska Institutet 2010, Nationalencyklopedin 2014). The southern Vietnam was going to supply the nation with food while the heavy industry and energy production was located in the north (Utrikespolitiska Institutet 2010). The Vietnamese government controlled the agricultural production when the agriculture sector was collectivized during 1978. Since the liberalization of the pesticide market in 1986 farms were
recognized as independent production units and the households seized control over all stages of production (Dasgupta et al. 2007) resulting in agricultural intensification; changes in production patterns; and a higher use of fertilizer and pesticides (Toan et al. 2013). The usage of pesticides has more than tripled during the last 20 years (Toan et al. 2013).

1.4 Climate change
There have been significant changes in the frequency and intensity of extreme climate events associated with climate change in Southeast Asian countries where Vietnam is one of the countries most significantly influenced (Dang et al. 2014). Rice production is affected by global climate change through various pathways (Wassmann et al. 2004). Increasing concentrations of carbon dioxide stimulate photosynthesis while global warming may result in heat stress for rice grown (Wassmann et al. 2004). The predictions are a rise in average temperature by 1.5°C – 2.5°C in 2070 with an increased number of days with a temperature over 25°C (Dang et al. 2014).

1.5 Agrichemicals
The Vietnamese government has promoted the use of pesticides to expand agricultural land and increase output per acre (Dasgupta et al. 2007). Strategies for increased agriculture production have mainly focused on intensified rice farming with high-yielding rice varieties and increased use of agrichemicals (Berg and Tam 2012). Expanded applications have been accompanied by widespread use of chemicals that are hazardous for human health and the environment (Dasgupta et al. 2007). A large number of chemicals have extensively been used to maintain high agricultural yields and mitigate vector borne diseases in Vietnam (Hoai et al. 2011).

Pesticides are still the main pest control method used by farmers (Heong et al. 1998, Berg and Tam 2012). A large proportion of their sprays are misused because of poor knowledge and uninformed decisions (Huan et al. 2008, Berg and Tam 2012). Toan et al. (2013) survey showed that up to 45 % of the Vietnamese rice farmers used more pesticides than the recommendation of the container label in order to be on the safe side protecting their crops. This is a lower figure than the 97 % of the farmers when pesticide usage were examined during 2000 (Dasgupta et al. 2007). Farmers do not only use more pesticides than the recommendation, a study by Toan et al. (2013) showed that farmers often mixed two or more types of pesticides per application to enhance the effectiveness of the treatment; save time and labour; prevent and repel several types of pests; imitate an application method other farmers use. Rice farmers in the Mekong Delta are not only extensively using pesticides, they have been using higher seed and fertilizer rates than necessary as well (Huan et al. 2005). The application of seeds and fertilizer is higher than the optimum application level established in research (Huan et al. 2008). Over usage of seeds, fertilizers and pesticides reduce the farmers’ profits; polluting the environment; and causing negative health effects. These practices might come from the belief that higher inputs results in higher outputs (Huan et al. 2008, Huan et al. 2005). However, usage of high seed and fertilizer rates can result in higher pest and disease plagues which results in a higher use of pesticides (Huan et al. 2005, Huan et al. 2008, Berg and Tam 2012). Crops were nitrogen has been added can make insect pests problems more severe since they produce more eggs; survive better; live longer; and become more ecologically fit (Huan et al. 2005). Nitrogen-added crops with high seed rates are more vulnerable to diseases (Huan et al. 2005). Huan et al. (2005) told the farmers to experiment with the seed, fertilizer and pesticides input. It resulted in an increase in gross margin were the highest contribution were from reduction in pesticide use and seed rates. Reduction in fertilizer had only small contributions to the increased gross margin. Pesticide reduction also resulted in reduction in labor and reduced exposure to pesticide poisoning. The farmers reduced their input of pesticides with 53 % with unchanged yield (Huan et al. 2005).
Inappropriate disposal of left-over pesticide solutions and waste contaminated with pesticides easily pollute surface water as it might have immediate contact with the water in the rice field during cultivation; or get washed away during the flooding season, resulting in pollution of water bodies (Toan et al. 2013). This results in unfiltered and immediate point source pollution of surface water by pesticide and expose aquatic organisms and humans as a consequence (Toan et al. 2013). A survey showed that 95 % of the farmers disposed residual pesticides by reapplying it to the same crop, sprayed additional crops or poured it into canals or ditches (Dasgupta et al. 2007). Another study by Toan et al. (2013) showed that 50 % of the farmers used up the left-over pesticide solutions by spraying part of their crop one more time on the same application day. Up to 43 % poured the left-over pesticide solutions directly in fields. Around 6 % directly poured pesticide waste into canals. Toan et al. (2013) also showed that 96 % of the farmers discarded empty pesticide containers directly in the fields.

As a response to the need for improving pest management to reduce the environmental impacts and health effects of chemical pesticides, two interventions were introduced to farmers in the Mekong Delta during the 90’s, the Farmer Field School (FFS) and the mass media campaign (Huan et al. 1999). Farmer Fields School is an information intensive educational method that takes place in the field (Rejesus et al. 2009). With its holistic perspective the aim is to strengthen farmers’ ability to address their own pest problems (Rejesus et al. 2009). The mass media campaign tried to motivate farmers to experiment whether early spraying for leaf-feeding insects was necessary (Huan et al. 1999). The message was “No Early Sprays (NES)”, to not spray pesticides for leaf-feeding insects in the 40 first days after sowing (Rejesus et al. 2009). Farmers believed that the leaf-feeding insects with their highly visible damage would cause yield loss (Heong et al. 1998, Huan et al. 1999, Huan et al. 2008). However, research showed that leaf-feeding insects that infest rice crops in the vegetative stages rarely cause yield loss (Heong et al. 1998, Huan et al. 1999, Huan et al. 2008) since the plant naturally compensates for any injury caused by these insects (Rejesus et al. 2009). Since leaf-feeding insects are the major target of pesticide use in Vietnam, a large proportion of the applications are unnecessary (Rejesus et al. 2009). Pesticides sprayed in the vegetative stages can instead cause secondary pest problems with an ecological disruption (Heong et al. 1998, Huan et al. 1999). The herbivore-predator relationship is changed when the food web chain is disrupted (Heong et al. 1998, Huan et al. 1999).

1.6 Health effects
The active ingredients are combined with other ingredients to create the pesticide products (Alavanja et al. 2004). Health effects of a pesticide product may be a consequence from either the active ingredient, the other ingredient or both ingredients (Alavanja et al. 2004).

Use of pesticides causes exposure through inhalation; ingestion; eye or skin contact (Dasgupta et al. 2007); and from a variety of sources including occupational exposures; applications to public spaces; home garden and lawn use; and residues in food and water (Alavanja et al. 2004). Humans may be exposed to pesticides through both direct and indirect routes. Direct exposure occurs to individuals who personally apply pesticides and are likely to get exposed for the highest levels (Alavanja et al. 2004). The greatest exposure to highly hazardous pesticides is for agricultural workers during application; mixing; and applying the pesticide (WHO 2010). The main exposure routes is dermal when preparing the pesticide mixture, and by dermal and inhalation during application of the pesticide. Ingestion might occur through consumption of food or drinks during or following work, or oral contact with contaminated hands. Contaminated clothes are a significant source of dermal exposure (WHO 2010).

