Advancing Ecohealth in Southeast Asia and China

Lessons from the Field Building Leadership Initiative




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ecohealth FBLI

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What is in this booklet?

This first booklet of the Field Building Leadership Initiative (FBLI): Advancing Ecohealth in Southeast Asia and China, describes how the FBLI has contributed to developing the field of Ecohealth by drawing on research and practical experiences from Southeast Asia (Indonesia, Thailand, Vietnam) and China. The case studies showed how local communities addressed and learned from challenges in managing agricultural intensification through joint efforts with researchers and other actors. This booklet aims to synthesize and present activities since program launch in October 2011 to 2015. The information in this booklet sets out a base framework for reporting final outcomes of the FBLI in the final synthesis booklet, a more comprehensive booklet expected to be published at the end of 2016. The final synthesis booklet will share more lessons learned and ways to move forward in building the Ecohealth field.

Who is this booklet for?

This booklet is intended for those interested in understanding and addressing complex health issues by using Ecohealth approaches. We think this booklet will be of interest to academics, researchers, practitioners and students in the fields of agriculture, development, environment, and public health. The executive summary highlights key findings that would appeal to policymakers and decision-makers in donor, government, and non-government organizations worldwide. We encourage people to start (or continue) to work with Ecohealth approaches.

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Executive summary

Intensification of crop and livestock production can improve food, nutrition, and income security; however, intensification can also lead to increased health risks, environmental degradation, and biodiversity loss. This is especially true in Southeast Asia and China, regions facing rapid economic growth. To address this complex challenge, a better understanding of the interactions between agricultural practices, human health, and ecosystems is required.

The Field Building Leadership Initiative (FBLI), supported by the International Development Research Centre (IDRC), has been working to understand and address intensive agricultural practices and associated health risks in Southeast Asia and China. Developed jointly by research centres in China, Indonesia, Thailand and Vietnam, and launched in 2012, this five-year initiative allows researchers and their partners to carry out research, capacity building, and knowledge translation to inform practice and policy.

Key messages

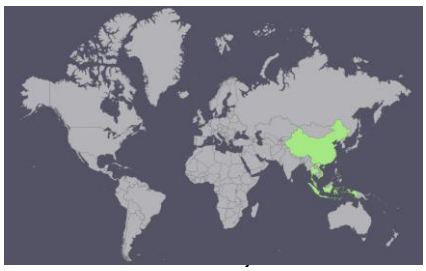
- Intensive agricultural practices can have far-reaching impacts on health and environment
- Smallholder farmers play an important role in meeting the global demand for food
- The livelihoods of smallholder farmers are affected both positively and negatively by agricultural intensification
- Measures which are likely to help to address challenges include:
    - Creation and dissemination of guidelines for best agricultural practices and monitoring and evaluation of guidelines;
    - Long-term commitment of partnership initiatives; and
    - Increased investment in research and policy surrounding agriculture and health

Research for development

The FBLI team, working with stakeholders from the onset of research for over four years, has achieved progress in improving the health of smallholder farmers. Specifically, the project created new evidence on health risks of agricultural intensification and developed innovative interventions to mitigate health risks and promote sustainable agricultural practices. The integration of FBLI research results into agricultural practices is testimony of the rigorous research efforts and productive engagement of FBLI with relevant stakeholders.

Through the initiative, researchers and partners undertook research on a number of issues:

- Pesticide use and its impact on human health and agricultural ecosystems in China;
- Human and animal waste management in Vietnam;
- Rubber plantations and vector-borne diseases in Thailand; and
- Small-scale dairying in Indonesia.



Ecohealth *are approaches that recognize that human health and well-being are the result of a complex set of interactions between people, social and economic conditions, culture, and the natural environment. In short, human health is dependent on the health of our ecosystems.*

A number of achievements were noted so far:

- Better understanding of health risks of agricultural intensification;
- Innovative products and interventions to address such health risks;
- Preliminary changes observed in behaviours and practices of farmers towards more sustainable agricultural development;
- Increased Ecohealth capacity of senior researchers and new generation of researchers
- Increased awareness of Ecohealth among researchers and academic institutions; and
- Involvement of academic institutions, NGOs, ministries, and community members in research activities through networking and engagement.

Building capacity and knowledge to action

The FBLI has been supporting the development of sustainable cohorts of Ecohealth practitioners and researchers. For example, through the FBLI's Global Health True Leader Series, a regional leadership training program, many young professionals from various fields (e.g., agriculture, health, and environment) developed their leadership skills and Ecohealth competencies. This program has reached over 400 participants from ten Asian countries. Ecohealth curricula has also been integrated in four universities in Southeast Asia and China.

The FBLI supported policy advocacy, for example, policy alliance groups were formed in each project country to facilitate research knowledge sharing and uptake. These groups consisted of mid-level policy makers, senior FBLI researchers and representatives from other regional networks. FBLI is connected with Ecohealth and One Health networks in the region to promote Ecohealth approaches, including Southeast Asia One Health Network (SEAOHUN), Ecohealth Emerging Infectious Diseases Research Initiative (Eco EID), Economic Development, and Ecosystem Changes, and Emerging Infectious Diseases Risks Evaluation (ECOMORE). The team is working towards raising public awareness on agricultural intensification issues through bulletins, publications, and a growing social media presence.

Moving forward and lessons learned

As FBLI progresses into its final year, the initiative will focus its programming on data analysis and reporting, monitoring outcomes, and knowledge sharing. The next synthesis booklet is expected to be published at the end of 2016.

Lessons learned:

- Despite interest of researchers in using the Ecohealth approach, it is a complex undertaking requiring substantial time and skills. However, the capacity of team members in using the Ecohealth approach increased through experiences.
- Linking researchers to policy makers and influencing policy decisions have proven to be challenging, but processes such as word-of-mouth can help facilitate the networking.

