INNOVATIVE PESTICIDE KIT MODEL FOR VEGETABLE FARM SAFETY SURVEILLANCE PROGRAM

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for the Degree of Doctor of Philosophy Program in Public Health
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รูปแบบนวัตกรรมชุดทดสอบสารกำจัดแมลงเพื่อการเฝ้าระวังความปลอดภัยในฟาร์มผัก

นางสาวลักษณา ลือประเสริฐ

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
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Thesis Advisor	Professor Surasak Taneepanichskul, M.D.

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ลักษณา ลือประเสริฐ : รูปแบบนวัตกรรมชุดทดสอบสารกำจัดแมลงเพื่อการเฝ้าระวังความปลอดภัยในฟาร์มผัก. (INNOVATIVE PESTICIDE KIT MODEL FOR VEGETABLE FARM SAFETY SURVEILLANCE PROGRAM) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. นพ. สุรศักดิ์ ฐานีพานิชสกุล, หน้า.

จากรายงานใน พ.ศ. 2554 มีแรงงานของประเทศไทย คิดเป็นร้อยละ 35.8 ประกอบอาชีพเกษตรกรรม พบการปนเปื้อนสารเคมีกำจัดศัตรูพืช ที่แบ่งได้เป็น 4 กลุ่มใหญ่ได้แก่ กลุ่มออร์กาโนฟอสเฟต คาร์บาเมต ไพเรทรอยด์ และออร์กาโนคลอรีน จึงได้พัฒนานวัตกรรมชุดทดสอบสารเคมี 4 กลุ่มนี้ เพื่อเป็นเครื่องมือตรวจเฝ้าระวังผลิตผลในฟาร์มผัก ได้สุ่มตรวจหาสารเคมีกำจัดแมลง 4 กลุ่มในผักสดซึ่งจำหน่ายที่ตลาดกลางสุรนครในจังหวัดนครราชสีมา และพบผักสดไม่ปลอดภัยร้อยละ 5.6 จึงให้โปรแกรมการศึกษากึ่งทดลองแบบมีกลุ่มควบคุม ระหว่างเดือนพฤษภาคม 2555 ถึงตุลาคม 2556 แก่กลุ่มเกษตรกรจากหมู่บ้านคลองตะแบก ตำบลลาดบัวขาว อำเภอสีคิ้ว จังหวัดนครราชสีมา และมีเกษครกรในหมู่บ้านท่างอย ตำบลจันทึก อำเภอปากช่อง จังหวัดนครราชสีมา เป็นกลุ่มควบคุม กระทรวงสาธารณสุข มีรายงานการตรวจพบสารเคมีตกค้างมากในผักคะน้า ในปี 2555 ผู้วิจัยจึงเลือกชนิดผักคะน้าในการศึกษานี้ ได้เก็บตัวอย่างจากแปลงผักของเกษตรกร ทั้งกลุ่มศึกษาและกลุ่มควบคุม กลุ่มละ 31 ตัวอย่าง ตรวจด้วยชุดทดสอบสารเคมีกำจัดแมลง 4 กลุ่ม ของกรมวิทยาศาสตร์ การแพทย์ ที่ได้รับอนุสิทธิบัตรจากกรมทรัพย์สินทางปัญญา ประเทศไทย และศึกษาวิจัยหาร้อยละของการยับยั้งเอนไซม์ อะเซติลโคลีนเอสเตอเรส ของสารเคมีกำจัดแมลงตกค้างในคะน้าทั้ง 62 ตัวอย่าง โดยใช้เครื่องมือ สเปคโตรโฟโตมิเตอร์ สำหรับตัวอย่างที่ตรวจด้วยชุดทดสอบพบว่าไม่ปลอดภัย หรือผลตรวจที่มีข้อสงสัย ได้นำส่งตรวจวิธีเครื่องมือก๊าซลิควิด โครมาโตกราฟฟี และ ไฮเพอร์ฟอร์มแมนซ์ ลิควิดโครมาโตกราฟฟี ที่ห้องปฏิบัติการอ้างอิง ผลตรวจก่อนให้โปรแกรม การศึกษา มี 2 ตัวอย่างในกลุ่มควบคุม ตรวจพบคลอไพริฟอส (สูงกว่าระดับกำหนดสูงสุดสากล) มีผัก 2 ตัวอย่างในกลุ่มศึกษาพบไซเปอร์เมทริน (ต่ำกว่าระดับกำหนดสูงสุดสากล) มีผัก 1 ตัวอย่าง ในกลุ่มศึกษา พบเมทโธมิล คาร์โบฟิวแรน และ 3-ไฮดรอกซี่ คาร์โบฟิวแรน (3 สารเคมีต่ำกว่าระดับกำหนดสูงสุดสากล) ส่วนผลการตรวจสารเคมีกำจัดแมลง 4 กลุ่ม ในผักจำนวน 62 ตัวอย่าง จากแปลงผักของกลุ่มศึกษา และกลุ่มควบคุม การศึกษานี้มีการถ่ายทอดเทคโนโลยีให้กลุ่มเกษตรกร มีความสามารถตรวจผลผลิตด้วยชุดทดสอบสารเคมีกำจัดแมลงได้เอง และมีการทดสอบความสามารถของเกษตรกร ในการตรวจผักตัวอย่างชุดเดียวกันกับที่ตรวจโดยห้องปฏิบัติการอ้างอิง ซึ่งมีผลการทดสอบที่มีความถูกต้องติดเป็นร้อยละ 92 โปรแกรมการศึกษานี้ มีความร่วมมือที่ดีจากผู้นำห้องปฏิบัติการชุมชน โดยสนับสนุนการให้กลุ่มเกษตรกรและอาสาสมัครชุมชน มีการใช้นวัตกรรมชุดทดสอบสารเคมีกำจัดแมลง เพื่อการเฝ้าระวังความปลอดภัยจากสารเคมี ของผักในฟาร์ม หลังจากดำเนินการศึกษาตามโปรแกรมนี้ ผักทุกตัวอย่างตรวจพบว่าปลอดภัย และพบว่ามีผลการตรวจหาค่าการยับยั้งของเอนไซม์ อะเซติลโคลีนเอสเตอเรส ของสารเคมีกำจัดแมลงตกค้างในผักสดที่เก็บจากกลุ่มศึกษา มีค่าลดลงคิดเป็นร้อยละ 51.9 (p-value < 0.011) แสดงว่าโปรแกรมการศึกษานี้ มีผลดีในการใช้เป็นเครื่องมือลดความเสี่ยงของผลิตผลที่เกษตรกรปลูก จากสารเคมีกำจัดแมลงตกค้างได้อย่างมีนัยยะสำคัญ และให้การอบรมถ่ายทอดเทคโนโลยี ทำให้เกษตรกรสามารถตรวจด้วยชุดทดสอบเฝ้าระวังความเสี่ยงจากสารเคมีได้เอง และทดสอบความสามารถในการตรวจสารเคมีในตัวอย่างทดสอบความชำนาญ หลังให้การฝึกอบรม พบว่าเกษตรกรสามารถตรวจได้ถูกต้องร้อยละ 93 ซึ่งมีผลสำเร็จที่ดีมาก ควรประยุกต์นำไปใช้ลดความเสี่ยงในพื้นที่ปลูกผักชุมชนอื่นได้

สาขาวิชา สาธารณสุขศาสตร์	ลายมือชื่อนิสิต ....
ปีการศึกษา 2556	ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก ....

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LAGSANA LEUPRASERT: INNOVATIVE PESTICIDE KIT MODEL FOR VEGETABLE FARM SAFETY SURVEILLANCE PROGRAM. ADVISOR: PROF. SURASAK TANEEPANICHSKUL, M.D., pp.

Agricultural farming was reported in 2011 as main common sector of Thailand, representing 35.8% of labor force. Recognizing that contaminated pesticides in farm produce, especially the 4 groups; organophosphate, carbamate, pyrethroid and organochlorine were detected. Innovative pesticide kit model was developed in Thailand for vegetable farm safety surveillance. Collected vegetable in central market of Nakhonratchasima province, 5.6% detected samples of unsafe pesticide residues. A quasi study was performed during May 2012-October 2013 in Nakhonratchasima province. Study group; klongtabak village, ladbuakao subdistrict, sekhiew district and control group; ta-ngoy village in chanthuek subdistrict, pakchong district. Pesticide residues were highly detected in marketed Chinese kale vegetable by MOPH, Thailand in 2012, Chinese kale samples from plantations in both groups, were purposively collected. Validated 4 groups innovative pesticide test kit of Department of Medical Sciences, obtained petty patents from Thailand Intellectual Property Department, was used to screen pesticide residues in 62 collected kale samples. All kale samples were analyzed, using spectrophotometer for % acetyl cholinesterase inhibition assay, that enzyme was inhibited by organophosphate and carbamate, detected or suspected unsafe samples were quantitatively determined of pesticide residues (Codex's MRL) using GLC/HPLC. Before intervention study, two detected samples of chlorpyrifos (>MRL) in control, two detected cypermethrin (<MRL) and one detected<MRLs of methomyl, carbofuran and 3-OH Carbofuran in study group but none were detected in both groups at post intervention. Transfer technology for self- test LAB in intervention farms, was trained to agriculturists. Results of 92% accuracy competence test by farmers, at inter-laboratory comparison of innovative kit testing with competent analysts of Department of Medical Sciences, reference laboratory of Thailand was acceptable at post laboratory training. This study program had cooperation with farm laboratory top management to support the use of innovative pesticide test kit by agriculturists for safe farm vegetable with less chemical contamination. These study tools were included in innovative pesticide kit model for vegetable farm safety surveillance program and aimed at evaluating effectiveness by comparing association of pesticide residues in Chinese kale produce before and after intervention. Study results show that decreased % enzyme inhibition at post period of intervention, compared with pre intervention period was 51.9% at p-value < 0.011, revealed that intervention program affected reduction of pesticide inhibition at 0.05% significance level. Farmers were trained self-test pesticide kit technology. Farmers could use innovative pesticide kits for self-testing in proficiency samples and efficiently analyzed to achieve 93% accuracy test after laboratory training. The program can be applied to reduce pesticide risk in other farm communities.

Field of Study: Public Health | Student's Signature ....

Academic Year: 2013 | Advisor's Signature ....

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LIST OF ABBREVIATIONS

AChE = Acetyl Cholinesterase Enzyme

AEC = ASEAN economic community

ASEAN = Association of South East Asian Nations

CCPR = Codex committee on pesticide residues

CODEX = International code

DOAE = Department of agricultural extension

ELIZA = Enzyme link immunosorbent assay

FAO = Food agriculture organization

FTA = Free trade agreement

FDA = Food and drug administration

GAP = Good Agricultural Practice

GDP = Gross Domestic Product

GLC = Gas liquid chromatography

GPO = Government Pharmaceutical Organization

HACCP = Hazard analysis critical control point

HPH = Health promoting hospital

HPLC = High performance liquid chromatography

IPM = Integrated pest management

% I = Percentage enzyme inhibition

LAB = Laboratory

LOD = Limit of detection

LD 50 = Lethal dose 50

M Kit = MedSci Pest Kit (Medical Sciences pesticide test kit)

TLC = Thin layer chromatography

TM Kit = TLC MedSci Pest Kit (TLC Medical Sciences pesticide test kit)

MOPH = Ministry of public health

MRL = Maximum residue limit

NESDB = National economic and social development board

OAC = Office of Agriculture Economics

UNEP = United Nation environment program

US = United State

US EPA = United State environment protection agency

WHO = World health organization

WTO = World trade organization

CHARPTER I
INTRODUCTION

1.1 Background of the study

Pesticides are widely used in agriculture. Main applications are done during production and post-harvest treatment of agricultural commodities for transport purposes (FAO/WHO, 2004). An average of 118,152 tons of pesticides valuing at about *16,816* million baht were imported to Thailand in 2009 in contrast with the 33,600 tons that were imported in 2000. These values show a massive 251.64% increase in quantity in only a nine year span (Economic and Agricultural Administration 2010 and FAO/WHO 2004). In recent years, many highly valued agricultural products, particularly vegetables, fruits, and cereals were detected to have insecticide residue due to overuse of pesticides in the highly competitive food produce business. The four groups of detected insecticide residues were organophosphates, carbamates, pyrethroids and organochlorines. The first three groups were popularly used in the agricultural and industrial businesses. The fourth group, organochlorines, was however banned in many countries (L Leuprasert, Thongbor, Chaiyasing, & Puydecha, 2010), it was still being used in Thailand (Sombatsiri, 1997). However, even now, these highly dangerous persistently used chemicals still play a large polluting role in Thailand's agriculture. Despite the prohibition process and public announcements regarding bans, the weak enforcement in Thailand, resulted use of prohibited pesticides, as documented continued use of endosulfan, methamidofos, parathion-methyl, and monocrotofos (Panuwet et al., 2008); (Plianbangchang, Jetiyanon, & Wittaya-areekul, 2009); (Sriprapat, 2004). Many farmers believed that pesticide application was necessary and continued use of large amount of pesticides was likely unless a campaign was conducted that educated farmers, changed pesticide attitude and proper pesticide use (Panuwet et al., 2012). These chemicals accumulate in the environment and cause a deleterious effect to animal and human health. On the global scale, last year, 1,330,000 tons of organochlorine and 2,600,000 tons of toxaphene and DDT were used. Rice consumers have also been put at risk due to the use of hazardous organochlorine pesticides such as Endosulfan which is used for the control of golden snails (*pomacea spp*) in rice fields (Oldner, 1995).

Preventive and control measures for the four groups of insecticides should be emphasized by government and private agencies for food safety. Health promotion, technology transfer and public empowerment should be managed to reduce pesticide risk in agricultural products. Good agricultural safety practice can be conducted to reduce health risks in the agricultural industry by using validated pesticide test kits for self-risk monitoring during pre-harvesting times. By doing this, the health of the agriculturists will be improved as well as the quality of consumer products. Nowadays, with food safety being a first priority to many countries, food contaminated pesticides may be linked to chronic health disorders and ailments such as cancer. Consumption of food contaminated with pesticides causes risks much like risks caused by the discharge of toxic chemicals into air and water. Between the years of 1995 and 2000, pesticide use in developing countries grew by 40% according to the World Bank Projection. Although many pesticides are now banned or heavily regulated in developed countries, many hazardous pesticides are still being used. For example, Thailand has been importing large quantities of Class I and II (most hazardous) pesticides, as defined by the World Health Organization (Poapongsakom, Lakchai, Hermann, & Frauke, 1999).

When Thailand imported pesticides in 1987, 50% of the imports by value were insecticides and 30% herbicides. Most of them were used on rice, cotton and vegetable (Lum & Mamat, 1993). However, fruit and vegetable products to export countries, containing Pyrethoids that were found and sent back from customers. Long lived persistent Organochlorine deposits in the environment and soil may also cause trade and carcinogenic health problems in exposed people. Based on data from hospitals and clinics, the extent of environmental pesticide poisoning was under-estimated. This under-reporting requires attention, particularly towards the preventive and control measures of pesticide residues in fruits and vegetables. The measures would best be conducted by stake holders, official staff members and networking volunteers who are qualified to perform safety monitoring. Department of Agriculture Division of Toxic Substances' studies on pesticide exposure revealed the danger from organochlorine insecticides to Thai people, owing to the heptachlor found in farmers' blood from 1980 to 1986 (Lum & Mamat, 1993). The project report of pesticide risk assessment and communication was made by agriculturists from four regions of Thailand employed by the Department of Medical Sciences, Ministry of Public Health. The studies were performed on 1,217 Thai exposed insecticide agriculturists and control groups, aged 18 – 65 years. The three biomarkers, Micronucleus assay (study of DNA Damage), Acetyl cholinesterase enzyme activity (red blood cell study of sub-chronic toxicity), and Cholinesterase Activity (plasma or serum study for pesticide acute toxicity) were studied by 295 exposed agriculturists and 211 control groups. The results showed that the exposed group who had acetyl cholinesterase enzyme (AChE) activity analyzed in its red blood cells were equal and above of 3,500 international units (AChE ≥3500 IU/ml or normal level) and were also detected to have micronucleus 5/1000 cells. In comparison with case subjects who had the enzyme activity, less than 3,500 international units, an abnormal level of sub chronic toxicity, were detected to have Micronucleus 13/1000 cells. The results showed a tendency to have genetic abnormalities that may be related to genetic disorders e.g. carcinogenicity. The detected sub chronic toxicity group also showed more toxic clinical symptoms than the control group (L. Leuprasert & K. Sripaoraya, 1997); (L Leuprasert et al., 2010). As a result of this, FTA and sanitary restrictions among ASEAN Trade and International countries i.e. the EU regarding the sampling of vegetable to detect insecticides were tightened. Now, amounts of residues found in food must be controlled to be as low as possible for consumer safety, fixing the maximum residue level (MRL) that is legally tolerated in food (Wilson & Otsuki, 2004).

Pesticide poisoning have been reported over decades, intake of excessive amount can lead to acute intoxication while long time exposure can cause chronic poisoning that affects reproductive and nervous system. Many pesticides have been identifies as active carcinogens. Chronic health effects may occur years after even minimal exposure to pesticides in the environment, or result from their residues ingested through food and water (Piece, 2006). Pesticides are widely used for agricultural and horticultural crops. Consumers however who are exposed to pesticide residues in these affected crops could have severe undesirable health effects. These undesirable health effects can be stopped with the control and regulation of the use of pesticides on crops. While fresh vegetables are a source of good health, the risk of pesticide residue intake and therefore adverse health effects are still possible. Nowadays, vegetables labeled as “pesticide free” and “safe” are available in markets at higher cost than non-labeled ones. However, in the Department of Medical Sciences’ monitoring reports of 359 vegetable samples (166 labeled safe, 193 unlabeled) the frequently detected 4 groups pesticides pyrethroid-cypermetrin, organochlorine- endosulfan, organophosphate- methamidophos, and carbamate-methomyl were found in both types of vegetables regardless of safety label. Pesticide residue was detected in 63.7 % of labeled safe produce and in 51.8% unlabeled produce. The levels of pesticide residue found in the two sample groups of produce were not significantly different ($p>0.05$), and the violation rate of pesticides found in the non-labeled vegetables were almost two times higher than in the labeled ones. (Atisook, Lertreungdej, & Suntudrob, 2006) 06). This data was reported as safe of pesticide maximum residue levels (MRLs) that were conformed to the Thailand Food Act 1979, the Notification of Ministry of Health #163 (1995) and / or conformed to the international CODEX’s MRLs (Alimentarius, 1969, Amended 1999).

If a company has a potential pesticide crisis and it has identified the pesticide contaminant in products that have to be destroyed, then the screening tests are extremely useful. In crisis-management situations, companies are often forced to test hundreds of samples and make decisions rapidly, and it could be impossible to keep up with analytical testing demands with traditional solvent extraction and gas or liquid chromatography methods. The test kits provide the benefits of reduced testing time, reduced solvent consumption (and disposal), and reduced cost per test (Villani, 1995). 1995).

It is very difficult, complicated, expensive, and especially time consuming to use reference laboratories for analysis and results, time spent doing so which is not used for economic competition. Nowadays, no four groups have been tested by using one kit for food safety monitoring before in the Thai or international markets. There is public need for an innovative pesticide test kits to be developed for new screening of 2 groups and identifying of 4 groups to use for networking fruit and vegetable safety management. A new tool kit is a valuable socioeconomic tool that can be used to improve vegetable and fruit quality. By 2015, Thailand, a planned popular medical hub in Asia aimed to be a world class health care provider and national medical hub strategy. From 2010 to 2014, expectedly 81, 945 million baht will be spent towards Thailand becoming a world medical hub, and 78,225 million baht towards health promotion (Medical hub strategy 2010-2014). FTA and sanitary restriction of pesticide residue and more concerning health problems among ASEAN trade and international countries is being increased for the upcoming year of 2015 in all items of the ASEAN free trade. There is therefore an increasing need for the agricultural community and its produce exporters to analyze pesticide residues in their agricultural products. Thailand and other developing countries have limited resources of advanced technology and expensive laboratory instruments. The lack of complicated technology with its high costs in acquiring time and money is a common problem among consumers such as small to medium enterprises who want to use these laboratory tools and the results made by them for business export, food registration and marketing purposes. Because of international concerns that might result in a ban of the hazardous agricultural exports, researchers are calling for pesticide reduction. The sharp increase in pesticide use by Thai agricultures has alarmed international markets and made the situation worse. Some chemicals were banned in many countries but have been still used for agricultural purposes in developing countries. With the EU's recent findings of prohibited chemicals in imported vegetables including basil, chili, Chinese bitter cucumber and bean, the ensuing fears of a possible EU ban on Thai vegetables has prompted the government to order a temporary suspension of shipments of produce from Thailand

(AgroNews, 2011). What the public needs is an easy to use and up to date test kit that is validated, rapid procedure, small sized, and inexpensive .It would need to give accurate results to measure insecticides and also be environmental friendly to create less hazardous exposure than the products that have been marketed before. Increasing and more diverse production, processing and trade in vegetables has been part of the transformation of the rural sector, fostered through proactive policy changes by some national governments, and through attention to the vegetable sector by national agricultural system and private sectors. Production volumes and areas of vegetables in tropical Asia have been increased steadily. Crop management technologies and pest control; the need to adopt and monitor good agricultural practice certification and meet the requirements of supermarkets and export buyers; and rising interest in organic and low pesticide produce (G.I Johnson, K Weinburger, & M.H Wu, 2008).

The use of pesticides has been an important strategy in ensuring food security in many countries, but the contamination of produce and the environment is hampering agriculture industry development and damaging human and environmental health. While recent research has provided new, cost-effective options for measuring and managing pesticide residues, in many countries the capacity to monitor contamination and to provide remediation is limited because of inadequacies in regulatory mechanisms, infrastructure support, laboratory facilities, or the availability of trained personnel (Kennedy, 1998).

The Codex Alimentarius contained a procedure that controlled the primary production of safe control material, creating a selection of vegetable and fruit that were less hazardous. It also kept records of their traceability which could be very useful for produce safety. The Department of Medical Sciences and the Ministry of Public Health reported that 28% of their tests on vegetable and fruit samples found results of pesticide residue (source: Information and Public relations Office, Ministry of Public Health on 21 April 2011). To identify where in the vegetable and fruit handling operation pesticide hazards can be controlled is undoubtedly a job that should go to produce safety vegetable and fruit control (Department, 2008).

Food safety shall begin on the farm, improper procedures of pesticide use, handling, storage and disposal does impact of the vegetable grown on farms. Farmers need to review these proper safety procedures and to follow the instructions for good agricultural practice and pest management.

Recording all procedures and data concerned, keeping record of pesticide use and traceability and also quality process system of the pesticide handling, storage, application and disposal with attention for the safe management (Education, 2008). It was obvious that the problem of pesticide contamination could not be treated in isolation from the environment in which food and fiber are produced. The simple test methods must be evaluated in the agricultural environment, where their results can help improve pesticide application strategies and develop remediation (Kennedy, 1998). Fruits and vegetables often contain residues of toxic chemicals, called pesticides, which were used by farmers to control pests and diseases. If farmers provide the correct pesticides dosage, stop spraying well in time before harvesting (waiting period) and use the least dangerous pesticides this would provide a greater guarantee that their products will be safe to eat. Some pesticides are more toxic than others. For most pesticides the World Health Organization has established a Maximum Residue Level (MRL). With the current knowledge about the chemicals it is expected that food with residues below this MRL can be safely eaten. “Safe” fruits and vegetables are produce where residues do not exceed these MRL levels. Many farmers still produce fruits and vegetables with residue levels exceeding the MRL. But there are also farmers who are producing safe products. Some of these safe products will be labeled, either by farmers themselves or by organization such as Department of Agriculture, Department of Medical Sciences or Royal Project to certify that residue levels are expected to be below MRL. These products are routinely tested to make sure that the safe claims are justified and to correct farm procedures if necessary. Many of the bigger supermarkets and department stores are taking food safety very serious and will only buy products from farmers they can trust to produce healthy food. In some areas, farmers directly develop relationships with consumers built on trust and knowledge of their farming practices. Hygienic fresh fruit and vegetable production pilot project was an initiative of Department of Agriculture. Currently about 400 farmers have been certified. Government officers regularly inspect these farms and take random samples of their farm produce. These samples are then tested for pesticide residues in order to guarantee the quality of farm products. While most of these claim that the food is “safe”, this does not always mean that they are completely free of pesticides, but it means that residues are controlled and kept below levels that are expected to be safe (IPM, 2003).

Quality testing process system of pesticide residues in vegetable and fruit, an initiative accreditation of Department of Medical Sciences, Ministry of Public Health to develop and accredit laboratory testing of pesticide residues. The national accreditation has been aimed to promote the quality system for vegetable and fruit growers and distributors to develop laboratory testing system of pesticide residues in vegetables and fruits (Jarunuch & Leuprasert, 2011). Since 1999 to 2011, pesticide residues testing laboratories of 15 vegetable and fruit entrepreneurs were accredited. The difficulties of setting quality pesticide residues testing laboratories of general legal entities may be probably concerned with the small farm land agricultural community using innovative pesticide test kits. Public awareness related to high levels of pesticide residues, are currently increasing and more food scares that sometimes the toxic residues were found on vegetables and fruits, consumers have increasingly demand `safe' foods. The vegetable and fruit samples were randomly tested for pesticide residues by government officials and local administration officials in order to guarantee quality of very few farm products but not covering high safe demand of people. There has not been sustained independence or self-tested by the community farmers and not easy access to the testing instrument such as innovative pesticide test kits or not affordable to pay cost of testing and uneducated of the knowledge tool to guarantee the agricultural produce by community self-test.

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The principal researcher of this study and teamwork of the Department of Medical Sciences have developed innovative medical sciences pesticide test kit to support this need for screening of pesticide groups and the identification of pesticides in vegetables, fruits and cereals. These pesticide test kit was validated and can be used even by less educated persons, are convenient to carry for use in community laboratory fields and farming sites. The innovative kit can be used for the control of pesticide health risks and self-monitoring by the community in line with public empowerment models in cooperation with government and private agencies to solve the community problem and create a valuable economy that can be competitive in worldwide markets. Setting of self-test laboratory in community farms as well as small farm land pesticide safety education were technology transferred and trained to intervention agriculturists. Good agricultural and laboratory practice by using the innovative key tools that were innovative pesticide test kits and self-test laboratory setting accompanied with knowledge tool model for small farm land pesticide safety education cannot only reduce consumer products' pesticide contamination and health risks but also reduce the impact of pesticide contamination in vegetables, fruits and cereals in the environment.

Food Safety Report from Bureau of Food Safety Extension and Support, the Ministry of Public Health, Thailand reported that 2.76% detected unsafe pesticide residues from 62,397 vegetable and fruit samples. Pesticide residues were mostly detected in Kana (Chinese Kale) vegetable (Support, 2012). The pesticide use in agricultural production particularly Chinese kale vegetable plantation was therefore studied due to highly unsafe findings and mostly popular vegetable to Thai consumers. The contamination could not be treated in isolation from the environment which food was produced, the simple test method must be evaluated, where results can help improve pesticide application strategies and develop remediation (Kennedy, 1998). Validated test kit of Department of Medical Sciences, granted petty patent from Thailand Intellectual Property Department, used to screen 2 and 4 pesticide groups in the vegetable farm samples (L Leuprasert, Thongbor, Puydecha, & Chaiyasing, 2012) (L Leuprasert, Thongbor, & Puydecha, 2012b). Pesticide monitoring in farms could be emphasized for food safety. Transferring of innovative pesticide kit technology to strengthen agriculturists should be focused for safety monitoring of pesticide contamination to guarantee vegetable produce safety. Some of the pesticides particularly organophosphate and carbamate had ability of inhibiting the acetyl cholinesterase enzyme and the % enzyme inhibition assay can be measured in vegetable by spectrophotometer to evaluate the difference of variables after intervention study. Small farm land pesticide safety education should also be trained to agriculturists for safe farm produce with less chemical use and the proper cultivation practice.

This study therefore aims to develop the application of the innovative pesticide kit model for vegetable farm safety surveillance program that include the use of new technology plus knowledge tool model for the safety monitoring of vegetables in community farms that have never been implemented before. Pesticide monitoring should be emphasized for food safety. Transfer of innovative kit technology to strengthen agriculturists should be focused for safety monitoring of pesticide contamination to guarantee better vegetable produce safety. Some pesticides particularly organophosphate and carbamate had ability of inhibiting the acetyl cholinesterase enzyme and % enzyme inhibition assay can be measured in vegetable farm produce by spectrophotometer to evaluate difference of variables after intervention study. Small farm land pesticide safety education should also be trained to agriculturists for safe farm produce with less use of chemicals and proper cultivation practice. This study will therefore strengthen the networking capacity of the farming communities practically small farm land agriculture, while maintaining the benefits of agricultural production and can also decrease insecticide residue contamination in farm produce purposively selected Chinese kale as a pilot program for safe food and good health from farm to fork or consumers.