The relationship between pesticide use and the symptoms of the short-term effects of occupational poisoning has been well established (Berg and Jiggins 2007). During the past three decades, indiscriminate use and improper handling of pesticides in agriculture have caused severe problems for human health in many developing countries (Dasgupta et al. 2007).
2007). Farmers with mild pesticide poisoning often do not report because treatment service are expensive; difficult to get to the clinic; or fear that drawing attention to themselves may result in the loss of employment (Dasgupta et al. 2007). Few farmers in Vietnam have health insurance (Nationalencyklopedin 2014). A report from WHO stated that there were a total of 7170 pesticide poisoning cases in Vietnam during 2002 and hospital admission in Vietnam records attributes 11 % of all poisonings to pesticide misuse (Dasgupta et al. 2007). WHO and UNEP estimate that there are 50 unreported cases of poisoning for every reported and registered poisoning case. Every year between 1 and 5 million agricultural workers get poisoned from pesticides and at least 20 000 workers die, the majority of the workers are living in developing countries (Dasgupta et al. 2007). Health-care professionals in rural areas often fail to correctly diagnose poisoning, as many of the related symptoms are quite general in nature or mimic to other common health problems (Dasgupta et al. 2007). Symptoms such as headaches; dizziness; vomiting (Alavanja et al. 2004, Dasgupta et al. 2007); nausea; pupillary constriction; excessive sweating; tearing; salivation muscle twitches; changes in heart rate (Alavanja et al. 2004); fetal death; hormonal changes; DNA damage; birth defects; Non-Hodgkin’s lymphoma; leukemia; lung cancer; and abnormal sperm; ovaries; and eggs (Dasgupta et al. 2007). Dasgupta et al. (2007) studied on reported symptoms after mixing and spraying pesticides. The survey response were dermal (skin irritation 66 %); neurological (headache 61 %, dizziness 49 %); ocular (eye irritation 56 %); and respiratory (shortness of breath 44 %). 88 % of the surveyed farmers reported multiple symptoms with an average of 4 and a maximum of 9 (Dasgupta et al. 2007).

A survey made by Dasgupta et al. (2007) found that the protective measures taken to minimize the effects of pesticide exposure were masks 61 %, hats 49 %, glasses 20 %, gloves 18 % and shoes 1,4 %. A survey made by Berg (2001) showed that less than 50 % of the farmers used any protective gear.

Indirect exposure occurs through air; dust; water; drinking water; and food. Indirect exposure may occur more frequently than direct exposure but generally in low concentrations (Alavanja et al. 2004). Chronic exposure is associated with a broad range of nonspecific symptoms including headache; dizziness; fatigue; weakness; nausea; chest tightness; difficulty breathing; insomnia; confusion; and difficulty concentrating (Alavanja et al. 2004). Pesticide exposure is also associated with changes in mood and affect. Pesticide exposed farmers reported higher level of tension, anger and depression. The symptoms are a consequence of overstimulation of postsynaptic cholinergic receptors following inhibition of acetylcholinesterase. Some effects have been observed several years after poisoning which suggest that the residual damage is permanent, even for mild poisoning (Alavanja et al. 2004). In the rural areas of the Mekong Delta, surface water still serves as one of the main drinking water sources (Toan et al. 2013). Additionally, surface water is used for personal hygiene; washing of food items; dishes; and clothes. The pollution from pesticides persist and reaches larger canals which are used by people for drinking and other domestic purposes. The surface water treatment used for preparing water for consumption is insufficient for the removal of pesticides. The concentrations occasionally exceeded the existing health guidelines in surface water and in drinking water. Boiling water is essential for the treatment of pathogens such as bacteria, parasitic worms, worm eggs etc. However, boiling water actually increases the concentrations of non-volatile pesticides. As long as pesticide management remains suboptimal the population will be exposed by pesticides due to ingestion (Toan et al. 2013). Bioaccumulation of pesticides does not only poses a risk to the environment when pesticide residues can enter the food chain (Toan et al. 2013). This is a threat for the local population since wild capture of fish, small scale aquaculture and livestock breeding within the rice fields is an important food source for a large part of the population. Bioaccumulation in fish might result in concentrations exceeding acceptable daily intake values (Toan et al. 2013). The acceptable daily intake (ADI) is a measure for the toxicity of a substance by long-term and repeated ingestion (Hoai et al. 2011). Hoai et al. (2011) found that a daily intake of 50 gram of any fish would reach the ADI for several pesticide compounds and only 10 gram fish for some more toxic compounds. A daily intake of 10
grams of some vegetables would exceed the ADI. With economic growth, fish and meat consumption are likely to increase and result in less consumption of rice (Mainuddin et al. 2011).

1.7 Environmental effects
Highly intensive agriculture systems have resulted in contamination of ground and surface water with nutrients and pesticide residues, and increasing resistance of insects and diseases to current methods of pest control (Strand 2000). Once released in the environment, pesticides may harm non-target species and animals as well as humans (Toan et al. 2013). The pollution persist and reaches larger canals which are used for aquaculture production. Residues of current used pesticides were found in considerable concentrations in water; soils; sediments of fields; field ditches; and canals. These environments are the most exposed to potential pesticide pollution due to their nearness to application places. The concentrations occasionally exceeded existing environmental guidelines for water (Toan et al. 2013). A prolonged misuse of pesticides has affected the development of inland fisheries and aquaculture negatively (Berg 2001, Berg 2002).

More than 70 different pesticides residues have been found in in the Mekong Delta (Hoai et al. 2011, Toan et al. 2013). Toan et al. (2013) survey showed that more than 100 pesticides were used at the survey site in the Mekong Delta. The wide range of pesticides and throughout the year indicates a chronic exposure of aquatic organisms. Among these pesticides, several are banned in Vietnam but can still be found in relative high concentrations (Toan et al. 2013). Organochlorines and organophosphates has been largely phased out and replaced by carbanates, pyrethroids and biopesticides (Toan et al. 2013). This development is beneficial from an environmental perspective since these substances tend to be less toxic and less persistent. However, some of the new compounds are toxic for aquatic animals, especially for fish. Nevertheless, surveys and environmental monitoring show evidence of further use of some banned compounds (Toan et al. 2013). PPD completed a nationwide survey in 2000 and found tones of banned pesticides and illegally imported or counterfeit pesticides, many of these pesticides were highly toxic, WHO category Ia or Ib (Dasgupta et al. 2007). Dichlorodiphenyltrichloroethane (DDT) (Hoai et al. 2011, Toan et al. 2013) and other persistent organochlorides and organophosphate are some of the banned pesticides that still occur frequently in the environment (Toan et al. 2013).

A survey made by Toan et al. (2013) showed that 81 % of the farmers cleaned the sprayers in irrigation ditches, canals or ponds nearby their fields, resulting in unfiltered and immediate point source pollution of surface water by pesticide and as a consequence expose aquatic organisms and humans (Toan et al. 2013).

1.8 Alternative pest management
Alternative pest control management has been developed as a response to the need for improving pest management to reduce the environmental impacts and health effects of chemical pesticides (Strand 2000). The main goal is to reduce rice farmers’ reliance on pesticides (Berg and Jiggins 2007, Rejesus et al. 2009). Pesticides are only used after monitoring indicates pests and are applied in a manner that minimizes risks to human health; beneficial for non-target organisms; and the environment (Strand 2000). Alternative pest control management is an ecosystem-based strategy that focus on long-term prevention of pests or their damage through a combination of techniques such as; biological control; use of resistant varieties; habitat manipulation; modification of cultural practices (Strand 2000); agronomic; crop physiology; ecology; and health topics (Rejesus et al. 2009). Farmers learn about supplication of fertilizer; water management; proper land preparation; and when pesticides should be applied. Alternative pest control management is based on: (i) grow a healthy crop through: resistant varieties; seed selection; efficient nutrient; water; and weed management; (ii) conserve natural enemies; (iii) observe the field weekly to determine necessary management actions (Strand 2000).
1.9 Purpose and aim
Previous research by Roslund (2015) was made during January till March 2015 where different rice farming models was compared. Even if there were differences between the rice farming models, every farmer did misuse pesticides. This raised the question and the curiosity about why the rice farmers in Mekong Delta, Vietnam misuse pesticides. The rice farmers misuse of pesticides results in a broad spectrum of negative environmental and health effects. While there is an increasing pressure to reduce the environmental impacts and health effects of agrichemicals, there is also an increasing pressure to increase the yield and quality of the crop to meet the food and market demands.

This thesis will further investigate the problematic usage of agrichemicals among the rice farmers in Vietnam. The aim of this study was to increase the understanding how the farmers’ knowledge and risk perception affects their handling of pesticides. With an understanding we can limit usage of pesticide substances to necessary situations for minimizing potential damage to human health and the environment.

1.10 Limitations
This study involved rice farmers in An Giang Province, Mekong Delta, Vietnam. The research was conducted when the winter-spring rice crop was cultivated. The research focus was on the farmers risk awareness and knowledge and how it affects the usage of pesticides and other input factors such as fertilizer and seed rates.