Contents

List of abbreviations

APEIR	Asian Partnership on Emerging Infectious Disease
CDC	Center for Disease Control and Prevention
CENPHER	Center for Public Health and Ecosystem Research
Eco EID	Ecohealth Emerging Infectious Diseases Research Initiative
Ecohealth	Ecosystem Approaches to Health
EHNA	Ecohealth Network Asia
ECOMORE	Economic Development, Ecosystem Changes, and Emerging Infectious Diseases Risks Evaluation
EcoZD	Ecosystem Approaches to the Better Management of Zoonotic Emerging Infectious Diseases in Southeast Asia
FAO	Food and Agriculture Organization
FBLI	Field Building Leadership Initiative
FGD	Focus Group Discussion
FORHEAD	Forum on Health, Environment and Development
GHTL	Global Health True Leaders
PAHI	Partnership on Avian and Human Influenza
PRA	Participatory Rural Appraisal
IDRC	International Development Research Centre
IPM	Integrated Pest Management
NCCR North-South	National Centres of Competence in Research North-South
NGO	Non-government Organization
SEAOHUN	Southeast Asia One Health Network
VOHUN	Vietnam One Health University Network
WHO	World Health Organization

Introduction

With the world population predicted to reach 9 billion by 2050, sustainably increasing food production systems is needed to achieve global food security (FAO, 2009a). Increasing food production systems is a real challenge, especially for developing countries where nearly all of the population growth is expected to occur. Agriculture is the primary source of livelihood for most of the world's rural poor, and about 70% of the world's poor live in rural areas. This figure is higher in Southeast Asia (Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor Leste, and Vietnam), where three quarters of the poor live in rural areas (IFAD, 2010). Growth in agriculture, notably livestock and crop production, can help increase global food security and livelihoods of farmers (The World Bank, 2008), and may help countries meet the sustainable development goals of ending poverty and hunger by 2030 (United Nations, 2015).

Agriculture and health are intrinsically linked. Agriculture, through its social, economic and environmental dimensions, affect the health of farmers (Charron, 2012). In turn, human health influences agricultural productivity and output. As such, health can be seen as both an outcome and a driving force for sustainable agricultural production. To what extent intense agricultural practices can be made to be more sustainable and expanded (WHO, 2013), while protecting human health, is a complex, pressing issue.

Rapid population and economic growth has led to agricultural intensification in Southeast Asia. Agricultural intensification is defined as the increase in the productivity of crops and livestock per unit of input. While agricultural intensification can be beneficial for human health, for example through increased food security and socio-economic development, the public health and environmental health impacts are not yet well understood (Lam et al., 2015; WHO, 2013). For instance, the intensive use of chemical fertilizers and pesticides for crop production can increase occupational exposure to chemical and pesticide residues, and can place pressures on the environment through excess nutrients and toxins in groundwater and surface water (Matson et al., 1997; Piya et al., 2011; Tilman et al., 2002). In another example, increased livestock production generates large amounts of waste-by-products; intense livestock production combined with outdated waste management technologies and practices can present health risks to farmers and community members from contaminants in waste (Lam et al., 2015), as well as environmental risks from excess nutrients, organic matter, and heavy metals (Do-Thu et al., 2011; Gerber et al., 2005; Raschid-Sally et al., 2001). As such, the potential impact of intensive agriculture on health and environment is a growing concern.

Agricultural intensification can have positive and negative impacts on ecosystems. Agriculture can contribute to the conservation of high-diversity systems (Tscharntke et al., 2005), but also contribute to loss of biodiversity (Firbank et al., 2008). Intensive agricultural practices can accelerate greenhouse gas production and exacerbate climate change (McMichael et al., 2007; Steinfeld et al., 2006). Further, the unsustainable dependence on agrochemicals and overexploitation of water resources place pressures on surface water ecosystems, including lakes, rivers and streams, as well as groundwater (IAASTD, 2009). Ecosystems provide many goods and services for humans including regulating climate change, filtering pollutants, and providing a

source of food and water. A better understanding of the conservation of ecosystem services in agricultural food systems is needed for sustainable agriculture and protection of human health.

Interest in understanding the relationship between the health of ecosystems and humans, started in the late 1980s (CPHA, 1992; Rapport, 1989). Recognizing the rapid changes occurring in global ecosystems, and potential consequences of ecosystem change for human well-being, the Millennium Ecosystem Assessment released a global assessment report on the links between ecosystems and human well-being in 2005 (MEA, 2005). Canada's International Development Research Centre (IDRC) played a lead role in advancing ecosystem approaches to health and largely introduced the approach in Latin America and Africa in the 1990s. Ecosystem approaches to health, or Ecohealth, recognizes that human health is linked to ecosystem health, or, at the very least, degraded environments. To address complex health issues, an understanding of the biophysical, cultural, economic, and social relationships between humans and ecosystems is needed. Six principles underline Ecohealth approaches including systems thinking, transdisciplinarity, participation, gender and social equity, knowledge-to-action, and sustainability (Charron, 2012).

Ecohealth approaches were introduced in Southeast Asia in the late 2000s (Nguyen-Viet et al., 2015). Early Ecohealth approaches in Southeast Asia such as the 'Ecosystem Approaches to the Better Management of Zoonotic Emerging Infectious Diseases in Southeast Asia' (EcoZD) and the 'Asian Partnership on Emerging Infectious Disease' (APEIR) focused on infectious diseases. Ecohealth research is also concerned with broad driving forces on ecosystems and health including agricultural intensification, climate change, and urbanization. More than 20 Ecohealth initiatives have been conducted over the past decade in Southeast Asia (Nguyen-Viet et al., 2015). While Ecohealth projects were designed to follow principles of Ecohealth approaches, a recent review found that many Ecohealth projects still fail to truly demonstrate transciplinarity, participation and equity (Richter et al., 2015). Incorporating a regional perspective in research, training, and policy translation has been suggested as a way forward to advancing Ecohealth research in Southeast Asia (Nguyen-Viet et al., 2015).

The need

Ecohealth approaches, while proven useful for addressing complex health and environmental issues in developing countries such as Latin America and Africa, are only newly introduced in Southeast Asia and China. Further, the potential impacts of agricultural intensification in Southeast Asia and China are not yet well understood. Applying the Ecohealth approaches in the context of agricultural intensification may help address agricultural intensification and advance Ecohealth in the regions. Applying Ecohealth approaches, however, is a complex undertaking, often requiring awareness and understanding of Ecohealth, commitment to principles, and individual, institutional and country capacity.