1.2 Research Question

Can Innovative Pesticide Kit Model Apply for Vegetable Farm Safety Surveillance Program?(Setting self-test LAB in farms by innovative pesticide kit model and small farm land pesticide education to develop pesticide safety in vegetable farm produce)

1.3 Research Objectives

General Objective

To evaluate effectiveness of innovative pesticide kit model (IPKM), for vegetable farm safety surveillance program.

Specific Objectives

The study was aimed at evaluating the effectiveness of innovative pesticide kit model (IPKM) for the vegetable farm safety surveillance program by measuring association of the % pesticide risks (% enzyme inhibition) in vegetable produce by researchers in the Klongtabak village, Nakhonratchasima province before and after intervention and transferring technology of self-test laboratory in the study farm community, obtained by training the study farm agriculturists and testing their laboratory testing competency.

1.4 Conceptual framework

The conceptual framework of this study was to evaluate the effectiveness of innovative pesticide kit model for vegetable farm safety surveillance program (IPKM). The intervention was studied to examine program effectiveness toward application of innovative pesticide test kit and transferring the test kit technology for self-test laboratory by farmers for vegetable farm safety monitoring. Pesticide risk reduction was measured by percentage cholinesterase enzyme analysis in vegetables and the competency testing of laboratory self–test by farmers using innovative test kit which were measured at pre and post intervention period as shown in figure I.I - I.II

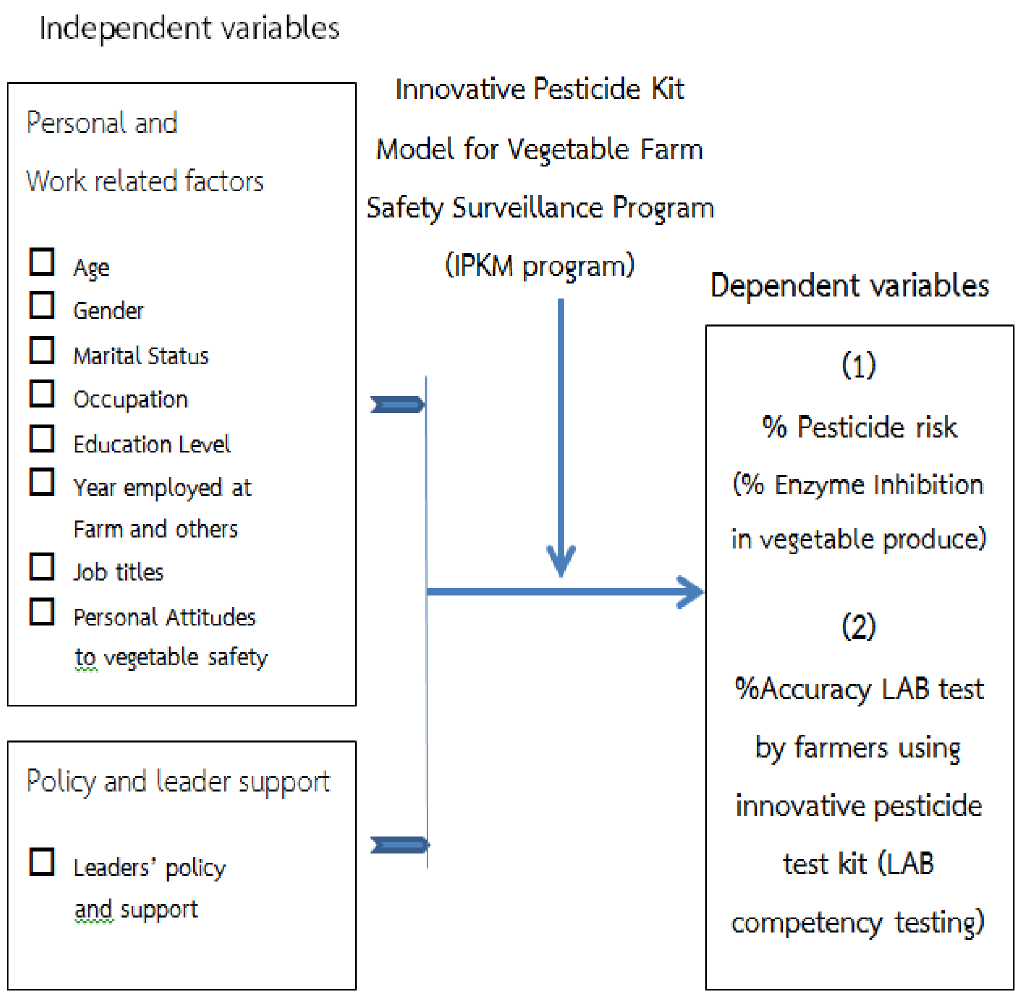


Figure I.I Conceptual Framework

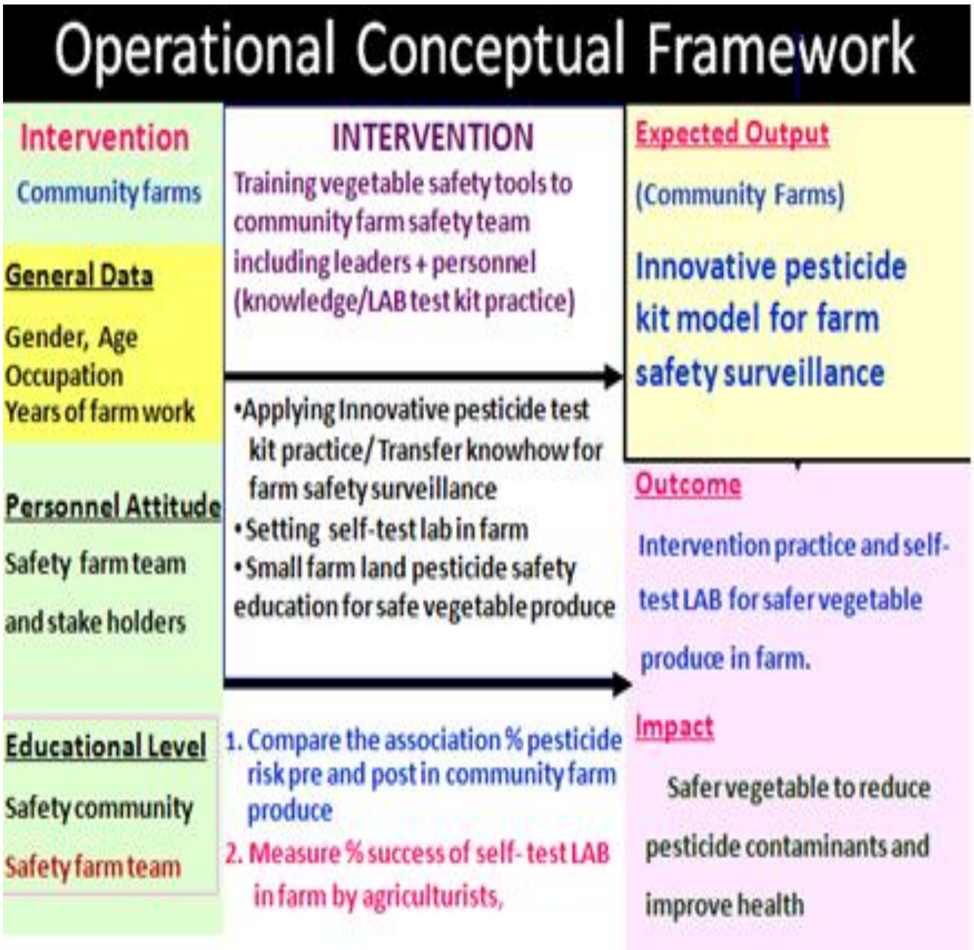


Figure I.II Operation Conceptual framework

Table I.I Variables of the Study

Category	Independent variable	Dependent variable
Personal Factors	☐ Age ☐ Gender ☐ Marital Status ☐ Occupation ☐ Education Level ☐ Year employed at Farm and others	
Work Related Factors	☐ Job titles ☐ Personal Attitudes to vegetable safety	
Policy/ managerial support	☐ Leaders' policy ☐ Leaders' support	
Application of innovative pesticide kit for vegetable farm safety surveillance		☐ Application of pesticide test kit and knowledge
Testing of pesticide residues' contaminants in vegetable produce		☐ Pesticide self-test laboratory, methodology and practice ☐ Setting of self-test LAB in intervention farm ☐ Competency measurement of testing pesticides in vegetable produce and proficiency test samples by farmers

1.5 Operational Definitions

Farm is any premise or establishment in which fresh vegetables, fruits and crops are grown and harvested. The farms are under control of the management and safety team using program application of innovative pesticide kits and knowledge tool model for safety monitoring in farm produce.

Insecticides are chemical substances used for killing insects.

Pesticides are chemical substances used for killing pests, as insects, weeds, etc and are used especially in agriculture and around areas where humans live that include fungicides, herbicides, insecticides, and rodenticides. In this study the pesticides are scoped as 4 groups of pesticides including; Organophosphate, Carbamate, Organochlorine and Pyrethroid. Organochlorine was the first generation used pesticides that remain biologically active for long years. Second generation pesticides, Organophosphate and Carbamate that were less persistent but widespread use. The third generation of pesticides was synthetic pyrethroid with less toxicity and can decompose quicker but more rapid pesticide resistance and high prices

To compare pesticide risk

To compare pesticide risk in this study refers to measuring % pesticide induced acetylcholine esterase enzyme inhibition, before and after intervention period in community farm produce, by using spectrophotometer method in vegetable farm produce before and after applying intervention study in research study group.

Pesticide tolerance refers to the amount of pesticide residue legally allowed to remain on the produce at harvest. For the establishment and regulation of the tolerances, agencies must consider the range of crops the pesticides have registered on.

Limit of Detection (LOD)

LOD of the pesticide test kit is the minimum amount of detection and quantification expressed as milligrams of pesticide residues per kilogram of vegetable and fruit as reported by the analytical method. In this project study, pesticide mainly refers to the insecticide and test kit minimum amount (limit) of detection.

Operational Definitions (continued)

Standard Method is the reference laboratory method of using one or more special instruments (GC, LC, GC-MS, and LC-MS). It was used as a validated method for comparing the testing results of test kit methods.

Innovative pesticide test kit

The project principal investigator team's newly developed technology was for screening pesticide residues of 2 groups (Organophosphates and Carbamates) and for identifying 4 groups of pesticides (Organophosphates, Carbamates, Organochlorines and Pyrethroids). The innovative pesticide test kits have been newly designed and validated for simple detection of insecticide residue contaminants in vegetable, fruit and cereal produce.

Innovative pesticide kit model (IPKM) for vegetable farm safety surveillance

In this study included 2 intervention contents, used in the innovative pesticide kit model for vegetable farm safety surveillance as follows;

1. Use of innovative pesticide test kit for evaluation of the pesticide kit model for vegetable farm safety surveillance (researchers test and compare association of % pesticide risk at before and after the intervention)

2. Setting self-test laboratory in study vegetable farms (self-test laboratory by farmers).

Application of innovative pesticide kit model for vegetable farm safety surveillance program

This is research's objective; to use the co-operatively innovative pesticide kit model (IPKM) for the reduction of insecticide residue contaminants in vegetable produce. For this study, the application of innovative pesticide test kits, setting of self-test laboratory for self-safety monitoring including small farm land pesticide education will be applied for vegetable farm safety surveillance program to reduce insecticide residue contaminants in farm produce and for recommendation of an alternative for vegetable safety monitoring system.

Operational Definitions (continued)

Maximum residue levels (MRLs) of pesticides

It is defined as the maximum concentration of pesticide residues in this study mainly refer to the insecticide (expressed in milligrams of residue per kilogram of vegetable) likely to occur in vegetable after the expected use of pesticides according to the Good Agricultural Practice (GAP) guidelines, i.e. when the pesticides have been applied in line with product label recommendations and have also kept with local environmental and conditions. MRLs help ensuring that residue levels do not pose unacceptable risks for consumers **(Committee, 2011)**.

Quality test process system of pesticide residues in vegetables

This refers to an initiative accreditation **of process system in fresh vegetables** of Department of Medical Sciences, Ministry of Public Health to develop and accredit laboratory testing system of pesticide residues. The accreditation aimed to promote quality system for vegetable and fruit growers and distributors to develop testing system of pesticide residues in vegetables and fruits. The scope of this national standard accreditation for farms that can be legal entities of growers, buyers from agricultural growers within nation or abroad and can also be marketing distributors that have permanent premises and legal body of management. The management of quality testing process system of pesticide residues, requires the laboratory shall be legally responsible and shall have managerial and technical personnel with the authority and sustainable resources for testing or doing their duties. The laboratory shall establish, implement and maintain a quality system and shall document its policies, systems, procedures and instructions to assure the laboratory test quality of pesticide residues in farm vegetables to test pesticide residues (Jarunuch & Leuprasert, 2011) (L Leuprasert, 2011).).

Operational Definitions (continued)

Application of pesticide test kit refers to the application of screening 2 groups and / or identifying 4 groups pesticide detection kit technologies that are transferred to farm safety team by laboratory training workshops. The knowledge gained from these kits includes education of farm safety surveillance program for the intervention farm's team and stakeholders to monitor with awareness of hazards and safety attitudes.

Safe Vegetables

This study of pesticide maximum residue levels (MRLs) are labeled as safe conforming to the Thailand Food Act of 1979, Legalization Announcement of Ministry of Health 163 (1995) or the international CODEX's MRLs (Alimentarius, 1969, Amended 1999).

Acetylcholine esterase (AChE)

AChE is a synaptic enzyme that plays role in neurotransmission in cholinergic synapses where it rapidly hydrolyzes the acetylcholine neurotransmitters. The widely and commonly used pesticides organophosphate and carbamate have a direct effect on the inhibition of acetyl cholinesterase enzymes. Since acetyl cholinesterase is an enzyme that degrades acetylcholine after the stimulation of a nerve, its inhibition allows acetylcholine to accumulate and therefore resulting in initial excessive stimulation followed by clinical pesticide toxicity (Website, 2009)

Acetyl cholinesterase-based pesticide detection kit

It is aimed for screening detection of organophosphate and carbamate pesticides which are

to semi-irreversibly inhibit AChE. The study's pesticide screening test kit tool which uses acetylcholine esterase based detection to detect organophosphate and carbamate pesticides. The farm safety team of the intervention farm site has this test kit to use for screening the organophosphate and carbamate pesticides by farmers as screening research tool for the pesticide safety monitoring in vegetable farms.

Operational Definitions (continued)

Thin layer chromatographic (TLC) method for 4 groups pesticide analysis

This technique is used for identifying detection of 4 groups pesticides (organophosphate, carbamate, pyrethroid and organochlorine). The detection kit is used by researchers for identification of pesticides to screen pesticide contamination in farm produce before and after intervention period. This innovative 4 groups pesticide test kit will be technology transferred to farmers and used for vegetable farm safety surveillance in addition to the acetyl cholinesterase based pesticide detection kit of the organophosphates and carbamates. However, this 4 groups detection kit have also been provided as an alternative research tool for four groups identify testing for farmers.

Small farm land

It refers to vegetable plantation in small farm land, about 1-20 rais or 1-50 acres that cultivate vegetable for consumers.

Small farm land pesticide safety education

The study refers to pesticide safety education for vegetable growing. Education of pesticide health impacts and awareness, knowledge includes selection of better, safer supply pesticide sources, use the less dangerous pesticides. Proper procedures of pesticide use, handling, storage and disposal. Recording pesticide handling procedures and pesticide test data, correct pesticides dosage, stop spraying well in time before harvesting etc.

Volunteer farm safety team

This refers to team of farmers, intensively trained by researchers and stake holders for intervention practice of innovative pest kit model for farm safety surveillance program.

Operational Definitions (continued)

Self-test laboratory of pesticide residues for farm safety surveillance

Self-test LAB setting has been aimed to strengthen vegetable farms to develop laboratory testing of pesticide residues in vegetable farms. Management of testing system of pesticide residues, requires the laboratory shall have technical personnel for testing or doing their duties. The laboratory shall document its policies for the laboratory test of pesticide residues in farms.

Competency testing measuring of insecticide residues of vegetable produce

(Testing by farm safety teams).

It is to analyze the pesticide residue contaminants in vegetable produce by farm safety team using the innovative pesticide kits. Proficiency testing vegetable samples will be sent to intervention safety farm laboratory for testing by farmers.

The farmers' competency of laboratory testing by using innovative pesticide test kits in this study was compared by the same vegetable laboratory testing between farmers and competent analysts from regional reference laboratory at baseline and follow up testing and the testing accuracy of farmers was measured for their competency results and for the laboratory workshop training achievement.

1.6 Scope of the study and Expected benefits

Scope of the study

The study intervention was conducted during May 2012-October 2013 at a village's community farm located in ladbuakao sub-district, Sekhiew district, Nakhonratchasima province, the northeast of Thailand and at another Ta-ngoy village's community farm, Chanteuk sub-district at, Pakchong district in the same province and north eastern region that was selectively chosen as control.

Expected Benefits

1. Increased availability of researched innovative pesticide test kit for the community farm volunteers to test insecticides by themselves.

2. Strengthening agriculturists using innovative pesticide test kit transferring technical education and self–test with innovative pesticide kit by farmers for vegetable farm safety surveillance program.

3. Establishment of self-test farm laboratory that can demonstrate, transfer know how and competence of self-test for safety monitoring of pesticide residues in vegetable produce.

4. Provision of consultative documents to self-monitor vegetable safety in farms with several means of education/knowledge transfer and document distribution of media including hard copy and electronic such as small

farm land pesticide safety manual, leaflet, poster, book, news, journal articles, DVD and You Tube etc.

CHARPTER II

LITERATURE REVIEW

Pesticide risks and risk reduction strategies, pesticides can protect crops, but if used improperly or excessively they can also have the opposite effect that include the increase in secondary pests due to inappropriate pesticide treatment of a primary pest and the disruption of soil ecology due to pesticide contamination. Furthermore, pesticides can have a range of detrimental environmental effects, contaminating the surrounding environment and water resources through spills, inappropriate disposal of pesticide, pesticide run-off or drift after aerial application. This can result in widespread death of wildlife and beneficial organisms such as bees, as well as negative effects on livestock, aquaculture and ecosystems.

2.1 Pesticide detrimental effects

The detrimental effects can occur not only in the immediate vicinity of the pesticide contamination but also in remote areas where run-off, ground water contamination, wind currents or animals have carried pesticides far from their original application. Contamination can reduce biodiversity, even in the contained agricultural setting by killing beneficial organisms. The pesticides that have an impact on biodiversity, persistent organic pollutants (POPs) have most long-lasting and far-reaching effects, as they can remain in the tissue of living organisms. Another concern is pesticide resistance among agricultural pests and disease vectors. Intensive pesticide use, or overuse, in an effort to control the pests and disease, vectors can reduce efficacy of pesticides for other purposes, such as vector control to protect human health or pest control for livestock production. When pests are resistant to a certain pesticide, farmers will simply and often apply more or different pesticides, thereby increasing the residues on food crops and strengthening the pest's resistance even further. In the end, when a pesticide is no longer effective, farmers often face a need to purchase newer, often more expensive products, which can be especially problematic in developing countries.

Another problem is how farmers deal with ineffective pesticides, through the use of pesticide "cocktails." Negative effects on human health can be caused by direct or indirect exposure to pesticides. Exposure is direct where the pesticide moves straight from the source to the person, as in the case of workers and farmers using pesticides on farms. Exposure is indirect where a pesticide goes through an intermediate pathway, for example via the consumption of food or water contaminated with pesticide residues. Pesticide exposure can have both acute and chronic effects. Acute effects are caused by a single exposure to highly toxic pesticides, while chronic effects arise from exposure to lower concentrations over longer time periods.

Developing countries face the most challenges in achieving the sound management of pesticides. A large proportion of the population is directly engaged in agricultural work, often on a very small scale. Farmers will purchase pesticide products for individual use, but may not be sufficiently literate to read the instructions or be comfortable in the language the instructions are written in. Particularly in remote areas, the only source of advice may be the pesticide seller, who may also be poorly informed, and whose advice may be guided by commercial self-interest. These populations are often not able to afford the newest minimum-risk pesticides, instead using older and often more dangerous products which are cheaper because they can be produced as generic products off-patent. Even appropriate products may be adulterated or have deteriorated because their shelf life expired while they were in storage or because they were stored improperly. Farmers using such pesticides are at risk of developing pesticide related illnesses and future pest problems. Lack of awareness and resources can lead to improper disposal of pesticides and reuse of the pesticide containers. Sub-standard pesticides through illegal trade or sometimes through international "donations" or dumping of pesticides that are no longer used in developed countries. These donations are often improper for the climate or local crops or are themselves pesticides that are obsolete or that recipient countries may not be capable of dealing with in sound manner. The improper use of pesticides can pose other health problems that can be particularly serious for developing countries. For example, exporting countries may find their agricultural products rejected where they contain unacceptable residue levels. Tourism can also be affected where ecosystems or marine fauna are threatened because pesticides have been used for killing fish or have leached into the waterways, or where travelers rightly or wrongly believe that a country's pesticide management problems make food or drinking water unsafe. Proper management of pesticides at national level therefore has far-reaching implications for a country's well-being with respect to the environment, human health and trade (Vapnek, 2007).

2.2 The first NESDB five year plan of export based agriculture

In Thailand, the national economic and social development (NESD) plan is a product of public bottom-up approach and the board of NESD (NESDB) is the national focal functioning authority. In1961, the government of Thailand implemented the first NESDB five years plan that shifted Thailand from consumption–based to export-based agriculture and emphasized industrial growth and development of industrial exporting. In 1991, pesticides were made exempt from export taxes, the Ministry of Agriculture and Cooperatives increased budgets for pesticide and fertilizer expansion program. In 1995, Act 163 of the Ministry of Health setted limits on the types of chemicals that Thai farmers could use; however, no limit on quantity was set. In 2007, NESDB tenth five year plan focused on building balance within Thai society between industrial growth and continued development of sufficient economy (Kim, 2008). Insecticides were 17% used approximately in world market (EPA, 2007).

2.3 Grain self-sufficiency and the Green revolution

In countries where grain self-sufficiency is being reached and for remote and marginalized communities, vegetables are a key option to diversify marketing opportunities, enhance community nutrition and boost income for farmers and traders. The Green Revolution encompassed the development and uptake of higher yielding, disease-resistant crops, and improved productivity of the livestock, fisheries, forestry, and post-harvest technology sectors. The increase in productivity was critical for food security, but it came at a cost. Today the excessive use of fertilizer and chemicals to boost yields is cause for concern. The increased interest and opportunities for high-value industries throughout tropical Asia reflect changing food preferences and customer requirements favoring high-quality meat, fisheries products, fruit and vegetables, and better access to markets. Farmers are able to have profit from high-value industries because of increased demand and improved market access, and because of increased productivity when advanced production and marketing technologies are available and adapted to the local situation. Increasing and more diverse production, processing and trade in vegetables has been part of the transformation of the rural sector, fostered through proactive policy changes by some national governments, and through attention to the vegetable sector by national agricultural system and private sectors. Production volumes and areas of vegetables in tropical Asia have risen steadily. Production area have been increased for developed countries and India, agricultural extension has a primary role in enabling dissemination and implementation of innovations in vegetable industry practices, market development, and sustainable practices. Key challenges include access to and the sustainable use of land; the potential to boost production through crop management technologies and pest control; the need to adopt and monitor Good Agricultural Practice Certification and meet the requirements of supermarkets and export buyers; and rising interest in organic, low pesticide and protected (G.I. Johnson, K. Weinburger, & M.H. Wu, 2008).

2.4 The effects of free trade with China

Chinese produce flooded the Thai market, in August 2004, the Office of Agricultural economics (OAE) released its quantitative analysis of the effects of free trade with China. They collected nine months data prior to the FTA (October 2002 to June 2003) and nine months after the elimination of tariffs (October 2003 to June 2004). The Table II.I compared the import and export values of the Thai vegetables and fruits for these two periods. Exporting the vegetables and fruits to China was not easy, besides China' s own production potential , exporting these fresh produce to China still faced a great number of obstacles such as the China non - tariff barriers to trade and in addition, China collected an additional value the added tax on the fruits and vegetables for instance. Transporting the produce to China was relatively slow , which affected quality of Thai produce by the time it reached to the hand of buyers. The exporters needed to obtain the product certification export permits from the related government departments and had their produce be inspected for chemical residues (Watch, 2005).

Table II.I Changes in values of imports and exports and the elimination of tariffs with China

Category of Goods	Exports(million Baht)	Imports(million Baht)	Balance of Trade (million Baht)
Vegetables			
Pre-FTA(Oct.-Jun. 2003)	3,829	346	+3,483
Post-FTA(Oct.-Jun.2004)	5,553	970	+4,583
Change	+45%	+180%	+1,100%
Fruits			
Pre-FTA(Oct.-Jun. 2003)	1,370	1,059	+321
Post-FTAOct.-Jun. 2004)	2,441	2,565	- 125
Change	+78%	+142%	+196

Retailers and processors seeking low-cost suppliers and exotic/ ethnic foods demanded by the U.S. consumers procure foods and ingredients all over the globe. It is often difficult to ensure that suppliers operate according to the high safety standards and tight quality control demanded by U.S. consumers. FDA has cited over 50 different violations in its refusals of Chinese products, but most fall into a few general categories that include general filth, unsafe additives or chemicals, microbial contamination, inadequate labeling, and lack of proper manufacturer registrations. Pesticide residues were a less frequently occurring problem during 2007-2008, accounting for about 4 percent of violations, down from 6 percent during 2002-2004. Unsafe pesticide residues were found on some vegetables and their products: celery, soybeans, lotus, pea pods, mushrooms, scallions, ginger, and ginseng. Several shipments of reported organic beans and berries were refused for unsafe pesticide residues. Farm-level problems like unsafe pesticide residues and heavy metal contamination could be more prevalent than indicated by FDA violations. Toxic residues could be detected only through lab tests, so they could be present in untested shipments that were rejected for more obvious violations, such as filth and inadequate labeling. Pesticide residues and heavy metal contaminants have been a major concern in China's exports to Japan and Hong Kong and in produce sold in China's domestic market. U.S. and Chinese officials are involved in complex multi-pronged efforts to address potential safety risks from food imports from China. These efforts included inspecting and testing products at the border as well as measures to address hazards at their source in processing plants and on farms, an approach stressed by the U.S. Interagency Working Group on Import Safety, U.S. Congress, and FDA's Action Plan for Import Safety. Domestic food safety efforts tend to lag behind those directed at exports. Chinese officials, in response to both domestic and international safety incidents have stepped up domestic inspection and testing of food, introduction and dissemination of standards, and regulation of food producers and have initiated other measures aimed at achieving a broad-based improvement in the general level of food safety (Gale & Buzby, 2009). Thailand majorly imported vegetable samples from China, India, Malaysia and Indonesia. India is the second largest producer of vegetables after China, accounts for 13.4 % of world production. Surveys carried out by institutions spread throughout the country indicated that 50-70% of vegetables were contaminated with insecticide residues. Thai People might have exposed to hazards from vegetable imported from India, the world second largest vegetable producer (Karanth, 2000). Investigations in India show that people hardly had food items, especially raw ones like vegetables that were free of pesticide residues. Most of them are burdened with organophosphates chemicals, which were similar to organochlorines in their destructive propensities. Market samples of six seasonal vegetables in Haryana state of India during 1996-1997 was monitored and reported to determine the magnitude of pesticide contamination and found contamination in 100% samples with 23% exceeding safe limits. The presence of pesticide residues in fruits and vegetables was getting higher than maximum permissible levels, revealed a 2009 survey by the Union Agriculture and Cooperation ministry. Various other studies have proved that the risk of residues compounds with leafy and green vegetables **(Betne, 2011)**. It is noted that pesticide consumption in India, the problem of pesticide residue in food products which mainly percolate from fruit and agriculture crops wherein pesticides are used to kill pests. Giving reasons for more pesticide residue in food products in India, However in India due to more use of persistent pesticide, their residues remain in food products. Due to problem of persistence of pesticide residues in food and agricultural products, as also lack of awareness on the part of farmers with regard to judicious use of pesticides, the parliament Committee of India called for detailed information from the Ministry of Agriculture, Central Insecticides Board and Registration Committee, which were the Government agencies entrusted with task of registration, regulation and usage of pesticides in the country. Their representatives were also called before the Committee to tender their oral evidence on the subject (WHO, 1989).