1.11 Specific research subjects
- How is the rice farmers’ knowledge and risk awareness affecting their input of agrichemicals, work practice and precaution measures?
- How can the usage of pesticide substances be limited to necessary situations and used responsible?

2 Method

2.1 Study site
The study site was conducted in the province of An Giang, situated in the Mekong Delta in the southern part of Vietnam. An Giang is one of the largest provinces in the amount of produced rice (Agricultural technician, pers. comm. 2015-01-16).

Vietnam has a tropical monsoon climate with heavy rain periods during May till October (Nationalencyklopedin 2014). The yearly perception is 1500 – 2000 mm (Nationalencyklopedin 2014) with approximately 90 % of the rain comes during the rainy season (Berg and Tam 2012).

2.2 Field survey
The data collection was conducted during January and February in 2015 when the winter-spring rice was cultivated. The analyses of the data were made during April 2015.

Two pre-interviews were completed to improve the interviewing method and to verify the questionnaire and observation subjects. 15 rice farmers were interviewed.

The farmers were briefed on the research subject and ethical considerations. The farmers’ permission to take photographs was asked for. Confidentiality was promised and that the farmers can exit the interview at any time. The collection of data was through the qualitative research method contextual inquiry which is based on observing the rice farmer do his or her work. A prepared observation template (Appendix 1) was used to secure that all research subjects are answered and notes were taken in the prepared template (Appendix 1) during the
observation. After the observation was completed, an interview was conducted with the farmers. The interviewer asked questions to fill in the blanks in the prepared template (Appendix 1) that the interviewer could not observe during the observation. The observation of the farmers’ work practices was first conducted so the questionnaire would not affect the result. An interpreter helped with the communication. The interpreter had an observation and questionnaire template translated to Vietnamese. The interviewer took notes based on the farmers’ answers on the questions. The answers was analysed based on the observation and farmers’ answers. The result was compiled and analysed by discover affecting factors so conclusions could be made.

2.4 Literature
Web of Science have been used for collecting previous research. The keywords in the search where “Rice; Mekong Delta” and “Pesticide; Mekong Delta”. The research articles where selected after their relevance.

Information has been gathered at Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), United Nations Environmental Program (UNEP), United States Environmental Protection Agency (US. EPA), Utrikespolitiska Institutionen and Nationalencyklopedin.

3 Result
3.1 General
All interviewed farmers were males (Table 1) with an average age of 44 years (Table 1). The rice farmers had on average 22 years working experience (Table 1). All farmers had completed 8 years education (Table 1) and almost half of them had completed previous training in safe handling of pesticides (Table 1).

Table 1: General information about the rice farmers’ gender, age, completed education, completed safe handling of pesticide training and working experience as a rice farmer.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Answers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>100 % male</td>
</tr>
<tr>
<td>Age</td>
<td>44 years on average</td>
</tr>
<tr>
<td>Education</td>
<td>8 years on average</td>
</tr>
<tr>
<td>Completed basic training in safe handling of pesticides</td>
<td>47 %</td>
</tr>
<tr>
<td>Working experience</td>
<td>22 years on average</td>
</tr>
</tbody>
</table>

3.2 Risk awareness
The rice farmers thought that they were exposed for a medium risk when handling pesticides. All farmers associated pesticides with the pesticides function, to fight diseases, fungus, and insects. The efficiency of the pesticide was the most important factor when buying pesticides, scoring the highest score for all farmers (Figure 1). The toxicity of the pesticide was the second most important factor (Figure 1) followed by the price (Figure 1). Legality was the second least important factor (Figure 1) and environmental sound pesticides were the least important factor when the rice farmers buy pesticides (Figure 1). Before the application, some farmers asked the interviewer to stand in a certain location so no exposure could occur because the wind direction.
3.3 Agrichemicals input

The interviewed rice farmers used agrichemical input in a wide range. The majority of the rice farmers used 1500 kilos fertilizer per hectare and year (Figure 2) with variations from 141-1800 kilos per hectare and year (Figure 2). The most common volumes of seed input was around 470 and 600 kilos per hectare and year (Figure 3) but had also variations from 180-1000 kilos per hectare and year (Figure 3). Around one third of the farmers used the recommended seed-fertilizer ratio that has been established in research to grow a high quality crop (Figure 4).

Figure 1: How important different factors are when the rice farmers buying pesticides, on a scale of 1-5 where 1 is the lowest and 5 the highest.

3.3 Agrichemicals input

The interviewed rice farmers used agrichemical input in a wide range. The majority of the rice farmers used 1500 kilos fertilizer per hectare and year (Figure 2) with variations from 141-1800 kilos per hectare and year (Figure 2). The most common volumes of seed input was around 470 and 600 kilos per hectare and year (Figure 3) but had also variations from 180-1000 kilos per hectare and year (Figure 3). Around one third of the farmers used the recommended seed-fertilizer ratio that has been established in research to grow a high quality crop (Figure 4).

Figure 2: The farmers input of fertilizer in kilos per hectare and year.

Figure 3: The farmers input of seeds in kilos per hectare and year.

Figure 4: The used seed-fertilizer ratio by the farmers. 2.5 kilo fertilizer per kilo seed is established in research to grow a high quality crop (Agricultural technician, pers. comm. 2015-01-16).
3.4 Pesticides

One fifth of the rice farmers applied pesticides to the crop on a calendar basis and almost every farmer applied pesticides when they have been observing pests or when they observed that the pest population has become too big. In average did the farmer spray the rice crop 6 times, that ranges from 4-8 times (Figure 6). The first application of pesticides was in average 30 days after sown but with a big range from 20 to 40 days (Figure 5). Most farmers did apply the pesticides for the first time 20 days after sown (Figure 5) and almost one fourth of the farmers did apply pesticides for the first time 40 days after sown (Figure 5).

![Figure 5: How many days after sown the first application of pesticides is completed by the farmers.](image1)

![Figure 6: How many applications of pesticides the farmers complete per crop.](image2)

3.5 Work practice

Almost every interviewed rice farmer said that they read the instructions on the pesticide container before application (Table 2). However, none of the farmers did read the container label before application during the observations. The rice farmers said that they did not need to read the instructions again since their long working experience. More than one out of ten rice farmers mixed different pesticides to reduce their labour (Table 2). Every rice farmer re-applied the same crop until the left-over pesticide solution was finished (Table 2). Some farmers mentioned that they never had any left-over pesticide solution because they knew the exact amount to prepare. However, when mixing the pesticide solution it was no exact volumes they used. After the application the farmers cleaned their application equipment in a nearby water body (Table 2). Nine out of ten farmers re-entered the rice field the day after application and one out of ten wait one or two days before they re-entered the rice field (Table 2). Around half of the rice farmers recycled the pesticide containers so they got refunds. If the container does not have refunding, the farmer will either leave or burn the container in the rice field or right next to the rice field (Figure 5).

Table 2: Farmers’ different work practice in percentage.

<table>
<thead>
<tr>
<th>Work practice</th>
<th>Answers in percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read container label before use</td>
<td>93 %</td>
</tr>
<tr>
<td>Mixing different pesticides</td>
<td>13 %</td>
</tr>
<tr>
<td>Reason why mixing different pesticides</td>
<td>Reduced labour</td>
</tr>
<tr>
<td>Left-overs</td>
<td>Spray</td>
</tr>
<tr>
<td>Cleaning equipment</td>
<td>Nearby water body</td>
</tr>
<tr>
<td>Re-enter the rice field after application</td>
<td>1 day</td>
</tr>
<tr>
<td></td>
<td>2 days</td>
</tr>
<tr>
<td></td>
<td>3 days</td>
</tr>
</tbody>
</table>
3.6 Health
None of the interviewed rice farmers used protective gear that was intended for chemical protection (Table 3). The gear the rice farmers used was shorts, long-sleeve shirt and a hat was used to protect the farmer from the intense sunlight. The reason why the farmers chose not to use any protective gear was because it is uncomfortable to wear since the hot weather (Table 3). Almost every rice farmers have experienced health effects related to handling and usage of pesticides (Table 3). The most common symptom was tiredness and difficulty breathing (Figure 8). More than half of the farmers reported numerous symptoms, at the most 6 symptoms. Around one fourth of the farmers were worried about the long-term effects of pesticides (Figure 8). After spraying pesticides, almost every farmer washed their hands in a nearby water body (Table 3). All farmers washed their hands, body and change clothes when they got back to their house (Table 3).

