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**IMPACTS OF COMMUNITY EDUCATION ON PESTICIDE RISK
REDUCTION IN VIET NAM**

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ABSTRACT

After almost two decades of integrated pest management (IPM) implementation in Vietnam, pesticide risk reduction (PRR) becomes one of key issues in adopting IPM approach. Pesticide risks can possibly be reduced through community farmer education with a fortified IPM training focused on minimizing pesticide hazard and exposures. With this regards, a community education program on PRR in safe vegetable production has been implemented in the country since 2008. The program was first implemented in Hanoi city and Thai Binh province. With two data sets collected from 95 local officials, 170 pesticide users and 15 pesticide sellers before and after PRR implementation in 2 experimented and 2 control communes of Hanoi city and Thai Binh province, this paper shows that: 1) The program has improved knowledge of local community officials, pesticide sellers and applicators in PRR, provided a strong enforcement of community actions on pesticide risk management; 2) It has strengthened community actions as well as individual farmers' behaviors in PRR by formulation of farmers' interest groups, construction of tanks, development of internal regulations on pesticide use techniques, building community ownership and resource mobilization to PRR; 3) it enabled local people to reduce pesticide risks in terms of hazards and exposure. On the hazardous side, farmers used pesticides listed for vegetables, used more bio, class III and IV pesticides. On the exposure side, positive impacts were more improper pesticide use techniques; use more protective equipment and better unused pesticides, container sprayer management. As a result of these impacts, the environmental impact quotients were reduced sharply from 20% to 78%; 4) It also has an extraordinary impact in supporting national pest management policy reform. The paper also draws some recommendations for improving PRR training and some legal policy issues for a sustainable vegetable farming.

1. INTRODUCTION

Vietnam started the integrated pest management (IPM) program in crop production in 1992 in order to help farmers acquire knowledge to become rationale decision makers on their own fields. The goal of the program was to empower small-scale farmers to become skilful and better-informed decision makers in managing the rice production system. The IPM program has been extended from rice to vegetable production since 1996 and a few years later to fruit cultivation (FAO, 2008). In order to meet Vietnam's growing demand for safe vegetables, there is an increasing need to adopt IPM to eliminate use of hazardous and persistent agro-chemicals through IPM farmer training in conjunction with better access to alternative pest management options and support for national pest and pesticide management policy reform. After almost two decades of IPM implementation, pesticide risk reduction (PRR) becomes one of key issues in adopting IPM approach. Pesticide risks can possibly be reduced through community farmer education with a fortified IPM training focused on minimizing pesticide hazard and exposures (Gerd, 2007). With this regards, Vietnam Plant Protection Department (PPD) has been implementing fortified PRR training through a Community-based Training Program on PRR in Safe Vegetable Production with Vietnam's Good Agricultural Practices Orientation to reduce pesticide risks since 2008 (Vietnam National IPM Program, 2008). The program seeks to involve a full participation of all stakeholders of the community including IPM farmers, local leaders, mass organizations and public health center in pesticide risk reduction by following activities: 1) Conducting PRR training for pesticide applicators, local officials and pesticide sellers; 2) Formation of farmers' interest groups for pesticide risk reduction. The farmer groups were facilitated to form its own action plan, field studies for PRR and its members were trained in PRR-Vietnam's good agricultural practices (VietGAP); 3) Development and enforcement of local regulations on pesticide trade, use and management; 4) Consultation for development of safe vegetable production zone including improving infrastructure (tanks for keeping pesticide containers); 5) PRR information dissemination by mass media, local village meetings. The PRR training programs were first implemented in Hanoi city and Thai Binh province. After two years of PRR program implementation, there are arose some questions on PRR training program: 1) Could PRR education program help the vegetable production community reduce pesticide risks? 2) What is the best strategy to reduce pesticide risks in vegetables production? The program have been implemented for 3 years. To date, a study that covers the aforementioned questions has

not yet been carried out. To fill this gap, this research was carried out to provide an impact assessment.