2.5 UNEP and WHO urge to reduce the pesticide use through IPM

In the Food Hazard Analysis Critical Control Point (HACCP) newsletter, it was reported that the source information of the Food and Agriculture Organization (FAO) of the United Nations Web Site in 2004 reported that an estimated one million to five million cases of pesticide poisonings occur every year, causing several thousands of fatalities. Most of the poisonings were reported to take place in the rural areas of developing countries, where pesticide safeguards are typically inadequate. Although developing countries use only 25 percent of the world's production of pesticides, they experience 99 percent of the world’s deaths due to the pesticide poisoning. To reduce pesticide poisoning; FAO, United Nation Environment Protection Agency (UNEP) and World Health Organization (WHO) urge to reduce the use of agricultural pesticides through Integrated Pest Management (IPM) and to train health care providers on the recognition and management of pesticide poisoning (Nations, 2004). World Health Organization / FAO: Agriculture and Consumer Protection actively applied food safety principles to fresh fruit and vegetable supplying chain, improving the quality and safety of fresh fruits and vegetables. They provide a clear understanding of the safety concept as applied to the production and trade of fresh fruits and vegetables. They also provide practical guidance and guidelines to assure the safety of fresh fruits and vegetables throughout the production and post-harvest chain, integrated “from farm to table”. The approach and scientific risk assessment is basing decisions on the best available scientific evidence e.g. chemical hazard identification and controlling measure of food safety standard hazard (F. a. A. Organization, 2006); (Pineiro, 2006). In Europe, the Council Regulation n. 2092/91/EEC regulates the production and trade of organic products and foodstuffs; national and regional legislation in Italy gives specific guidance on the surveillance of organic agriculture. However, the monitoring of specific chemical residues in organic foodstuffs is part of the regular controls on food, aiming to safeguard consumer's health. Monitoring programs are coordinated at the national level by the Ministry of Health and at local level by Regional authorities. In Lombardy of Italy, in accordance with the provisions of the General Directorate of Health of the Region and under the supervision of the 15 Local Health Units, a monitoring program of pesticide residues in food of plant origin is undertaken every year. The International Centre for Pesticides and Health Risk Prevention (ICPS), on behalf of the General Directorate of Health of the Region of Lombardy, has been collecting and elaborating the data resulting from the analysis of food samples, carried out by the local laboratories (Tasiopoulou & Chiodini, 2007).

2.6 US FDA Program's domestic food surveillance

In 1993, FDA's regulatory monitoring program analyzed samples of domestically produced food and imported food from 107 countries; 12,166 were surveillance samples, meaning that there was no prior knowledge that a specific food shipment contained illegal pesticide residues (Program, 1994). In the FDA Program's Domestic food surveillance, no pesticide residues were found in 64 percent of the 5,703 domestic surveillance samples, 34 percent had detectable residues below tolerances, and less than one percent had residues that exceeded EPA tolerances. The FDA program's also imported food surveillance; one percent had residues for which there was no established tolerance for that particular pesticide or commodity of the 6,463 import surveillance samples, 69 percent had no detectable residues, 27 percent had detectable residues below tolerances, less than one percent had residues that exceeded tolerances, and three percent had residues for which there was no established tolerance (Insight, 2009). The agriculture community has important economic reasons to be concerned and informed about food safety requirements and issues. To be accepted in the marketplace, agricultural products must meet governmental food safety standards and maintain a safety level that inspired continued consumer confidence. For the latest information about food safety programs in EPA and other federal agencies, the topic of pesticide residues that remain in food at harvest were monitored to avoid hazards to the humans. The Food Quality Protection Act, passed in 1996, established a strong, health-based safety standard for pesticide residues in all foods. The food safety standard for pesticide residues in food was a "reasonable certainty of no harm" standard for aggregate exposure using dietary residues and all other reliable exposure information. The EPA established maximum residue levels (tolerances) when registering a pesticide. A tolerance was the maximum amount of pesticide residue that might legally remain on or in treated crops (EPA, 2011). Promotion of food safety has been one of the government's priorities under Healthy Thailand campaign. Food should be safe for domestic consumption as well as for export. The government assigned responsibility to several agencies. In the Ministry of Public Health, these included Food and Drug Administration, Department of Medical Sciences and Bureau of Health Promotion. In Thailand, Ministry of Agriculture, the agencies concerned were the National Bureau of Agriculture Commodities and Food Standards, the Department of Fisheries. Good coordination and collaboration among these concerned agencies needs to be strengthened. Strengthening the surveillance system for health problems resulting from chemical substance or pesticide use among farmers was also one of the issues of WHO support during 2008-2009 (W. H. Organization, 2011).

2.7 National food safety program in Thailand

Thailand has been very concerned about the risks and hazards posed by the consumption of unsafe foods among not only domestic consumers but also consumers worldwide. The Thai government has pursued a food safety policy. The national food safety program has been implemented and supported by the Thai government with the cooperation of international agencies and food industries in order to ensure the safety of Thai food in both domestic and global markets. The Ministry of Public Health has implemented measures for strict and regular surveillance and monitoring of the food contaminants, focusing on the pesticide residues as they have been one among the major hazardous chemicals contaminating some of the food available in the Thai market. (Srithamma, 2005). Thailand also made remarkable progress in strengthening its status as the 'Medical Hub of Asia'. In 2004, about 600,000 foreign patients seeking treatment in Thailand generated 20 billion baht of revenue for the country. Regarded as a sector that offers great promise in generating significant foreign exchange earnings, medical tourism grew by an impressive 66 percent in the two years later with approximately one million foreign patients travelling to Thailand for medical treatment and health services. As the 'Health Tourism Hub of Asia', the priority for its medical services was to ensure that Thailand is perceived as being a quality destination in the delivery of superior medical and health-related services. Medical care, dental care, and medical check-ups are the core products offered (Thailand, 2011). Thailand's medical hub policy was at the end of phase I in 2009 and proceeding to phase II (2010-2014) which receive approval from the National Health Federation Summit III before public hearings are held. The Thailand medical hub strategic plan would then be submitted to the cabinet for final approval (Post, 2010). As medical consumers demand safe food, a food safety practice guideline would be one of the best public health responses in health promoting hospitals to promote our country as a world class health care provider.

2.8 Hospital food management and Health promoting hospitals

Back in 1986, the World Health Organization (WHO) produced the Ottawa Charter for Health Promotion. The intention of the charter was to create a framework that conveyed the nations of capacity building into a structured process for health promotion action in specific settings. This charter subsequently provided the vehicle from which the

Health Promoting Hospital (HPH) initiative was launched, culminating in the Budapest Declaration of Health Promoting Hospitals (Bensberg & Kennedy, 2002). Health Promoting Hospitals (HPH) not only offer high quality comprehensive curative services but also integrates and implements health promotion through changes on the organizational development of social structures and organizational culture of the hospital. HPH initiates and supports active participation of patients and staffs, builds supportive hospital environment, and links the community to the health system. Although health promotion activities have been already included in hospitals' services, most of hospitals in Thailand are primarily curative oriented. Hospitals are the center of medical treatment and allocation of various types of resources where functioning basically passive curative services. With these strengths, the Ministry of Public Health has reconsidered and shifted the hospital's services to a more integrated proactive approach of health promotion and prevention to a so-called Health Promoting Hospitals. Developing new structure and roles of the hospital while working closely with the community and the people, the potential to meet the overall health development through changing people's health behavior, and have subsequently decreased overall health cost would become possible. To move towards health promoting hospitals, Thailand was aimed to gear its health development activities with 5 basic strategies recommended in the Ottawa Charter namely:

(1) To build healthy public policy

(2) To create supportive environments

(3) To strengthen community action

(4) To develop personnel skills

(5) To re-orient health services, all of which are responsive to the health need of the people.

The Health Promoting Hospital Master Plan for Thailand officially developed in 1998. The main objectives are to reorient and adapt the hospital services to a more balanced systematic, standard and integrated preventive, promoting, curative and rehabilitative approach which encourage favorable people's attitude and values so as to enable and empower hospital staff and people's ability to control over their health in a supportive physical, social and spiritual environment (Aumkul & Keereewong, 1999). Hospitals are clinical places where service daily mass catering for patients and hospitals' staffs, hospitals' food safety management is highly important and necessary for administrators and people who are responsible in the area of nutrition at hospitals. Nowadays, there has been still no appropriate safety to be used as a guideline in hospital's food management for it to be highly safe for consumers. The hospital's food management which could be used with the integrated models of qualitative, quantitative and operative research methods. Other example groups were 306 government's hospitals where under management of Thai Ministry of Public Health, the statistics used for analysis were a relation model of linear structure and of confirmative composition, regression and causal effects. The research result found that in a hospital's food safety management model, the two most important aspects of food safety management were food safety control and the sourcing of safe raw materials. Both of these issues succeeded in both aspects of administrator's policy and support and its hospital food safety development team. The experimental results of the food safety management model were used with the interested hospitals and were found to have capability to produce better food safety administration in various aspects. This research model was able to be constructed as a guideline for any hospital's application in order to produce a food safety service that was both friendly to visitor health and importantly, more reliable (Panurach, 2011).

2.9 Insights into the need for rapid pesticide testing

In recent years, relatively inexpensive analytical test kits had been developed for rapid testing of pesticides in foods. Many manufacturers of these kits advertised that users can get results faster and at less of a cost than before, and that the kits could detect pesticide levels lower than the conventional solvent extraction and gas chromatography based multi-residue methods. But were these new methods as good as kit manufacturer claim? What were their best applications? What were their limitations? There had been no simple answers to these questions. Some useful insights into the need for pesticide testing and how to do it come from General Mills Inc. (GM). In 1995, General Mills learned some 21 million bushels of their oats were tainted with an unauthorized pesticide. As a result, GM was forced to destroy approximately 50 million boxes of Cheerios and Lucky Charms and 15 million bushels of raw oats because of contaminated pesticide, chlorpyrifos-ethyl which was approved for use with some grains, but not for oats. GM suffered astounding losses to its reputation, and finances, reportedly losing as much as $140 million. A Minnesota state regulatory laboratory reportedly detected the unauthorized pesticide in General Mills' cereal during a routine check using a gas chromatography, a multi-residue screening test. The multi residue screening tests that GM could have used, involve a slightly different extraction procedure, followed by either using gas liquid chromatography (GC) or High Performance Liquid Chromatography (HPLC) as a detector. The major advantage of the multi-residue screening test was that they could accurately detect (with great sensitivity) several hundred possible pesticide contaminants. Of course, even with broad-spectrum multi residue tests there was no guarantee that all pesticide residues present in a food material would be detected; after all, there were approximately 11,000 different registered pesticides listed in the US Farm Chemicals Handbook. If a company had a potential pesticide crisis and it had identified the pesticide contaminants, then screening tests were what would be extremely useful. In crisis-management situations, companies were often forced to test hundreds of samples and make decisions rapidly, and in those situations it could be impossible to keep up with the analytical testing demands involved with traditional solvent extraction and gas liquid chromatography methods. This alternative use of screening test kits provided the benefits of reduced testing time, reduced solvent consumption (and disposal), and reduced cost per test. Screening tests also had a much better chance at detecting a possible contaminant than the less-expensive, quicker ELISA-type test kits which detect only specific classes of pesticides. The disadvantage of pesticide multi-residue testing was that it was very expensive and time consuming. When properly applied, rapid test kits for pesticide analysis were an invaluable tool for food companies, panel of immunoassay kits for pesticide residues were very difficult and costly to detect by traditional techniques. Enzyme-linked immune sorbent assays (ELISAs) combine selective antibodies with sensitive enzyme reactions to produce analytical systems capable of detecting very low concentrations of chemicals. The technical concept was based on the use of novel magnetic particles as a solid support and means of separation in an ELISA system. Food companies were using these pesticide test kits for HACCP analysis, import and export testing requirements, and crisis management. The limitation of the ELISA based kits however was what analytical chemists call specificity, or a test's ability to measure only the chemicals of interest and not similar pesticides or interfering compounds. The specificity of the ELISA tests was described in terms of its antibody cross-reactivity to other related compounds. Each of these chemicals responded differently to kit reagents. For example, the ELISA test was approximately 1,000 times less sensitive for propachlor than for metolachlor. Another choice of simple testing methodology was an enzyme-based test method that rapidly detects the presence of approximately 50 different carbamate, thiophosphate and organophosphate pesticides. The test is less specific than ELISA/immunoassay tests and is not quantitative. The test is based on the reaction between pesticides and enzymes. It was very sensitive to cholinesterase inhibitors. The test could detect pesticide contamination in the range of part per million (ppm) to low part per billion (ppb) levels, depending on the sample matrix, extraction efficiencies, and type of pesticides present. If positive tests are found, the samples should be retested by traditional methods for confirmation (Villani, 1995) A study of the safety level of Tangchay (Chinese food made from cabbage or reddish) and its development of its production of fresh cabbage was currently available on the studied market. In Tangchay, investigators working in the study reported three unsafe level samples contaminated with pesticide residues containing more than a 50% inhibition of acetyl cholinesterase enzyme. The study used the private GT pesticide test kit, and also clarified that if test percentage of inhibition was more than 50%, the pesticide residue level would be dangerous to the consumer. The high level of contamination might have been due to the high level of pesticides used in the field and unwashed raw cabbage material (J & P, 2009). Washing and peeling are very important steps in both household and commercial preparation of most fruits and vegetables. Several types of pesticides residue can be removed by using these important steps (Kaushik, Satya, & Naik, 2009). Vegetable and fruit safety management is currently recognized as a key performance indicator among hospital food safety control as they are an important part of everyone's diet. Special care must be taken to ensure their quality and safety particularly for sensitive patient groups in hospitals. Although many hospitals have been implementing health promoting activities, others would rather be curative-oriented rather than to operate comprehensive health promotion hospital activities. Since 1998, the Ministry of Public Health has supported Health Promoting Hospitals to create a public health promotion system and support active participation of patients, hospital staffs and the community in order to integrate the best balance of illness and wellness service approach in hospitals(Aumkul & Keereewong, 1999). The absolute output of the two dimensions would offer good health delivery at the hospital level which benefits from a low cost at the national level and brings about sustainable application of the innovative pesticide test kits. It would be an approach to better vegetable and fruit safety and could also anticipate and control of insecticide residue contamination in hospital produce. The innovative insecticide test kits application was essential to promote effective control of the pesticide residues in hospital produce which was a key to meeting hospital customers' expectation of an environment free harmful insecticide residue contamination. The researchers will therefore practice by using the key tool of innovative test kits and relevant knowledge to reduce the impact of chemical pesticide contamination in vegetable and fruit produce.

2.10 Washing pesticide residues on agricultural crop

The international food standard of the World Health Organization and FAO/WHO (Codex) called the General Principle of Food Hygiene (Alimentarius, 1969, Amended 1999). It contained a procedure to control the primary production of cleaning, maintenance, and personnel hygiene including accessories and responsible personnel to ensure cleanliness and reduce risk contaminants. Washing pesticide residues on agricultural crops is the primary step in both household and commercial food preparation. The removal of pesticides with washing may be performed not only through the dissolution of pesticide residues in washing water or by rinsing with chemical baths (alkaline, detergents, acid, hypochlorite, ozonated water, metabisulfite salt etc) but also through the removal of dust or soil particles which previously absorbed pesticide residues from the outer layer of the agricultural crops. Consequentially, the use of an appropriate detergent which has the ability to solubilize waxes may dissipate pesticide residue present in a fruit's epicuticular wax layer (Stoytcheva, M., 2011). Proceedings of the 46th Kasetsart University Annual

Conference reported a study which told how to reduce pesticides by washing. Leafy Chinese-Kale treated produce with carbamate pesticides (methomyl and carbaryl) and subjected the produce to various chemical aqueous washes to determine the level of pesticides residue left afterwards. The results showed that washing vegetable with solutions prepared from the household chemicals are more effective in reducing pesticides than washing with water alone (Repository, 2008)(Thai Agricultural Research Repository. 2008).

2.11 Codex harmonized food standards

The Codex Alimentarius Commission (Codex), a joint body of FAO and WHO, elaborates harmonized food standards which are recognized by the World Trade Organization (WTO) through the Agreement on the Application of Sanitary and Phytosanitary Measures. Most relevant to Management of pesticides are the standards for maximum residue limits (MRLs) established by the Codex Committee on Pesticide Residues(CCPR). The CCPR is a subsidiary body of Codex, entrusted with the preparation of the MRLs to be adopted by Codex (Vapnek, 2007). The WTO Sanitary and Phytosanitary (SPS) Measures Committee, meeting on 27–28 June 2007, discussed the issue of private sector standards for Good Agricultural Practices adopted by some importing countries. Many of these new standards are either more restrictive than the internationally agreed upon standards of Codex or impose standards where none have been set internationally. These higher standards are also much broader since they cover not only the safety of the final product but also the way foods are produced – addressing fair trade, labor practices and environmental issues. Critics complain that these higher standards create an unfair trade barrier by imposing standards on exporting countries which they have not agreed upon (Vapnek, 2007).

Food crisis Causes, consequences and alternatives were discussed, current food model was from top to bottom subject to a high company concentration, being monopolized by a series of transnational agribusiness interests that placed economic interests above the good of the public and the community. Between the 1960s and **90s,** structural causes of the so called "green revolution", promoted by various international institutions and agricultural research centers , took place with the theoretical objective of modernizing agriculture in non- industrialized countries. There are alternatives for farmers who could feed themselves and sold their products to local communities, the surplus being assigned to fair international trade. The practices that carried out for centuries and have guaranteed food security for broad sections of the population through diversification of crops, care of the land, the use of water, the creation of local markets and community food systems. The methods of production and distribution of equitable and sustainable food supplies already exist, the ownership and production of land was necessary, together with nationalization of natural resources. The results of a comprehensive international consultation that lasted four years and involved more than 400 scientists, carried out for the International Assessment of Agricultural Science and Technology in Development (IAASTD), a system of assessment set up by the World Bank in partnership with the FAO, the UNDP, UNESCO, representatives of governments and private, scientific, social institutions, concluded that agro-ecological production provides income, food and money to the poor while generating a surplus for the market. A study by the University of Michigan concluded that agro-ecological farms are highly productive and able to guarantee food security throughout the planet, contrary to industrialized agricultural production and free trade. Several studies showed that peasant production on a small scale can yield a high performance while using fewer fossil fuels, especially if food is marketed locally or regionally. As a result, investment in household peasant production was the best guarantee of eradicating poverty and hunger, and more so when three third of the of the world’s poorest people are small farmers. Governments should support small-scale and sustainable production, not through mystification of "small" or ancestral forms of production, but because it would allow us to regenerate soils, save fuel, reduced global warming and achieved food sovereignty. Small farmers would have to be supported with the best prices for their products and more stable markets to produce food for themselves and their communities, which would mean an increase in investment in the production of food of peasant origin for local marketing. Public policies promoted indigenous farming which was sustainable, organic, free of pesticides, and for products not cultivated locally to employ fair trade instruments at the international level. It was necessary to protect agro-ecosystems and biodiversity which were seriously threatened by the current model of agriculture. Faced with neoliberal policies it was necessary to generate mechanisms of intervention and regulation to stabilize market prices, control imports, set quotas, prohibit dumping and at times of over production create specific reserves for times of food shortage. At the national level, countries should decide their degree of self-sufficiency in production and prioritize the production of food for domestic consumption without external intervention. In the area of consumption, we could participate in consumer cooperatives of agro-ecological products that usually operated at neighborhood level on the basis of self-managed work establishing direct purchase relationships with the farmers and producers in our environment with the aim of carrying out an ecological, solidarity-based consumption supporting local farmers (Vivus, 2011). Although pesticide hazards and exposure are inextricable from pesticide products, selecting less hazardous products and reducing the risk of exposure could mitigate the risks. Reducing pesticide use was the first step to reduce exposure; further steps included the selection of a mode of application that involved a lower chance of exposure, and naturally the proper use of appropriate protective gear. In this respect, the Code of Conduct suggested that products "whose handling and application require the usage of equipment that was uncomfortable, expensive or not readily available should be avoided", and that governments and industry should cooperate in "promoting the use of proper and affordable personal protective equipment" (Vapnek, 2007).

2.12 Pesticide health survey data of farmers in Thailand

Pesticide health surveys data of 606 farmers in Thailand with varieties of crops' growing and fields' sizes. Summary of data results on pesticide use by 606 farmers in 6 provinces of Thailand during August 2003-July 2004, many farmers were found to use chemicals that were very toxic as the following data;

15% of farmers used chemicals, classified in WHO class I a (extremely dangerous class)

39% of the farmers used WHO class I b pesticides (highly hazardous class)

58% of farmers used Organophosphates, 22% used Carbamates and 31% used Paraquat

40% of the farmers used pesticides that were on the "watch list". Most popular of these watch list pesticides were Endosulfan and Parathion-methyl, banned by Thai Government

14% of farmers used pesticides that were banned in Thailand, mainly Methamidophos.

Most farmers experienced signs and symptoms of pesticide poisoning:

56% of the farmers had experienced moderate signs of pesticide poisoning

1% of the farmers experienced severe symptoms of poisoning

6% of the farmers reported no signs and symptoms of poisoning

187 farmers 11% were found to have dangerous level of blood cholinesterase inhibition.

There was a big variation in volume of pesticide use and frequency of pesticide use between farmers.

It was found that some farmers had extreme high frequency of pesticide use.

24% of the farmers had more than 20 risk days per year

17 out of 606 farmers (2.8%) sprayed 52 or more days per year (on average once a week).

The maximum was a farmer with 120 spray days (on average every 3 days).

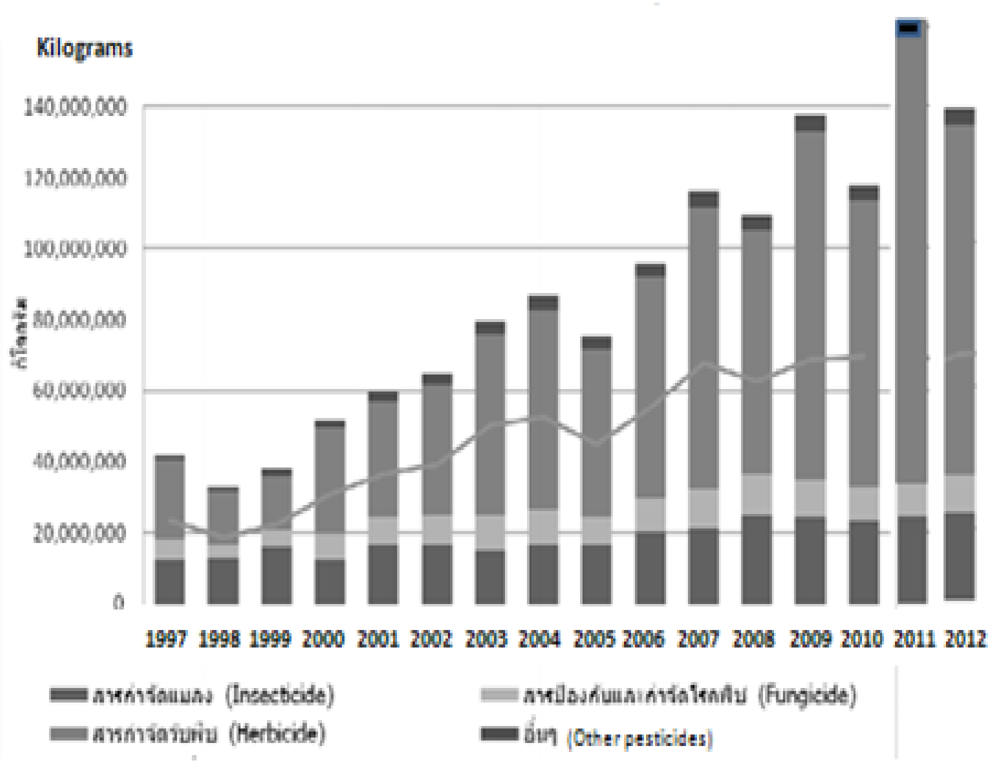
In conclusion, this report gave a picture of pesticide use in Thailand, especially by showing that many high hazardous chemicals, including watch list and banned chemicals were frequently used. The report also showed clear evidence that the pesticide poisonings were common health problem among agriculturists (Danida, 2004). Annually, Thailand imported several thousand metric tons of herbicides, fungicides, and insecticides. Agricultural goods were among the country's primary exports. Over the past decade, Thailand's agricultural sector shifted from labor-to machine-intensive farming practices. Production steadily increased due to expansion of cultivated land, technological innovations, and heavy applications of fertilizers and pesticides. Pressures to sustain high crop yields led to heavy usage of pesticides. Residues, especially organochlorine and organophosphate compounds, have been found in soil, water, and agricultural products throughout country. About 24% of the pesticides used in Thailand are applied to fruits and vegetables (O. O. A. Economics, 1995). Pesticide residues on agricultural products could be transferred directly to humans, with deleterious health effects. In order to evaluate the occurrence of pesticide residues in agricultural products, samples (including crops, fruits, and vegetables) were collected randomly throughout Thailand during 1987–1989. Respectively 48, 27, and 13 percent of Thailand’s fruits, vegetables, and crops were polluted by pesticides. Insecticides, particularly organophosphate and organochlorine compounds, were commonly detected. Carbamates, pyrethroids, acaricides, and fungicides were also found, particularly in vegetables of the remaining 76%, 18% was allocated to grains, 12% to rice, 10% to cotton,9% to maize, 7% to soybean, 4% to sugarcane, and 16% to other crops (OAE1995). Over the past decade, the three most heavily applied pesticides in Thailand were insecticides, herbicides, and fungicides (Thapinta, A. and Hudak, P.F. 2000). Thailand exports industrially processed food and agricultural products such as rice, cassava, rubber, corn, and tropical fruit. In 2009, agricultural products accounted for 9% of Thailand’s gross domestic product (GDP), but their production used 40% of the workforce and 40% of the land area. Despite this relatively small portion of the GDP, agricultural products made up approximately 19% of Thailand’s total export value. Rural Thai people are heavily dependent on agriculture as their main source of income. As a result of the world economic recession, industrial sectors making up the largest proportion of the national GDP (40%) are declining while agriculture, a more reliable source of income, is increasing (Administration, 2010). As an agricultural country and one of the world’s major food exporters, Thailand relies heavily on the use of pesticides to protect crops and increase yields. During the past decade, the Kingdom of Thailand has experienced an approximate four-fold increase in pesticide use. Thailand ranked fourth out of 15 Asian countries in annual pesticide use and third in pesticide use per unit area (ASIA-Workshop, 2005). This increase in pesticide use is a result of many factors including insect resistance and resurgence of pests, industrialization of crop production, and conversion of crop type from one season to another to satisfy market demand despite changes in environmental conditions. The increase presents a challenge for the Royal Thai Government in effectively managing and controlling pesticide use based upon the current policies and legal infrastructure. One of the main obstacles to effective pesticide regulation in Thailand was the lack of a consolidated, uniform system designed specifically for pesticide management. This deficit has weakened the enforcement of existing regulations, resulting in misuse or overuse of pesticides, and consequently, increased environmental contamination and human exposure (Panuwet et al., 2012).

2.13 Safe food shall start at the farm

Safe food shall start at the farm! How the farmers can produce fruits and vegetables that are safe to eat. If farmers provide the correct pesticides dosage, stop spraying well in time before harvesting (waiting period) and use the least dangerous pesticides this would provide a guarantee that products will be safe to eat. This can be done by means of which many different tools are combined to avoid pests or to keep pest populations at acceptable levels. Integrated Pest Management (IPM) is based on thorough understanding of crop ecology by farmers which enable them to make informed decisions on the best strategy to grow a healthy crop and to produce food that is safe and healthy. Integrated Pest Management, which is a sustainable approach to manage pests and crops by use of the least amount (necessary dose) and will only treat the parts of the field where the problem exists. Farmers will be very strict in maintaining a waiting period before harvest to make sure that residues are below maximum residue level. Some pesticides are more toxic than others, for most pesticides, World Health Organization has established a Maximum Residue Level (MRL). With the current knowledge about the chemicals it is expected that food with residues below this MRL can be safely eaten. “Safe” fruits and vegetables are produce where residues do not exceed these MRL levels (Danida, 2004).. How do people know if vegetable is safe? In theory, all food should be safe and residue levels of all products should be well below the MRL. Unfortunately in Thailand this is currently not the case. Many farmers still produce fruits and vegetables with residue levels exceeding the MRL (IPM, 2003). There are also farmers who are producing safe products. Some of these safe products are labeled, either by the farmers themselves or by public organization or Royal Project to certify that residue levels are expected to be below MRL. These products are claimed to be routinely tested to make sure that the safe claims are justified and to correct farm procedures if necessary. Many of the bigger supermarkets and department stores are taking food safety very serious and will only buy products from farmers, they can trust to produce healthy food. In some areas, farmers directly develop relationships with consumers built on trust and knowledge of their farming practices (IPM, 2003). An example of a logo that is found on fruits and vegetables is that of the “Hygienic fresh fruit and vegetable production pilot project”, an initiative of Department of Agriculture (DOA). Currently about 400 farmers have been certified and are allowed to use this logo on their products. Agricultural officers regularly inspect these farms and take random samples of their farm produce. These samples are then tested for pesticide residues in order to guarantee the quality of farm products that carry the logo. Similar systems of certifying farms and testing the safety of food are carried out by other institutions and organizations such as the DOAE, Ministry of Public Health, Royal Project Foundation, etc. While most of these logos claim that the food is “safe”, this does not always mean that they are completely free of pesticides, but it means that residues are controlled and kept below the maximum levels that are expected to be safe (Danida, 2004).