Table 3: Shows the farmers usage of protective gear and their personal hygiene routines in percentage.

<table>
<thead>
<tr>
<th>Personal hygiene</th>
<th>Specifics</th>
<th>Answers in percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No protective gear</td>
<td></td>
<td>100 %</td>
</tr>
<tr>
<td>Reason why not use</td>
<td>Uncomfortable because of the heat</td>
<td>100 %</td>
</tr>
<tr>
<td>protective gear</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experienced health effects</td>
<td></td>
<td>87 %</td>
</tr>
<tr>
<td>Washed hands</td>
<td>Nearby water body</td>
<td>87 %</td>
</tr>
<tr>
<td></td>
<td>Home</td>
<td>100 %</td>
</tr>
<tr>
<td>Washed body</td>
<td>Home</td>
<td>100 %</td>
</tr>
<tr>
<td>Changed clothes</td>
<td>Home</td>
<td>100 %</td>
</tr>
</tbody>
</table>
3.7 Alternative pest control methods

Around one third of the interviewed rice farmers used an alternative pest control method to reduce their usage of pesticides (Table 4). Biological control is the most common method followed by resistant varieties (Table 4). Around half of the farmers who do not use any alternative pest control method thought that it does not work (Figure 9). Other reasons why not using any alternative pest control method was that the farmers thought that will result in less quality of the crop (Figure 9); pesticides are more effective (Figure 9); or that their neighbours do not practice any alternative pest control method (Figure 9).

Table 4: How many of the rice farmers that practice an alternative pest control method and what alternative pest control method they used.

<table>
<thead>
<tr>
<th>Alternative pest control methods</th>
<th>Answers in percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use alternative pest control method</td>
<td>27 %</td>
</tr>
<tr>
<td>Biological control</td>
<td>100 %</td>
</tr>
<tr>
<td>Resistant varieties</td>
<td>24 %</td>
</tr>
</tbody>
</table>

Figure 8: Short term health effects related to pesticide handling or application. Long term health effects worries.

Figure 9: The reason why the rice farmers do not practice any alternative pest control method.
4 Discussion

4.1 Risk awareness
Rice farmers in the Mekong Delta think that they are exposed to a medium risk when handling pesticides. A medium risk could either be “pesticides are not that dangerous so it is a medium risk” or “pesticides are pretty dangerous but there are other hazards that are more dangerous”. First we have to settle what type of medium risk the interviewed rice farmers think about. As a conclusion from the discussions and observations, the interviewed rice farmers think that they are exposed for a medium risk when handling pesticides, they think that pesticides are not that dangerous so it is “only” a medium risk. This conclusion was made from the observations when the farmers do not care about safety precautions when handling pesticides. The farmers mix the pesticides, apply the pesticides, clean the equipment (Table 2), and leave the containers in the rice field or nearby water body (Table 2) without any thought about the environmental pollution. The farmers also mix the pesticides and apply the pesticides without using any chemical protective gear (Table 3). The interviewed rice farmers’ risk perception might have been less than medium. However, their risk perception might increase because almost every farmer have experienced health effects when handling pesticides (Table 3) and several of the farmers are worried about their future health when being exposed to pesticides (Figure 8).

The rice farmers associations with pesticides is another result from this study that strengthens the conclusion that the farmers think that they are exposed to “only” a medium risk when handling pesticides. The farmer’s associate pesticides with the pesticides function, to kill, repel and fight pests such as diseases, fungus and insects. None of the farmer mentioned that pesticides can cause negative health effects or environmental degradation. If the interviewed rice farmers risk awareness was higher it should have resulted in associations with negative health effects and environmental degradation.

When the farmers think that they are exposed to “only” a medium risk it could result in why none of the interviewed farmers used chemical protection (Table 3) since the pesticides are not that dangerous according to the farmers. Dasgupta, et al., (2007) showed that an increased amount of pesticides increased the rice farmers precaution measures and therefore reduced the risk of poisoning. Dasgupta et al. (2007) also showed that an increased percentage of highly toxic pesticides did not affect the usage of protective gear which resulted in higher risk for poisoning. Dasgupta, et al., (2007) conclusions were that the farmers use more or less protective gear depending on the amount of used pesticides. The farmers are not aware of the toxicity of the pesticides and therefore do they not use more protective gear when they handle a more toxic pesticide. The most important factor that reduced the risk of poisoning was usage of protective gear and not what type of pesticide that was used (Dasgupta et al. 2007). If the used amount of pesticides decrease, it could result in less used protective measures by the farmers. To reduce the reliance on pesticide and start practice safe handling, information and education is needed. When the farmers learn about the hazards of pesticides, they need to get information about how essential protective measures are for them selves, other humans and the environment. However, this survey showed that several farmers had participated in basic training for safe handling of pesticides but they still misusing the pesticides without any or minimum precautions (Table 3). Therefore a good education and restrictions is needed to make a change for the better. Dasgupta et al. (2007) conclusions were that the farmers are not aware of the toxicity of the pesticides, therefore are regulations and bans of highly toxic pesticides needed.

Some of the interviewed rice farmers are aware of the risks of pesticides. They proved this by asking me to stand in a certain place next to the rice field while they were spraying the pesticides. They chose the location after they have been observing the wind direction. This proves that some farmers are aware of the risks and hazards of pesticides. The rice farmers did not want me to get exposed of the pesticides aerosols from the application even if I was
standing 30 meters away from the application location. I would have got exposed to a low concentration compared to the farmers since they were standing in the middle of the pesticides aerosol mist where the highest concentrations are. Farmers often misuse pesticides because poor knowledge and uninformed decisions (Huan et al. 2008, Berg and Tam 2012). The farmers proved that they have the knowledge about the risks and hazards of pesticides when they made sure that I would not get exposed from the pesticides. The decision to spray the rice field without any precaution is therefore a choice that is an uninformed decision when they are aware of the risks but ignore them or some other factor is affecting their handling of pesticides.

The easiest and cheapest way to reduce the exposure during spraying is that the applicator needs to be aware of the wind direction and start the application in the corner of the field where the wind blows towards. The applicator need to hold the stick away from the body and walk through the field so the wind will blow the pesticide aerosols away from the applicator. However, the corner of the field that the farmer started the application in will get a higher dosage of pesticide, the dosage will decrease as closer we get to the corner the applicator finished the application. The rice paddy that gets a high dosage of pesticide might result in that the ADI of the rice paddy exceeds. With the knowledge about this, the applicator can adjust the spraying pattern and speed to get a similar dosage all over the field. The farmers also need to be aware of the wind direction so the pesticide aerosols will not follow the wind direction towards the house or other places where people or vulnerable environments could get exposed.

The interviewed rice farmers consider that the effectiveness of the pesticide is the most important factor when they buy pesticides, scoring the highest score for all farmers (Figure 1). This is reasonable when you want the pesticide to work, which is what you are paying for. The second most important factor was toxicity (Figure 1). There might have been some interpretation errors or misunderstandings answering this question. Some farmers may have answered the question about how toxic the pesticides are against pests, in other words how effective it will be in killing pests. Some other farmers may have answered the question about how toxic the pesticides are for your own health, which was the actual intention of the question. It is logical that the farmers who interpreted the question as toxicity to kill pests consider the toxicity as very important because it is basically the same thing as efficiency that got the highest score. Farmers that answered the second option, but still gave it a high score is making some sense since the farmers do not use any protective gear because of the heat. When the farmers do not use any protective gear they might want to reduce their exposure and therefore choose a less hazardous pesticide. Since most of the farmers have experienced health effects or are worried about their future health related to pesticide use, it is also a rational action to reduce their exposure of hazardous pesticides. The price was the third most important factor (Figure 1). Since rice farmers consider that the price is important when buying pesticides, there could be a risk that some of them prefer to buy cheaper but illegal pesticides. Legality was the fourth most important factor (Figure 1). The farmers consider that other factors are more important, such as efficiency, toxicity and price. This has been proved by other researchers who have found that rice farmers still using the banned pesticide DDT for fighting pests (Dasgupta et al. 2007, Hoai et al. 2011, Toan et al. 2013). Environmental sound pesticides were considered the least important factor when buying pesticides (Figure 1).