The response

As a response to this need, the Field Building Leadership Initiative (FBLI), supported by IDRC, was created. The FBLI is a five-year regional program launched in October 2011 to address ecosystem and health issues related to agricultural intensification using Ecohealth approaches. Over 35 partner institutions comprising of researchers, practitioners, and government and non-government representatives contribute to the FBLI. Developed jointly by research centres in China, Indonesia, Thailand, and Vietnam, the FBLI was designed to:

- Strengthen the Ecohealth field in Southeast Asia and China, and build a mature field of research, training, and practice;
- Train a new generation of researchers and practitioners in the region;
- Produce useful and relevant research for policy and decision-making; and
- Create linkages between research and policy circles in Southeast Asia and China.

FBLI's long-term vision is to build a well-established field of Ecohealth that is *sustainable*, *institutionalized*, and *influential* in global processes that drive environmental and health policy and practice, and is supported by a strong community of practice and policy makers.

A regional core group sets up strategic directions of the FBLI. The FBLI has three strategic objectives:

i) ***Research*** – conduct Ecohealth research to address ecosystem and human health issues related to agricultural intensification;
ii) ***Capacity building***– strengthen Ecohealth capacity and leadership; and
iii) ***Knowledge translation***– translate research evidence to inform policy decisions, and facilitate dialogue between research and policy communities.

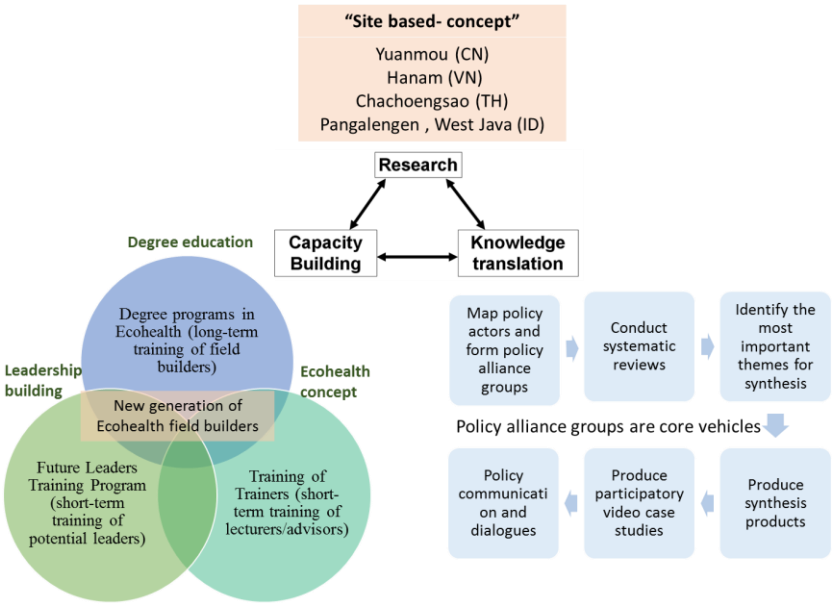


Figure 1. FBLI strategic framework

Research

Research is crucial component of the FBLI in generating new knowledge and informing interventions and policies surrounding agricultural intensification.

The main objectives of the research component are to:
1) conduct transdisciplinary, multi-institutional, multi-country and site-based Ecohealth research to generate knowledge and innovative solutions for addressing agricultural intensification; and
2) use research to inform knowledge translation and capacity building activities.

The FBLI has supported four research projects (one in each FBLI country) that investigate the impact of agricultural intensification on human and ecosystem health. Within each country team, collaborations between institutes, researchers, ministries, and community stakeholders were initiated. Research topics and priority areas were identified and developed through a consultative process. While Ecohealth research share a common set of principles, the actual application of such principles and techniques often differed region to region growing out of different local, cultural and ecological contexts. The Ecohealth approaches used focused on a 'learning-by-doing' approach, and the process of conducting this approach emphasized the need for Ecohealth capacity building.

While the research teams are in the late stages of data collection, analysis, and reporting, some research findings have already been disseminated and interventions have commenced. Local stakeholders have been actively involved in the validation of research findings, testing intervention programs, and eventually, the evaluation of their impacts. The experiences and lessons learned from conducting Ecohealth research are presented below as case studies.

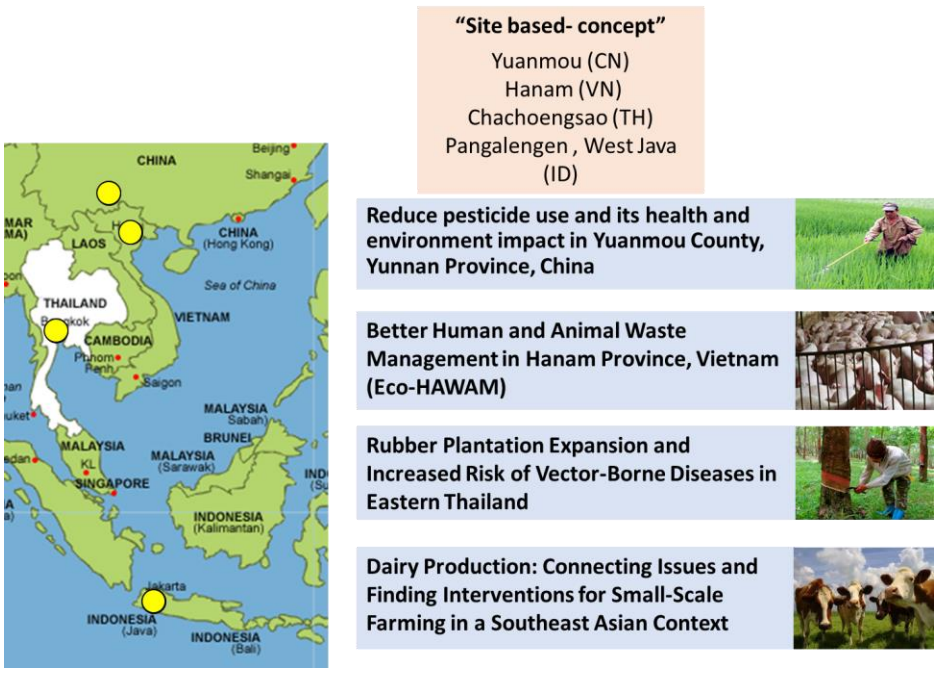


Figure 2. FBLI research framework

Case study in China

Using ecosystem approach to reduce pesticide use and its health and environmental impacts in Yuanmou County, Yunnan Province, China.