2.14 Residue testing laboratory to screen for a better guarantee of pesticide safety

Residue testing laboratories are important instruments to screen for a better guarantee of the safety of agricultural produce. The principal investigator's teamwork in this research study has therefore developed innovative pesticide test kits for use on vegetables, fruits and cereals. This test kit can be effectively used for the safety monitoring of pesticide residues in vegetable and fruit for the health of agriculturists and their relatives. The test kits are used to detect insecticide residue in vegetables, fruits and cereals due to the high amount of pesticide use in the highly competitive production business. The four groups of insecticide residue that can be found are organophosphates, carbamates, pyrethroids and organochlorines. There are two types of test kits: screening and identifying. The screening pesticide kit it is used for detecting organophosphates and carbamates and is an acetyl cholinesterase enzyme-based test method (MedSci Pest Kit). The other kit uses a thin layer chromatography-based method called TLC MedSci Pest Kit and is used to identify the four groups of pesticides. Quality validation data of the screening MedSci Pest Kit was taken by testing 73 samples using the screening test kit and 89 samples using the TLC MedSci Pest Kit. Each sample was tested ten times for precision. The results of the tests were compared for accuracy with testing performed by using the national method of gas liquid chromatography and high performance liquid chromatography performed at Department of Medical Sciences laboratory. The percentage rates of the screening MedSci Pest Kit's accuracy, sensitivity and specificity are 93, 98 and 79 respectively. Its positive predictive value is 93% and the negative predictive value 94%. The percentage rates of identifying TLC MedSci Pest Kit's accuracy, sensitivity and specificity are 96, 86 and 100 respectively. Its positive predictive value is 100 % and the negative predictive value is 94 %. However, the screening test kit is better for the environment and personnel health regarding smaller use of volatile solvents. The test procedure and kit does not contain a vacuum machine to pump the volatile solvents that are irritating and smelly out of its reaction tubes. The identifying test kit has not been developed with four pesticide groups anywhere before and can be used for commercial production companies and exporters. The innovative pesticide test kits can test quickly and are used easily even among low educated persons. They are also convenient to carry and package for use in community laboratory field and farming sites. These quality kits have been developed at a cheaper price than other private and foreign brands, are easily affordable to assess, simple to use, and rapid; screening tests at ten samples for thirty minutes and identifying test at ten samples for one hour. The test kits have good design and good quality with validated results proving its accuracy precision, specificity, and sensitivity. These rapidly used test kits can be used for agriculture farms, community, producer, distributor, market, school, hotel, university, educational institution, hospitals, health agencies, volunteer foundations or agencies, guarantee inspection units, organization, education, importers and exporters and other responsible public and private agencies (L Leuprasert et al., 2010). Agricultural farming is the main common employment sector of Thailand, representing high proportion of labor force, 65% in 2006 and 35.8% in 2011 (Office, 2011). Agrochemical use has been increasing in country that raised environmental and human health concerns. To compare average 132,909 tons per year of pesticides imported during 2008 - 2012 (table II.II) with 25,540 tons imported to Thailand in 1996, the increased total quantities of pesticides imported to be 520.4% (A. Economics, 2009; O. O. A. Economics, 1995).



Source: Department of Agriculture, Miinistry of Agriculture and Cooperatives, Thailand (1997-2012)

Figure II.I Quantities of pesticides imported to Thailand 1997-2012

Table II.II Quantities and values of pesticides imported to Thailand

Year	Herbicides (Tons)	Insecticides (Tons)	Fungicides (Tons)	Total (Tons)	Cost (million baht)
2008	68,825	25,332	11,255	109,908	19,182
2009	97,957	24,680	10,367	137,594	16,816
2010	80,278	23,417	9,671	117,698	17,924
2011	112,177	34,672	12,179	164,383	22,044
2012	106,860	16,797	6,972	134,377	19,357

Source: Department of Agriculture, Miinistry of Agriculture and Cooperatives, Thailand (1997-2012)

Pesticides have been highly used in vegetable farming where higher market pressure for safety resulted in crop price. Lack of knowledge about correct use among farmers was also related to rapid rise in pesticide use in Thailand. Toxic pesticide residues could also pollute water for consumption. From 1993 to 1999, a survey in main rivers in Thailand found pesticide residues of the insecticide endosulfan in Tachin river, followed by the Chao Phraya and Bangpakong rivers. In all cases, levels of pesticide residues were above safety limit set by the European Union (0.1 microgram per liter). Ground water was also polluted, during 2001, 68% and 71.2% of ground water samples analyzed in the lower central and lower northeast region, respectively, were contaminated with endosulfan and other insecticides. Improper pesticide application in vegetable cultivation in Thailand that may leave residues in food was focused and reviewed. Pesticides are often used as front line defense against plant diseases, insects and pests and improper use may cause pesticide adverse effects to health and environment. Factors which caused improper pesticide application in Chinese kale cultivation were studied and reported to be characters of short term vegetable cultivation, planted throughout the year there were various types of pests. Most farmers were lacked of good knowledge, problems of marketing and price control of products were also important factor in the cultivation (Kanjanamangsak & Benjapong, 2010).

CHAPTER III
METHODOLOGY

3.1 Research Design

The quasi experimental study design, percentage pesticide risk would be conducted to evaluate the effectiveness of the innovative pesticide kit model for vegetable farm safety surveillance program. This study had one village farm of intervention group to implement research and one control group in the same north eastern area (both groups of pre-test and post-test design). These two groups were used to evaluate activity output of the intervention for safety surveillance. The quasi study was conducted during May 2012 - October 2013. The protocol was reviewed and approved by the Institutional Review Board of the Ethical Committee of Chulalongkorn University, Thailand (COA No. 156.1/2013 on January 6, 2013).

3.2 Study Area

3.2.1 Intervention study group area

The study intervention area was Ladbuakao sub-district, Sekhiew district, Nakhonratchasima province in northeast of Thailand. Selection of intervention farm was conducted by purposively selecting as the vegetable intervention community, which was interested and had willing to participate with research intervention program of the safety monitoring of the agricultural produce . The management and leader policy of commitment and cooperation as well as support from the community levels and stake holders from the public and non–governmental organization in the intervention community were considered as selecting criteria for project participation. The factors, strength, considerate practice in team work-participation exhibited with activities in the northeastern area of Thailand, the Klongtabak village farm, Ladbuakao sub-district, Sekhiew district, Nakhonratchasima province, Thailand has been selected for this study intervention group.

3.2.2 Control group area

A control farm with no intervention input in the Ta-ngoy village, Chanteuk sub-district, Pakchong district, Nakhonratchasima province in the same northeastern area was selected. The cultural style of living and local practices of the use of pesticides in the intervention and control communities, were alike though different district in the same province. The main agricultural growing occupation played same major roles in both village communities of approximately 80-100 households.

3.3 Study population

Intervention farmer group, analytical vegetable sample size and selection

A letter containing a walk-through survey, information to conduct intervention group and control group activities, participating informed consent forms and also a request for the facility support was delivered to chiefs of responsible community leaders and stake holders of participating farms. The direct contact and co-operation were implemented to obtain the written permission for project application, sample and data collection. Innovative pesticide test kit and methodology were performed at a laboratory farm or other functioning sites **as** proposed by the farm safety team and stake holders who would be considered to be co-operative investigators. The information was communicated to stake holders that pesticide test kit and knowledge tool model should reduce pesticide residues in vegetable produce for the safety monitoring of vegetables in community farms or self-test farm that could support need and trained procedure for safety monitoring of pesticide contamination in vegetables. The suitable financial compensation should be rewarded for participants.

This qualitative study method, using a site walk-through survey, follow up visits, audits, observations, meetings, supervision, education, workshop, field visits to experience best practices of safety farms and training of laboratory test for strengthening farm volunteers' competency. Cooperative team work participation with the intervention farms to use innovative pest kit model for vegetable farm safety surveillance program.

Study population

Inclusion Criteria

In this project, inclusion criteria were farmer participants. Stake holders such as stake holders from the village and sub-district chiefs. Stake holders are from Department of Medical Sciences, Department of Agriculture Promotion, College of Agriculture and Technology, Provincial Health and Agriculture Administration and Agriculture and Education Agencies. The operational leaders should be the agricultural leaders of the farm community. The advisory group included the advisors from College of Agriculture and Technology, the community medical sciences laboratory and staffs from responsible Regional Medical Sciences Center, the research principal investigator and team. The farm safety farm participants should be selected from farm volunteers who were 18-65 years old, could read and write, who were willing to participate till the project end time, and had at least primary school education background for laboratory analysis work and test process system. This group should be comprised of approximately 40 persons for general education and brain storming, but about half of them or approximately 20 farmers who planted Chinese kale, these agriculturists were purposively selected for closer supervision, test kit training, and intensive laboratory workshop because this study selected Chinese kale growers as a pilot program to study the intervention effects. Farm consultation teams co-operatively arranged theoretical education and practical workshop, risk communication, and general education agenda for farmer participants and farm stake holders. Participants would be informed of their rights, project objectives, questionnaire details and that there would be no major risk anticipated for participants in this study.

Exclusion Criteria

Participants, who did not want to participate to the end of this study could leave without giving reasons, their benefits and relationship with the local community was remained and would be excluded.

3.4 Sample size

Farm safety team's participants and vegetable sampling from study and control plantations, the study group; from Klongtabak village, Ladbuakao sub-district, Sekhiew district, Nakhonratchasima province, Thailand

Intervention farmers and Vegetable sampling groups from intervention and control areas

Sample size calculation was based on the study main objective to analyze for measuring association of % pesticide risks in agricultural produce of the study group before and after the intervention. The samples groups in this study were divided into 2 independent small groups, study and control groups. The research plan was to demonstrate the issues and conducted research using experimental data to link to the research problems (Kerlinger & Lee, 2000). Relevant sample size (N) from the study and control groups should be at least 20 samples ((Wongwanich & Wiratchai, 2003).

3.4.1 Sample size (farmer group)

Klongtabak village was consisted of about 80-100 households, most of villagers are farmers. They grew some kinds of rice, vegetables and crops in each farm with varieties of farm size. The farmers of village members from all households participated to be representatives as volunteer farm safety team that was included in the inclusion criteria of this study (at least one volunteer from two households or 50 % from all households. About 40-50 adults would be included in the study inclusion criteria after interview of the farmers' educational background. After interview of willingness to participate till project end and primary school educational criteria, some farmers might be excluded out of this operational study, all of the fit in with criteria trainees of community representatives would be purposively selected with strength in team work participation and leadership to be participants in this study.

About 80% of the inclusion criteria (40 adults) were community representatives and would be educated general education and brain storming participation through focus group meetings. This volunteer farm safety group would be purposively selected again for only Chinese kale growers and about half of them or at least 20 farmers (Wongwanich & Wiratchai, 2003), for training of the innovative test kit technology and intensive knowledge. The intervention safety laboratory team should be comprised of not too many persons (not quantities but quality) for training workshop, appropriate number of trainees with more efficient brain storm and interview, closed supervision, innovative test kit laboratory training and proficiency laboratory testing for competency of farmers, innovative pesticide kit's transferred technology and education for farm safety surveillance program, pesticide self-test workshop and intervention. For general education, excluding laboratory competency test, that includes health risk and general pesticide awareness education, all household representative members of the village would be invited to be trained and educated. The innovative pesticide test kit and transfer technology education were trained to these group adults of intervention team and practiced the intervention program by the trainers, agricultural and health experts, researchers and stake holders for vegetable farm safety surveillance program.

3.4.2 Sample size (vegetable group)

To perform the sample size of different % pesticide risk (d) and SD of difference (σ) were used to calculate sample size. Vegetable samples were purposively selected from the judge or sampling group of the Chinese kale regular growing agriculturists who provided important pesticide use and cultivation information during the interview and program participation. Only one vegetable sample from one Chinese kale plantation and the selected plantations were purposively sampling from the same available cultivation sites of the Chinese kale regular growing farmers (about 5-6 farmers) during the same collections periods at both pre-test (January-February 2013) and approximately after 6 months' time of intervention period or post-test (July-August 2013) either intervention and control groups. About the same number of Chinese kale samples were collected at each selected farmers' sites that one vegetable sample was collected from one Chinese kale plantation.

According to the researchers' prior trial study of measurement % pesticide acetylcholine enzyme inhibition by spectrophotometer in 23 vegetable produce samples of anti-cholinergic pesticide residues in the northeast area.

The mean and standard deviation at the 95% confidence level at power 80 (mean 12.84%, range 36.2%, SD = 8.99)

Sample size calculation (Kadam and Bhalerao 2010)

$$n = \frac{2(Z_{\alpha} + Z_{1-\beta})^2 \sigma^2,}{\Delta^2}$$

Calculate at the confidence (α) = 95 % Power 80 %

n= 2 (1.96 +0.84)^2 SD^2 / difference^2

Standard deviation of 23 trial Chinese kale analysis (SD) = 8.99

Mean % enzyme inhibition at before (Pre survey calculation) = 12.84

% Enzyme Inhibition at Expected Value 50 % Less at After = 6.42

Difference = 6.42

(Sample size at expected difference at 50%) N = $\frac{2\ (2.8)^2\ (8.99)^2}{(6.42)^2}$

Vegetable sample size = (2 x7.84) x 80.82 / 41.22 = 31 samples

The 31 vegetable samples from Chinese kale plantations in intervention group and 31 samples from vegetable plantations in control group

3.5 Testing Procedure: Agricultural Standard, method of sampling for determination of pesticide residues (Ministry of Agriculture and Cooperatives. 2008) was followed. Purposive and random sampling collection method was educated to farmers.

The Intervention vegetable farm samples were collected at many appropriate sampling points as shown picture in the figure III.I, if the farm produce's estimate weight at about less than 50 to 500 kilograms, the three to five different sampling points were collected into one sample at about a kilogram lot. If a group's sample weight in the same lot is between 500 to 2000 kilograms, the ten different sampling points were collected into one sample at about a kilogram lot of the vegetable sample for collection and analysis.

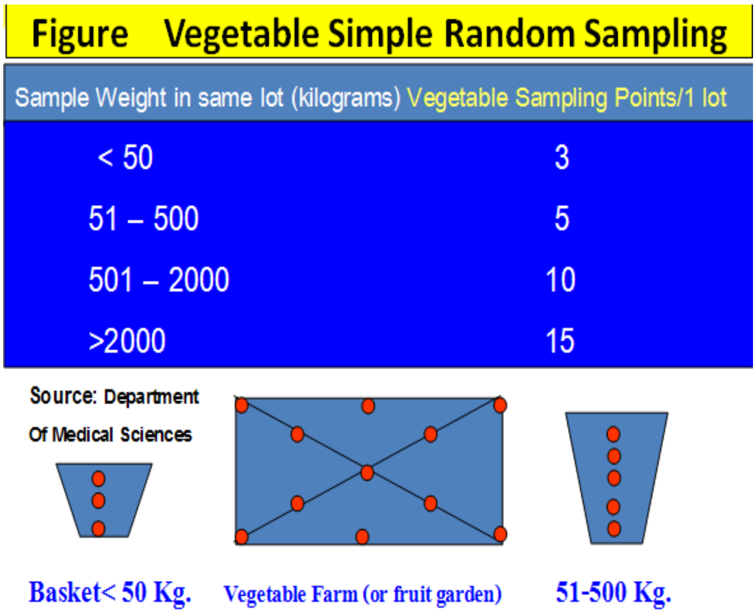


Figure III.I Thai Agricultural Standard, method of sampling for determination of pesticide residues

3.5.2 Pre and Post - intervention testing by researchers

Test statistics (proportion ratio, mean, percentage test, student T-Test, SPSS Test) were used for vegetable farm safety surveillance in farm produce of collected vegetable samples at pre and post intervention test by researchers. Intervention farms' vegetable, was collected and tested. Researchers or research assistants collected one sample of the Chinese kale vegetable from one plantation in vegetable farms, each sample weigh approximately 1 kilogram and collected method of many representative points of collection were followed with Department of Medical Sciences instruction as written in figure III.I of this study, Chinese kale were collected in village intervention and control farms. All samples were tested by researchers using the 4 group innovative pesticide test kit for screening and using spectrophotometer for % acetyl cholinesterase enzyme inhibition. Pesticide residues, more than limit of detection of innovative test kit and suspected unsafe or high % enzyme inhibition detected were sent to reference laboratory for confirmation by GLC/HPLC either pre and post-test for laboratory conclusion.

3.5.3 Self-test laboratory by farmers and community volunteers

Selected intervention group in the Klongtabak village grows Chinese kale vegetable that was purposively selected as the sample kind for safety surveillance by farmers using innovative pesticide test kit. The trained farm safety team would collect the vegetable samples from farm's produce before supplying to customers and tested them using innovative test kit. The vegetable farm samples would be self-tested by the farm safety team at designed time plan. If unsafe vegetable produce was detected, agricultural procedures for correction should be discussed among the farm safety team and the advisors (researchers and agricultural experts) of this project to discuss about the laboratory techniques, small farm land pesticide education and other suitable corrections to improve the vegetable growing pesticide safety for the community.

3.5.4 Conclusive testing procedure

Pre and Post intervention testing by researchers and Self-test laboratory by farmers and Post intervention test of vegetables by researchers by using innovative 4 group pesticide (organophosphate, carbamate, pyrethroid and organochlorine) test kit (MedSci Pest TLC Kit or TM Kit)

- **Designed time plan testing** of vegetables by farmers, self-test for organophosphate and carbamate by using screening pesticide test kit (MedSci Pest Kit or M Kit) or innovative 4 group (organophosphate, carbamate, pyrethroid and organochlorine) pesticide test kit (MedSci Pest TLC Kit or TM Kit)

- **The pre and post intervention test of the vegetable samples,** collected by researchers were analyzed for % acetylcholine esterase inhibition by using special instruments of spectrophotometer.

- **Unsafe screening test results by innovative test kit or suspected unsafe of high % acetylcholine esterase inhibition** would be sent to reference laboratory for confirmation by GLC/HPLC either pre and post-test for laboratory conclusion.

3.6 Vegetable Sample Analysis (Analytical Measurements)

Measure the association (pre and post-test design) using Mean, Safety Difference, Percentage, Standard Deviation, % Sample Risk, Laboratory competency, Laboratory proficiency testing and Inter- laboratory comparison. Progress of community self-test laboratory setting by measuring %success of self- test LAB setting in farms.

Farm intervention group and control group that will be conducted to evaluate the outcome of farm safety team's activity participation in the intervention of vegetable safety by using the innovative pesticide kit model for farm safety surveillance and measure outcome. The study will be implemented with one intervention group (Klongtabak Village farms in Ladbuakao district) and one control group (one selected faming site in Pakchong district, the northeastern area, to analyze vegetable produce at the same pre and post intervention time without any intervention) that will be used to evaluate the outcome of the intervention farm team activity participation. Vegetable produce will be grown by intervention farmers. The innovative pesticide test kits will be trained to the farm safety team as research tools for studying the applications of pesticide kit model. The farm safety team will then be intensively trained in the training course of pesticide test kit usage and trained knowledge of innovative pesticide kit transferred education and also training of self-testprocess system of pesticide residues residues in vegetable that include proficiency test measurement to test competency of the farm safety team.

3.7 Measurement tools and Procedures

Measurement tools and Intervention procedures of Innovative pesticide kit model for farm safety surveillance program referred to 2 intervention contents as follows;

- Application of innovative pesticide test kit for farm safety surveillance (innovative 4 group pesticide test kit).

- Setting self-test LAB in vegetable farms (participation and technology for self-test by farmers.

Measurement Tools and Procedures of Innovative pesticide kit model for farm safety surveillance program

3.7.1 Innovative pesticide test kit, spectrophotometer and GLC/ HPLC assay

To intensify safe agricultural production with less chemical use and awareness of good and safety practice, using integrated model of knowledge and innovative pesticide kit, was needed to reduce toxic contamination. Pesticide residues in farm produce was difficult to be measured by reference laboratory that is very expensive and time consuming. ((L Leuprasert, Thongbor, & Puydecha, 2012a). Department of Medical Sciences developed screening test kit 4 groups of pesticide residues in vegetable, fruit and cereal, the number 7554 for 4 groups, granted from intellectual property department of Thailand (L Leuprasert et al., 2012a). The field test kit was validated to have high specificity, accuracy and sensitivity (L Leuprasert et al., 2010);(Thongbor, Puydecha, & Leuprasert, 2011).

Spectrophotometer was used for inhibition assay of percentage acetyl cholinesterase, that was inhibited by organophosphate and carbamate pesticides. This assay was tested by researchers for cholinesterase enzyme inhibition based colorimetric assay (Procedure & 8, 2011). Vegetable samples in vegetable samples, were analyzed by test kit and cholinesterase enzyme inhibition based colorimetric assay, were then quantitatively determined of 4 groups pesticide residues by gas liquid chromatography and high performance liquid chromatography (Steinwandter, 1989).

Education tools of innovative pesticide kit manual, test kits, procedures, electronic and hard copies etc. for farm safety surveillance using the test kit and knowledge, reviewed and edited by authors and the Klongtabak vegetable farm safety network to contain important educated topics that were pesticide handlings and safe pesticide use to man and the environment, good agricultural practice, prevention and control of important pests, integrated pest management, pesticides and their grouping by mode of actions and toxicity classes, chemical safety monitoring and reduction by community if found unsafe pesticide residues in their produce. Educational tools and medias, electronic and hard copies; You tube, DVD, books, printed articles, leaflets, procedures, agricultural and health sciences knowledge were provided.

3.7.2 Intervention of innovative pesticide kit model for safety surveillance program

The quasi study was performed in study group of klongtabak village, ladbuakao subdistrict in Sekhiew district and control group of ta-ngoy village, Chanthuek sub-district, Pakchong district in Nakhonratchasima province. Chinese kale vegetable was purposively studied from cultivated farms and measured for pesticide residues before and after intervention. 62 Chinese kale samples were collected, 31 each, from the study and control farms, 1 sample from each vegetable farm plantation. About 80% of household volunteers (40 farmers) in the study farms, were knowledge-educated and laboratory technology transferred of the innovative test kits to screen the four groups pesticides. Cholinesterase inhibition assay using spectrophotometer was measured in all 62 samples. Unsafe samples or suspected to be unsafe, were sent to test 4 groups pesticide residues at central laboratory using gas liquid chromatography and high performance liquid chromatography. In addition to laboratory test by researchers, technology transfer of self-test laboratory in study farms obtained by training agriculturists for safety monitoring by community. Regarding their laboratory competency, Proficiency test samples were prepared and analyzed by researchers and also tested by farmers for inter-laboratory comparison of innovative test kit with competent analysts from department of Medical Sciences' laboratory. Innovative pesticide test kit transferred technology was educated to agriculturists for safer farm production with less toxic pesticide use.

3.7.3 Evaluating effectiveness of innovative pesticide kit model for vegetable farm safety surveillance program

To transfer technology of self-test laboratory in the Klongtabak farms, obtained by training agriculturists and volunteers for safety monitoring by the farm community. For competency test, the inter-laboratory comparison of innovative test kit by farm volunteers with competent medical scientists from reference laboratory, Department of Medical Sciences, was performed. Collected kale samples were tested and 93% accuracy was found at post laboratory training, revealed satisfactory acceptable results compared to 77% accuracy at first laboratory training. The 62 collected Chinese kale samples, 31 samples from each group. All kale samples were analyzed by spectrophotometer for the % cholinesterase inhibition assay that organophosphate and carbamate pesticides inhibited the enzyme. Detected or suspected unsafe, were determined quantitatively of 4 groups pesticide residues (Alimentarius, 1969, Amended 1999) using Gas Liquid Chromatography and High Performance Liquid Chromatography by central reference laboratory.

3.7.4 Research Tools

The research tools and research media for transferring innovative pesticide kit technology for vegetable farm safety surveillance.

1. Screening MedSci Pest kit (M Kit) and Identifying TLC MedSci Pest kit (TM Kit) , package, chemicals and accessories
   (Appendix C1)

2. Poster presentation of screening 2 Groups MedSci Pest kit and Identifying 4 groups TLC MedSci Pest kit, Innovative screening 2 group and identifying 4 group pesticide Test Kits (Appendix C 2)

3. Poster: Screening procedure of the 2 Groups MedSci Pest kit (M Kit)
   (Appendix C3)

4. Poster: Identifying procedure of the 4 groups TLC MedSci Pest kit (TM Kit)
   Part Organochlorines and Pyrethroids

   (Appendix C4)

5. Poster: Identifying procedure of the 4 groups TLC MedSci Pest kit (TM Kit)
   Part Organophosphates and Carbamates

   (Appendix C5)

6. Petty patent granted from the intellectual property department, Thailand,
   Screening 2 groups MedSci Pest Kit

   (Appendix C6)

7. Leaflet: procedure of screening 2 groups MedSci Pest Kit

(Appendix C7)

8. Petty patent granted from the intellectual property department, Thailand, Identifying 4 groups TLC MedSci Pest Kit

(Appendix C8)

9. Leaflet: front pages of identifying 4 groups TLC MedSci Pest Kit
(Appendix C9)

10. Leaflet: Identifying procedure of 4 groups TLC MedSci Pest kit

Part Organochlorines and Pyrethroids
(Appendix C10).

11. Leaflet: Identifying procedure of 4 groups TLC MedSci Pest kit

Part Organophosphates and Carbamates
(Appendix C11).

12. Distributed DVD of Procedure Manual to Stake Holders with English subscript

(Appendix C12)

13. Procedures educational tools: electronic copies, You Tube for public social media

(Appendix C13).

14. Document of pesticide risk communication and education

(Appendix C14)

15. Example; Newsletter, educational tool for vegetable farm safety monitoring (Appendix C15).

16. Education knowledge tools: Innovative pesticide test kits and knowledge for vegetable and fruit safety monitoring tools. (Appendix C16)

17. Education tools: Small farm land pesticide safety manual (Appendix C17)

3.8 Applying procedure of innovative pesticide kit model for vegetable farm safety surveillance program

3.8.1 Phase1. Preliminary Study of Innovative Pesticide Kit

The principal investigator invented and provided the availability of the team of researchers' innovative pesticide test kits, information and methodology validation data for farm use, and also assisted the written procedure concerning test kits for users and stake holder participants.