4.2 Protective gear
Berg (2001) raised the question if the warm climate in Vietnam affects the usage of protective gear. This survey showed that the main reason why farmers do not use protective gear is because of the heat which makes the protective gear uncomfortable to wear (Table 3). The climate change is causing higher temperatures in Vietnam (Dang et al. 2014) which could result in a decrease of the usage of protective gear that results in increased exposure for the farmers. The protective gear has to be adapted to the warm climate so the farmers can use it.
even during the hottest periods. Fans or air conditions in a whole body suit is one already existing solution but it need promotion and subsidization. A full body suit will not only protect the farmer from the agrichemicals but also from the intense sunlight and heat, which was the reason why the farmers used clothes and a hat during the applications. However, this protective gear is more expensive than ordinary equipment and the farmers already have a scarce economy (Agricultural technician, pers. comm. 2015-01-16). The protective gear has to be adopted to Vietnam’s warm climate, otherwise will the farmers think it is inconvenient to wear. It has to be a reasonable price, otherwise will the farmers think it is not worth the money since pesticide exposure only is a medium risk.

The protective gear protect the farmers from pesticide exposure. However, if the farmers use protective gear that is not intended for chemicl protection they might handle the pesticides with less precaution since the belief they are protected and therefor increase their exposure. Usage of protective gear can also have the oppisite effect, the farmers increase their risk awareness and handle the pesticides safely.

Socio-economic factors and available resources are commonly shown to influence the adaptation intention and behaviour of farmers in response to climate change (Dang et al. 2014). Therefore evidence is needed to prove that a better protective gear will pay off in the long run. Even though no farmer mentioned that it was because the price they did not use any protectective gear, some farmers’ who live under poor conditions may not want to pay for expensive protective gear. The farmers have to be informed about the long-term benefits of using protective gear. Reduction of labor and reduced exposure to pesticide poisoning resulting in less absent because sickness and reduced hospital admissions.

4.3 Work practice
Almost every interviewed rice farmer said that they read the pesticides containers label before use (Table 2). However, none of the farmers did read the container label during the observations. The farmers said that they did not need to read it this time because they read it before. However, none of the farmers followed the recommended precaution measures. This clearly states that the farmers do not follow the instructions if they even read the container label in first place. Some of the interviewed rice farmers could not read and write. If the farmers can not read, they cannot possibly read the container label and understand its’ information and precaution advice. The farmers do not follow the protective gear precaution advice so they most likely do not follow the concentration recommendation for the solution. Toan et al. (2013) and Dasgupta et al. (2007) found that 45 % and 96 % of the farmers respectively overused the amount of pesticides. When mixing the pesticide solution the farmers used the pesticide cap to measure the amount of pesticide or just poured the pesticide concentrate directly into the spraying device. A bucket was used when the farmers collected water from a nearby waterbody. The most precise volume was the cap when pouring the pesticide is only a guess how much pesticide concentrate is added and the bucket was no mark and the farmers did not fill it up to a precise volume, they just got some water and then filled the tank to dilute the pesticide concentrate. This handling of pesticide will result in a pesticide solution with the wrong concentration. Since the farmers think that the efficiency of the pesticide is the most important factor (Figure 1), they will not risk that the application will be useless and therefore is it most likely that the farmers mix a pesticide solution with a higher concentration than the recommendation.

All farmers prepared the pesticide solution right next to the field by pouring the pesticides into the spraying tank and filled it with water from the field or nearby waterbody. WHO (2010) states that the highest exposure of pesticides are through the dermal route while preparing the pesticide solution, this should also be the case with the interviewed rice farmers in this study when observations were made that the farmers spilled pesticide concentrate which got direct contact with the soil and skin on the farmers’ hands. The farmers get directly exposed to the pesticide through the respiratory route during spraying.
since they walk into the aerosol mist without any mask (Table 3) and then inhale the pesticide aerosols. WHO (2010) states that one of the main exposure routes is through the respiratory route while inhaling pesticide during application, this should also be the case with the interviewed rice farmers in this study. Since none of the farmers used protective gear for protecting the skin (Table 3), they will get directly exposed through the dermal route since the pesticide aerosols deposit on the skin in high concentrations, but not as high as during the preparation of the pesticide solution. However, the exposure during the application is in lower concentration but a bigger skin-area will be exposed.

13 % of the farmers did mix different types of pesticides to reduce their labour (Table 2). This result is confirmed by previous research completed by Toan et al. (2013) which showed that farmers often mixed two or more types of pesticides per application to enhance the effectiveness of the treatment; save time and labour; prevent and repel several types of pests; imitate an application method other farmers use. When the farmer is mixing different types of pesticides to reduce their labour, they will also reduce the number of times they will get exposed for pesticides. However, mixing different types of pesticides may also result in synergetic effects that could cause some severe health effects. From the environmental point of view is it most likely better if the farmer do not mix different types of pesticides and use one at the time to exterminate targets and not spray the whole field. This will result in preservation of the natural enemies that could fight the pests in a natural way where no pesticides is needed. When mixing two or more different types of pesticides, conclusions can be made that the farmers spray just for spraying and not go for target extermination. The conclusions that the farmers do not go for target extermination when they mix different pesticides strengthens by the result that 20 % of the farmers apply pesticides on a calendar basis. Most of the farmers apply pesticides on a certain number of days after sowing the rice plants but only one fifth of the farmers apply pesticides on a calendar basis. Some farmers may have answered how many days it usually goes before applying pesticides and some farmers may have answered how many days they waited during the current cultivated crop. The result in how many days after sowing passes before the farmer apply pesticides to the crop was around 30 days with the highest number of farmers applying pesticides on day twenty (Figure 5). This raises some questions about the rice farmers knowledge since research has proven that application anytime before 40 days after sowing is useless and might even result in secondary pests problems (Rejesus et al. 2009). The mass media campaigns that has informed the farmers about not applying pesticides during the 40 first days (Huan et al. 1999, Rejesus et al. 2009) seems to have been ineffective when only a very small portion of the farmers follow the advice. The information may have changed the application date for a large amount of farmers’ right after the campaign but several farmers may have slipped back into old habits.

Every farmer did spray the rice field until the pesticide solution was finished (Table 2). This result is confirmed by previous research where 95 % (Dasgupta et al. 2007) and 99 % (Toan et al. 2013) of the farmers disposed residual pesticides by reapplying it to the same crop, poured the left-overs directly in the field or canals. Some farmers said that they never had some left-overs since they knew how much pesticide solution that they needed to prepare. However, this study showed that the farmers do not follow the recommendation of the container label when mixing the solutions concentration or protective gear. When the farmers do not follow the recommendations of the pesticide concentration, there is nothing that suggests that they follow the amount of applied pesticides to the crop with the right concentration.

Every interviewed rice farmers cleaned their equipment in a nearby waterbody after usage. This result is higher than previous research where Toan et al. (2013) showed that 81 % of the farmers cleaned the sprayers in irrigation ditches, canals or ponds nearby their fields. This will create a hot spot in the water that is especially dangerous for the environment since some pesticides are extremely toxic for aquatic life (Toan et al. 2013).
No farmer used a signboard to mark the sprayed area. 87% of the farmers re-entered the sprayed field the following day (Table 2) and the other 13% on the second or third day (Table 2). Perhaps it is because the field will not be a restricted area longer than a day or two the farmers do not put up a warning sign. The rice farmers risk perception can also have a say in this, because the farmers spray the pesticides without any protective gear (Table 3) they will get exposed for a high level concentration of pesticides. The farmers think that it does not matter when they got exposed for a much higher concentration during the spraying. However, the farmers do not think about the long-term effects and the repeated exposure.