The overall objective of the impact study is to assess the impacts of the community-based training Program on PRR in Safe Vegetable Production in Vietnam. The specific objectives of this research are identify impacts of this training program on: 1) local people's perception of PRR; 2) people' behaviors and decision making on PRR; 3) pesticide risk reduction in the studied communes; and 4) to draw recommendations for adopting PRR approach to eliminate use of hazardous and persistent agro-chemicals with better access of alternative pest management options

2. RESEARCH DESIGN AND METHODOLOGY

2.1 Study Design

A “Double Delta Approach” (DDA) was employed to examine the impacts of PRR training. The helps of DDA are to estimate differences between success indicators (e.g. changes in perception of and behaviors in pesticide risk management) before and after the PRR training for both PRR participants and non PRR-participants (control group) and then comparing the difference between the two groups. Hence, the effect of factors affecting the success indicators of both groups, other than PRR training, is “differenced out”. With this design, two typical communes, namely Dang Xa and Le Chi (Hanoi city), Thai Giang and Thuy Son (Thai Binh province) were selected for an in-depth study for baseline and post PRR training surveys. Farmers in Hanoi’s communes planted cabbages while those in Thai Binh produced melon. These vegetables are potential for consumer risks. These paired communes are similar and representative for the province in terms of pesticide risks, agro-ecological conditions, and vegetable production and IPM FFS activities. Farmers in these selected communes had a commitment that they continued grow the same vegetable at least three years (2008- 2010). After the base-line survey, one of these two commune received a PRR training (called PRR commune) in 2008, the other did not get PRR training until 2010 (called control commune). Differences between PRR and control commune in terms of knowledge, decision making behaviors of farmers, pesticide dealers and local community officials and community actions, situation of hazards and exposures before and after PRR training are considered as impacts of the PRR training on farm and community levels (Table 1)

Table 1. Communes under Study by Province and Study Crop

Province	PRR commune	Control commune	Vegetable name
Hanoi city	Dang Xa (Gia Lam district)	Le Chi (Gia lam district)	Winter Cabbage (Nov- Jan)
Thai Binh province	Thai Giang (Thai Thuy district)	Thuy Son (Thai Thuy District)	Spring Melon (April to Mid June)

2.2 Data Collection

Secondary information including legislative documents on banned, restricted and permitted plant protection pesticides for vegetables and Vietnam's good agricultural practices (VietGAP), permitted pesticide list in Vietnam, pesticide lists for vegetable production were collected from Ministry of Agriculture and Rural Development (MARD, 2009), PPD and Provincial PPD, district plant protection department and other relevant offices. Information on environmental impact quotient (EIQ), EIQ tables were collected from Food and Agriculture Organization (FAO, 2008), New York State Integrated Pest Management Program, FAO-EU IPM program for Cotton in Asia (Rikke Peterson and Gerd Walter-Echols, 2004)

The PRR impact assessment comprises of a baseline data collection before the PRR activities and a post-survey data collection period one year later, during the same crop calendar as the baseline survey. The baseline survey has been carried out in 2008. The PRR program was implemented Dang Xa and Thai Giang commune in 2009. PRR farmers in Dang Xa and Thai Giang commune continued cultivating their crops in 2010 crop. Cropping seasons in 2008 and 2010 were similar in terms of climatic, pest and disease conditions. Thus, the post-PRR training survey for impact assessment was conducted in 2010 in Hanoi city and Thai Binh province. Three types of samples, namely, local officials, pesticide sellers and applicators were selected for interviewing, direct observation, book keeping for base-line and post training survey (Table 2).

Table 2. Sample Size by type of Communes and Type of Respondents in Base-line Survey and Post PRR Training Survey

Type of Respondent	All	Hanoi city			Thai Binh province		
		PRR commune	Control commune	Sub total	PRR commune	Control Commune	Sub total
Community officials	95	25	20	45	22	28	50

Type of Respondent	All	Hanoi city			Thai Binh province		
		PRR commune	Control commune	Sub total	PRR commune	Control Commune	Sub total
Pesticide Applicators	170	33	33	66	56	48	104
Pesticide sellers	15	5	4	9	3	3	6

Information on pesticides given by farmers were clarified in terms of World Health Organization's classification. Information on pesticide exposures were gathered by direct observation and interviews.