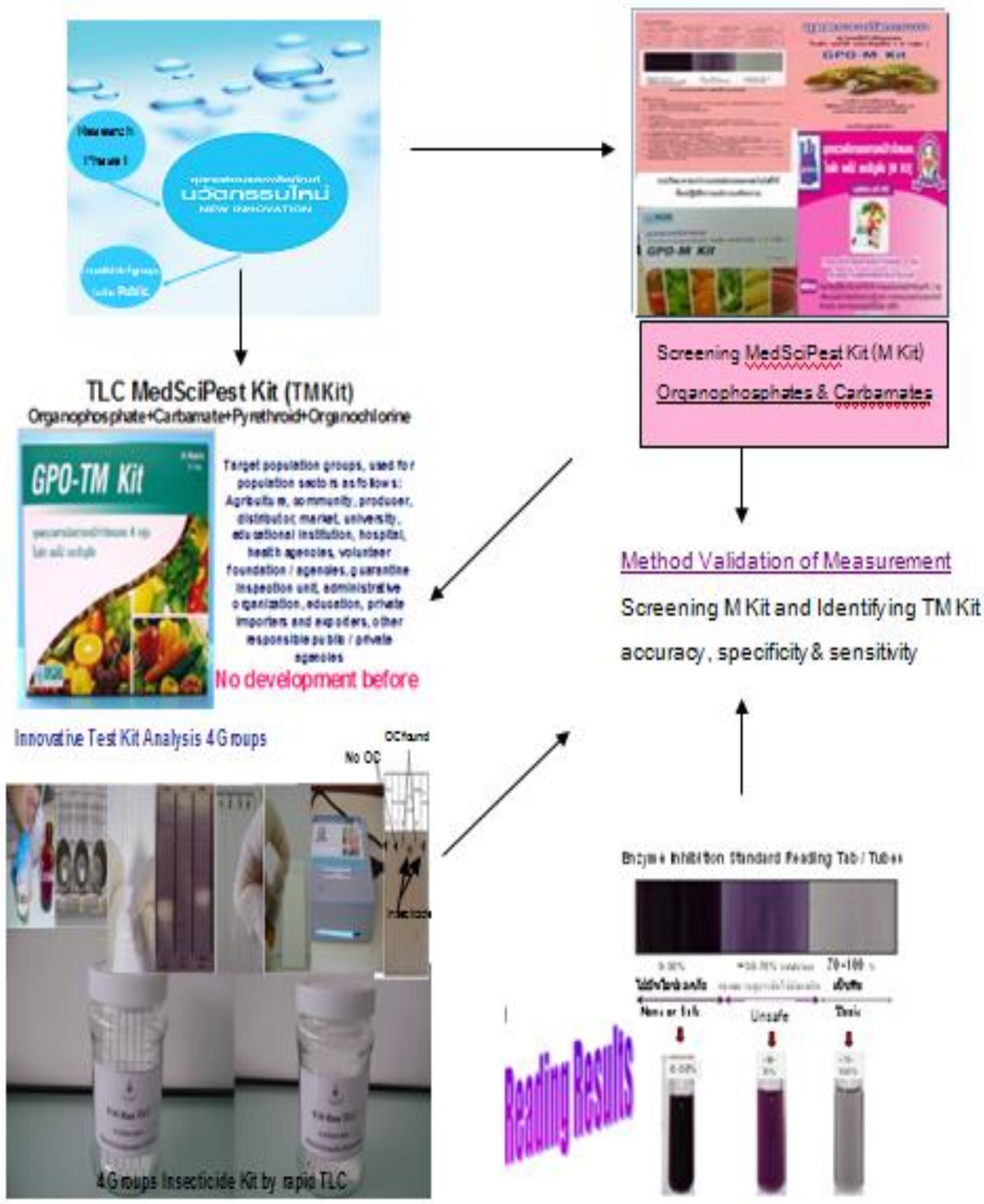


Figure III.II Availability and information: Innovative screening

2 groups (Organophosphate and Carbamate)

3.8.2 Method Validation Data of Test Kits

The test kits' method has been validated in 139 and 57 vegetable and fruit sample groups with known spiked pesticide standards for 4 groups TLC MedSci Pest kit and 2 groups MedSci Pest kit respectively. The spiked samples were then analyzed by reference laboratories of Thailand for screening color test and semi-quantifying Thin Layer Chromatography MedSci pesticide test kits' accuracy, specificity, and sensitivity

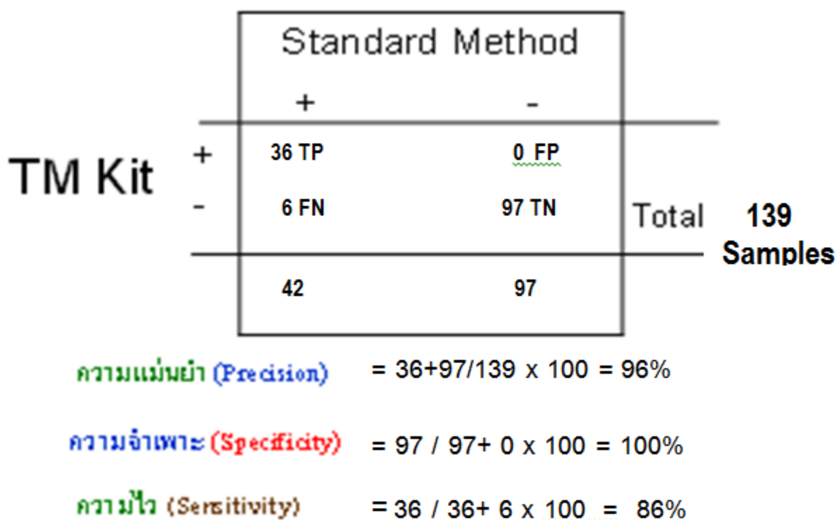


Figure III.III Method Validation of identify 4 group pesticide test kit

%Positive predictive Value = $\frac{\text{True positive samples X 100}}{\text{All positive (TP+FP) samples}}$ = 100%

%Negative predictive value= $\frac{\text{True negative samples X 100}}{\text{All negative (TN+FN) samples}}$ = 94%

		Standard Method +	Standard Method -	
M Kit	+	53 TP	4 FP	
	-	1 FN	15 TN	
		54	19	total = 73

(Accuracy) = (TP+TN) / total X 100 = (53+15) / 73 x 100 = 93%

(Specificity) = TN/ (TN+FP) X 100 = (15 / (15+4) x 100 = 79%

(Sensitivity) = TP/ (TP+FN) X 100 = (53 / (53+1) x 100 = 98%

Positive Predictive Value = TP/ (TP+FP) X100 = 53 / (53+4) X 100 = 93%

Negative Predictive Value = TN / (TN+FN) X100 = 15 / (15+1) X 100 = 94%

Figure III.IV Method Validation of innovative 2 group pesticide test kit

Validated data of innovative test kits

To use reference laboratories for analysis was difficult, complicated, expensive, and their results were time consuming to wait for, which was time for economic competition. No available 4 groups have tested by using one kit for food safety monitoring before in Thailand. We developed innovative pesticide test kits to analyze pesticides for networking vegetable farm safety monitoring.

Simplicity

The pesticide test kits were tested quickly (screening time for 2 group test M Kit was 30 minutes for 10 tests and identifying 4 group TM Kit 60 minutes for 10 tests), could be used by low educated persons, and carry for use in community field and at farming sites.

Reliability and Validity

The innovative pesticide test kits were validated in quantitative study methodology at 7 different repeatable times and the results could be reproduced with consistency and considered to be reliable and valid. Checked vegetable samples (139 samples with TM Kit and 73 samples with M Kit) were extracted of pesticide residue with solvents. The pesticide residue extract was tested with M Kit and TM Kit using the test kit cutoff L.O.D. level (Limit of Detection level) to compare with known spiked concentration of pesticide standards. The results are then analyzed by reference laboratories Thailand by using special instruments (GLC/ HPLC) and validated methods. The method validation data for percentages accuracy, specificity and sensitivity testing for identifying the 4 groups pesticide test kit, were 96, 100 and 86 respectively and for screening 2 group M Kit were 93, 79 and 98 respectively. The positive predictive values of the identifying 4 groups TM Kit and the screening 2 group M Kit were 100% and 93% respectively and the negative predictive value of the both TM and M Kits were 94%.

3.8.3 Application of Innovative pesticide kit model for vegetable farm safety surveillance program

There are two research intervention contents, used in the innovative pesticide kit model for farm safety surveillance program

1 **Application of innovative pesticide test kit for farm safety surveillance.**

2 **Self- test LAB by farmers in vegetable farms for safety surveillance.**

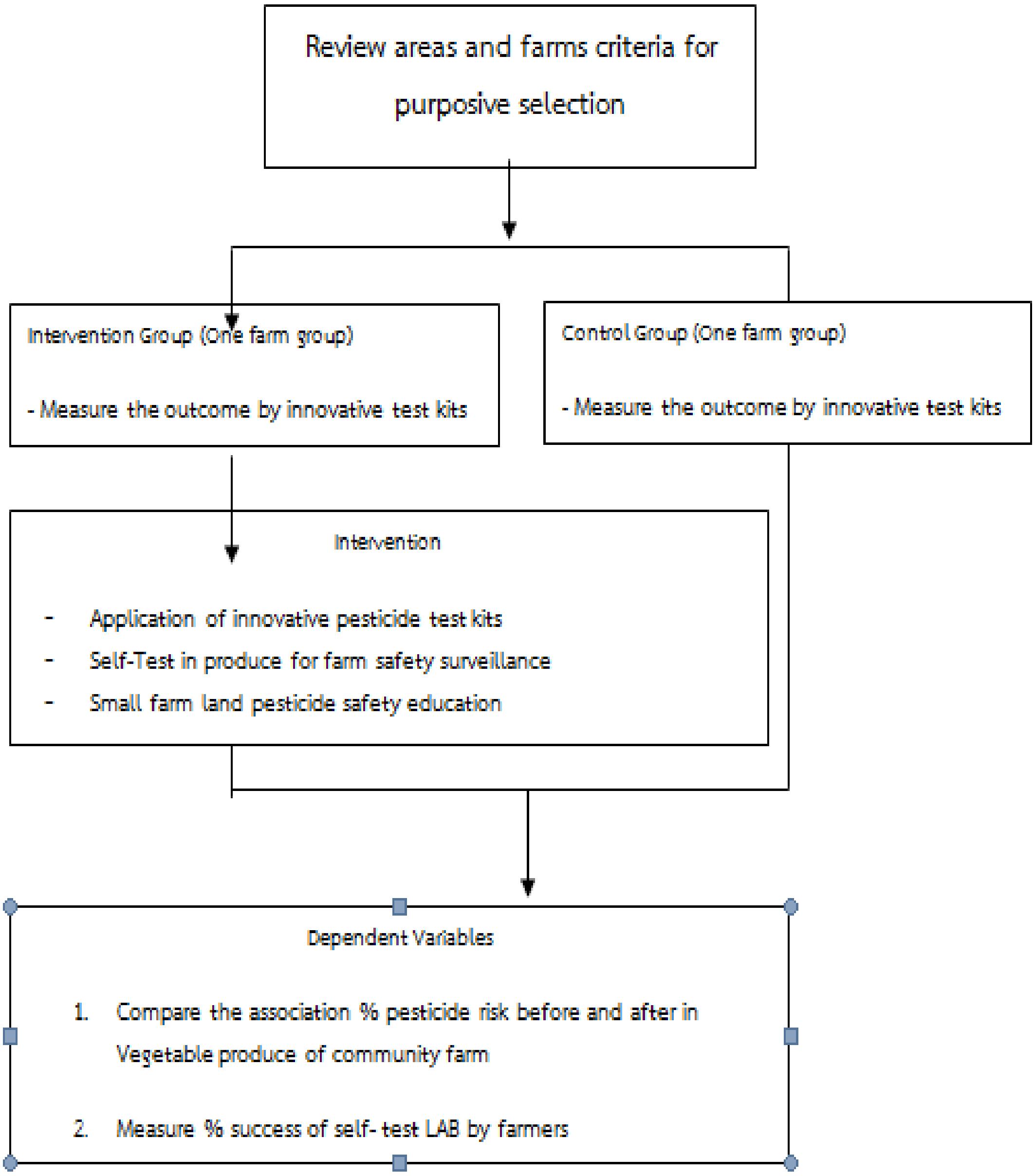


Figure III.V Flow Chart of innovative pesticide kit model for vegetable farm safety surveillance

3.8.3 Application procedures of innovative pesticide kit model program (IPKM)

Application procedures of the IPKM program; the two intervention activities were implemented by principal investigator team, farm team and stake holders.

- Cooperatively established work team, and action plan for finance supporters, administrators, leaders, trainers, advisors, professional specialists, medical scientists, supporting laboratories and communities of vegetable safety in pilot farm group.

- Cooperatively organized meetings for brain storming networking personnel. To plan activities, safety monitoring, educational documentations e.g. manual, leaflets, operating procedures, media, and means for transferring technology education.

- Strengthened the working team's capacity and have networking personnel. To establish farm network by using innovative model for farm safety surveillance.

- Educational activities, meetings, field visits and the preparation of education documentations for the application of innovative pesticide test kit and the transferring technology.

- Organize laboratory training workshops/seminars teaching use of innovative test kits for the farm safety team work. Also teach practical implementation of laboratory intervention such as how to analyze pesticide residue contaminants in vegetable produce along with the test process system of pesticide residues. (the trainers were the researcher and teamwork from Department of Medical Sciences, College of Agriculture and technology, agricultural experts and farm networks)

- Cooperatively educate the public and the farm team and stake holders **using transferring innovative test kit technology** through training medias.

- to analyze the pesticide residue contaminants in vegetable produce by farm safety team using the innovative pesticide kits. Proficiency testing vegetable samples will be sent to intervention safety farm laboratory for testing by farmers.

- The farmers' competency of laboratory testing by using innovative pesticide test kits in this study was compared by the same vegetable laboratory testing between farmers and competent analysts from regional reference laboratory at baseline and follow up testing and the testing accuracy of farmers was measured for their competency results and for the laboratory workshop training achievement.

- **Discussion, summary and evaluation**

3.8.4 Sample and data collection

Data Collection

Data collection was conducted to answer research questions of this study. Some tables for data collection were prepared for recording test data using the innovative test kits. Questionnaire was prepared for interviewing pesticide use in farm by applying questionnaire form used by the Department of Medical Sciences project of the Health Risk assessment and risk communication of pesticide exposure of agriculturist in 4 regions of Thailand (L. Leuprasert & K. Sripaoraya, et al, 1997) by Department of Medical Sciences Ethical Committee in 2007. The questionaire was also approved by reviewer board of the Ethical Committee of the Chulalongkorn university on January 6, 2013.

3.8.5 Vegetable sample analysis and % enzyme inhibition assay

This study compared the association of vegetable pesticide risk before periods and after period of intervention testing. The measurement used in this study consisted of the analytical data recording forms of safety monitoring tests. The collected measurement data would be analyzed using descriptive statistics such as percentage risk and comparative pre and post test data to see any association in the produce, data at the laboratory test would be collected and analyzed for corrective action. If tested pesticide residues, at above maximum residues level (MRLs) detection in vegetable that should be labeled as unsafe conforming to the Thailand Food Act. The results would be communicated to stake holders to use co-operatively innovative pesticide kit model development and knowledge in local community for risk reduction of chemical contaminants in the vegetable products that were aimed to reduce pesticide contamination in post intervention test.

Vegetable samples were analyzed by using the innovative screening test kit, the colorimetric % enzyme inhibition assay by spectrophotometer for % acetyl cholinesterase inhibition assay, that was inhibited by organophosphate and carbamate pesticides, more than the limit of detection in samples by test kit and above the tolerance enzyme inhibition level by colorimetric assay, were quantitatively determined of 4 groups pesticide residues by using the gas liquid chromatography and high performance liquid chromatography. All the vegetable samples collected from the intervention and control farms, were measured before and after intervention period time.

To record unsafe sample and Count **U** = Unsafe Detected Produce

Count **S** = Safe produce

To give total sample counts = **N**

Vegetable Percentage Unsafe = $\frac{U \times 100}{N}$

To calculate twice at before and after intervention time

Unsafe produce will be compared before and after the intervention period to see changes for data, reviewed and implemented corrective action

3.8.6 Colorimetric % enzyme inhibition assay using spectrophotometer

To determine the degree of toxicity using % acetyl cholinesterase inhibition assay that was inhibited by the organophosphate and carbamate pesticide residues in vegetable (Procedure & 8, 2011). The mean of analysis results were recorded in table forms of the measurement as the following examples;

Table III.I Vegetable measurement of % Enzyme Inhibition (test data recording form)

Vegetable Sample No.	Control(C) Pre Test Pre % I	Control(C) Post Test Post % I	Intervention (I) Pre Test Pre % I	Intervention (I) Post Test Post % I	Control Mean %I Pre-Post SD	Intervention Mean %I Pre–Post SD
Sample 1	PreC1	PostC1	Pre I 1	Post I 1		
Sample 2	PreC2	PostC2	Pre I 2	Post I 2		
Total (N)	31 Pre Control	31 Post Control	31 Pre Intervention	31 Post Intervention		
Mean (% I) Vegetable	Pre C 1-31	Post C 1-31	Pre I 1-31	Post I 1-31	Pre SD Post SD	Pre SD Post SD
Mean Difference (%I Diff Post-Pre)		Control Mean %I Post-Pre		Intervention Mean %I Post-Pre		
(%I) Mean %Decrease/ % Increase		XX %		YY %		

Table III.II Test results in collected vegetable from control and intervention farms (test data recording form)

Sample frequency	Screen 4 groups by test kit and No.resulst	Special Instrumental Analysis result GLC/HPLC measurements	International Standards CODEX's MRLs
Control (Pre-Test)	(N1) Detected or Not Detected	Pesticide Kinds Detected or None and Quantities	> or < MRls
Control (Post-Test)	(N2) Detected or Not Detected	Pesticide Kinds Detected or None and Quantities	> or < MRls
Intervention (Pre-test)	(N3) Detected or Not Detected	Pesticide Kinds Detected or None and Quantities	> or < MRls
Intervention (Post-test)	(N4) Detected or Not Detected	Pesticide Kinds Detected or None and Quantities	> or < MRls

3.9 Ethical Consideration

This study ethics were monitored through the Ethical Committee of Public Health Sciences College, Chulalongkorn university. The chiefs of the intervention administration and research sites and also control farm groups were contacted for a request to obtain written permission for project application and data collection. The farmers participated in this study were considered to be investigators. The participating investigators were informed before enrollment in consent form that there would be no major risks anticipated for participants in the study. Participants were assured that they could halt the participation at any time. The participants were also assured that if they stopped participating, their choice would not affect their relationship with the farming community. Farm stake holders would be assured of their anonymities by using code numbers on documents instead of names. No individual would be able to identify names from any data reports. All data will be kept in locked filing cabinets accessible only to researchers, when not in use. The list liking to the name data of the participants were destroyed upon completion of the study. The protocol was reviewed and approved by the Institutional Review Board of the Ethical Committee of Chulalongkorn University, Thailand (COA No. 156.1/2013 on January 6, 2013).

Table III.III Project Time Schedule (18 months)

Activities	Duration (Month)					
Intervention Practice	1-3	4-6	7-9	10-12	13-15	16-18
1 Provided availability of the innnovative pesticide test kits, knowledge of tools with documentation of information, and cooperatively establish a teamwork and project plan. To monitor study ethics for approval through Ethical Committee of Public Health Sciences College, the Chulalongkorn University.	↔	↔	↔			
2. Cooperatively organized meetings for brain storming and networking. Personnel were decided the activities, farm safety surveillance, pesticide test kit education and produced educational documentations.		↔	↔	↔		
3. Strengthen working team and networking personnel capacity to establish farm networks and the self-test LAB by farmers for community farm safe surveillance and safe produce.			↔	↔	↔	↔
4. Conduct educational activities and meetings, field visits and preparation of documentation to educate innovative pesticide test kit for pesticide safety produce to consumers, and the transferedr technology to farmers for safety monitoring.				↔	↔	↔
5. Laboratory workshop/ training to practice intervention using the innovative test kits to analyze pesticide residues' contaminants in vegetable produce and train vegetable farm safety surveillance program for farmers.			↔	↔	↔	↔
6. 6.Educate the farmer safety team and stake holders				↔	↔	↔
7. Discussion, Summary and Evaluation						↔

CHAPTER IV
RESULTS

This quasi study was conducted in a Chinese kale vegetable farm community in intervention Klongtabak village, Ladbuakao sub-district, Sekhiew district, Nakhonratchasima province, Thailand. The control group was performed in a Chinese kale farm community of Ta-ngoy village, Chanteuk sub-district, Pakchong district in the same Nakhonratchasima province. Study Klongtabak village had about 600 households that agriculture was main occupational sector. There were about 80-100 households of Chinese kale vegetable plantations. About twenty of vegetable growing households that frequently planted Chinese kale and this farm study group were intensively interviewed for relevant in-depth information. These participants were purposively selected to be plantation sampling farms for the Chinese kale sample collection to be analyzed by innovative test kit, spectrophotometer and special GLC/ HPLC instruments

The control Ta-ngoy village had about 500 households with same occupational sector and living cultural style in the northeast area of Thailand. About 5-10 farm households that mostly planted the Chinese kale and there were approximately same number of 80-100 farm vegetable plantations in both study and control groups. There were several intervention contents to be performed in the study group and no intervention in the control group. The cultural style of living and local practices of the pesticide use in the intervention and control farm communities were similar though different districts but in the same province. Conversational and formal interviews were performed with the purposive selected 20 agriculturists from 20 households (one representative from each household) in Klongtabak, Ladbuakao. The formal interviews used information from questionnaires. The questionnaires used in this project were used for interviewing agriculturists in 4 regions of Thailand in 1997(L. Leuprasert & K. Sripaoraya, et al, 1997), reviewed and approved by Ethical Committee of Department of Medical Sciences in 1997, the questionnaire was tested and monitored through Ethical Committee of Chulalongkorn University in 2013.

Conversational interviews with the agriculturists, stake holders, responsible personnel and experts from the government and non-government agencies in the study areas for relevant information, were also conducted and observed during the five times of meetings and seminars that were organized by researchers and networks during the study period. The study data observation and collection was then closely examined during the field visits in addition to those meeting and seminars both participatory with focused groups and participatory meetings. The data was collected, observed, analyzed and completed during May 2012 - October 2013.

4.1 Questionnaire information

The questionnaire (see Appendix 1 A) consisted of 2 parts;

Part1. General information for the agriculturists and community volunteers such as agriculturist ID, gender, age, address, highest education, information regarding personal diseases, kinds of growing crops, pesticide use, nearby farms that used pesticides and what groups of used pesticides (see Appendix 1 A.)

Part2. Pesticide use information regarding specified pesticide use, the used sprayers, agriculturists' personal protective equipment, pesticide use, how they spray pesticides, how they applied routine practice of pesticides before and after using pesticides associating with good agricultural practice. Prevalence of related pesticide symptoms in farmers was interviewed (see Appendix A).

Questionnaire general information of study farmer group

General farmers in the study group, who grew several kinds of crops were invited to participate in the program. There were 42 agriculturists who came to participate with the meetings, aged 30-70 years in Klongtabak village, Ladbuakao sub-district, Sekhiew district in Nakhonratchasima province. The average age (± 9.79 SD) was 48.43 years (±9.79), minimum age was 33 years and the maximum age was 70 years. Majority of participants were male (62%) and 38% were female. Their highest education degree, 64% from primary school, 29% from secondary school and 7% for higher than secondary school such as higher diploma and bachelor's degree (see table IV.I).

Table IV. I Socio-demographic characteristics of 42 vegetable planted agriculturists in study group (general farmers who grew several kinds of crops)

Socio-demographic Characteristics		Number (N=42)	Percentage (%)
Gender	Total	42	100
	Male	26	62
	Female	16	38
Age Mean (48.43 years)			
	30-40	13	31
	>40-50	14	33
	>50-60	10	24
	>60-70	5	12
	Total	42	100
(±9.79 SD) Range = 37 Min=33 Max=70			
Education			
	Primary School	27	64
	Secondary School	12	29
	>Secondary School	3	7

4.2 Pesticide use and pesticide-related symptom prevalence in farmers

This part was to determine pesticide use and pesticide-related symptoms prevalence in twenty farmers who mostly grew Chinese kale at all around year time. There were 20 agriculturists, aged 35-65 years in Klongtabak village, Ladbuakao sub-district, Sekhiew district in Nakhonratchasima province. The average age (± 8.65 SD) was 48.45 years (± 8.65), minimum age was 35 years and maximum age was 65 years. Majority of participants were female (60%) and 40% were male. Their highest education degree, 65% from primary school, 30% from secondary school and 5% for higher than secondary school such as higher diploma and bachelor’s degree (see table IV.II).

Table IV.II Socio-demographic characteristics of the 20 Chinese kale farmers

Socio-demographic Characteristics		Number (N=20)	Percentage (%)
Gender	Total	20	100
	Male	8	40
	Female	12	60
Age Mean (48.45 years)			
	30-40	6	30
	>40-50	8	40
	>50-60	4	20
	>60-70	2	10
	Total	20	100
(±8.65 SD) Range = 30 Min = 35 years Max = 65 years			
Education			
	Primary School	13	65
	Secondary School	6	30
	> Secondary School	1	5

4.3 Characteristics of pesticide use among the study Chinese kale farmer group

Pesticide use during routine cultivation among the total approximate of 20 Chinese kale farmers, who were pesticide mixers or sprayers, or exposed to pesticides, could be insecticides, herbicides or other used pesticides. All the 20 interviewed farmers used insecticides and herbicides, their routine jobs and the cultivation practices regarding pesticide use were mixing, spraying and maintaining cultivation farm work as they were all self-employed small farm land agriculturists. Mixing used pesticides were prepared by all the 20 study farmers (100%) and mostly mix in 200 liters barrel plastic containers by using a wooden stirrer to mix the pesticides (50%).They read pesticide label directions at containers for understanding before use (95%) and follow label directions of mixing chemicals (90%). Regarding application or spraying pesticides, the farmers used the manual back pack pesticide sprayers (85%) and back pack pesticide sprayers with motors (15%). Maintenance and fixing for assuring spray equipment for spraying was made sure for well-prepared applicator (75%). All preparative mixing pesticide was sprayed at once the working time finished (60%). They did not use mouth to blow the blocked head of the sprayer **(55%).** They prayed at upwind and avoid spraying at very windy time for reducing pesticide risk (55%). Cleaning sprayer when finished applying, was conducted for preventing the blockage and residual pesticides (50%). Characteristic of personal pesticide protective equipment (PPE) among the study farmers, they wore 6 PPEs (mouse and nose mask, gloves, boot/safety shoes, long sleeve shirt/top, long do pant or trousers and turban wrap/hat (65%). They used and wore 4 out of the 6 listed PPES (10%). They used and wore 2 out of the 6 listed PPES (15%). In total of using and wearing the any listed PPEs were 90% and 10% did not wear any PPEs (see table IV.III).

Table IV.III Characteristics of pesticide use among 20 Chinese kale agriculturists in study group

Pesticide application characteristics	Number (N=20)	Percent (%)
Pesticide use during routine cultivation among total 20 farmers		
Insecticide use in agricultural farm	20	100
Herbicide use in agricultural farm	20	100
Routine jobs or practices regarding pesticide use		
Mixing pesticides		
Preparing and mixing pesticides in containers by farmers	20	100
Read pesticide label directions for understanding before use	19	95
Follow label directions of mixing chemicals	18	90
Use wooden stirrer to stir or mix the pesticides	10	50
Application or spraying pesticides		
Farmers used manual back pack pesticide sprayers	17	85
Farmers used back pack pesticide sprayers with motors	3	15
Maintenance and fixing for assuring the well prepared sprayers	15	75
Do not use mouth to blow the blocked head of the sprayer	11	55
Cleaning pesticide applicator (sprayer)	10	50
Spray all preparative mixing pesticides at once working time finished	12	60
Spray at upwind and avoid spraying at very windy time.	11	55
To reduce exposed contamination of pesticides in food/environment		
Do not drink water, alcohol, smoke cigarette or eat food during application.	8	40
Washing pesticide contaminated cloths separately.	17	85
Body washing and cleaning after pesticide application	15	75
Warning notices of no entry to the pesticide application areas	7	35
To keep separately in safety place away from water sources and children reach.	18	90
To clean pesticide containers before final disposal and destruction for no reuse.	11	55
To dispose used container underground in safety place away from water sources and residential areas	14	70
Personal pesticide protective equipment (PPE)		
No protective equipment	2	10
Wear 6 PPEs (mouse and nose mask, gloves, boot/safety shoes, long sleeve shirt/top, long do pant/trousers and turban wrap/hat	13	65
Wear 4 PPEs (4 out of the 6 PPES)	2	10
Wear 2 PPEs (2 out of the 6 PPES)	3	15
In total of using and wearing the any listed PPEs	18	90
Did not wear any PPEs.	2	10

4.4 Pesticide related symptoms prevalence in farmers

The information was collected by interview, conversation and observation. They were all self-employed in cultivation, had long years in agricultural practice and out of 12 (60%) planted vegetables in the study areas for more than 20 years. The growers' health symptoms, during pesticide application or after the pesticide use, were classified into five anatomical systems: **1)** Alimentary tract such as nausea, vomiting, stomachache and diarrhea **2)** Respiratory e.g. breathing difficulties, running nose, chest congestion, cough and sore throat **3)** Skin e.g. itching, sweating, rashes and irritation4**)** Eye e.g. blurred vision**,** irritation and running tears. 5) Nervous system that were **5.1**) neurologic symptom e.g. whirling, dizziness and headache 5.2) Neuromuscular e.g. weakness**,** tiredness**,** muscle twitching, muscle fatigue, cramps, numbness, heart rate rising and decreased body weight.

All symptoms described in table IV.IV, alimentary tract in 9 users (45%), respiratory in 7 users (35%), skin in 5 users (25%), eyes in 10 users (50%) and neurologic including 1) neurology, occurred in 16 users (80%) and 2) neuromuscular in 15 users (75%) from total of 20 agriculturists. Each agriculturist had one or more than one and up to six of the body system listed above (see table IV. **IV).**

Table IV.IV Users' symptoms among vegetable growers

Users' symptoms	Number of users (N=20)	Percentage (%)
1. Alimentary tract symptoms	9	45
2. Respiratory symptoms	7	35
3. Skin symptoms	5	25
4. Eye symptoms	10	50
5. Nervous system		
5.1) Neurologic symptoms	16	80
5.2) Neuromuscular symptoms	15	75
Neurologic symptoms	16	80
Number of users (N)	20	100
Number of users who had 1-3 of the 1-5 listed symptoms	15	65
Number of users who had 3 or more of 1-5 listed symptoms	7	35
REMARK: Each agriculturist had one or more than one and up to five of those symptoms.	Min=1 symptoms	Max=5 symptoms

Chinese kale had short term cultivation periods of 45-55 days and planted throughout the year. As described in table 4.5, the periods were preparing soil and cultivation, 10-20 days of cultivation, 30-40 days of pre-harvesting and 45-55 days of harvesting. There were 9 groups of 28 kinds (100%) kinds of use) of pesticides, were used by 20 users (100% users) agriculturists in the selected study areas. An agriculturist (1 user) used more than 1 group and also more than 1 kind of pesticides.