The interviewed rice farmers burned or buried the pesticide containers in the rice fields (Figure 7). This result is confirmed by previous research that the majority of the farmers leave the empty pesticide containers in the rice field (Toan et al. 2013). This will result in direct contamination of the soil and water bodies where a hot spot has been created. The hot spot will be extremely toxic for animals and other living things. The farmers burn or bury the containers if they cannot get refunds from the retailer. This shows that it is the economic factors that are decisive if the farmers should choose the more environmental friendly waste management. The farmers do not collect the containers to protect the environment from pollution. This conclusion strengthens with the result that the interviewed rice farmers did think that the price is more important than environmental sound pesticides when buying pesticides (Figure 1).

4.4 Personal hygiene and health

Every rice farmer washed their hands in the water body where they just cleaned their used equipment (Table 3). The water body is also right next to the sprayed area which results in leakage from the rice field into the water. Washing the hands in the contaminated water will probably reduce the concentration of pesticides on their hands, especially when observations were made that some farmers got exposed to pesticide concentrate directly on their hands. However, more research is needed before any conclusions can be made. Cleaning your hands in contaminated water can trick the farmers into thinking that their hands are clean but still have toxic concentrations of pesticides due to the polluted water. The farmers must be aware of this so they do not use their hands before they washed them properly. The farmers can get exposed by pesticides if the farmers contaminated hands get in contact with food, eyes or something else that cause dermal or oral exposure. The farmer could also get in contact with their children who are extra vulnerable. That the farmers wash their hands directly in a nearby waterbody (Table 3) shows that they do not care about the environment.

Almost every farmer has experienced health effects related to pesticides (Table 3). This result is confirmed by previous research where 88% reported multiple symptoms and the most common symptoms were skin irritation, headache, dizziness and shortness of breath (Dasgupta et al. 2007). Around one third of the farmers are worried about their future health related to pesticides (Figure 8). However, this has not affected their handling and usage and precautions. With the short-term health effects and worries about the long-term effects it should result in a more precautions. However, the rice farmers fight against poverty (Agricultural technician, pers. comm. 2015-01-16) and therefore might make an active choice not to spend money on precaution measures. The future might be on such a far distance and therefore the farmers think about the present. However, getting exposed to pesticides might cause severe health effects so the farmers must get medical help that could cost even more than the precaution measurements.

With economic growth, fish and meat consumption are likely to increase and result in less consumption of rice (Mainuddin et al. 2011). This is a risk for the local population since pesticide residues can enter the food chain (Toan et al. 2013). Bioaccumulation in fish might result in concentrations exceeding acceptable daily intake values (Toan et al. 2013). Hoai et al. (2011) found that a daily intake of 50 gram of any fish would reach the ADI for several pesticide compounds and only 10 gram fish for some more toxic compounds. A daily intake of
10 grams of some vegetables would exceed the ADI. How will the increased fish and meat consumption affect the consumers if the ADI exceeds in fish and other food. However, fish, meat are not the only risk, rice can also exceed ADI if the farmers misuse the pesticides which they do.

4.5 Environment
Toxicity is more likely to be the decisive factor when buying pesticides than environmental sound when environmental sound pesticides were the least important factor when buying pesticides (Figure 1). This suggests that farmers care more about their own health than the environment. None of the interviewed rice farmers used protective gear that is intended for chemical protection (Table 3), and if the farmers do not use any precaution measures for their health it is unlikely they use any precaution measures for the environment. This have resulted in that the farmers mix the pesticide solution in the rice field and use water from a nearby water body; clean the equipment (Table 2) and hands (Table 3) in nearby water body; spray the left-overs (Table 2); and leave or burn the pesticide containers in the rice field (Figure 7). This will result in direct contamination of the soil and water bodies and hot spots with extremely high concentrations of pesticides.

4.6 Alternative pest control methods
Pesticides have been the main pest controlling method ever since the Vietnamese government promoted usage of pesticides during the 1950s (Dasgupta et al. 2007). Pesticides and other agrichemicals are causing negative environmental and health problems and therefore is it essential to reduce the usage of agrichemicals. One way to reduce the usage of agrichemicals is alternative pest control methods. However, the majority of the rice farmers do not believe alternative pest control methods work (Figure 9). The Vietnamese government should promote alternative pest control methods to challenge the rice farmers’ opinion that pesticides are the best pest controlling method. This survey shows that biological control were natural predators fight the pest is the most common alternative pest control method (Table 4). A question mark is being raised about the farmers’ knowledge and provided information to the farmers since several of them used resistant seed varieties but only one fourth of the farmers said that they used resistant seed varieties (Table 4). It might have not been an active choice but the farmers still use seed varieties that are more resistant against pest and diseases which should result in less usage of pesticides if the farmers have the knowledge.

4.7 Economy
The rice farmers have a scarce economy and live under poor conditions, 20 % of the rice farmers are extremely poor (Agricultural technician, pers. comm. 2015-01-16). This study shows that the rice farmers think that the price is the third most important factor when buying pesticides (Figure 1), and therefore a decisive factor. The farmers rather buy a cheap pesticide, which sometimes can result in more toxic and less environmental sound pesticides. It could also result in usage of illegal and banned pesticides. Rice farmers using illegal and banned pesticides have been confirmed by previous research (Hoai et al. 2011, Toan et al. 2013).

Toan et al. (2013) and Dasgupta et al. (2007) found that 45 % and 96 % of the farmers respectively overused the amount of pesticides. The application of seeds and fertilizer is higher than the optimum application level established in research (Huan et al. 2008) which been confirmed by this study that showed that one third of the rice farmers overuse fertilizer (Figure 4) and one third have a too high seed rate (Figure 4) due to the seed-fertilizer ratio. These practices might come from the belief that higher inputs results in higher outputs (Huan et al. 2005, Huan et al. 2008). Over usage of seeds, fertilizers and pesticides reduces the farmers’ profits and polluting the environment (Huan et al. 2008). Usage of high seed and fertilizer rates can result in higher pest and disease plagues which results in a higher use of pesticides (Huan et al. 2005, Huan et al. 2008, Berg and Tam 2012). Crops were nitrogen
have been added can make insect pests more severe since they produce more eggs, survive better, live longer and become more ecologically fit (Huan et al. 2005). Nitrogen-added crops with high seed rates are more vulnerable to diseases (Huan et al. 2005). Huan et al. (2005) proved that the rice farmers can reduce their input of pesticides with 53 % with unchanged yield. The farmers also reduced their input of seed and fertilizer which resulted in increased gross income (Huan et al. 2005). If the rice farmers starts to follow the recommendations of agrichemical input their gross income would increase due to less agrichemical input and because their crop have a higher quality. The degradation of the environment and negative health effects would also decrease. This study shows that the rice farmers use the left-over pesticide solution by re-applying it to the same crop (Table 2) instead of saving the solution till next application. The farmers might also mix a pesticide solution with a higher concentration than the recommended which is over excessive and cost extra money.

It is interesting that the farmers rank the prize as the third most important factor when buying pesticides (Figure 1) and that they will only collect and recycle empty pesticide containers if they get refunds (Figure 7). This is proofs that the farmers’ economy is very important if a sustainable agriculture will be realized. This strengthens the conclusion that the farmers overuse agrichemicals comes from the belief that higher inputs results in higher outputs (Huan et al. 2005, Huan et al. 2008). The farmers cannot risk crop failure and therefore do they overuse agrichemicals even if it will decrease their gross income.

4.8 Education
The interviewed rice farmers had on average 8 years education (Table 1) but several of them could not read or write. Around half of the farmers have completed basic training in safe handling of pesticides (Table 1). However, a big question mark remains about what that training taught the farmers since everyone still misuse agrichemicals. The previous intervention No Early Sprays (NES) informed the rice farmers that they should not spray their rice fields within the 40 first days after sowing (Rejesus et al. 2009). Rejesus et al. (2009) showed that the majority of the rice farmers waited 40 days after spraying their crop after the intervention. However, this study shows that only one fourth of the rice farmers did wait 40 days until their first application of pesticides (Figure 5). This suggest that the rice farmers have slipped back into old habits and spray their crops closer to the sowing date. This is not based on poor knowledge since they received the information, the decision is based on a uninformed decision where the farmers believe that it is better to spray their crop before the recommendation established in research.