Pesticide use has seen a dramatic increase worldwide and in China farmers extensively use pesticides to control crop pests and diseases. This increase can partly be attributed to China's rapid population growth and the need to meet the food demands of its 1.3 billion people. The Chinese government encouraged the intensification of farming systems to raise agricultural output, thus increasing the need for agricultural chemicals and pesticides. China has become one of largest pesticide suppliers, exporters, and consumers in the world (Zhang et al., 2011).

Yuanmou County is an important producer and exporter of vegetables in China. Over the past few decades, Yuanmou has experienced dramatic changes in agricultural practices. For example, pesticide use increased significantly between 1990 and 2000, reached a peak in 1999 and 2000, and decreased sharply after (Fang et al., 2011). In 2000, the county government became aware of the economic importance of green agriculture, and took measures to control the use of highly toxic, highly concentrated, and highly residual pesticides (Fang et al., 2011). At the same time, the government promoted low toxic, low residual and highly efficient pesticides. By 2003, Yuanmou was recognized by the China Ministry of Agriculture as one of the 100 demonstration counties that produced "non-harmful" vegetables in China (Fang et al., 2011).

The county government, in cooperation with international and national organizations, also introduced integrated pest management (IPM) and other bio-methods to control pests. A new generation of pesticides was promoted which claimed to be highly effective and low in toxicity. These pesticides are supported by the agricultural extension department in China and are widely used by farmers. While the health and environmental risks of pesticides are well-known, the long-term risks of the new generation of pesticides are not yet well understood. Research is urgently needed to identify the health and environmental impact of these new pesticides.

This pesticide issue in Yuanmou County was partly explored before the start of FBLI. During 2006-2010, an IDRC funded Ecohealth project entitled "Land use change and human health in eastern Himalayas: an adaptive ecosystem approach" was conducted (http://www.icimod.org). This study involved a scoping study to understand the land use change and health problems in this county. Health and environmental issues determined include, among others, the increasing prevalence of non-communicable disease, waterborne diseases, and fertilizer and pesticide use. The focus of the project was on IPM, water and sanitation and fluorosis control.

The FBLI project aims to further address the pesticide issue in Yuanmou, with the goal of reducing pesticide use and associated health risks in Yuanmou while encouraging sustainable economic development. The objectives were to:
1) understand the history, current situation, drivers, and future trend of pesticide use;
2) determine the impact of pesticide use on human health, animals and the environment;
3) develop interventions to reduce pesticide use and promote sustainable practices; and
4) disseminate research findings and promote uptake of research findings by policy-makers.

Approach

Research took place in six villages in Yuanmou County. Yuanmou is located in Yunnan Province, about 200 km from Kunming City (capital city of Yunnan Province). Yuanmou is one of the main vegetable production regions of Yunnan.

Because of the previous Ecohealth project, some relationships have already been established between the research team in Kunming and local collaborators such as the County Center for Disease Control and Prevention (CDC) and the County Health Bureau. Further, partnerships were formed with institutions including Yunnan Agricultural University, Kunming Institute of Batony, Chinese Academy of Sciences, and a network called Forum on Health, Environment, and Development (FORHEAD). The research team consisted of nine experts from the fields of development studies, clinical medicine, public health, epidemiology, anthropology, botany, agriculture, and environment. In addition, master students and undergraduate students are important forces of the research team.

Data came from several sources, including field site visits, interviews (with local health, agricultural and environmental departments of the county government, health workers in local hospitals, pesticide sellers and farmers), household questionnaires of 418 household farmers and 298 plantation farmers (on demographics, socioeconomic data, current pesticide situation, health status, and questions relating to knowledge, attitude and practice of pesticide use), secondary data collection and analysis, participatory rural appraisal (PRA), and laboratory testing of pesticide residues in vegetables, water, soil, and urine samples.

Results

Farmers highly depend on pesticides in commercial vegetable plantation but most of them do not know how to properly and correctly choose and use pesticides. Farmers often depend on information from pesticide sellers when their plants suffer from pests and diseases. While farmers are aware of health risks of pesticides, many are not aware of the risks to animal and environmental health. Further, many farmers know self-protection techniques but seldom apply them. Out of 120 urine samples collected, pesticide residues were detected in 52 samples (43%). Some farmers reported health symptoms when using pesticides. Pesticide packages were found freely disposed and a lot of empty containers were seen in the fields, rivers, and nearby wells.

Some farmers have knowledge and methods in traditional pest control, however, they do not use these methods anymore due to several reasons. First, the current crop pests are perceived to be more complex and resilience than those before; as such, farmers do not have confidence in the traditional methods. Secondly, chemical pesticides are so easily accessible, affordable and convenient, therefore farmers do not want to use traditional methods which often requires some preparation. The use of chemical pesticides is also considered common practice. Thirdly, the advertisement, promotion and marketing of pesticides are strong and pervasive; for example, sellers of pesticides allow farmers to use the pesticides first, and pay the fee after harvesting. Lastly, and perhaps interestingly, chemical pesticides are perceived to be more scientific, advanced and effective than the traditional methods, of which are usually perceived as ‘backward’ and ‘not scientific’.

Interventions

Many community-led interventions took place in the six project villages:

- A 12-person team of teachers and students from Kunming Medical University went to the villages to share research findings, in particular, the laboratory test results of pesticide residues in vegetable and urine samples. By talking face-to-face with farmers who provided urine samples, awareness of farmers of the health risks from the pesticides was raised.
- 'Street theater' was used to facilitate health education on pesticides. The aim was to raise awareness of the harmful effects of pesticides and share tips for self-protection.
- Calendars and posters were designed and produced. The materials provided health education. One calendar was sent to each family, and posters were posted in the six project villages.
- On August 2015, in cooperation with faculty and students of Yunnan Agricultural University, a health campaign was launched to share information on some common pests of plants and how to use pesticides correctly.

Figure 3. Street theatre performance

Figure 4. Health promotion poster

Conclusion

The use and overuse of pesticides in agricultural production is just a section of the pesticide problem, which involve many different stakeholders. To promote less and rational using of pesticides, engagement of more stakeholders outside of those involved in the research project (e.g., pesticide producers and media) is recommended.

Lessons learned

- Input from community members can help improve communication tools
- 'Know someone who knows someone', connecting with researchers who have with links to policy-makers can help reach policy makers

Case study in Indonesia

Ecohealth and dairy production: Connecting issues and finding interventions for small-scale farming in a Southeast Asian context.