The following table IV.V, IV.VI and IV.VII showed study findings of 9 groups and 28 kinds of pesticides used by 20 (N) Chinese kale agriculturists in each shown period of cultivation. Most frequency of the used pesticide kinds was by percentage (%) of the used kinds Organophosphates 10 kinds (35.7%), Carbamates 4 kinds (14.3%), Pyrethroids 2 kinds (7.1%) and new pesticides 6 groups, 12 kinds (42.9%). All groups and kinds of pesticides were also summarized in relation with percentage comparison with users and total percentage kinds' use. Percentage kinds and toxicity rating classes were also listed to examine pesticide kinds relating to their toxicity classes and purposive selection of pesticide use. WHO classification scheme, was listed to describe pesticide's oral median acute lethal dose, as class 1 was extremely or highly hazardous (<5-50 mg/kg), class 2 was moderately hazardous (50-500 mg/kg), class 3 was slightly hazardous (500-5000 mg/kg), class 4 was practically non-hazardous (IPCS & safety, 2004) The study data findings including their classified toxicity rating pesticides (Siriwat, 1990);(IRAC, 2012);(IPCS & safety, 2004) were as follows:

Chinese kale vegetable growers used 10 kinds (35.7% used kinds) of organophosphates (15 users, 75% of users), 4 kinds were class 1 (14.3%used kinds); Dichrotophos (13 users, 65% of users). Monochrotophos (1 user, 5% of users), Methamidophos (3 users, 15% of users) and Carbophenothion (2 users, 10% of users), and 6 kinds were class 2 (21.5% used kinds); Chlorpyriphos (11 users, 55% of users) and

Dichlorvos (6 users, 30% of users), Dimethoate (5 users, 25% of users), Profenofos (4 users, 20% of users), Phenvalerate (2 users, 10% of users) and Ethion (1 user, 5% of users).

Most Organophosphates group was frequently used during 10-40 days of cultivation periods. Not only were Chlorpyriphos and Dichrotophos used during 10-40 days but they were also used during period of preparing soil and cultivation by 5% and 10% successively. Monochrotophos was only used during 10-20 days and Ethion was only used during 45-55 days of harvesting time, each of these 2 pesticides was used by 5% of users. Chlorpyriphos and Dichrotophos were used during 10-20 days by 50% and 40% of users successively. These chemicals were also used during 30-40 days by 20% and 5% of users respectively. Carbophenothion, phenvalerate and Methamidophos were used during 10-20 days by 5%, 5% and 10% successively and each of these 3 pesticides was used during 30-40 days by 5%. Dichlorvos, Dimethoate and Profenofos were used during 10-20 days by 30, 20 and 20% of users respectively and 30-40 days by 20, 20 and 0% respectively.

Carbamates group (10 users, 50% of users), had 4 kinds (14.3% used kinds), 2 kinds were class 1 pesticides (7.1% used kinds) that were Carbofuran (4 users, 20% of users) and Methomyl (3 users, 15% of users) and the other 2 kinds were class 2 pesticides (7.1% used kinds) that were Carbosulfan (2 users, 10% of users) and Carbaryl (6 users, 30% of users) (IPCS & safety, 2004) Methomyl, was not only used by 5% of users during each of the 3 periods; during preparing soil period, 30-40 and 45-55 days but it was also used by 10% of users during the period of 10-20 days. Other carbamates; Carbaryl, Carbofuran and Carbosulfan were used during preparing soil period by 20%, 5% and 5% of users respectively. The pesticides were also used during 10-20 days by 10%, 10% and 5% of users respectively.

Pyrethroids group (6 users, 30% of users) had two kinds (7.1% of used kinds) which were Permethrin (3 users, 15% of users) and Cypermethrin (4 users, 20% of users), both kinds were class 2 pesticides (IPCS & safety, 2004) that were used during 10-20 days by 10% and 15% of users respectively and also used during 30-40 days by 5% and 20% of users respectively.

New pesticides used by the growers (15 users, 75%of users) had 6 groups and 12 kinds (42.9% of used kinds) as follows:

Neonicotinoids group had 4 kinds (14.3% used kinds), 3 kinds were used:- the class 3–Dinotefuran (2 users, 10%ofusers), Acetamiprid (2 users, 10% of users) and Thiamethoxam (4 users, 20% of users) and the other kind, Imidaclopid was class 2 (IRAC, 2012); (IPCS & safety, 2004).

Dinotefuran, Acetamiprid and Imidaclopid, all were used during 10-20 and 30-40 days by 5% of users at each period. Dinotefuran was used at 45-55 days by 5% of users and Imidaclopid was also used during preparing soil period by 5% of users. Thiamethoxam was also used during preparing soil period, 10-20 and 30-40 days by 5%, 20% and 10% respectively.

Spinosin group had 1 kind (3.6% of used kinds) – Spinosad 3 users (15% of users) and was class 4 pesticide (IRAC, 2012); (IPCS & safety, 2004) that was used during10-20 days by 10% and 30-40 days by 5% of users.

Avermectins group, 2 used kinds (7.1% used kinds) – Abamectin of class 1 pesticide [IRAC, 2012 and EC Agency Committee., 2010], 40%of growers used during10-20 and 30-40 days by 25% and15% users respectively. Emamectin benzoate of class 2 pesticide (IRAC, 2012) ; (Opinion, 2010). 10% of growers used during10-20 days by 10% of users.

Benzoyl Urea group had 3 used kinds (10.7% of used kinds) – Diflubenzuron (class 3 pesticide) had 1 users (5% of users), was used during 10-20 days. Chlorfluazuron (class 4) had 15 users (75% of users), was used during 10-20, 30-40 and 45-55 days by 45%, 30% and 5% users. Chlorfenapyr was class 2 pesticide (15% of users), was used during 30-40 days period by 15% users (IRAC, 2012); (IPCS & safety, 2004).

Neristatins had 1used kind (3.6% kinds of use) – Cartap hydrochloride was class 2 pesticide (10% of users), was used during 10-20 and 30-40 days by 5% of users at each period (IRAC, 2012); (IPCS & safety, 2004).

Oxadiazine had 1 used kind (3.6% kinds of use) – Indoxacarb was class 3 (20% of users), that was used during 10-20 and 30-40 days by 15% and 20% of users successively (IRAC, 2012); (IPCS & safety, 2004).

Table IV.V Used Organophosphate pesticides, frequency % of users during cultivation period

No	Pesticide Groups	Toxicity Rating	% of Total Users (N=20	%users of total agriculturists (N=20) in each Kana cultivation period (days)			
Organophosphate Pesticides			15 users (75% users)	Preparing soil and Cultivation	10-20 days of young cultivation	30-40 days of pre-harvesting	45-55 days of the harvesting
1	Chlorpyrifos	2	55	5	50	20	0
2	Dichrotophos	1	65	10	40	5	0
3	Carbophenohion	1	10	0	5	5	0
4	Phenvalerate	2	10	0	5	5	0
5	Methamidophos	1	15	0	10	5	0
6	Monochrotophos	1	5	0	5	0	0
7	Dichlorvos	2	30	0	30	20	0
8	Dimethoate	2	25	0	20	20	0
9	Profenefos	2	20	0	20	0	0
10	Ethion	2	5	0	0	0	0

Table IV.VI Used carbamates, pyrethroids, new pesticides and % users during cultivation periods

No	Pesticide Groups	Toxicity Ratings	% of Total Users (N=20)	%users of total agriculturists (N=20) in each Kana cultivation period (days)			
	Carbamate pesticides		50% users	Preparing soil and Cultivation	10-20 days of young cultivation	30-40 days of pre-harvest	45-55 days of the harvest
1	Carbaryl	2	30	20	10	0	0
2	Carbofuran	1	20	15	5	0	0
3	Methomyl	1	15	5	10	5	5
4	Carbosulfan	2	10	5	5	0	0
	Pyrethroid pesticides		30% users)				
1	Permethrin	2	15	0	10	5	0
2	Cypermethrin	2	20	0	15	20	0
	New pesticides		75% users				
New	Neonicotinoid Pesticides						
1	Dinotefuran	3	10	0	5	5	5
2	Acetamiprid	3	10	0	5	5	0
3	Immidaclopid	2	10	5	5	5	0
4	Thiamethoxam	3	20	5	20	10	0
New	Spinosins						
1	Spinonosad	4	15	0	10	5	0
New	Avermectins						
1	Abamectin	1	40	0	25	15	0
2	Emamectin	2	10	0	10	0	0
New	Benzoyl Urea						
1	Diflubenzuron	3	5	0	5	0	0
2	Chlorfluazuron	4	75	0	45	30	5
3	Chlorfenapy	2	15	0	0	15	0
New	Neristatin						
1	Cartap HCl	2	10	0	5	5	0
New	Oxadiazine						
1	Indoxacarb	3	20	0	15	20	0

Table IV.VII Used-Organophosphate, Carbamate, Pyrethroid, New Pesticide, %Toxicity Class

NO	Pesticide Groups and Kinds (% of N = Users)	Toxicity Rating Class	Kinds Use %Total Kinds	Class 1	Class 2	Class 3	Class 4
	Organophosphate (75) had 10 kinds	**1,2**	**35.7**	**14.3**	**21.5**	**0**	**0**
1,2	Dichrotophos (65), Monochrotophos (5)	1	7.14	7.14	0	0	0
3,4	Methamidophos(15), Carbophenothion(10)	1	7.14	7.14	0	0	0
5,6	Chlorpyriphos (55), Dichlorvos (30)	2	7.14	0	7.14	0	0
7,8	Dimethoate (25), Profenofos (20	2	7.14	0	7.14	0	0
9,10	Phenvalerate (10), Ethion (5)	2	7.14	0	7.14	0	0
	Carbamate (50) had 4 kinds	1,2	14.3	7.1	7.1	0	0
1,2	Carbaryl (30), Carbosulfan (10)	2	7.14	7.14	0	0	0
3,4	Carbofuran (20) , Methomyl (15)	1	7.14	0	7.14	0	0
	Pyrethroids (30) had 2 kinds	2	7.1	0	7.1	0	0
1,2	Permethrin (15), Cypermethrin (20)	2	7.14	0	7.14	0	0
New	**New Pesticides (75) had 6 groups**	2,3,4	42.9	3.6	14.3	17.9	7.1
New	**Neonicotinoid Group had 4 kinds**	2,3	14.28	0	3.57	10.71	0
1-3	Dinotefuran (10), Acetamiprid (10) Thiamethoxam (20)	3	10.71	0	0	10.71	0
4.	**Immidaclopid(10)**	2	3.57	0	3.57	0	0
New	**Spinosins Group had 1 kind**	4	3.57	0	0	0	3.57
1	Spinosad (15)	4	3.57	0	0	0	3.57
New	**Avermectins Group had 2 kinds**	1,2	7.14	3.57	3.57	0	0
1	Abamectin (40),	1	3.57	3.57	0	0	0
2	Emamectin benzoate (10)	2	3.57	0	3.57	0	0
New	**Benzoyl Urea Group had 3 kinds**	2,3,4	10.71	0	10.71	3.57	3.57
1	Diflubenzuron (5)	**3**	3.57	0	0	3.57	0
2	Chlorfluazuron (75)	**4**	3.57	0	0	0	3.57
3	Chlorfenapyr (15)	**2**	3.57	0	3.57	0	0
New	**Neristatin Group, 1 kind**	2	3.57	0	3.57	0	0
1	Cartap (10)	2	3.57	0	3.57	0	0
New	**Oxadiazine Group,1 kind**	3	3.57	0	0	3.57	0
1	Indoxacarb (20)	2	3.57	0	0	3.57.	0
	Total 28 (100%) pesticide kinds	1-4	100%	25.0%	50.0%	17.9%	7.1%

IV.V Pesticide safety in vegetable marketed in northeast central market

Regional medical Sciences Center 9 Nakhonrachasima, Suranakorn central market laboratory where the author analyzed 396 vegetable samples (Chinese kale, Lettuce, Cauliflower, Cabbage, Chili and Cucumber) collected by Suranakorn central market during March – October 2012, then tested for pesticide residues and 5.6% of 22 samples were detected to have the above maximum pesticide residues limit as unsafe findings (Popattanachai et al., 2013). The 22 pesticide unsafe vegetable samples, 9 detected unsafe Chinese kale collected samples (40.9% of unsafe vegetables and 2.3% of total samples). Out of 9 detected unsafe Chinese kale samples, there were 7 Chinese kale samples from Sekhiew district, Nakhonratchasima province.

4.6 Evaluating effectiveness of innovative pesticide kit model for farm safety surveillance program

4.6.1 Transfer technology of self-test laboratory to farmers

Transfer technology of self-test laboratory in Klongtabak farms, obtained by training agriculturists and volunteers for safety monitoring by the community. For competency test, inter-laboratory comparison of innovative test kit by farm volunteers with competent analysts from reference laboratory, Department of Medical Sciences, was performed. Collected Chinese kale, the same lot of samples was tested by researchers and farmers or volunteers by using 4 group innovative test kit.

4.6.2 Result of laboratory competency testing

Obtained results of the laboratory competency testing of collected Chinese samples from the same study farmers' plantations and tested by competent researchers from reference laboratory and also tested by trained farmers (table IV.XIII). Results at the first laboratory training to study farmers, 93% accuracy of testing by farmers was found at post or the follow-up laboratory training (tested 30 Chinese kale samples, obtained accurate results in 28 samples) The follow-up workshop training revealed very satisfactory acceptable results compared to 77% accuracy at first laboratory training to farmers (tested 30 Chinese kale samples, obtained accurate results in 23 samples). The farmers were awarded laboratory competency certificate from the regional reference laboratory, Regional Medical Sciences Center 9 Nakhonratchasima.

4.6.3 Evaluation by comparing association of % pesticide risk in samples before and after intervention period.

To test 62 collected Chinese kale samples from the vegetable plantations, one collected sample from one plantation, 31 samples were collected from the same plantations at pre and post intervention period from each of the study and control group. All Chinese Kale samples were analyzed by using the 4 group innovative pesticide test kit and the spectrophotometer for % cholinesterase inhibition assay that organophosphate and carbamate pesticides inhibited the enzyme. Detected or suspected unsafe, were determined quantitatively of 4 groups pesticide residues (Alimentarius, 1969, Amended 1999) using GLC and HPLC by central laboratory; Before intervention, two detected samples of Chlorpyrifos (>MRL) in control, two detected samples of Cypermethrin (<MRL)

and 1 detected <MRLs of Methomyl, Carbofuran and Carbofuran-3-OH in study group but none were detected from both groups at post intervention period (see table IV.VIII).

Results of the % cholinesterase enzyme inhibition in Chinese kale, analyzed by researchers using spectrophotometer showed the compared percentage difference of enzyme inhibition between before and after intervention period. Within intervention group, results of %decreased enzyme inhibition at post intervention, compared with pre-intervention was 51.9%, the % difference had p-value<0.011 using the dependent t-test, revealed that intervention program affect pesticide residue reduction of %enzyme inhibition at the 0.05% significance level (see table IV.IX, IV.X).

To compare difference within control group, results of % increased enzyme inhibition at post intervention, compared with pre intervention was 38.9%, the % difference had p-value < 0.001 by using dependent t-test (see table IV.IX, IV.XI).

Table IV.VIII Vegetable test results in control and intervention farms by researchers from reference Laboratory

Sample Frequency	Screen 4 groups by test kit	Special Instrument Analysis	International Standards
Control (Pre-Test)	Pre – test	GLC/HPLC measurements	CODEX's MRLs
29 samples	Not Detected	-	-
2 samples	Pesticide Detected	Chlorpyrifos 3-3.5 mg/kg	1 mg/kg (Chinese cabbage)
Control (Post-Test)	Post Intervention	GLC/HPLC Measurements	
31 samples	Not Detected		
Intervention (Pre-Test)	Pre intervention period test	GLC/HPLC measurements	
28 samples	Not Detected	-	
2 samples	Pesticide Detected	Cypermethrin 0.1-0.2 mg/kg	0.7 mg/kg (Leafy vegetable)
*1 sample *Suspected Unsafe	Not Detected by test kit but high % Enzyme Inhibition. Analyzed by GLC/HPLC	Methomyl 0.16 mg/kg Carbofuran 0.14 mg/kg Carbofuran-3-OH 0.13 mg/kg	5 mg/kg (Cabbage head) 1 mg/kg (Common bean)
Intervention (Post-Test)	Post intervention period test	GLC/HPLC measurements	
31 samples	Not Detected	-	

Table IV.IX Vegetable Measurement %Enzyme Inhibition by researchers

Using spectrophotmeter

%Enzyme Inhibition (%I)	Control (Pre Test) Frequency	Control (Post Test) Frequency	Intervention (Pre Test) Frequency	Intervention (Post Test) Frequency
0-10	24	20	22	22
>10-20	7	8	4	8
>20-30	0	1	3	1
>30-40	0	0	2	0
Total	31	31	31	31
Mean (% I)	4.99	6.93	8.08	3.89
Mean Increase (%I)		6.93-4.99 (1.94)		
Mean Decrease (%I)				3.89-8.08 (- 4.19)
Difference %I Mean %Increase	Mean % Increase	$\frac{1.94}{4.99} \times 100$	- 38.9%	
Mean %Decrease	Mean % Decrease	$\frac{-4.19}{8.08} \times 100$	- -51.9%	

Table IV.X Comparing the difference within the intervention group by using dependent t-test

Intervention measurement	Pre intervention (N =31)	Post intervention (N =31)	*p*-value
Intervention study group	Mean SD.	Mean SD.	0.011*
% Enzyme Inhibition	8.08 10.70	3.89 6.39	*significant at *p*-value < 0.01

Table IV. XI Comparing difference within control using Dependent t-test

Intervention measurement	Pre intervention (N =31)	Post intervention (N =31)	*p*-value
Control group	Mean (SD).	Mean (SD).	0.001**
% Enzyme Inhibition	4.99 (6.29)	6.93 (6.89)	**significant at *p*-value < 0.001

Table IV.XII Comparing difference between intervention and control group at post intervention by using independent t-test

Intervention measurement	Intervention (N =31)	Control (N =31)	*p*-value
Statistic	Mean (SD).	Mean (SD).	0.076***
% Enzyme Inhibition	6.93 (6.89)	3.89 (6.93)	***significant at *p*-value < 0.10

Table IV.XIII Farmers' competency test between baseline and follow-up

Innovative pesticide kit testing vegetable samples by farmers	Baseline (Tested vegetable Samples, N =30)	Follow-up (Tested vegetable Samples, N =30)	RESULT COMPETENCY TESTING
Statistics (%)	Accuracy (%).	Accuracy (%).	Pass $\geq$ 60% Fair $\geq$ 70% Satisfactory $\geq$ 80 Very satisfactory $\geq$ 90%
Farmers Testing Competency Test	23 (76.7)	28 (93.3%)	Very satisfactory

CHAPTER V
DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Discussion

Recognizing that agricultural farming, more than one third of work sector of Thailand represented 35.8% of labor force in 2011 (Office, 2011). Some contaminated pesticides in the environment and accumulated in the food chain, posing hazards to human health, maturely organophosphate, carbamate, pyrethroid and organochlorine. The first three groups were popularly used, while the organochlorine was banned in many countries (L Leuprasert et al., 2010), it was still being used in Thailand (Sombatsiri, 1997). Many farmers believed that pesticide application was necessary and continued using unless campaign for changed pesticide attitude and proper pesticide use. (Panuwet et al., 2012). Pesticide residues were highly detected in marketed Chinese kale vegetable by MOPH, Thailand, (Food safety report, 2012). Detected unsafe pesticide residues in 22 samples, 5.6% of 396 vegetable samples**,** marketed in Suranakorn central market, Nakhonratchasima province, 9 out of those 22 (40.9%) were tested pesticide unsafe in Chinese kale samples (Popattanachai et al., 2013). Farmers used large amount of pesticides indiscriminately which could affect the consumer's health, The contamination could not be treated in isolation from the environment which food was produced, simple test method should be applied, where results could help improve pesticide application strategies and develop remediation. Validated test kit of Department of Medical Sciences, granted petty patent from Thailand Intellectual Property Department, could be used to screen 4 pesticide groups in vegetable farm samples (L Leuprasert et al., 2012a) and innovative pesticide test kit model including the application of the innovative test kit model for vegetable farm safety surveillance program and the transferring technology of self-test laboratory to farmers in intervention group would be useful for farm safety monitoring and increasing vegetable safety.

In descriptive results of the studied farmers' baseline interview, many pesticides of 9 groups and 28 kinds identified as percentage frequency of the 20 farmers; Organophosphate (35.7%), Carbamate (14.3%), Pyrethroid (7.1%) and the new pesticide kinds were currently notified to be high (Neonicotinoid-14.3%, Benzoyl urea-10.7% and Avermetin-7.1%). These top four mostly used percentage pesticides might be related to farmers' health symptoms but this study considered prevalence of pesticide use and symptoms that was not formally tested whether the use was related to the symptoms. This could lead to some uncertainty in the interpretation of results whether the symptom rates were higher in farmers with high pesticide exposure than the low exposure group. However, the used pesticides of Methomyl, Carbofuran (2 kinds of Carbamates) and dichrotophos (Organophosphate) were the chemicals under a watch list by Department of agriculture (Health, 2012) that showed probable health risk to exposed farmers and possible contamination to vegetable produce and intake of the excessive amount at long time could lead to chronic poisoning that affect reproductive and nervous system. This study also reported other identified highly and moderately hazardous kinds of pesticides during various Chinese kale cultivation periods and symptoms prevalence (L Leuprasert, Taneepanichskul, Monmora, Puangtapa, & Chaiifan, 2014) that focused further study to strengthen the farmers.

Pesticide residues were difficult to be measured by the reference laboratories, presently very limited to access with very long waiting time (approximately 1 month of analysis and reporting time. The analysis cost was also unaffordable and expensive for farmers (L Leuprasert et al., 2012). It was needed to focus less contaminated pesticides in vegetable produce by the innovative pesticide kit model for farm safety surveillance program that was firstly developed including application of the researchers' invented pesticide test kits and co-operatively worked with farmers and stake holders in study community farm of Thailand. The Chinese kale vegetable was purposively selected as risky pesticide contaminated produce for the study (Popattanachai et al., 2013).

Chinese kale has short cultivation periods and the 45-55 days of harvesting period was collected time for sale and also for the proper collecting period for analysis of pesticide residues. Only 5 from 62 collected samples, were detected contaminated pesticide residues by using innovative test kit and special instruments (spectrophotometer and GLC/HPLC) and had low percent cholinesterase enzyme inhibition and low quantities of pesticide residues. Among 5 detected Chinese kale samples, only 2 samples from control were detected at higher amounts than WHO CODEX's maximum residue limits (>MRLs) of Organophoosphate (Chlorpyrifos) residues. The possible answers regarding a few detected >MRLs pesticide residues in the collected Chinese kale that harvesting time periods of the vegetables, some farmers frequently used bio-pesticides, anti-fungal and new groups of pesticides. The 4 groups innovative test kit, spectrophotometry method to analyze percent enzyme inhibition and GLC/HPLC could not measure the frequently used pesticides which were discussed because of the research scope and used techniques that implied only 4 group pesticides (Organophosphate, Carbamate, Pyrethroid and Organochlorine). During Chinese kale's harvesting period, the scoped 4 group pesticides were used very little (0-5%) at each cultivation periods; soil preparing period of 5%, 10-20 days at young cultivation of 5%, 30-40 days period at pre harvesting time of 0% and 45-55 days at harvesting time of 0% (L Leuprasert, Taneepanichskul, Monmora, Puydecha, et al., 2014). Further formal study of the pesticide residues at each cultivation periods at shall provide accurate results. Various kinds of the new pesticide groups are currently used by farmers, the public and government officials do not generally know adverse information about new pesticides that presently grow rapidly in economy competitive use including their mutagenic and teratogenic effects.

Laboratory screening for the new pesticides are more difficult and need study development regarding the vast difference of new groups and multiple pesticide modes of actions.

Pesticide monitoring should be emphasized for food safety. Transfer of innovative kit technology to strengthen agriculturists should be focused for the safety monitoring of pesticide contamination to guarantee vegetable produce safety. Some pesticides particularly organophosphate and carbamate had ability of inhibiting the acetyl cholinesterase enzyme and % enzyme inhibition assay can be measured in vegetable by spectrophotometer to evaluate difference of variables after intervention study. The study was aimed at evaluating the effectiveness of innovative pesticide kit model for farm safety surveillance program by measuring association of pesticide residues in vegetable produce by agriculturists in Klongtabak village, Nakhonratchasima province before and after intervention, and transferring technology of self-test LAB in study farm community, obtained by training and testing their laboratory competency. Transfer technology of self- test laboratory in intervention farms obtained by training the agriculturists, shall be beneficial for self-economy to add agricultural value for ASEAN countries and follow self-dependence and sustained economy policy of the royal Thai government.

5.2 Conclusion

Chinese kale farmers in the study community used a vast variety of Organophosphate, Carbamate, Pyrethroid and many new pesticide groups. Results of % cholinesterase enzyme inhibition assay in 62 collected Chinese kale, 31 samples from intervention and 31 samples from control plantations, using spectrophotometer showed compared percentage difference of enzyme inhibition between before and after intervention period. The within intervention group, results of the decreased % enzyme inhibition at post intervention, compared with pre-intervention was 51.9%. The % enzyme inhibition difference had *p*-value<0.011 using the dependent t-test, revealed that the intervention program affect pesticide residue reduction of the % enzyme inhibition at the 0.05% significance level (see table IV.X and IV.XII). To compare difference within the control group, results of increased enzyme inhibition at post intervention, compared with pre intervention was 38.9%, the % difference had *p*-value <0.001 by using dependent t-test (see table IV.XI and IV.XII).

To train farmers, the self-test laboratory using innovative test kit and testing their competency by inter-laboratory test comparison in the proficiency test samples (tested with standard method) using innovative test kit and compare results between farmers and competent analysts of Department of Medical Sciences. Test progress result of 93% accuracy was very satisfactory acceptable and documented at post laboratory training comparing to 77% accuracy at baseline or pre laboratory training. The two interventions; application of innovative pesticide kits and self-test transferring technology were included in the innovative pesticide kit model for farm safety surveillance program. The program of this pilot model could be used in other communities for beneficial agricultural safety. The intensive skill base of farmers and sustained farmer safety monitoring will be continuously required particularly the continuous support by key decision and community policy makers.

5.3 Limitation

1. Interventions that were used in this study included innovative pest kit model for vegetable farm surveillance program. Others that were not used might also have effects with the program.
2. If there was turnover when farm safety team who performed the innovative pest kit model for vegetable farm safety surveillance program. About 20 farm safety volunteers at intervention farms would be all trained for the community safety monitoring and duty replacement in case of any personal absence.
3. The limitation, innovative test kit was tested for 4 groups: organophosphate, carbamate, pyrethroid and organochlorine. The test kit could not be used to screen new pesticides which were not included in the pesticide groups' scope.
4. The study considered prevalence of agricultural pesticide use and symptoms, not formally tested whether pesticide use was related to symptoms that lead to some uncertainty in interpretation of results whether symptom rates were higher in farmers with high pesticide exposure than the low pesticide exposure group.
5. This study identified vegetable growers' symptoms during or after application of pesticides, approximately within a week. These symptoms were similar to symptoms caused by insecticide exposure, some of the symptoms might be caused by other factors and not by the insecticide exposure and there might be some other symptoms that would take longer time to appear.

5.4 Recommendation

5.4.1 New pesticide groups laboratory field tests are more difficult and require further laboratory development transferred technology of the new self-test laboratory obtained by training agriculturists in the farm community.

5.4.2 Further research need to study other factors that may have effect with vegetable farm surveillance program excluding the innovative pesticide kit model and study their relationship with the exposed farmers' health effects.

5.4.3 The pilot educational tools used in this study program, should be used for further pesticide risk communication steps for other farm communities and the public.

5.4.4 The innovative pesticide kit model for vegetable farm safety surveillance program should be included in routine farm vegetable safety practice of the local community administration so that support could remain to run the activities.

5.4.5 Formally tested prevalence of agricultural pesticide use and symptoms should be further studied whether the pesticide use was related to those health symptoms.

5.4.6 Quality testing process system of pesticide residues in vegetable and fruit which was the initiative accreditation with officially attached logo of Department of Medical Sciences (Ministry of Public Health, Thailand), should be developed and accredited in the future. The top administration shall support for safe produce, safe health of consumers and for value added to the AEC market competitive produce of implemented communities.

5.4.7 The policy management may consider the IPKM program of this pilot model for conducting in other farm communities. The pesticide reduction, awareness of pesticide risk and also for self-economy strategy can bring community benefits

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APPENDICES

APPENDIX A

QUESTIONAIRE

(English version)

APPENDIX A

Questionaire about pesticide use

Interviewer ID..Date...

Group [1] Pesticide Users Please check [/][1.1] Insecticide Users [1.2] Pesticide Users

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Questionaire

Innovative Pesticide Kit Model for Vegetable Farm Safety Surveillance Program

Operational Definitions

1. Agriculturists are occupational farmers who cultivate land and crops, age 18-65 years old.
2. Pesticide used agriculturists are pesticide mixers or sprayers, or exposed to the pesticides.
3. Pesticides are hazardous chemicals; insecticides and/or pesticides used for agriculture.
4. Insecticides are hazardous chemicals of one or more pesticide groups such as organophosphate, carbamate, organochlorine and pyrethroids.

Please check [/] in blanket and fill to complete the blanket data.

Part 1General information of agriculturists and community volunteers

1.1 Agriculturist ID...

1.2 Gender [1] Male [2] Female

1.3 Age ....

1.4 Address No. ....Moo ....Road................Sub-district..............................
District.................. Province............ Telephone..................... (if available)

1.5 Highest education
[1] Primary School [2] Secondary school, High School or Vocational School
[3] Bachelor's Degree [4] Higher Bachelor's Degree [5] Other.....................