Training, information and interventions can be questioned about what information they provide and how the education form is since only a minority of the farmers still practice the advices. More education is needed to increase the knowledge and risk awareness of pesticides. However, this study shows that training and intervention only have a short-term effect. The messages must be repeated and the general education level must be raised.

4.9 Governance
The Vietnamese government need to create new laws, restrictions and bans to improve the agriculture and reduce the environmental degradation and negative health effects. Recommendations from researchers should be implemented as new laws to get a greater impact. The system today is not sufficient enough, for example have researchers established that there are no benefit to spray the crop before the 40 firsts days after sowing, and the amount of seeds and fertilizers should be 600 and 1500 kilos per hectare and year respectively. Only a few farmers follow these advices and recommendations and that is why the government should implement the recommendations into new laws. For example should it be forbidden to spray the rice crop within the 40 first days after sowing since it just causing secondary pest problems, environmental degradation and negative health effects. It should be forbidden to overuse agrichemicals such as seeds, fertilizer and pesticides since over usage of seed and fertilizer rates only cause more severe pest problems, environmental pollution,
and over usage of pesticides cause negative health effects, environmental degradation and change the food chain. It should also be forbidden to leave, bury or burn the containers, the containers must be brought back to the retailer or some other place where the waste can be handled safely.

Regulations that forbid highly toxic pesticides will result in an expanding market for bio-pesticides or environmental sound pesticides. However, when applying biocides the farmers must have knowledge about the weather conditions such as sunlight, rain and wind. Biocides cannot be applied during intense sunlight since it will lose its effect. This will result in that the farmers only can apply pesticides during a short period of time every day when the sun is still shining but the sunlight is not that intense. This will probably cause big opposition when the farmers always have been used to control their own time.

Toan et al. (2013) and Dasgupta et al. (2007) found that 45 % and 96 % of the farmers respectively overused the amount of pesticides. One solution is that the retailers start to sell ready-to-spray pesticide solutions instead of pesticide concentrate which the farmers dilute them selves. This will decrease the risk of pesticide solutions with a higher concentration than the recommended one and it will decrease the risk for negative health effects for the farmers and polluting the environment. During the observations some farmers got dermal exposure with pesticide concentrate directly on the hands and the farmers spilled pesticide concentrate directly on the soil. With a ready-to-spray pesticide solution these risks would decrease. Some of the interviewed rice farmers could not read and write and therefore are the farmers not able to read the instructions and follow the recommendations and precautions advice. With a ready-to-spray solution the farmers do not need to be able to read. The labels on the ready-to-spray containers should show pictures that are easy to understand for those farmers who are not literacy. However, a ready-to-spray container will cause bigger logistical problems.

This study showed that price is more important than legality when the farmers buy pesticides (Figure 1), which could result in usage of illegal and banned pesticides. This is confirmed by previous research where some farmers still used banned pesticides such as DDT (Hoai et al. 2011, Toan et al. 2013). The Vietnamese government need to implement more laws and restrictions. Even if some farmers do not follow the law, the majority of the farmers will follow. The government need to control that the laws and restrictions are being followed.

4.10 Further research
The result should be complemented with a quantitative study to confirm or invalidate the result. This thesis mention some economic and social benefits, however it would be interesting with a study focusing on the economic and social factors and how it affects the rice farmers’ work practice and handling of pesticides.

13 % of the interviewed farmers did mix different pesticides to reduce their labour (Table 2). Mixing several different pesticides into one solution will decrease the number of days the farmer get exposed to pesticides due to less applications, but there can be some unknown synergetic effects that could cause some severe health effects. Applying one pesticide at the time will increase the number of days the farmers get exposed of pesticides but it will only be one pesticide at the time. The farmers in this study applied pesticides 6 times with variations from 4-8 (Figure 6). Is it more dangerous to get exposed of pesticides more frequently or get exposed for mixed pesticides solutions that could cause synergetic effects? Synergetic effects are something that still could affect the farmers even if they keep the pesticide solutions separate, especially if the pesticides have a long-term effect. The research focusing on mixing or not mixing pesticides should also include the environmental impact. With the pesticide solutions kept separated, the farmer could go for target extermination, even if this could not be observed during this study. When mixing several pesticides into one solution the farmers just spray the crop without any notice to the field and pest condition. The environmental
impact could cause losses from several insects or fungus or weed or something else that will affect the food chain and get some severe secondary problems. Keeping the pesticide solutions separated and close monitoring of the field condition would probably be better for the environment. There could also be a risk when mixing several different pesticides, the farmer add the respectively pesticide concentrate and then add the water to the tank, resulting in that the pesticide solution have a too high concentration of pesticides when it is the double amount in the tank with the same amount of water. The farmers cannot add more water since every separate pesticide would get a too low concentration and then risk the effectiveness of the application, something that the farmers would not risk since that is the most important factor when buying pesticides (Figure 1). The example above is pesticides with the same concentration recommendation. However, mixing two different pesticides that have different concentrations recommendations could be even more problematic.

This study shows that almost every farmer re-enters the rice field the next day (Table 2) so they will get repeatedly exposed of pesticides during a longer time of period than just the application date. Research should be conducted where the farmer’s exposure is measured when they re-enter the rice fields. Recommendations about how long the rice farmers should wait to re-enter the rice field after application should be implemented as new laws to get a greater impact. A less controversial suggestion is that guidelines for different types of pesticides should be informed and printed on the container label of how many days the rice field should be a restricted area.

Another interesting research topic is to study the farmers’ personal hygiene. This study showed that almost every farmer washed their hands in a nearby waterbody after applying pesticides (Table 3). However, the farmers washed their hands in the water where they just cleaned the used pesticide equipment and the waterbody lies right next to several rice fields which also contaminated the water. So will washing the hands in a waterbody nearby the rice field actually reduce the pesticide concentration on the farmers’ hands? Most likely will the concentration decrease. However, what is more important, do the farmers believe the hands are clean and safe to use after they washed their hands in the contaminated water? With the assumption that their hands are clean, there is a risk that the hands could get in contact with food, children, pets or other things that you should not touch before the hands are properly washed.

4.11 Method
Agrichemical use in the Mekong Delta is a well-researched topic. However, most of the research is often survey based where the farmers answered questions. Surveys and questionnaires assume the asked questions are important and usability tests assume that the performed task is relevant. The only person who really knows everything about his or her work is the one doing it. The interviewer does not know what’s important to pay attention to and the interviewer does not know what will turn out to matter. The farmers are trying to explain their work in a conference room to interviewers who do not do their work. To reveal all aspects of work practice, when even those who do it cannot articulate it in detail, you have to see and experience the work. It is like trying to explain how to drive a car or showing how to drive a car. The key to getting good and reliable data is to go where the work is happening and observe it firsthand while it happens. The interviewer that is looking at work-flow from the outside can point out aspects the farmer might take for granted. The advantages with contextual inquiry is that the gathered data is concrete rather than abstract when the gathered data is ongoing experience rather than summary experience. However, it is understandable why researchers chose a quantitative research model since the qualitative research model is resource intense and the farmers do not want to spend a lot of time being interviewed. Contextual inquiry is a resource intense method that requires travels to the farms; interview with each farmer; and then interpretation of the results from the interviews. This limits the number of interviewed rice farmers which resulted in only 15 interviews was conducted which do not make the result statistical significant for the millions of rice farmers.
in the Mekong Delta, Vietnam. However, 10-20 farmers are usually enough to gather sufficient data, which also has been completed with 15 interviews. The information that is gathered from the contextual inquiry method is highly reliable and detailed therefore conclusions can be made. The result from the contextual inquiry method may also be affected by the researcher and interviewer. After observing the same thing several times, the interviewer might draw conclusions based on previous experience and interviews and therefore miss out important factors.