2.3 Methods of Analysis

Descriptive statistical methods such as means, standard deviation, frequencies and cross tab were employed to describe changes in people's perception, knowledge on pesticide risks, pesticide risk reduction, changes in people's behaviors on pesticide risk reduction. Comparisons using DDA between two pairs of data sets before and after PRR training were analyzed. $DDA = \Delta_E - \Delta_C$ (Where $\Delta_E = \text{Performance in 2010 (after PRR-Training)} - \text{Performance in 2008 (Before PRR Training)}$ in a PRR commune) and $\Delta_C = \text{Performance in 2010 (after PRR training)} - \text{Performance in 2008 (Before PRR training)}$ in a control commune). Pesticide risk reduction was measured in terms of changes in hazards and exposure. The progress in exposure reduction is measured in terms of percentages of applicators who used protective equipment, safe sprayer, and pesticide good container management and pre-harvest interval. Pesticide risk reduction was measured by Environmental Impact Quotient (EIQ).

3. IMPACTS OF COMMUNITY BASED TRAINING PROGRAM

3.1 Impacts on People's Knowledge on Pesticide Risk Reduction

3.1.1 Impacts on Community Officials' Knowledge on Pesticide Risk Reduction

In Vietnam's pesticide policy context, if a person who is aware of four policy issues, namely, safe vegetable regulation, pesticide list for vegetables, regulation on pesticide trading and use, good agricultural practices for vegetable production (VietGAP) is considered to be those who completely know key government policies on pesticide risk management. PRR training has increased the number of local community officials to be aware of some pesticide risk management policies increased about 10% in Hanoi and 20% in Thai Binh (Table 3).

Table 3 Impacts on Community Officials' Knowledge on Pesticide Risk Management and Regulation

	PRR Commune		Control Commune		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
HANOI					
1. Awareness of Government Policies on Pesticide managements (%)	92.0	+13.2	70.0	+3.3	+9.9
Knew 3 policies	40.0	+40.0	0	0	+40.0
2. Remember VietGAP contents	60.9	+60.9	21.4	+21.4	+39.5
3. Remember of Safe vegetable standards (%)*	77.1	+10.5	60.0	-1.9	+13.5
THAI BINH					
1. Awareness of Government Policies on Pesticide managements (%)	90.9	+24.2	67.9	+4.9	+20.0
Knew 3 policies	59.1	+53.5	0	0	+53.5
2. Remember VietGAP contents	90.0	+90.0	0	0	+90.0
3. Remember of Safe vegetable standards (%)*	77.3	+44.4	35.7	+2.4	+42.0

Figures in Table are percentages of respondents reporting a particular knowledge they perceived in total respondents

* Multiple choices

A number of local officials who knew three of four policies in PRR communes increased 40% in Hanoi City and 53.5% in Thai Binh as compared with the situation before PRR training. PRR training enabled local community officials to be aware of VietGAP and safe vegetable standards. The impacts in Thai Binh were found to be better than those in Hanoi (Table 3). The differences in terms of training curriculum and implementation of PRR program in two studied communes lead to a significant change in training impacts.

3.1.2 Impacts on Sellers' Knowledge on Pesticide Risk Reduction

Sellers were asked to express their views on the issue such as whether their shops meet required standards, reasons for not meeting requirements and their awareness of local regulation on PRR in both pre and post PRR training (Table 4).

Table 4 impacts on Pesticide Sellers' Knowledge on Pesticide Risk Management and Regulation

	PRR Commune		Control Commune		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
1. Number of sellers' who assessed that their shop had met required shop standards*	50.0	-12.5	66.7	+11.1	-12.5
2. Awareness of local regulation on PRR*	50.0	+50.0	0	0	+50.0

* Percentages of sellers reporting a particular issue they perceived in total sellers;

** Percentages of sellers reporting a particular issue they perceived in total sellers reporting their shop that did not meet the required standards

After PRR training, sellers had a better understanding of requirements for running a pesticide shop. Less sellers in PRR communes self-assessed that their shop had met a required shop standards than those in control communes. It implies that sellers had better knowledge on shop requirements. PRR training enabled 50% of sellers to be aware of local regulation on PRR. Local known PRR regulation were that only selling permitted pesticides, opening the shop with a registered license and general requirements for selling pesticides. Detail regulation to reduce pesticide risks such as fire control and safety, pesticide storage, use of protective equipments while selling pesticides were reported by few respondents.