1.6 Do you have personal diseases? [No] [Yes] Specify ....

1.7 What kinds of crops have you grown? [Vegetable] Specify..

[Fruit] Specify.................................... [Other] Specify............

1.8 Have you ever used pesticides during your routine cultivation ?

Can answer more than 1

[1] No [2] Yes ....Please specify [2.1] Insecticides [2.2] Herbicide [2.3] Pesticides

1.9 Are there any nearby farms that use pesticides? Can answer more than 1

[1] No [2] Yes ....Please specify [2.1] Insecticides [2.2] Herbicide [2.3] Pesticides

Part 2 Pesticide Use Information

2.1 What are your jobs regarding pesticide use? Can answer more than 1

[1] Preparing and mixing pesticides. Please specify the used mixer....................

[2] Spraying pesticides

Please specify the used sprayer [2.1] Manual back pack sprayer [2.2] Back pack sprayer with motor

[3] Other, Specify..

2.2 How do you protect yourselves from exposed pesticide hazards at routine agricultural practice?

[1] No protective equipment for mouth, nose, hands and feet

[2] With protective equipment [2.1] Wear mouth and nose protective equipment

[2.2] Wear gloves [2.3] Wear boot/ safety shoes

[2.4] Long sleeve shirt/top [2.5] Long do pant/ trousers

[2.6] Put on turban wrap / hat

2.3 Pesticide use

Pesticide names	Preparative pesticide use	How do you spray pesticides?
1.		[ ] Spray at once and used spray time.............minutes. [ ] Spray many times and total used spray time......minutes.
2.		[ ] Spray at once and used spray time................minutes. [ ] Spray many times and total used spray time......minutes.
3.		[ ] Spray at once and used spraytime................minutes. [ ] Spray many times and total used spray time......minutes.
4.		[ ] Spray at once and used spray time........minutes. [ ] Spray many times and total used spray time......minutes.
5.		[ ] Spray at once and used spray time................minutes. [ ] Spray many times and total used spray time......minutes.

2.4 How is your routine practice of pesticide application? Can answer more than 1

[1] Read pesticide label directions for understanding before use.

[2] Maintenance and fixing for assuring the well prepared sprayers

[3] Follow label direction of mixing chemicals. [4] Use stirrer to mix pesticides.

[5] Spray at upwind and avoid spraying at very windy time.

[6] Spray all preparative mixing pesticides at once the working time finished

[7] Do not use your mouth to blow the blocked head of the sprayer.

[8] Do not drink water, alcohol, smoke cigarette or eat food during application.

[9] Restrict use of pesticide to avoid chemical hazards[10] Other (specify)..............

2.5 How is your routine practice after pesticide use? Can answer more than 1

[1] Washing pesticide contaminated cloths separately.

[2] Body washing and cleaning after pesticide application

[3] Cleaning pesticide applicator

[4] Warning notices of no entry to pesticide application areas [5] Others, specify...

2.6 How do you manage the pesticide waste and containers? Can answer more than 1

[1] To keep separately in safety place away from water sources and children reach.

[2] Clean pesticide containers before final disposal and destruction for no reuse.

[3]Dispose used container underground in safe place away from water sources and residential areas.

[4] Other, specify..............

2.7 Have you been sick or had unusual symptoms during working or post application approximately about within 1 week. Can answer more than 1

[1] Headache	[2] Dizziness,	[3] Sweating	[4] Flowing saliva	[5] Irritation
[6] Running Tears	[7] Skin irritation	[8] Chest Congestion	[9] Breathing difficulties	[10] Blurred Vision
[11] Vomiting	[12] Weakness, tiredness	13] Muscle Twitching	[14] Body pain	[15] Running nose, Nasa congestion
[16] More saliva	[17] Nausia	[18] Stomachache	[19] No appetite	[20] Muscle Contraction
[21] Coughing	[22] Diarrhoea	[23] Heart beating	[24] Fainted heart	[25] Fainting
[26] Decreased body weight	[27] Urinary incontinence	[28] Tachyphonia	[29] Restlessness	[30] Convulsion

2.3 Pesticide use by interview (%Users of total agriculturists during all/each of cultivation periods)

No	Pesticide group / kind use	Details	% of Total Users (N=20)	Preparing soil and Cultivation	10-20 days of young Cultivation	30-40 days of pre-Harvesting	45-55 days of the Harvesting
1							
2							
3							
4							

APPENDICES;

APPENDIX B

QUESTIONAIRE

(Thai version)

แบบสอบภามการใช้สารเคมีกำจัดศัตรูพืช

รหัสผู้เก็บข้อมูล .... วันที่สอบถาม ....

กลุ่ม [1] กลุ่มใช้สารเคมีกำจัดศัตรูพืช โปรดระบุ [1.1] ใช้สารเคมีกำจัดแมลง [1.2] ใช้สารเคมีกำจัดศัตรูพืช

<u>แบบสอบถาม</u>

โปรแกรมต้นแบบในการเฝ้าระวังความปลอดภัยสารเคมีกำจัดแมลงในฟาร์มผัก ด้วยชุดทดสอบและองค์ความรู้ใหม่

<u>ข้อตกลง</u>

1. เกษตรกร คือ ผู้ที่ประกอบอาชีพ หรือปฏิบัติงานในพื้นที่เกษตรกรรม และมีอายุอยู่ในระหว่าง 18-65 ปี
2. เกษตรกรที่ใช้สารเคมีกำจัดศัตรูคือ ผู้ทำหน้าที่เตรียมสารผสมหรือฉีดพ่น หรือ สัมผัสสารเคมีกำจัดศัตรูพืช
3. สารเคมีกำจัดศัตรูพืช คือ สารเคมีอันตรายที่ใช้ในการเกษตร ทั้งสารเคมีกำจัดแมลง และ/หรือ สารเคมีกำจัดศัตรูพืชอื่นๆ เช่น สารเคมีกำจัดวัชพืช
4. สารเคมีกำจัดแมลง คือ สารเคมีอันตรายที่ใช้ในการเกษตร ทั้งที่ใช้กลุ่มใดกลุ่มหนึ่ง หรือหลายๆกลุ่ม ได้แก่กลุ่มออร์กาโนฟอสเฟต คาร์บาเมต ออร์กาโนคลอรีน และไพเรทรอยด์

กรุณาทำเครื่องหมาย [✓] ในช่องว่าง และเติมข้อมูลในช่องว่างให้สมบูรณ์

ส่วนที่1 ข้อมูลของเกษตรกร/อาสาสมัครชุมชน

1.1 ชื่อ-สกุล นาย/นาง /นางสาว...

1.2 เพศ [1] ชาย [2] หญิง

1.3 อายุ............ปี

1.4 ที่อยู่ บ้านเลขที่.........หมู่ที่......ถนน............ตำบล...... อำเภอ.........จังหวัด.............โทรศัพท์ .... (ถ้ามี)

1.5 ระดับการศึกษาสูงสุดหรือเทียบเท่า

[1] ประถมศึกษา [2] มัธยมศึกษาอาชีวศึกษาหรือเทียบเท่า(ปวช. ปวท.)

[3] ปริญญาตรี [4] สูงกว่าปริญญาตรี [5] อื่นๆ ....

1.6 โรคประจำตัว [1] ไม่มี [2] มีระบุโรค...

1.7 ชนิดของพืชที่ปลูก(ตอบได้มากกว่า 1 ข้อ)[1] ผัก ....[2] ผลไม้ ......[3] อื่นๆ ....

1.8 ในการประกอบอาชีพตามปกติ ท่านมีการใช้สารเคมีกำจัดศัตรูพืชหรือไม่

[1] ไม่มี [2] มี ระบุชื่อ ....(ตอบได้มากกว่า 1 ข้อ)

[2.1] สารเคมีกำจัดแมลง [2.2] สารเคมีกำจัดวัชพืช

1.9 สถานที่ใกล้บริเวณสวน/ไร่ของท่านมีการใช้สารเคมีกำจัดศัตรูพืชหรือไม่

[1] ไม่มี [2] มี ระบุชื่อ .... (ตอบได้มากกว่า 1 ข้อ)

[2.1] สารเคมีกำจัดแมลง [2.2] สารเคมีกำจัดวัชพืช

<u>ส่วนที่ 2 ข้อมูลการใช้สารเคมีกำจัดศัตรูพืช</u>

2.1 ท่านมีหน้าที่เกี่ยวข้องกับสารเคมีกำจัดศัตรูพืชอย่างใดบ้าง (ตอบได้มากกว่า 1 ข้อ)

[2.1.1] เป็นผู้เตรียมผสมสารเคมี

อุปกรณ์ที่ใช้ผสมสารเคมีคือ ....

[2.1.2] เป็นผู้ฉีดพ่นสาร เครื่องพ่นสารเคมีกำจัดศัตรูพืชที่ใช้คือ

[1] แบบสูบโยกสะพายหลัง [2] แบบเครื่องยนต์สะพายหลัง [3] อื่นๆ ....

[2.1.3] หน้าที่อื่นๆ(ระบุ) ....

2.2 ในการทำงานตามปกติท่านมีวิธีป้องกันตนเองจากอันตรายของสารเคมีกำจัดศัตรูพืชอย่างไร

[2.2.1] ไม่ป้องกัน (ไม่ป้องกัน ปากจมูก มือ และเท้า)

[2.2.2] ป้องกันโดย

[1] ใส่ที่ปิดปากปิดจมูก [2] ใส่ถุงมือยาง [3] ใส่รองเท้าหุ้มมิดชิด/รองเท้าบู๊ท

[4] เสื้อแขนยาว [5] กางเกงขายาว [6] ผ้าโพกศรีษะ/หมวกคลุมผม

[7] อื่นๆ (โปรดระบุ) ....

2.2.3 สารเคมีกำจัดศัตรูพืชที่ใช้

ชื่อสารเคมีกำจัดศัตรูพืช	การเตรียม	ลักษณะการฉีดพ่นสาร
		[ ] ฉีดหมดครั้งเดียว ใช้เวลา .... นาที [ ] ฉีดหลายครั้งรวมทั้งหมดใช้เวลา.............นาที
		[ ] ฉีดหมดครั้งเดียว ใช้เวลา .... นาที [ ] ฉีดหลายครั้งรวมทั้งหมดใช้เวลา.............นาที
		[ ] ฉีดหมดครั้งเดียว ใช้เวลา .... นาที [ ] ฉีดหลายครั้งรวมทั้งหมดใช้เวลา.............นาที

2.2.4 ขณะใช้สารเคมีกำจัดศัตรูพืช ปกติท่านปฏิบัติอย่างไรบ้าง (ตอบได้มากกว่า 1 ข้อ)

[1] ก่อนใช้อ่านฉลากให้เข้าใจ

[2] ตรวจสอบซ่อมแซมเครื่องพ่นก่อนใช้

[3] ผสมสารตามที่ฉลากแนะนำ

[4] ใช้ไม้ในการกวนหรือคลุกสารให้เข้ากัน

[5] พ่นสารเหนือลมเสมอและหยุดพ่นเมื่อลมแรง

[6] พ่นสารให้หมดทุกครั้งเมื่อผสมใช้

[7] ไม่ใช้ปากเป่าหรือดูดหัวฉีดที่อุดตัน

[8] ไม่ดื่มน้ำ สุรา สูบบุหรี่ หรือกินอาหาร

[9] ระวังการใช้สารไม่ให้เกิดอันตรายขึ้น

[10] อื่นๆ ระบุ ....

2.2.5 ภายหลังใช้สารเคมีกำจัดศัตรูพืช ปกติท่านปฏิบัติอย่างไร (ตอบได้มากกว่า 1 ข้อ)

[1] ซักเสื้อผ้าที่ใช้แล้วโดยแยกซักจากเสื้อผ้าอื่น

[2] ทำความสะอาดร่างกายหลังใช้สารทุกครั้ง

[3] ทำความสะอาดเครื่องพ่น

[4] ติดป้ายเตือนห้าม บริเวณที่พ่นสาร

[5] อื่นๆระบุ ....

2.2.6 ท่านจัดการกับสารเคมีกำจัดศัตรูพืชที่เหลือ และภาชนะที่ใส่สารเคมีฯ อย่างไร (ตอบได้มากกว่า 1 ข้อ)

[1] เก็บแยกจากในที่ปลอดภัย ห่างมือเด็กและแหล่งน้ำ

[2] ทำลายภาชนะที่ใช้แล้วไม่ให้นำมาใช้อีก

[3] ภาชะที่ใช้แล้วนำฝังดินให้มิดชิด ห่างจากแหล่งน้ำ ที่พัก

[4] อื่นๆระบุ ....

2.2.7 **ในรอบปีที่ผ่านมา**ท่านมีอาการเจ็บป่วยหรือความผิดปกติขณะทำงานหรือหลังการทำงานต่อไปนี้หรือไม่ (อาการที่แสดง ระหว่างการใช้สารเคมีกำจัดศัตรูพืช หรือหลังจากการใช้ในช่วงประมาณ 1 สัปดาห์ โดยตอบได้มากกว่า 1 ข้อ)

[1] ปวดศีรษะ	[2] เวียนศีรษะ มึนงง	[3] เหงื่อออกมาก	[4] น้ำลายไหลมาก	[5] แสบตา เคืองตา
[6] น้ำตาไหล	[7] ระคายเคือง ผิวหนัง	[8] แน่นหน้าอก	[9] หายใจลำบาก	[10] ตาพร่ามัว
[11] อาเจียน	12] อ่อนเพลีย/ เหนื่อยง่าย	[13] กล้ามเนื้อ กระตุก	[14] ปวดเมื่อยตามตัว	[15] คัดจมูก น้ำมูกไหล
[16] มีเสมหะมาก	[17] คลื่นไส้	[18] ปวดท้อง	[19] เบื่ออาหาร	[20] เป็นตะคริว
[21] ไอ	[22] ท้องเสีย	[23] ชีพจรเร็ว ใจสั่น	[24] หน้ามืด (เป็นลม)	[25] หมดสติ
[26] น้ำหนักตัวลด	[27] กลั้นปัสสาวะ ไม่ค่อยได้	[28] เสียงแหบ แห้ง	[29] กระวนกระวาย อยู่ไม่สุข	[30] ชัก/เกร็ง

2.3 การใช้สารเคมีกำจัดศัตรูพืช

ลำดับ	สารเคมีกำจัดศัตรูพืชที่ใช้	รายละเอียด	% ของผู้ใช้สารเคมี (เกษตรกร)	ร้อยละ (%) ของเกษตรกรผู้ใช้สารเคมี			
				ช่วงเตรียมแปลงปลูก	10-20 วันช่วงต้นอ่อน	30-40 วันช่วงก่อนเก็บเกี่ยว	45-55 วันช่วงเก็บเกี่ยว
1							
2							
3							
4							

Appendix C

Vegetable farm safety surveillance communication materials

Appendix C 1

Screening MedSci Pest kit (M Kit) and

Identifying TLC MedSci Pest kit

(TM Kit), Package, Chemicals and Accessories

Appendix C 2

Poster Presentation of Procedure Screening and

Identifying 4 Groups Pesticide Test Kit

Left Pink: Screening of the MedSci Pesticide Test Kits 2 groups of pesticides (Organophosphates and Carbamates)

Middle & Right: Identifying 4 groups pesticides (TLC MedSci Pest Kit

Middle; Pyrethroids and Organochlorines

Right; Organophosphates and Carbamates

Appendix C 3

Screening Procedure of 2 Groups MedSci Pest Kit

Appendix C 4

Identifying 4 groups pesticides by TLC MedSci Pest Kit

(Organochlorines and Pyrethroids)

Appendix C 5

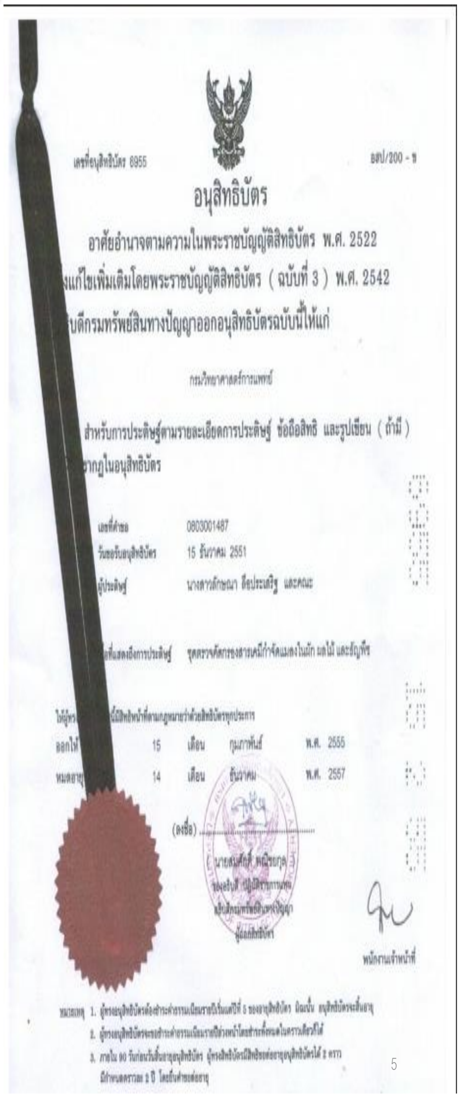
Identifying 4 groups pesticides by TLC MedSci Pest Kit

(Organophosphates and Carbamates)

Appendix C 6

Petty patent granted from intellectual property department, Thailand, Screening 2 groups MedSci Pest kit

(Medical Sciences pesticide test kit)


เลขที่อนุสิทธิบัตร 6955 อสป/200 - ข

อนุสิทธิบัตร

อาศัยอำนาจตามความในพระราชบัญญัติสิทธิบัตร พ.ศ. 2522
แก้ไขเพิ่มเติมโดยพระราชบัญญัติสิทธิบัตร (ฉบับที่ 3) พ.ศ. 2542
บดีกรมทรัพย์สินทางปัญญาออกอนุสิทธิบัตรฉบับนี้ให้แก่

กรมวิทยาศาสตร์การแพทย์

สำหรับการประดิษฐ์ตามรายละเอียดการประดิษฐ์ ข้อถือสิทธิ และรูปเขียน (ถ้ามี)
ากฏในอนุสิทธิบัตร

เลขที่คำขอ	0803001487
วันขอรับอนุสิทธิบัตร	15 ธันวาคม 2551
ผู้ประดิษฐ์	นางสาวลักษณา ลือประเสริฐ และคณะ
ที่แสดงถึงการประดิษฐ์	ชุดตรวจคัดกรองสารเคมีกำจัดแมลงในผัก ผลไม้ และธัญพืช

ออกให้	15	เดือน	กุมภาพันธ์	พ.ศ. 2555
หมดอายุ	14	เดือน	ธันวาคม	พ.ศ. 2557

(ลงชื่อ) ....

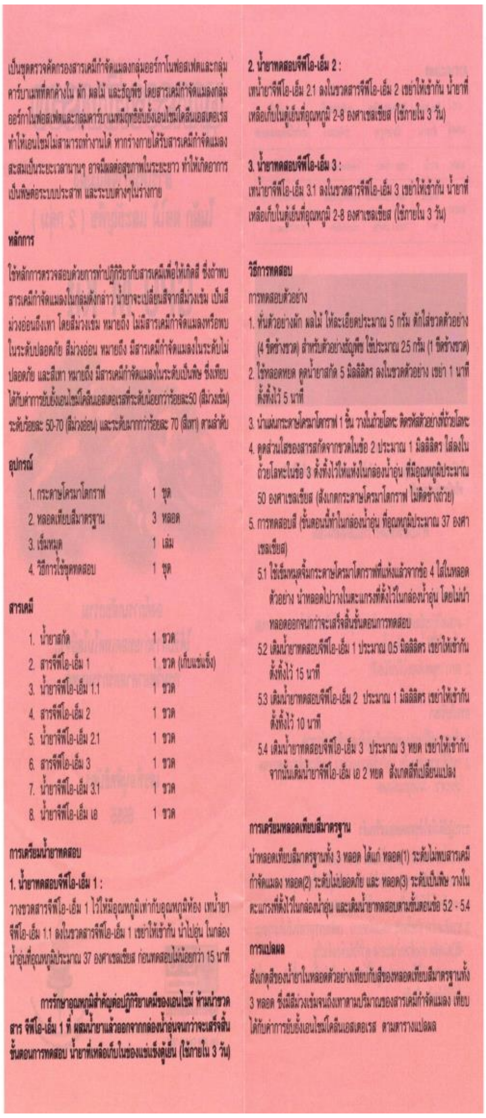
พนักงานเจ้าหน้าที่

5

Appendix C 7

Leaflet procedure of screening 2 groups MedSci Pest kit

(Medical Sciences pesticide test kit)



Appendix C 8

Petty Patent granted from intellectual property department, Thailand, Identifying 4 groups MedSci Pest kit

Appendix C 9

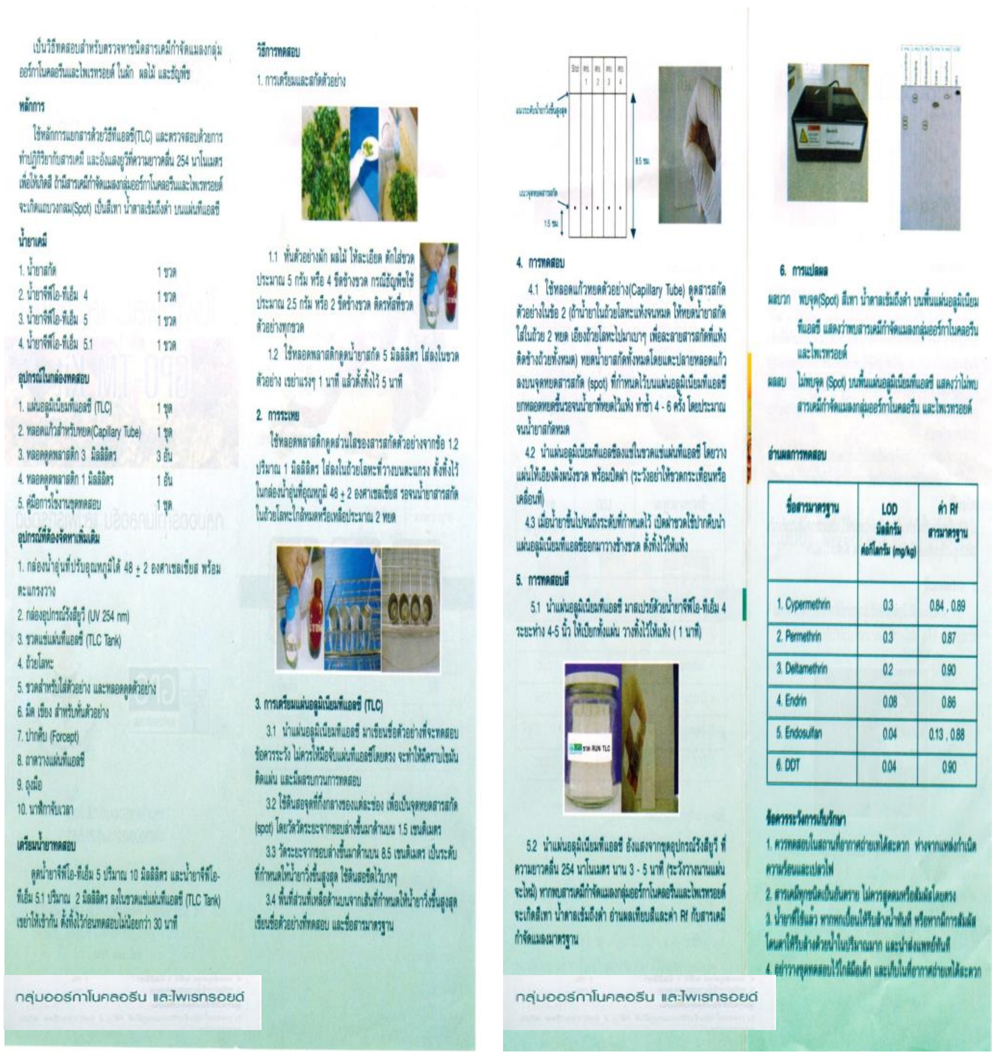
Front pages: leaflet procedure of

Identifying 4 groups MedSci pesticide test kit

Appendix C 10

Leaflet; Identifying procedure of 4 groups TLCpesticide test kit

Organochlorines and Pyrethroids



เป็นวิธีทดสอบสำหรับตรวจหาชนิดสารเคมีกำจัดแมลงกลุ่มออร์กาโนคลอรีนและไพเรทรอยด์ ในผัก ผลไม้ และธัญพืช

หลักการ

ใช้หลักการแยกสารด้วยวิธีทีแอลซี(TLC) และตรวจสอบด้วยการทำปฏิกิริยากับสารเคมี และอ่านผลภายใต้แสงอัลตราไวโอเลตความยาวคลื่น 254 นาโนเมตร เพื่อให้เกิดสี ถ้ามีสารเคมีกำจัดแมลงกลุ่มออร์กาโนคลอรีนและไพเรทรอยด์ จะเกิดแถบวงกลม(Spot) เป็นสีเทา น้ำตาลเข้มถึงดำ บนแผ่นทีแอลซี

น้ำยาเคมี

1. น้ำยาสกัด 1 ขวด
2. น้ำยาจีพีโอ-ทีเอ็ม 4 1 ขวด
3. น้ำยาจีพีโอ-ทีเอ็ม 5 1 ขวด
4. น้ำยาจีพีโอ-ทีเอ็ม 5.1 1 ขวด

อุปกรณ์ในกล่องทดสอบ

1. แผ่นอลูมิเนียมทีแอลซี (TLC) 1 ชุด
2. หลอดแก้วสำหรับหยด(Capillary Tube) 1 ชุด
3. หลอดดูดพลาสติก 3 มิลลิลิตร 3 อัน
4. หลอดดูดพลาสติก 1 มิลลิลิตร 1 อัน
5. คู่มือการใช้งานชุดทดสอบ 1 ชุด

อุปกรณ์ที่ต้องจัดหาเพิ่มเติม

1. กล่องน้ำอุ่นที่ปรับอุณหภูมิได้ 48 ± 2 องศาเซลเซียส พร้อมตะแกรงวาง
2. กล่องอุปกรณ์รังสียูวี (UV 254 nm)
3. ขวดแช่แผ่นทีแอลซี (TLC Tank)
4. ถ้วยโลหะ
5. ขวดสำหรับใส่ตัวอย่าง และหลอดดูดตัวอย่าง
6. มีด เขียง สำหรับหั่นตัวอย่าง
7. ปากคีบ (Forcep)
8. ถาดวางแผ่นทีแอลซี
9. ถุงมือ
10. นาฬิกาจับเวลา

เตรียมน้ำยาทดสอบ

ดูดน้ำยาจีพีโอ-ทีเอ็ม 5 ปริมาณ 10 มิลลิลิตร และน้ำยาจีพีโอ-ทีเอ็ม 5.1 ปริมาณ 2 มิลลิลิตร ลงในขวดแช่แผ่นทีแอลซี (TLC Tank) เขย่าให้เข้ากัน ตั้งทิ้งไว้ก่อนทดสอบไม่น้อยกว่า 30 นาที

วิธีการทดสอบ

1. การเตรียมและสกัดตัวอย่าง

1.1 หั่นตัวอย่างผัก ผลไม้ ให้ละเอียด ตักใส่ขวดประมาณ 5 กรัม หรือ 4 ขีดข้างขวด กรณีธัญพืชใช้ประมาณ 2.5 กรัม หรือ 2 ขีดข้างขวด ติดรหัสที่ขวดตัวอย่างทุกขวด

1.2 ใช้หลอดพลาสติกดูดน้ำยาสกัด 5 มิลลิลิตร ใส่ลงในขวดตัวอย่าง เขย่าแรงๆ 1 นาที แล้วตั้งทิ้งไว้ 5 นาที

2. การระเหย

ใช้หลอดพลาสติกดูดส่วนใสของสารสกัดตัวอย่างจากข้อ 1.2 ปริมาณ 1 มิลลิลิตร ใส่ลงในถ้วยโลหะที่วางบนตะแกรง ตั้งทิ้งไว้ในกล่องน้ำอุ่นที่อุณหภูมิ 48 ± 2 องศาเซลเซียส รอจนน้ำยาสารสกัดในถ้วยโลหะใกล้หมดหรือเหลือประมาณ 2 หยด

3. การเตรียมแผ่นอลูมิเนียมทีแอลซี (TLC)

3.1 นำแผ่นอลูมิเนียมทีแอลซี มาเขียนชื่อตัวอย่างที่จะทดสอบ ข้อควรระวัง ไม่ควรให้มือจับแผ่นทีแอลซีโดยตรง จะทำให้มีคราบไขมันติดแผ่น และมีผลรบกวนการทดสอบ

3.2 ใช้ดินสอจุดที่กึ่งกลางของแต่ละช่อง เพื่อเป็นจุดหยดสารสกัด (spot) โดยวัดวัดระยะจากขอบล่างขึ้นมาด้านบน 1.5 เซนติเมตร