Smallholder dairy farms provide a good source of livelihood for crop farmers in mixed-farming systems in Southeast Asia (Moran, 2009). This is evident in Indonesia and other Southeast Asian countries where some crop farmers turned to small-scale dairying and made sufficient income to become a sustainable enterprise. Smallholder dairy development can provide an opportunity to address the persistent problem of rural poverty by improving food and nutrition security for poor rural and urban households (FAO, 2009b).

The dairy industry is an important industry in Indonesia with over 100,000 Indonesian dairy farmers producing around 930,000 tons of milk annually (International Finance Corporation, 2011). Around 90% of Indonesian milk production is produced by smallholder farmers (averaging 3 to 5 cows) (Wright and Meylinah, 2013). The Indonesian Government supports dairy industry development and is targeting to meet at least 50% of the national milk demand domestically by 2020 (International Finance Corporation, 2011). Strategies put forward to scale up include, among others, campaigning to drink fresh milk, promoting proper milk handling hygiene and production practices, and improving farm sizes.

The dairy industry has been expanding to meet the increasing demand for milk and dairy products. From 2005 to 2011, Indonesia's dairy cow population and milk production increased annually by an average of 7.4 percent and 14.6 percent, respectively (International Finance Corporation, 2011). Despite the growth in the dairy industry, growth is still hindered by a range of well-documented challenges including the high price of quality feed, poor farm management, low dairy cow productivity, poor animal health and sanitation, and farmer's relationship with the local dairy cooperative (Madeley, 2006; Panggabean, 2004; Pingali, 2007; Soedjana, 2012).

Dairy farms can contribute positive social and economic benefits including reducing food insecurity and rural poverty; however, intensive dairy farm management can present environmental and health risks. Threats to ecosystems and environment can include pathogens, contaminants and greenhouse gas emission from excess cow waste. Threats to animal health can come from intensive animal husbandry, poor handling and sanitation during dairy management practices. Developing the small-scale dairy industry while minimizing environmental and health concerns is a challenge, as such provides an opportunity to conduct Ecohealth research and find sustainable solutions.

While a good deal of attention has been paid to unidirectional aspects of problems related to dairy farming, human health, animal health and the environment, this research aims to explore linkages between dairy farm management and environmental and health issues. The objectives were to:1) identify issues of underperforming smallholder dairy farmers in Indonesia, and 2) implement interventions that will have a positive impact on animal health, milk production, environmental health, human health and economic profitability of these smallholder dairy farms.

Approach

West Java is the second largest milk producer accounting for 29% of Indonesia's milk production. Pangalengan, south of Bandung, the major city in West Java, was chosen as the study site because of its long history and scope of dairy farming. Research was done in Cipanas and Warnasari districts of Pangalengan.

At the beginning of the project, a multidisciplinary research team was created consisting of seven researchers from public health, humanities, veterinary, and agricultural fields. The team was modified over time as local leaders in the community, and members of research universities, and government and non-government organizations joined. A research station was set up in Pangalengan to better facilitate communication with the community. An assessment of the current health situation and issues surrounding dairy farming was conducted through site visits, focus-group discussions, in-depth interviews, detailed questionnaires of 148 farms, and collection of health-related data and lab analysis (e.g., river water samples).

Results

Most farms in Pangalengan were small, with cows kept continuously in small stalls and no grazing land was available. The quality of the complete feed supplements supplied by the local dairy cooperative was poor quality in terms of nutrients. Sanitation was generally poor on farms as cow stalls were not very clean and improper milking practices were used. Milk yields were low averaging 11 liters per cow per day compared to 25-30 litres per cow per day of corporate dairy herds, such as the one owned by Ultra Jaya in Pangalengan. In addition, the quality of the milk was poor, both in terms of fat content and bacterial count.

Farmers raised that the problem with the greatest impact on farm productivity was access to feed. Feed is a perishable and if not produced locally, its price may be higher due to transportation costs. In addition, small-scale farmers have less bargaining power when negotiating price as compared to larger farmers. One possible line of intervention, therefore, was the provision of local processing facilities, such as feed choppers, perhaps in combination with the modification of local feed production.

If interventions intended to improve dairy productivity are to be successful, the complexities of farming systems and importance of stakeholders need to be taken into account. It is important that local people are involved in the process of determining what interventions should be attempted and that interventions are geared towards achieving community goals; therefore small-scale farmers and community leaders were consulted in the process of intervention design.

Interventions

The research team and community members developed an intervention combining innovative feed with better farm management. The new complete feed mixture was trialed with two small groups of farmers in Pangalengan. The results initially revealed a modest improvement in milk output, but subsequent trials found poor results, and so the intervention was terminated. An investigation revealed that one of the farmers had tampered with the results so that the

intervention would fail. As it is not often feasible or easy to address this challenge, a different intervention was designed, targeting cow waste.

Often farmers dispose cow waste directly into the environment without treatment. Processing cow waste into fertilizer and animal feed can reducing health risks and provide an economic benefit. Trials for a new series of interventions have been carried out in a number of sites in Pangaelengan and outside Pangalengan, involving the processing of waste, the use of processed cow waste to improve crop yields, and the use of animal herbal feed supplement. Early results of these trials were extremely promising with higher yields in some treatments, for example, lower chicken feed conversion ratio, and higher milk production in cow. However, challenges include applying appropriate technology and raw materials preparation.

Figure 5a. Cow waste was converted and used as organic fertilizer; Figure 5b. Organic fertilizer resulted in higher production of tomato.

The conversion of farm waste into useable products had solved some environmental problems and gave additional income for the local farmers who produced waste products. The products made from farm waste include biofertilizer, casting, solid and liquid organic fertilizer, earthworms and animal herbal feed supplement. Even though several laboratory tests are still ongoing regarding efficiency and safety, local farmers in Pangalengan have produced products and sold them beyond Pangalengan area. The testimony gathered from the consumers (found at www.superjamu.com) demonstrated significant impacts of products for crops and livestock.

Conclusion

The research plan originally proposed an intervention targeting better feed to improve milk production. Previously unnoticed factors relating to local practices and relationships surfaced to reveal significant obstacles in achieving our objectives. The flexibility of Ecohealth research allowed us to move beyond these obstacles and address our original objectives with a new intervention on cow waste, seen as both a health risk and also potentially valuable resource. Waste was converted into several valuable products which are being analyzed in national laboratories and field tested among smallholder farms in Java. This intervention has the potential to scale up to more substantial social and economic impact than our original intervention would have had.