3.1.3 Impact on Applicators' Knowledge on Pesticide Risk Reduction

Other impact of the PRR program were improvements of applicators awareness of pesticide risk management production regulations, their perception of pre-harvest intervals, understanding of pesticide containers, pesticide types, techniques of fertilizer and pesticide use, treatment techniques after spraying in both pre and post PRR training. After training, numbers of farmers who were aware of three important policy regulations, namely safe vegetable standards, basic contents of Vietnam agricultural practices for vegetables and fruits (VietGAP) and internal commune regulations in the PRR communes increased significantly (Tables 5). The program had equipped farmers with a better knowledge in understanding right pre-harvest interval, a pesticide container, pesticide label, bio and chemical pesticides, permitted pesticide list and basic principle for pesticide use, timing for spraying. As a result, numbers of applicators in the PRR commune who knew these issues increased significantly (Table 5).

Table 5 Impacts on Applicators' Knowledge on Pesticide Risk Management

	Dang Xa (PRR)		Le Chi (control)		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
HANOI					
1. Awareness of safe vegetable standards	90.9	+32.7	69.7	+11.4	+21.3
2. Awareness of Viet GAP	69.7	+69.7	3.0	+3.0	+66.7
3. Awareness of commune regulations *	87.5	+87.5	6.1	+6.1	+81.4
4. Knowing a pre-harvest interval	90.9	+34.2	69.7	+9.7	+24.5
5. Percpetion of Pesticide containers	78.8	+72.8	21.2	+1.2	+71.6
6. Know information in a pesticide label	60.6	+39.0	27.2	+12.1	+26.9
7. Knowing bio-pesticides	93.8	+47.0	82.6	+35.3	+12.0
8. Knowing a permitted pesticide list	51.5	+48.5	3.0	0	+48.5
9. Know 4 rights principle for pesticide use	51.5	+45.5	6.1	+1.1	+44.4

	Dang Xa (PRR)		Le Chi (control)		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
10. Knowing best time for spraying	97.0	+47.7	51.5	+1.5	+46.2
THAI BINH					
1. Awareness of safe vegetable standards	100	+61.2	33.3	-3.5	+61.2
2. Awareness of Viet GAP (%)	98.2	+98.2	0	0	+98.2
3. Aware of commune regulations *	100	+100	2.1	+2.1	+97.9
4. Knowing a pre-harvest interval	91.1	+82.1	37.5	+28.7	+54.0
5. Perception of pesticide containers	85.7	+76.7	2.1	0	+76.7
6. Know information from in pesticide label	46.4	+23.0	8.4	-12.5	+23.0
7. Knowing bio-pesticides	100.0	+80.8	15.8	-2.4	+80.8
8. Knowing a permitted pesticide list	80.4	+77.4	0	-1.8	+77.4
9. Know 4 rights principle for pesticide use	50.0	+48.2	0	-1.8	+48.2
10. Knowing best time for spraying	82.1	+44.8	37.5	-1.1	+44.8

Figures in Table are percentages of respondents reporting a particular knowledge they perceived or responded in total respondents

* Multiple choices

3.2 Impacts on People's Behaviors on Pesticide Risk Reduction

3.2.1 Impacts on Local Community Actions toward Pesticide Risk Reduction

Community officials were asked in pre and post PRR training surveys about whether if there was any responses to the pesticide risk situation in their community and if any community actions taken toward reducing pesticide risks. The program enabled the local community to see their responsibility and take collective actions towards PRR (formation of farmer interest groups for vegetable production, construction of pesticide container tanks, formation and enactment of internal PRR regulations, organization of PRR training, dissemination of PRR information, control and inspection of pesticide shops, gathering pesticide containers, constructing poster, booklets, self-control and PRR information sharing) (Table 6). The program has built a self-reliance of local organization toward pesticide risk reduction.