Contextual inquiry is a flexible method that was suited when several visits were completed to rice farmers’ homes and workplaces and when the conditions varied from farm to farm and from farmer to farmer. The contextual inquiry method gives a better understanding for the farmers’ work and their conditions (Beyer and Holtzblatt 1998). The observations that were made raised some questions and were discussed directly with the farmers to get a better understanding. Discussions were conducted with farmers about why the farmers worked in certain ways, these discussions are not possible with a quantitative method. Contextual inquiry addresses how to get data about the structure of work practice and how to get at low-level details of work that has become habitual and invisible (Beyer and Holtzblatt 1998). Knowledge and information that the farmer is not consciously aware of can be discovered when they describe and perform their work (Beyer and Holtzblatt 1998). This is a really important advantage with contextual inquiry.

Contextual inquiry is a suited method to minimize communication errors. Neither I nor the farmers have English as a mother tongue. Misunderstandings due to interpretations are minimized when the method is based on observations. Since my rice farming knowledge and experience comes from the academic world and the farmers knowledge and experience from the practical world, we might use different technical terms for the same object. Communication was a significant problem during the interviews, even though an interpreter was used, some interpretations errors occurred and data was left out. Misunderstandings occurred as well since interpretations errors and the farmers may have answered some questions from another point of view than the intended one.

If I was going to repeat this survey, I would have been clearer when describing what point of view the question was intended for, have more time to complete more interviews and be very clear with the Peoples Committee how I would want to collect my data. I would add some research questions and subjects that I mentioned in 4.10 Further research section.

5 Conclusions

More research is needed to get statistical data that confirm or concur the conclusions.

The agricultural sectors misuse of agrichemicals is a health and environmental risk. Significant improvements need to be completed in every area of rice production to create more sustainable rice farming in the Mekong Delta, Vietnam.

Spraying pesticides is the most obvious situation of pesticide exposure. The more abstract exposure routes through water or food is not as obvious and therefore a less concern for the farmers. As long as the farmers do not use protective gear during the spraying they will not use other precaution measures to protect the environment or surroundings.

Clearly the transition to a sustainable agriculture is going slow. Old recommendations from the government; pesticide companies that try to sell their products through commercial; and the general lack of knowledge among the farmers are some factors that halts the development. More education and information is essential to improve the rice farming in Mekong Delta, Vietnam. New guidelines established in research must be informed to the
farmers and the messages must be repeated so the farmers do not slip back into old habits. Messages that challenge the farmers’ opinion, perception and knowledge must be informed. To get a greater impact from researchers’ recommendations, the government should implement restrictions and bans that are forbidding the farmers to misuse pesticides. The Vietnamese government have a big responsibility to implement new recommendations, laws, restrictions and bans to speed up the transition for a sustainable agriculture.
6 References

Agricultural technician; Peoples Committee. 2015. Interview 16 01 2015.


Appendix 1: Observation and interview template

Appendix 1 was used by the interviewer to fill in the observations. If the interviewer was unable to observe a question, then the interviewer asked the farmers after the observation. The prepared template was used to make notes in. The prepared template was used to secure that all research topics was answered. The template is divided in two sections, first the observation section where questions that are easy to observe are gathered. The other section is the interview section where questions that could be difficult to observe are gathered.

Observations

1. Read instructions on the pesticide container before using
2. Containers
   a. Store pesticides in other containers
   b. Use pesticide containers for storing
3. Mixing pesticides
   a. Location/facility
   b. Pouring/pumping
   c. Open/closed system
   d. Protective gear/measures
4. Equipment / technical aid
5. Application
   a. Spray when windy
   b. Spraying against the wind
   c. Spray when raining
   d. Spray when sunny
   e. Spray in front/behind
6. Type of protective gear while applying pesticides
   a. Hat
   b. Glasses
   c. Mask
   d. Jacket
   e. Gloves
   f. Pants
   g. Boots
7. Signboard after spraying
8. Personal hygiene
   a. Location/facility
   b. Contact with mouth/eyes
   c. Change clothes
      i. Cleaning clothes
      ii. wastewater
   d. Wash hands/body after spraying
      i. wastewater
   e. Contact with food/drink/cigarettes
9. Empty containers
   a. Disposal
   b. Cleaning
      i. Protective gear
      ii. Location (distance to water)
      iii. wastewater
   c. Recycling
10. Pesticide left-overs
    a. Use
       i. Spraying the same area
       ii. Spraying a new area
iii. Pour it out
b. Save

11. Cleaning of used equipment
   a. Protective gear
   b. Location/facility (distance to water)
   c. Wastewater
   d. Nostril with blowing or thin wire

12. Usage of environmental protective measures
   a. Wall/screen
   b. Canal/ditches
   c. Pound
   d. Vegetation
   e. Wastewater treatment

13. Other protective measures/precaution measures

**Interview**

**General information**

1. Gender:
   □ Male
   □ Female

2. Age: ...................................... years

3. Highest completed education?
   □ No schooling
   □ Primary (5 years)
   □ Secondary (9 years)
   □ Higher school (12 years)
   □ University

4. Working experience as a rice farmer: ..................................... years

**Property and cultivation**

5. What is the size of your farm, production area: .............................. ha

6. Spring yield: ................................. tons

**Fertilizer and seeds**

7. Amount of fertilizer: ................... kg/year

8. Amount of seeds: ......................... kg/year

**Pesticides**

9. What do you associate pesticides with? (Name 3 things)

   □ □ □

10. On a scale of 1-5, how much risk do you think you are exposed to while using pesticides?
   1: □ No risk at all
   2: □ Small risk
   3: □ Medium risk
4: □ High risk
5: □ Very dangerous

11. Have you ever received basic training on safe handling for applying pesticides?
   □ Yes
   □ No

12. Amount of used pesticides: ............................. L/year

13. Number of used pesticides: ............................../year

14. Who is deciding which pesticide to buy?
   □ Farmer
   □ Agriculture engineer
   □ Other (specify): .................................................................

15. When buying pesticides, what is the importance of the following criterion? 1 = lowest, 5 = highest

<table>
<thead>
<tr>
<th>Criteria</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
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<td></td>
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<tr>
<td>Efficiency</td>
<td></td>
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<tr>
<td>Legality</td>
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<tr>
<td>Toxicity</td>
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<tr>
<td>Environmental sound</td>
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<td></td>
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</tr>
</tbody>
</table>

16. Who is deciding when to apply the pesticides?
   □ Farmer
   □ Agriculture engineer
   □ Other, specify: .................................................................

17. Do you apply pesticides on a calendar basis?
   □ Yes
   □ No

18. Do you apply pesticides when observing pests?
   □ Yes
   □ No

19. Who is the applicator?
   □ Farmer
   □ Agriculture engineer
   □ Other (specify): .................................................................

20. When is the first application of pesticides after sowing: ............

21. Number of sprays per crop: .................................

22. Where and how do you store pesticides?

23. Do you usually read the container label before using the pesticide?
   □ Yes
   □ No

24. Do you usually mix different pesticides before application?
□ Yes
□ No

a. If YES, how many pesticides do you mix?
b. What is the main reason you mix the pesticides?
□ Unsure about the quality of pesticides
□ Uncertain about the effectiveness of pesticides
□ Imitating other applicators
□ Following suggestions from other farmers
□ Reduce labour
□ Other (specify): ..................................................

25. Where and how are you mixing pesticides?

26. What type of protective gear do you use when applying pesticides?

27. Have you experienced any health problems related to pesticide use?
□ Yes
□ No

a. If YES, please name the symptoms.

28. Why do you not use (more) protective gear?

29. What do you do with pesticide left-overs after application is finished?

30. What do you do with empty pesticide containers?

31. Where and how do you clean the used equipment?

32. After application of pesticides, do you
   a. Wash hands?
   b. Wash body?
   c. Change clothes?

33. How many days pass before you re-enters the field: ......................

Alternative methods

34. Do you use any pest control techniques to reduce the need of pesticides?
□ Yes
□ No

   a. If YES, which methods do you use?
      □ Organic production
Mechanical techniques
Resistant varieties
Biological control
Rotation of crop
Other (specify): .................................................................

b. If NO, why do you not adopt to alternative pest management methods?
Pesticide method is cheaper
Requires lots of labour
Less yield
Less quality
Doesn't work
Neighbours do not participate
Other (specify): ..................................................................