Lessons learned

- Partnerships with the community and other stakeholders were essential in gaining their trust and participation in the planning process and development and adoption of new interventions.
- An important consideration in designing interventions is the farmer's relationship with the local cooperative and the farmer's perception of the benefits (and risks) of the intervention.

Case study in Thailand

Rubber plantation expansion and increased risk of vector-borne diseases in Eastern Thailand.

Rubber plantations are rapidly expanding in Southeast Asia, and in areas where rubber crop were not historically found (Fox and Vogler, 2005). Natural rubber production has increased by over 50% since 2000 (Ahrends et al., 2015), with approximately 97% of the global natural rubber supply coming from Southeast Asia (Li and Fox, 2012). This supply is largely provided by small-holders in China, Vietnam and Thailand (Fox and Castella, 2013).

The increasing demand for rubber has led to rapid land use conversion to rubber, resulting in economic, environmental, and social outcomes. While financial stability can increase due to higher demand for rubber products, expansion also play a role in altering environments that affect human well-being and ecosystem services. For example, large-scale land surface change affect climate, water reserves, carbon stocks and soil productivity (Foley, 2005; Li et al., 2007; Zhang et al., 2007). Biodiversity is also affected as new rubber plantations are frequently placed on lands that are important for biodiversity conservation and ecological functions (Ahrends et al., 2015). Socio-economic concerns on rubber farmer's livelihoods include rubber price fluctuations, dependency on global markets, and food security.

Thailand is the largest producer for rubber and like many Southeast Asian countries, Thailand has experienced substantial environmental change over the past decade. Since 1989, rubber plantation has gradually shifted from the south to the Northeast, with the Thai government actively promoting rubber cultivation and expansion. The expansion has negatively altered ecosystems where rubber trees had replaced ecologically important forests (Li and Fox, 2011). Deforestation of wide areas has profound impacts on ecosystem health and vector-borne disease transmission.

Rubber plantations are known to be a significant site for malaria transmission. In Thailand, land transformations to rubber have resulted in local malaria re-emergence and at high levels (Bhumiratana et al., 2013; Singhasivanon et al., 1999). Rubber plantation tappers are most at-risk to malaria transmission as rubber tappers often work outdoors at night when malaria vectors are most active. The changes in ecology from forests to rubber cultivation and the maturation of rubber trees are likely to alter risk for vector-borne diseases. There is a need to better understand the relationship between rubber plantations and vector-borne disease emergence.

This study used an Ecohealth approach to: 1) understand ecology of vectors and vector-borne diseases (focusing on malaria, dengue, and chikungunya) in rubber plantations; and 2) determine the relationship between ecological, biological, and social factors of rubber plantations and their implications for vector-borne diseases.

Approach

Like many parts of Thailand, the eastern region has faced substantial expansion of rubber plantation. Research took place in Chachoengsao Province, located about 80 kilometers east of Bangkok. Three out of 11 districts were selected: Plaeng Yao, Sanam Chai Khet and Tha Ta Kieb. The Thailand team did prior research in Chachoengsao Province before the FBLI. As such, cooperation of government authorities and local communities with the team has already been established due to long history of engagement in community-based research.

A situational analysis was conducted to collect baseline information on the ecological, biological and social factors relating to rubber plantation in Chachoengsao. Data was collected on landscape and land use changes, health and environmental issues, local epidemiology of malaria, dengue and chikungunya, and risk factors for vector-borne disease and other health problems. Data collection tools included site visits, interviews, focus group discussions, secondary document reviews, questionnaires, and biological and chemical sampling.

Results

Rubber is an important crop in Chachoengsao province, representing nearly 10% of the total plantation area. Land use is mainly characterized of cassava-mixed crops or paddy fields, with the exception of Tha Ta Kieb where land use is mainly characterized of tropical rain forests.

From 2002-2014, a total of 585 malaria cases were reported in Chachoengsao Province. The greatest numbers of malaria cases reported were in the age group of 11-20 years (28%), followed by 21-30 years (27%). About 76% of cases were males. Nearly 61% of malaria cases were found among rubber plantation labourers, followed by agricultural workers at 16%. During the same period, a total of 11,845 dengue cases were reported in Chachoengsao Province. The greatest numbers of dengue cases reported were in the age group of 11-20 years (40%), followed by 21-30 years (21%). About 51% of cases were males. Nearly 48% of dengue cases were found among students, followed by labourers 35%. Eleven cases of chikungunya were reported from 2008 to 2014, with eight of those cases found in the three selected districts.

Risk for dengue and chikungunya appeared to be higher in areas with rubber plantation in comparison to those without rubber plantation. In addition, remote sensing and spatial analysis revealed that there was a trend of dengue spread and cluster in areas with rubber plantation.

The study also gathered information on health risk factors related to the living and working conditions including accessibility to social welfare and health services of migrant rubber workers. Questionnaires (n=84) and focused group discussions (n=42) revealed that only 19% of migrant workers accessed social welfare and health services and 64% paid for their own health service. About 50% of migrant workers reported that they sought health care from pharmacy shops, and 14% went to private clinics for quick examination.

Environmental conditions within the rubber plantation area was assessed. Chemical fertilizers and herbicides for rubber crops were periodically used. Improper handling and disposal of chemicals among rubber workers, along with the lack of a disposal site, were observed. Our study revealed that samples of water (n=82) in some rubber plantations were not

appropriate for drinking or other domestic usage. Ground water samples demonstrated *E. coli* contamination over standard level (29% of samples). Water from natural reservoirs was contaminated with iron (60.9%) and ammonia (56.5%) while wastewater was highly contaminated with *Salmonella spp.* (87.5%). Although the concentration of selected heavy metals such as lead, manganese, nickel and cadmium in water and soil did not exceed the reference values, the blood samples from domestic dogs showed high concentration level of manganese (100%), nickel (76.9%) and cadmium (54.5%).