Table 6 Local Community Actions toward Pesticide Risk Reduction

Criteria	Dang Xa (PRR)		Le Chi (control)		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
HANOI					
1. Do nothing, assign to cooperative to do PRR	4.0	-22.0	50.0	+27.8	-22.0
2. Formation of PRR farmer group	64.0	+64.0	0	0	+64.0
Number of PRR farmer groups formed (group)	5	+5	0	0	+5
3. Construction of pesticide container tanks	12.0	+12.0	0	0	+12.0
Pesticide container tanks built (tank)	7	+7	0	0	+7.0
4. Formation of local PRR regulation	28.0	+28.0	0	0	+28.0
5. Organizing PRR training	84.0	+84.0	0	0	+84.0
6. Information dissemination	72.0	+24.2	38.9	+2.0	+22.2

Criteria	Dang Xa (PRR)		Le Chi (control)		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
7. Control pesticide shops	56.0	+56.0	0	0	+56.0
Number of unqualified pesticide shop closed	1	+1	0	0	+1
8. Garthering pesticide containers	0	0	0	0	0
9. Constructing foster, booklets, VCD	12.0	+12.0	0	0	+12.0
10. Self control and PRR information sharing	12.0	+12.0	0	0	+12.0
11. Pest surveillance and warning	28.0	19.3	16.7	0	+16.7
THAI BINH					
1. Your Organization does some things	86.4	+13.6	28.6	+13.0	+0.6
1. Do nothing, assign to cooperative to do PRR	13.6	-13.6	71.4	+55.8	-13.6
2. Formation of PRR farmer group	69.6	+69.6	0	0	+69.6
Number of PRR farmer groups formed (group)	6	+6	0	0	+6
3. Construction of pesticide container tanks	27.3	+27.3	0	0	+27.3
Number of container tanks built (tank)	4	+4	0	0	+4
4. Formation of local PRR regulation	50.0	+50.0	0	0	+50.0
5. Ogranzing PRR training	95.5	+95.5	0	0	+95.5
6. Information dissemination	86.4	+54.6	35.0	+3.2	+50.8
7. Control pesticide shops	72.7	+72.7	0	0	+72.7
Number of unqualified shop closed (shops)	2	+2	0	0	+2
8. Garthering pesticide containers	59.1	+59.1	0	0	+59.1
9. Constructing foster, booklets, VCD	45.5	+45.5	0	0	+45.5
10. Self control and PRR information sharing	31.8	+31.8	0	0	+31.8
11. Pest surveillance and warning	22.7	+13.6	28.6	+28.6	0

Figures in Table are percentages of respondents reporting a particular community action in total respondents with an exception of numbers of farmer groups formed, tanks built and the closed shops.

3.2.2 Impacts on Sellers' Behaviors toward Pesticide Risk Reduction

The PRR program enabled the shop keepers to change their practices toward risk reduction such as arranging shop with safe environment, fire controller, used right pesticide store methods (Table 7). Sellers recognized their responsibility in selling pesticides (number of those who left untrained person selling reduced), used more protective clothing, stopped selling instant foods and drinks together with pesticides and sold more bio-pesticides (Table 7). This indicates the PRR program had changed sellers behaviors which created an opportunity for farmers to buy bio-pesticides so that they can reduce pesticide risk.

Table 7. Impacts on Pesticide Sellers' Behaviors on Pesticide Risk Reduction

Criteria	PRR Commune		Control Commune		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
1. Shop was cool and good airflow	100	+50.0	66.7	+33.3	+16.7
2. Shop equipped with fire controller	50.0	+50.0	0	0	+50.0
3. Right pesticides store method	100.0	+87.5	11.1	0	+87.5
4. Left untrained person selling pesticides	25.0	-25.0	66.7	0	-25.0
5. No use protective equipment (cloths, masks..)	0	-62.5	77.8	-22.2	-48.3
6. Selling other goods	100.0	+12.5	100.0	0	+12.5

Criteria	PRR Commune		Control Commune		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
Selling instant foods and drink	25.0	-46.4	66.7	0	-46.4
7. Average number of pesticide type/shop (type)	27.0	+2.0	43.4	+14.84	+2.0
. Bio pesticide type share in total types (%)	19.4	+13.4	6.1	-1.0	+13.4

Figures in Table are percentages of respondents having a particular behavior in total pesticide sellers with an exception averaged number of pesticides per shop and Item No.7