3.3 วัดระยะจากขอบล่างขึ้นมาด้านบน 8.5 เซนติเมตร เป็นระดับที่กำหนดให้น้ำยาวิ่งขึ้นสูงสุด ใช้ดินสอขีดไว้บางๆ

3.4 พื้นที่ส่วนที่เหลือด้านบนจากเส้นที่กำหนดให้น้ำยาวิ่งขึ้นสูงสุด เขียนชื่อตัวอย่างที่ทดสอบ และชื่อสารมาตรฐาน

4. การทดสอบ

4.1 ใช้หลอดแก้วหยดตัวอย่าง(Capillary Tube) ดูดสารสกัดตัวอย่างในข้อ 2 (ถ้าน้ำยาในถ้วยโลหะแห้งจนหมด ให้หยดน้ำยาสกัดใส่ในถ้วย 2 หยด เอียงถ้วยโลหะไปมาเบาๆ เพื่อละลายสารสกัดที่แห้งติดข้างถ้วยทั้งหมด) หยดน้ำยาสกัดทั้งหมดโดยแตะปลายหลอดแก้วลงบนจุดหยดสารสกัด (spot) ที่กำหนดไว้บนแผ่นอลูมิเนียมทีแอลซี ยกหลอดหยดขึ้นรอจนน้ำยาที่หยดไว้แห้ง ทำซ้ำ 4 - 6 ครั้ง โดยประมาณจนน้ำยาสกัดหมด

4.2 นำแผ่นอลูมิเนียมทีแอลซีลงแช่ในขวดแช่แผ่นทีแอลซี โดยวางแผ่นให้เอียงพิงผนังขวด พร้อมปิดฝา (ระวังอย่าให้ขวดกระเทือนหรือเคลื่อนที่)

4.3 เมื่อน้ำยาขึ้นไปจนถึงระดับที่กำหนดไว้ เปิดฝาขวดใช้ปากคีบนำแผ่นอลูมิเนียมทีแอลซีออกมาวางข้างขวด ตั้งทิ้งไว้ให้แห้ง

5. การทดสอบสี

5.1 นำแผ่นอลูมิเนียมทีแอลซี มาสเปรย์ด้วยน้ำยาจีพีโอ-ทีเอ็ม 4 ระยะห่าง 4-5 นิ้ว ให้เปียกทั้งแผ่น วางทิ้งไว้ให้แห้ง (1 นาที)

5.2 นำแผ่นอลูมิเนียมทีแอลซี ฉายแสงจากชุดอุปกรณ์รังสียูวี ที่ความยาวคลื่น 254 นาโนเมตร นาน 3 - 5 นาที (ระวังวางนานแผ่นจะไหม้) หากพบสารเคมีกำจัดแมลงกลุ่มออร์กาโนคลอรีนและไพเรทรอยด์ จะเกิดสีเทา น้ำตาลเข้มถึงดำ อ่านผลเทียบสีและค่า Rf กับสารเคมีกำจัดแมลงมาตรฐาน

6. การแปลผล

ผลบวก พบจุด(Spot) สีเทา น้ำตาลเข้มถึงดำ บนพื้นแผ่นอลูมิเนียมทีแอลซี แสดงว่าพบสารเคมีกำจัดแมลงกลุ่มออร์กาโนคลอรีนและไพเรทรอยด์

ผลลบ ไม่พบจุด (Spot) บนพื้นแผ่นอลูมิเนียมทีแอลซี แสดงว่าไม่พบสารเคมีกำจัดแมลงกลุ่มออร์กาโนคลอรีน และไพเรทรอยด์

อ่านผลการทดสอบ

ชื่อสารมาตรฐาน	LOD มิลลิกรัมต่อกิโลกรัม (mg/kg)	ค่า Rf สารมาตรฐาน
1. Cypermethrin	0.3	0.84 , 0.89
2. Permethrin	0.3	0.87
3. Deltamethrin	0.2	0.90
4. Endrin	0.08	0.86
5. Endosulfan	0.04	0.13 , 0.88
6. DDT	0.04	0.90

ข้อควรระวังการเก็บรักษา

1. ควรทดสอบในสถานที่อากาศถ่ายเทได้สะดวก ห่างจากแหล่งกำเนิดความร้อนและเปลวไฟ
2. สารเคมีทุกชนิดเป็นอันตราย ไม่ควรสูดดมหรือสัมผัสโดยตรง
3. น้ำยาที่ใช้แล้ว หากหกเปื้อนให้รีบล้างน้ำทันที หรือหากมีการสัมผัสโดนตาให้รีบล้างด้วยน้ำในปริมาณมาก และนำส่งแพทย์ทันที
4. อย่าวางชุดทดสอบไว้ใกล้มือเด็ก และเก็บในที่อากาศถ่ายเทได้สะดวก

กลุ่มออร์กาโนคลอรีน และไพเรทรอยด์

กลุ่มออร์กาโนคลอรีน และไพเรทรอยด์

Appendix C 11

Leaflet: Identifying procedure 4 groups TLC pesticide test kit

Organophosphates and Carbamates

Appendix C 12

Distributed DVD of Procedure Manual to Stake Holders (English subscript under all pages of the DVD)

Appendix C 13

Procedures educational tools:

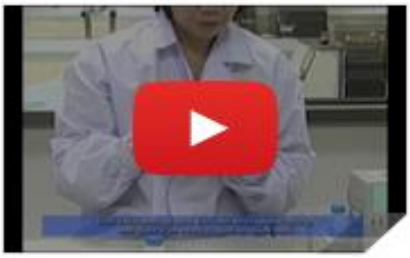
electronic copies, You Tube for the public

Distributed You Tube of

Procedure Manual, Innovative Test Kits

คลิป 3 นาที
http://www.youtube.com/watch?v=X-9QVLFCS48&feature=youtu.be

10 นาที
http://www.youtube.com/watch?v=gIDfPxsPO8M&feature=youtu.be



Appendix C 14

Research Tool, Water Bath for Pesticide Test Invented technology, Granted Petty patent 8183

Appendix C 15

Document of Pesticide Risk Communication and Education

Source: Left; Leuprasert, L. Self Application of Innovative Test Kits, Chemical Monitoring by the Sufficient Economy Community. Newsletter on Chemical Safety. 16 (1) February 2011: 1-3

Right; Jarunuch, S. Leuprasert, L. et al. Accreditation of Pesticide Residues Testing Laboratory in fresh Vegetable and Fruit. Department of Medical Sciences, Ministry of Public Health ISBN 978-616-11-0570-9

Appendix C 16

Example of Newsletter as educational tool for vegetable safety monitoring in farm

ใส่ใจสุขภาพผู้สูงวัย เฝ้าระวังลดสารพิษในฟาร์มคัดแยกบรรจุผักขาย ด้วยนวัตกรรมชุดทดสอบผักปลอดภัย

(ต่อจากหน้า 1)

กรมวิทยาศาสตร์การแพทย์ ร่วมกับจุฬาลงกรณ์มหาวิทยาลัย ได้นำเทคโนโลยีชุดทดสอบสารเคมีกำจัดแมลงในผัก ผลไม้และธัญพืช สู่ชุมชนโดยนักวิจัยผู้ประดิษฐ์นวัตกรรมอนุสิทธิบัตรของกรมวิทยาศาสตร์การแพทย์ ไปถ่ายทอดเทคโนโลยีให้เกษตรกรสามารถใช้ตรวจคัดกรองและตรวจชนิดสารเคมีกำจัดแมลง 4 กลุ่ม ได้ด้วยตนเอง ซึ่งใช้เวลาประมาณ 1 ชั่วโมงต่อ 10 ตัวอย่าง ชุดทดสอบที่ใช้ตรวจคัดกรองเบื้องต้นคือเมดไซเพส คิท หรือ เอ็มคิท (Med SciPest Kit or M Kit) มีความถูกต้องแม่นยำ ความไว และความจำเพาะสูง ร้อยละ 93, 98 และ 79 ตามลำดับ ส่วนชุดตรวจชนิดสารเคมี คือ ทีแอลซี เมดไซเพส คิท หรือ ทีเอ็มคิท (TLC Med SciPest Kit or TM Kit) มีความถูกต้องแม่นยำ ความไว และความจำเพาะสูง ร้อยละ 92, 83 และ 100 ตามลำดับ ชุดทดสอบนี้สามารถพกพานำไปใช้ได้อย่างสะดวก ทั้งในฟาร์มเกษตร ตลาดสด ท้องถิ่นชุมชน โรงเรียน ด่านนำเข้า หรือโรงงานผลิตผักขาย นวัตกรรมนี้ และองค์ความรู้เกี่ยวกับการล้างผักในฟาร์มคัดแยก ก่อนการบรรจุผักจำหน่ายนี้ ได้ถ่ายทอดไปสู่เกษตรกรอำเภอชำสูง ขอนแก่น และอำเภอธวัชบุรี ร้อยเอ็ด สำหรับระบบการล้าง 3 อ่าง ที่ได้ถ่ายทอด คือการล้างดินสิ่งสกปรกในอ่างแรก ตามด้วยน้ำยาที่หาง่ายในครัวเรือนแล้วแต่ชนิดของผัก เช่น ผงฟู ใช้สำหรับผักทั่วไป เช่น คะน้า กระหล่ำปลี หรือสารส้มสำหรับผักที่มีลักษณะกรอบง่าย เช่น ผักกาดหอม ผักกาดแก้ว หรือน้ำยาลดแรงตึงผิวสำหรับผักที่มียางเหนียว เช่น แตงกวา แตงร้าน

นักวิจัยได้ทำการตรวจสารเคมีกำจัดแมลงตกค้างด้วยชุดทดสอบฯ พบว่าก่อนล้างมีระดับที่ไม่ปลอดภัยร้อยละ 18.2 แต่หลังจากการล้างแล้วพบว่าทุกตัวอย่าง มีความปลอดภัย การพัฒนาให้มีต้นแบบของการเฝ้าระวังความปลอดภัยสารเคมีกำจัดแมลงในฟาร์มปลูกและบรรจุผักมีผลดีโดยช่วยลดผลกระทบต่อสุขภาพของผู้บริโภค จากสารเคมีกำจัดแมลงตกค้างด้วยชุดทดสอบและองค์ความรู้ใหม่ เพราะเป็นที่ทราบทั่วไปว่าสารเคมีกำจัดแมลงมีพิษภัยต่อสุขภาพ โดยมีผลวิจัยจากห้องปฏิบัติการของกรมวิทยาศาสตร์การแพทย์ตามโครงการประเมินและสื่อสารความเสี่ยงในเกษตรกร 4 ภาคของประเทศไทยในปี 2551

ในกลุ่มตัวอย่างจำนวน 850 คน พบอาการพิษทางคลินิค เช่น ปวดศีรษะ มึนงง คลื่นไส้อาเจียน ท้องเสีย น้ำลายมาก เหงื่อออก เคืองตา กล้ามเนื้อกระตุก หายใจลำบาก ซึ่งพบอาการผิดปกติเหล่านี้ในกลุ่มที่ใช้สารเคมี มากกว่ากลุ่มที่ไม่ใช้ (หรือหยุดการใช้มาอย่างน้อยหนึ่งปี) จำนวน 407 คน ผลงานนี้จึงมีประโยชน์ช่วยสร้างสุขภาพทั้งต่อผู้บริโภค เกษตรกรผู้ปลูก โดยเฉพาะในกลุ่มผู้สูงวัยที่คนไทยให้ความสำคัญ

ที่มา : โครงการการเฝ้าระวังผักปลอดภัยจากสารเคมีกำจัดแมลงในโรงบรรจุคัดแยกของฟาร์มผัก โดยใช้องค์ความรู้และชุดทดสอบใหม่. ลักษณา ลือประเสริฐและคณะ 2555.

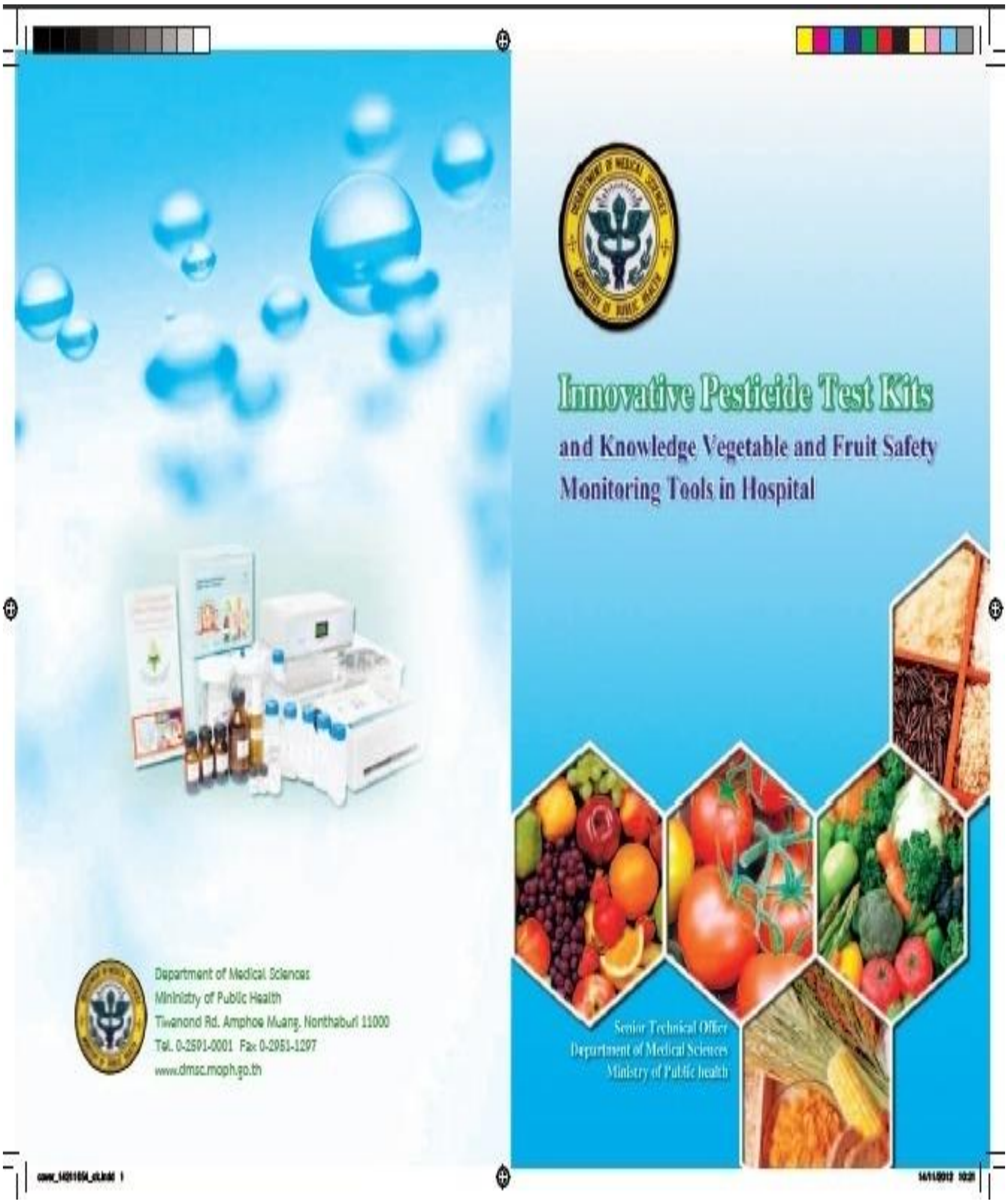
ได้รับการสนับสนุนจาก โครงการส่งเสริมการวิจัยในอุดมศึกษาและการพัฒนามหาวิทยาลัยวิจัยแห่งชาติ ของสำนักงานคณะกรรมการการอุดมศึกษา

Appendix C17

Education knowledge tools ISBN 978 616 1113766:

Innovative pesticide test kits and knowledge for

vegetable and fruit safety monitoring tools in hospital



Appendix C 18

Education tools ISBN 978 616 348 372 0:

Small farm land pesticide safety manual

ข้อมูลทางบรรณานุกรมของสำนักหอสมุดแห่งชาติ
National Library of Thailand Cataloging in
Publication Data
หนังสือคู่มือการเฝ้าระวังความปลอดภัยสารเคมีในพื้นที่ปลูกผักคะน้าด้วยชุดทดสอบและ
องค์ความรู้ – กรุงเทพ:
ลักษณา ลือประเสริฐ
วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย.
ประเทศไทย, 2556.

Appendix D

Policy announcement of top community management

Innovative pesticide kit model for

vegetable farm safety surveillance program

Top Community Management Policy For Vegetable Farm Safety Surveillance

Management policy: Safety Monitoring Laboratory of Pesticide Residues in Farm Vegetable, Administrative Organization of the Ladbuakao Sub-district, Nakhonrachasima Province.

1. The safety monitoring of vegetable farm produce for marketing by farm safety development team (agriculturists and volunteers) using pesticide test kits of Department of Medical Sciences for promotion of community health safety and customers' confidence.
2. Vegetable farm produce sample shall be sampling for analysis of pesticide residues at a designed time plan by community and the analysis data shall be recorded.
3. If unsafe vegetable produce detected, procedures for correction shall be discussed among farm safety team and community advisors for guidelines and alternative corrections.
4. Resources shall be supported as appropriate.

....

Chief Executive, Ladbuakao Sub-district Administrative Organization

....

Klongtabak Village Chief

นโยบายผู้บริหาร: การเป็นห้องปฏิบัติการตรวจเฝ้าระวังความปลอดภัยสารเคมีในฟาร์มผักฯ องค์การบริหารส่วนตำบลลาดบัวขาว นครราชสีมา

1. เพื่อการเฝ้าระวังความปลอดภัยของผลผลิตการเกษตร ที่จะออกขายสู่ตลาด มีการใช้เครื่องมือชุดทดสอบของกรมวิทยาศาสตร์การแพทย์ โดยเกษตรกร หรืออาสาสมัคร เป็นการส่งเสริมความปลอดภัยต่อสุขภาพของชุมชนในท้องถิ่น และช่วยสร้างความมั่นใจให้กับผู้บริโภค

2. มีการสุ่มตัวอย่างผักจากพื้นที่ปลูก นำไปทำการตรวจวิเคราะห์สารเคมีกำจัดศัตรูพืช ตามระยะเวลาที่ชุมชนร่วมกำหนด และมีการบันทึกผลของการตรวจวิเคราะห์

3. เมื่อตรวจพบสารเคมีปนเปื้อนในระดับที่ไม่ปลอดภัย ควรจะได้มีการปรึกษา หารือกันระหว่างเกษตรกร และผู้มีส่วนได้เสียในท้องถิ่น เพื่อหาแนวทาง และ ร่วมดำเนินการแก้ไข

4. มีการสนับสนุนทรัพยากรที่จำเป็นตามที่เห็นสมควร

....(นายณรงค์ ภูมิจันทึก)

นายกองค์การบริหารส่วนตำบลลาดบัวขาว

....(นายสมาน พวงทาผา)

ผู้ใหญ่บ้าน หมู่บ้านคลองตะแบก

Appendix D (continued)

Policy announcement of top community management

Innovative pesticide kit model for

vegetable farm safety surveillance program

Management policy: Safety Monitoring Laboratory of Pesticide Residues in Farm Vegetable

Agriculture and Technoogy Nakhonratchasima College, Nakhonratchasima province, Thailand

1. The safety monitoring of farm produce for the community by the safety development team (College personnel and agriculturists) using pesticide test kits of Department of Medical Sciences for promotion of community health safety and customers' confidence.
2. Vegetable farm produce sample shall be sampling for analysis of pesticide residues at a designed time plan by community and the analysis data shall be recorded.
3. If unsafe vegetable produce detected, procedures for correction shall be discussed among farm safety team and community advisors for guidelines and alternative corrections.
4. Resources shall be supported as appropriate.

....

Director Agriculture and Technology Nakhonratchasima College

....

Klongtabak Village Chief

นโยบายผู้บริหาร: การเป็นห้องปฏิบัติการตรวจเฝ้าระวังความปลอดภัยสารเคมีในฟาร์มผักฯ วิทยาลัยเกษตรและเทคโนโลยีนครราชสีมา

1. เพื่อการเฝ้าระวังความปลอดภัยของผลผลิตผลทางการเกษตร ที่จะออกสู่ชุมชน โดยมีการใช้เครื่องมือชุดทดสอบของกรมวิทยาศาสตร์การแพทย์ โดยบุคลากรของวิทยาลัย และเกษตรกร เป็นการส่งเสริมความปลอดภัยต่อสุขภาพของ ชุมชนในท้องถิ่น และช่วยสร้างความมั่นใจให้กับผู้บริโภค

2. มีการสุ่มตัวอย่างผักจากพื้นที่ปลูก นำไปทำการตรวจวิเคราะห์สารเคมีกำจัดศัตรูพืช ตามระยะเวลาที่ชุมชนร่วมกำหนด และมีการบันทึกผลของการตรวจวิเคราะห์

3. เมื่อตรวจพบสารเคมีปนเปื้อนในระดับที่ไม่ปลอดภัย ควรจะได้มีการปรึกษาหารือกันระหว่างเกษตรกร และผู้มีส่วนได้เสียในท้องถิ่น เพื่อหาแนวทาง และร่วมดำเนินการแก้ไข

4. มีการสนับสนุนทรัพยากรที่จำเป็นตามที่เห็นสมควร

....

ผู้อำนวยการวิทยาลัยเกษตรและเทคโนโลยีนครราชสีมา

....

ผู้ใหญ่บ้าน หมู่บ้านคลองตะแบก

Appendix E

Innovative pesticide test kit: laboratory intervention

Appendix E 1

Testing Form of the self-test laboratory competency of agriculturists

Inter-laboratory comparison of innovative test kit by farm volunteers with competent medical scientist (Research tool using screening 2 groups innovative pesticide test kit

Number ลำดับที่	Sample Label Code รหัสตัวอย่าง	Color Test and Result of Analysis (สีของหลอดตัวอย่างและผลการตรวจวิเคราะห์)		
		✓ Test by agriculturistXTestby competent medical scientists		
		Dark Purple =ม่วงเข้ม ($I_{0-50\%}$)	Light Purple =ม่วงอ่อน($I_{>50\%}$)	Grey = สีเทา ($I_{>70\%}$)
		Not Detected / Safe (ไม่พบ/ปลอดภัยฯ)	Unsafe (ไม่ปลอดภัย)	Toxic (เป็นพิษ)

ลงชื่อ............................ . ลงชื่อ............................ .... ลงชื่อ...................................... ..ลงชื่อ ....

Signature of agriculturist Signature of agriculturist Signature of agriculturist Signature of agriculturist

เกษตรกรผู้วิเคราะห์ เกษตรกรผู้วิเคราะห์ เกษตรกรผู้วิเคราะห์ เกษตรกรผู้วิเคราะห์

ลงชื่อ .... ลงชื่อ ....

Signature of medical scientist Signature of supervisor

นักวิทยาศาสตร์การแพทย์ผู้วิเคราะห์ นักวิทยาศาสตร์การแพทย์ผู้ตรวจสอบ

Appendix E 2

Testing Form of the self-test laboratory competency of agriculturists

Inter-laboratory comparison of innovative test kit by farm volunteers with competent medical scientist **using** Research tool 4 groups innovative pesticide test kit

Number (ลำดับที่)	Sample label Code **(รหัสตัวอย่าง)**	TLC Test and Result of Analysis **(แถบสีของตัวอย่างและผลตรวจวิเคราะห์)**			
		✓ Test by agriculturist		X Test by competent medical scientists	
		ครั้งที่ 1(Test 1)	ครั้งที่ 2 (Test 2)	ครั้งที่ 1 (Test 1)	ครั้งที่ 2 (Test 2)

ลงชื่อ............................ .... ลงชื่อ............................ .... ลงชื่อ..ลงชื่อ ....

Signature of agriculturis tSignature of agriculturist Signature of agriculturist Signature of agriculturist

เกษตรกรผู้วิเคราะห์ เกษตรกรผู้วิเคราะห์ เกษตรกรผู้วิเคราะห์ เกษตรกรผู้วิเคราะห์

ลงชื่อ .... ลงชื่อ ....

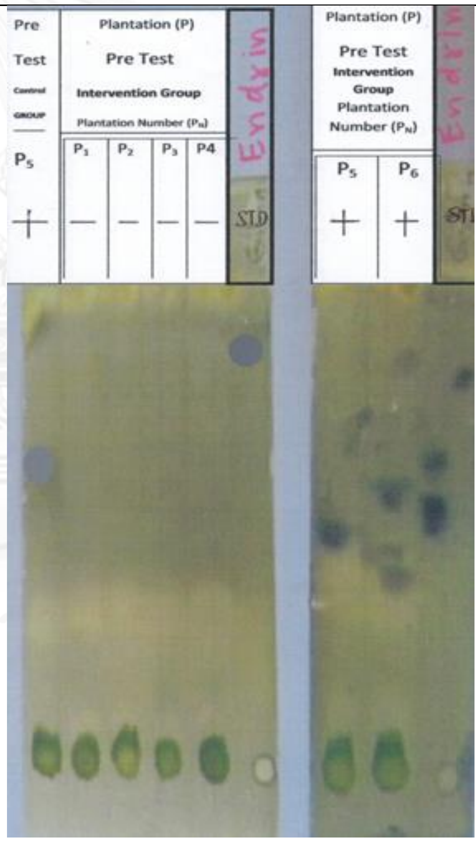
Signature of medical scientist Signature of supervisor

นักวิทยาศาสตร์การแพทย์ผู้วิเคราะห์ นักวิทยาศาสตร์การแพทย์ผู้ตรวจสอบ

Appendix E 3

Testing vegetable samples in study and control groups by competent medical scientists

☑ TM Kit (Pre Intervention and Post Intervention Test using innovative test kit)

Number ลำดับที่	**Sample Label Code** รหัสตัวอย่าง	TLC Test and Result of Analysis (แถบสีของตัวอย่างและผลวิเคราะห์)		Identify pesticides in record, photograph, drawing, forms etc.
		Not Detected (ไม่พบ)	Detected (พบ)TLC-RF	
				

ลงชื่อ .... ลงชื่อ ....

Signature of medical scientist Signature of supervisor

Appendix F

Competency Certificate

Self Test Laboratory Workshop Training and Competency Test

ศูนย์วิทยาศาสตร์การแพทย์ที่ ๘ นครราชสีมา

ขอมอบประกาศนียบัตรฉบับนี้ให้ไว้เพื่อแสดงว่า

นายสมาน พวงทาผา ผู้ใหญ่บ้าน และกลุ่มเกษตรกร หมู่บ้านคลองตะแบก ตำบลลาดบัวขาว

ได้ผ่านการอบรมเชิงปฏิบัติการ

เรื่อง การตรวจสอบสารเคมีกำจัดแมลงในผักสด /ผลไม้สด

ด้วยชุดทดสอบของกรมวิทยาศาสตร์การแพทย์ GPO-M Kit และ TM - Kit

ณ ห้องปฏิบัติการองค์การบริหารส่วนตำบลลาดบัวขาว อำเภอสีคิ้ว จังหวัดนครราชสีมา

วันที่ ๒๔ มิถุนายน ๒๕๕๖ และ ๑๒ ตุลาคม ๒๕๕๖

(นางธิดารัตน์ บุญรอด)
ผู้อำนวยการ
ศูนย์วิทยาศาสตร์การแพทย์ที่ ๘
นครราชสีมา

(เภสัชกรลักษณา ลือประเสริฐ)
อดีตผู้ทรงคุณวุฒิด้านวิจัยและพัฒนา
วิทยาศาสตร์การแพทย์ (เคมี)
หัวหน้าโปรแกรมการอบรมฯ

(นายณรงค์ ภูมิจันทึก)
นายกองค์การบริหาร
ส่วนตำบลลาดบัวขาว
ประธานพิธีเปิดการอบรมฯ

Appendix G

Methods of agricultural sampling for the determination of

pesticide residues.

THAI AGRICULTURAL STANDARD

TAS 9025-2008

METHODS OF SAMPLING FOR

THE DETERMINATION OF PESTICIDE RESIDUES

National Bureau of Agricultural Commodity and Food Standards
Ministry of Agriculture and Cooperatives

ICS 03.120.30 ISBN xxx-xxx-xxx-x

VITA

VITAE

Name Miss Lagsana Leuprasert

Date of Birth 10nd May 1952

Place of Birth Samutsakorn Province, Thailand

Educational Achievement

- Bachelor in Pharmacy, Chulalongkorn University, Thailand 1975
- Post Graduate Diploma in Toxicology, University of Surrey, England 1979
- Master of Public Health, Johns Hopkins University, U.S.A, 1991
- Diploma in Environmental Impact Assessment, Institute of Professional Education, University of New South Wales, Australia 1990
- Diploma Program in Public Economic Administration, King Prajadhipok's Institute, Thailand, 2005
- Diploma in Training for Top Administrators, Leaders with Vision, Office of Civil Service Commission, Thailand, 2006.

Research Experiences

1. Leuprasert, L. et al, Water Bath for Chemical Reaction and Evaporation (Invention Petty Patent Number 8183 dated 31 July 2013 with Intellectual Property Department of Thailand).

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