Interventions

The research team has been working with several local organizations, for example, the Office of the Rubber Replanting Aid Fund, Provincial Labour Department, District Hospitals, Public Health Centers, Rubber Plantation Cooperatives, and Sub-District Administrative Organizations, to plan the intervention in mid-2016. Health education on the risk of vector-borne diseases and risk of chemicals used in the rubber crops will be our main intervention focus. Safe handling practices of chemicals and vector-borne disease prevention will be promoted. In collaboration with the National Nanotechnology Center, trials on the efficacy of mosquito repellent jackets and its application in the rubber communities are currently ongoing.

Figure 6a. Engagement of migrant workers by research team; 6b. Reducing risk of vector-borne diseases in a rubber worker using a repellent-impregnated jacket.

Conclusion

Local rubber worker's health issues were not the main concern of local authorities, which gradually changed as the FBLI project progressed. Many rubber farmers had limited knowledge of vector-borne diseases and transmission, and were mainly concerned with the earning potential of their rubber. Through many interactions, rubber workers and owners of rubber plantations became more aware of their health and more cautious about how the environment may affect their health. Perhaps surprisingly, many farmers positively cooperated during the research activities. For example, farmers shared information on work-related problems and many farmers agreed to have their blood screened, as they mention that blood screening is a costly activity.

Overall, this research provided positive collaboration between researchers, local communities and local authorities to address health and environmental issues in rubber plantations.

Lessons learned

- Research activities (e.g., blood screening) can be an incentive for community engagement
- Working with the community may not be too difficult, community members are willing to cooperate provided that their culture and situation were considered.

Case study in Vietnam

Using Ecohealth Approaches for Better Management of Human and Animal Waste in Hanam Province, Vietnam.

Vietnam's national livestock strategy currently favors industrial production systems, with the perception that industrialization will improve productivity, profitability, and food safety (MARD, 2009). However, with the increasing demand for livestock products combined with the shortage of domestic production, policy-makers have been reconsidering the role of the smallholder farmers. Smallholder farmers, mostly women, are the main suppliers of livestock products, and smallholder production systems have been shown to be competitive and efficient (Lapar and Staal, 2010; Tisdell, 2010). Further, smallholder livestock production can provide social and economic benefits to many poor farmers, both men and women, along the value chain.

Agricultural intensification is driving up livestock production systems and subsequently, the amount of waste and waste-by-products generated. Livestock waste is often reused in agriculture and aquaculture for fertilizer and feed, respectively. While re-use of livestock waste can contribute to sustainable development and economic activity, the increased livestock waste combined with outdated management practices can present human and environmental health risks (Lam et al., 2015; WHO, 2013). While the risks of waste management practices are generally known, the impact of such practices is not well understood. Generating evidence on the impacts and ways to properly manage waste can help inform policies to enhance and protect smallholder farming in Vietnam.

Prior to the FBLI, the Center for Public Health and Ecosystem Research (CENPER) has worked for over five years in Hanam Province, Vietnam, focusing on developing tools to assess health risks of integrated human and animal waste management. This project was funded by the National Centres of Competence in Research (NCCR) of the Swiss National Science Foundation and was concluded in 2012. Several results demonstrated risks from waste management; for example, occupational exposure to human waste and wastewater increased the health risk of helminth infection and diarrhea (Pham-Duc et al., 2013, 2011). In another example, current production systems placed stress to the local environment through excess nutrient discharge, mainly from on-site sanitation systems (Do-Thu et al., 2011). Many farmers perceived that health risks of wastewater include 'mùi hôi' (bad smell) and skin problems (Jensen et al., 2008; Knudsen et al., 2008). While the NCCR project has identified risks from waste management and developed tools for risks assessments, a more integrated assessment considering human, animal, and environmental health together is needed to determine best practices for waste management.

This research builds on the previous NCCR project by using an Ecohealth approach. The goal is more sustainable waste management, and improved health and well-being for smallholder livestock farmers in Hanam, Vietnam, and neighouring countries. The objectives were to: 1) further determine risks of human and animal waste management to human, animal, and environmental health; 2) determine socio-economic and cultural factors surrounding waste management; 3) identify and implement interventions for better waste management; and 4)

engage stakeholders, including forming a policy alliance group, for uptake of research findings and impact beyond Hanam.

Approach

Hanam Province is situated about 60 km south of Hanoi, in northern Vietnam. In Hanam, as well as many other areas in central and northern Vietnam, wastewater and excreta are commonly used in agriculture. Three specific communes were selected including Hoang Tay commune and Le Ho commune of Kim Bang district, and Chuyen Ngoai commune of Duy Tien district. Research was previously done in Hanam and so some connections with farmers and local leaders have already been established.

The research team consisted of five senior researchers in the fields of public health, medicine, biology, economics and medical anthropology. A research assistant and PhD student were also members of the research team. Key stakeholders and partners included farmers, and representatives from local organizations (e.g., women's union, farmer's association), Ministry of Health, Ministry of Agriculture and Rural Development, NGOs and private sectors. Partnerships were also established with networks including the Food Production-Environmental-Health in Vietnam, South East Asia Regional Wildlife Health Capacity Assessment & Networking Forum, and Vietnam One Health University Network.

Multiple site visits to Hanam were conducted to further establish connections with community members, observe current situation, and informally collect background information on agricultural activities and issues surrounding agricultural intensification. A stakeholder inception workshop was held in January 2013 which included 46 participants from agriculture and health sectors as well as farmers from Hanam. Concerns and expectations of stakeholders for this research were discussed. Focus group discussions (FGDs) using participatory rural appraisal tools (PRAs) and questionnaires were used to collect information on community profile, agricultural activities and agricultural intensification issues. Reports (many provided by villagers and partner institutions) on the socio-economic status, health status, environmental sanitation and agricultural production in the community over the last five years were reviewed. Environmental impacts were determined through collecting and analyzing wastewater samples from river water, drainage, and from biogas systems.

Results

Agricultural intensification issues in the community include, among others: household waste management; hormone and antibiotic residues in human and livestock; misuse of plant protection chemicals and pesticides; and management of animal and solid waste. The main concern of farmers and stakeholders was poor livestock waste management, in particular, the poor sanitation at breeding facilities. Some households use animal waste without proper treatment as fertilizers.

The PRAs and FGDs with the farmers and stakeholders raised a number of issues, including: i) while the number of households raising livestock decreased, the number of pigs raised increased; ii) biogas system is commonly used to treat waste; iii) most farmers do not use waste as fertilizers for crop anymore, instead, they prefer chemical fertilizers; v) pesticide use and

disposal; and vi) poor drainage infrastructure. Farmers expressed interest in improving environmental sanitation situation of their communes.