3.2.3 Impacts on Applicators' Behaviors toward Pesticide Risk Reduction

As a result of farmer interest group formation, almost all farmers in the PRR communes had joined farmer groups. This is an impressive impact of the program that promotes farmer participation in a collective action to reduce risk (Table 8). After training, farmers had better confidence in selecting pesticides (based on their owned experiences) than the situation before PRR program enactment. The program enabled farmers used only pesticides in the permitted list. As a result, it reduced number of pesticide types used in the field. The training increased numbers of farmers who often read a label before pesticide use, placed their sprayers at a safe place, raising mouth after spraying, while it reduced numbers of applicators who mixed wrongly pesticide cocktails (Table 8).

Table 8 Impacts on Applicators' Behaviors on Pesticide Risk Reduction

	Dang Xa (PRR)		Le Chi (control)		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
HANOI					
1. Joining farmer interest group	90.9	+90.9	0	0	+90.9
2. Information sources for selecting pesticides					
Applicators' experiences of pesticide use	51.5	+9.7	45.5	-2.8	+9.7
Seller's instruction	24.2	-27.3	54.5	+14.5	-27.3
3. Number of pesticide types used (type)	11	-7	24	+6	-7
4. Often read the label before use	97.0	+42.0	57.6	+2.0	+40.0
5. Number of applicators mixed wrongly*	0	-42.5	31.8	-10.3	-32.2
6. Cleaning sprayers whenever convenient	90.9	-3.5	93.9	+10.5	-3.5
7. Keep sprayers, pesticides at a safe place	87.9	+46.0	21.2	-21.2	+46.0
8. Raising mouth after spraying	84.8	+72.8	21.2	+10.2	60.6
THAI BINH					
1. Joining farmer interest group	100.0	+100.0	0	0	+100.0
2. Information sources for selecting pesticides					
Applicators' experiences of pesticide use	30.4	+3.5	12.5	+1.5	+2.0
Seller's instruction	57.1	-0.4	70.8	+7.6	-0.4
3. Number of pesticide types used for crop	12	-8	18	-1	-7
4. Often read the label before use	85.7	+40.9	43.8	0	+40.9
5. Number of applicators mixed wrongly*	10.8	-45.5	2.3	-55.5	0
6. Keep sprayers, pesticides at a safe place	78.6	+18.3	68.6	+7.2	+11.1
8. Raising mouth after spraying	78.6	+60.6	18.8	+2.8	+57.8

Figures in Table are percentages of respondents having a particular behaviors in total respondents with an exception of the criteria No.3 and those marked with star symbols

* Percentages of respondents having a particular behavior in total respondents who reported mixing pesticides

3.3 Impacts on Pesticide Risk Reduction

3.3.1 Impacts on Reduction of Hazards

Risks to applicators may depend on types of pesticide use. By World Health Organization's (WHO) toxicity class, pesticides are categorized into four groups. By environmental effects, they are grouped into types including chemical and bio-pesticides. If applicators use more class III and IV pesticides and bio-pesticides, it implies that they are wise rational applicators. It was found that after the PRR program implementation, the number of pesticide types used in the whole community, averaged number of sprays per farm in the crop as well as a dose of pesticide used per hectare of cultivated crop and number of wrong cocktailed applications reduced significantly as compared with those before implementation of the PRR program (Table 9)

Table 9. Changes in Pesticide Use After PRR Program Implementation

	PRR Commune		Control Commune		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
HANOI CITY					
1. Number of pesticide types used (type)	11	-7	24	+6	-7
Bio-pesticides used (%)	45.5	+39.7	20.8	+15.3	+24.4
Class II pesticides (%)	45.5	-21.2	66.7	-3.3	-17.9
Class III Pesticides (%)	54.5	+20.8	33.3	+3.3	+17.5
2. Averaged number of sprays per farm (spray)	3.9	-2.8	7.0	-0.7	-2.1
3. Pesticide used per ha (kg)	2.17	-0.38	7.91	+4.55	-0.38
4. Wrongly mixed applications in all mixes (%)	0.0	-54.0	58.3	-0.3	-53.7
THAI BINH PROVINCE					
1. Number of pesticide types used for crop (%)	12	-8	16	-1	-7
Bio-pesticides used (%)	16.7	+16.7	11.1	+11.1	+5.6
Class II pesticides (%)	41.6	-30.4	31.2	-44.6	0
Class III Pesticides (%)	50.0	+22.2	37.5	-21.5	+22.2
Class IV Pesticides (%)	8.4	+8.4	31.2	+31.2	0
2. Averaged number of sprays per farm (spray)	3.9*	-6.5	6.5*	-3.9	-2.6
3. Pesticide used per ha (kg)	6.35*	-4.42	4.40*	-0.13	-4.29
4. Wrongly mixed applications in all mix(%)	20.0	-54.0	36.9	-38.1	-15.9

% Percentages of a particular pesticide group in total pesticide types used in the whole community

* Significant at 1% level.

3.3.2 Impacts on Reduction of Exposure

One of the most important factors to reduce pesticide risk exposure is to use protective equipments when spraying. This issue was examined by direct observations, interviewing applicators and re-checked by group discussion in both pre and post PRR training surveys. After training, the PRR training enabled more farmers to use protective equipment when spraying, used better sprayers and practiced rightly pre-harvest interval (Table 10). Farmers in the PRR commune were observed having better pesticide container management practices. Four to 7 tanks were built in Thai Giang and Dang Xa communes for farmers to dispose pesticide containers during the course of PRR implementation. PRR Farmers had put their pesticide containers and wastes in the tanks located in the fields. Aside from this activity, Thai Giang farmers had collected pesticide containers 2 times monthly in other fields. As a result, the fields in the PRR commune during cropping season was cleaner and less pesticide containers found in the field compared with the situation before the PRR implementation, whereas, the situation in the control communes seemed unchanged.

Table 10. Changes in Using Protective Equipments When Spraying

	PRR Commune		Control Commune		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
HANOI					
1. Applicators always used protective tools	100	+77.6	48.5	+23.5	+54.1
2. Applicators used poor sprayer	0	-16.0	9.0	-1.0	-15.0
3. Applicators did right pre-harvest interval (%)	100	+46.3	51.5	0	+46.3
THAI BINH					
1. Applicators always used protective tools	85.7	+66.2	35.4	+9.1	+57.2
2. Applicators used poor sprayer	0	-30.4	10.4	-10.8	-19.6
3. Applicators did right pre-harvest interval (%)	100	+53.7	87.5	+38.5	+15.2

Figures in Table are percentages of respondents no-used or used particular protective equipment in total respondents

3.3.3 Impacts on Reduction of Environmental Impact Quotient (EIQ)

As a positive consequence of impacts discussed in the previous section, an optimistic change in knowledge and behaviors lead to significant reduction of hazards and exposure which resulted to sharp improvement in averaged values of EIQ presented in Table 11 . This implies that PRR training program had positive impacts in reducing possibility to pesticide risks to human and environment. In Hanoi city, while in field use EIQ values of farmers in control commune (Le Chi) continued to increase in terms of EIQ (214.5%), those values of farmers in PRR commune (Dang Xa) reduced significantly, marking an decreased of 78.1% for EIQ (Table 11). This fact reveals

without PRR training implementation, a possibility for pesticide risks increases as farmers use more pesticides for vegetable production.

Table 11. Changes in Field Use EIQ Value per Farm

	PRR Commune		Control Commune		Impact= $\Delta_E - \Delta_C$
	2010	Δ_E	2010	Δ_C	
Hanoi city (n=33 / commune)					
1. Field Use EIQ	6.6	-23.6 (-78.1)	71.6	+48.8 (+214.5)	-23.6 (-78.1)
2. EI Farm worker	2.2	-16.3 (-88.3)	65.4	+48.5 (+286.6)	-16.3 (-88.3)
3. EI Consumers	1.0	-5.9 (-86.0)	27.3	+20.3 (+288.5)	-5.9 (-86.0)
4. EI Ecology	16.7	-48.5 (-74.4)	122.0	+77.6 (+175.2)	-48.5 (-74.4)
Thai Binh province (n= 46 / commune)					
1. Field Use EIQ	33.4	-204.9 (-86.0)	51.0	-100.8 (-66.4)	-104.1 (-19.6)
2. EI Farm worker	20.4	-159.4 (-88.6)	28.2	-82.2 (-74.5)	-77.2 (-14.2)
3. EI Consumers	7.6	-29.6 (-79.6)	11.4	-14.1 (-55.2)	-15.5 (-24.3)
4. EI Ecology	73.5	-424.4 (-85.2)	113.5	-206.0 (-64.5)	-218.4 (-20.8)

Note: Figures in parentheses are percentages of changes in EIQ value compared with base-line and between PRR and control communes.

The situation of field use EIQ value change in Thai Binh province differed from those in Hanoi city. The situation marked a decrease in EIQ values between two communes ranging from 14.2% to 24.3%. This is because the fact that during the course of the study, there was a campaign on bio-pesticide use promoted by chemical companies in Thai Binh. The campaign covered many districts including Thai Thuy. As a result, the Thuy Son farmers in the control commune were also affected by this pesticide campaign. However, the field use EIQ values of farmers in PRR commune reduced larger and resulted a significant differences between after and before program implementation. Nevertheless, a reduction in terms of field use EIQ values as well as EI values were attributed by an improvement of pesticide use techniques with a wise pesticide selection and spraying with right pest, right amount and right time.

3.4 Impacts on Pest Management Policy Reform

Based on performances of the program in Hanoi city and Thai Binh province during monitoring process, Ministry of Agriculture and Rural Development (MARD) has issued Directive No. 1504/CT-BNN-BVTV dated 3rd June 2008 on Strengthening Pesticide Management. Regard to this directive, the commune's people committees are responsible for management of pesticide use and trade at a commune level. Few months later, in the 11th August 2009, MARD issued a Circular No. 2388-BNN-BVTV on Pesticide Management in Vegetable Production. This circular guides a measure to

Promote Model of Safe Vegetable Production in Compliance with VietGAP with pesticide management authorities of commune as an outcome of pilot PRR project in Thai Giang and Dang Xa. These policies are now being effective in the whole country. This is an extraordinary impact of the PRR program that contributes to pesticide policy improvement

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions

The PRR program had positive impacts in pesticide risk reduction in following aspects: 1) improvement of local people's perception of and behaviors toward pesticide risk reduction; 2) Strengthening community actions as well as individual farmers' behaviors in pesticide risk reduction such as formulation of farmers' interest groups, construction of tanks, development of internal regulations on pesticide use techniques, building community ownership and resource mobilization to pesticide risk reduction; and 3) reduction of pesticide risks in terms of hazards and exposure (farmers used pesticides listed for vegetables, used more bio, class III and IV pesticides, better pesticide use techniques; use more protective equipment and better unused pesticides, container sprayer management). As a result of these impacts, the environmental impact quotients were sharply reduced. This conserve ecological as well protect environment. The program also has an extraordinary impact in supporting national pest management policy reform. At the national level, the model of pesticide risk reduction is being extended to many other provinces using local resources, not from central government. This indicates a fact that the program has built sustainability for safe vegetable production.

4.2 Recommendations

Although the impacts of the program are impressive, for the sake of strengthening these impacts, following measures are recommended for improvement of the PRR program: 1) training contents should focus more on risk reduction rather than IPM aspects; 2) Training should be season-long training (12-14 week course) for applicators and maybe 2 days for local officials and sellers; 3) There should have a guideline on formulation and implementation of internal regulation for the local community; 4) more efforts should be devoted to instruct and consult with local authorities as well as mass organization to form and operate farmer interest groups, self-control and self-help farm group; 5) to

ensure long terms effects, development and implementation of a TOT program for PRR is crucial for a success of the program; 6) a close coordination of cooperative, mass organizations, commune's people committee is important for a success and strengthen the impacts of the program; 7) It was found that local community unable to treat the pesticide containers that applicators put into tanks. There should have a legal framework and technique for treating the collected containers. Pesticide companies may be responsible to bear the cost for treating these collected containers; 8) Now tanks for collecting pesticide containers have been built. However, tank design and construction are unclear. Thus, there should have a guide on these issues



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