As biogas system was a concern repeatedly raised throughout the data collection phase, a quantitative microbial risk exposure assessment was conducted in March 2014 in Hanam province, Vietnam. A total of 451 households with biogas in three communes were surveyed using a structured questionnaire, and biogas samples were taken (150 samples from outlet tanks and drains). All samples exceeded industry standards for *Escherichia coli*, *Giardia, Salmonella*, *Cryptosporidium*, BOD_5, and COD.

The results showed that the percentage of households that use pig manure, poultry manure and human waste loaded into the biogas system were 90%, 30% and 80%, respectively. The percentage of households that discharged effluent directly into drains and lakes were 67% and 13%, respectively. While the microbiological and chemical indicators in waste have decreased by treatment with biogas, the *E. coli* concentrations in the biogas wastewater still exceeded WHO recommended standards for use in agriculture.

The survey also showed that using biogas wastewater in agriculture was popular. The percentage of farmers using biogas wastewater for vegetable irritation, crops irritation and fruits irritation that were 14%, 27% and 33%, respectively. Through occupational exposure, farmer's health is at risk, for example, the average diarrhea risk was from 45.7% to 89.4% during one year time when farmer worked closely to biogas wastewater.

Intervention

Vietnam's new national program for rural development in June 2010 set objectives for improving agriculture production and environmental sanitation, providing a timely platform for FBLI research to make a positive impact. Community based interventions started in October 2014 which initially sought to promote best practices among biogas users. A core group of 12 villages and researchers was formed to pilot an education campaign on 6 steps of best practice in using biogas systems. This intervention was developed iteratively through 17 interviews and 4 FGDs. Posters, calendars, and booklets were also created. In addition, a biogas technical expert was invited to the community to present ideas for effective biogas management.

Change was also promoted at the communal level. The "Hương Ước", a traditional document in each rural village, sets village rules in accordance to local cultures and practices. Eight rules of sanitation were added to the document, and new rules were actively promoted through loudspeakers and word-of-mouth in the community, raising awareness of farmers regarding effective biogas management.

Figure 7. Health promotion messaging in a calendar

Figure 8. Health promotion messaging in traditional village regulation document

Conclusion

This research provided opportunities for community members to design and implement interventions. Farmers understood how collectively, farmers can make an impact in their community. The idea of inviting a biogas expert was brought up by community members. Overall, team members changed their way of doing research by working with the local community, and increased the understanding and application of Ecohealth approach.

Lessons learned

- The flexibility of the Ecohealth approach allowed for other issues to be explored which were not originally set out by objectives (e.g., pesticides)
- Community engagement allowed for better identification of issues specific to the community

Capacity building

While Ecohealth has been promoted for a relatively long time in many parts of the world, it has only been recently introduced in Southeast Asia. As such, there is a need to develop competent future leaders in Southeast Asia and facilitate further implementation of the Ecohealth approach. Capacity building has seen the largest development since FBLI implementation, from training Ecohealth practitioners to integrating Ecohealth in training materials.

Supporting a new generation of Ecohealth practitioners

FBLI Indonesia has a future leader program which aims to nurture potential health workforce to collaborate in combating Ecohealth problems, and provides several seed funding grants. A series of future leader training had been successfully conducted in Indonesia, Thailand, Vietnam and China from 2014-2015. Since 2015, nearly 400 participants across professions participated in the training including graduate and postgraduate students, medical doctors, veterinarians, NGO's staff, academics, managers, government officers, and public health practitioners. The *Ecohealth Trainer Manual*, a resource created by FBLI and Veterinary Without Borders in 2013 for educators worldwide, was used during these workshop series and was very well received throughout the region.

The seed funding grants were used to give funding for 24 small Ecohealth projects proposed by alumni of GHTL 2014. Awardees organized workshops, research, and community empowerment in priority areas to address local health challenge in their community.

Figure 8. Cohort of Global Health True Leaders participants (Global Health True Leaders Series, 2014)

Incorporating Ecohealth approaches into higher education

The FBLI has also overseen the development of Ecohealth courses and degree programs:

- At the University of Indonesia, undergraduate public health students are now required to take a course on global health that includes Ecohealth approaches to health research.
- Mahidol University, through the Faculty of Science, in Thailand has offered a multi-disciplinary Ecohealth-based course at the graduate level since 2007. This course eventually formed the basis for further development of Ecohealth Degree Programs, the first in Asia, involving 9 faculties within Mahidol University. The development plan of Ecohealth Degree Programs was approved by Mahidol University Council, and degree Programs are expected to launch in the year 2016.
- The Hanoi School of Public Health offered a course entitled "Introduction to Ecohealth" and is developing a training workshop on avian influenza and an elective course on the Ecohealth/OneHealth approach.
- Kunming Medical University has offered an 18 hours selective course on Ecohealth for undergraduate students since 2011 and Ecohealth was integrated into a selective course for master degree students since 2012.

Knowledge translation

The key purposes of the knowledge translation component are to disseminate the FBLI research findings to appropriate audiences, and to inform policy decisions surrounding agricultural intensification, health, and ecosystems. At the regional level, newsletters (every 6 months) and annual technical reports have been produced, highlighting key activities and results (see Appendix A). These newsletters have been distributed through the FBLI website and mailing list, along with conference presentations. Activities were shared through social media platforms, including Facebook and Twitter pages. Research findings were shared in international conference presentations, including: the International Ecohealth Conference, hosted in Montreal, Canada in August 2014; the 14th World Congress on of Public Health hosted in Kolkata, India in February 2015; The 4th Food Safety and Zoonosis Symposium for Asia Pacific held in Chiang Mai, Thailand in August 2015; and the 9th European Congress on Tropical Medicine and International Health, Basel, Switzerland, in September 2015.

FBLI partially supports Ecohealth Network Asia (EHNA) and is connected with Ecohealth and One Health networks in the region to promote Ecohealth approaches, including Southeast Asia One Health Network (SEAOHUN), Ecohealth Emerging Infectious Diseases Research Initiative (Eco EID), Economic Development, Ecosystem Changes, and Emerging Infectious Diseases Risks Evaluation (ECOMORE), The Asia Partnership on Emerging Infectious Diseases Research (APEIR), China One Health Association, Partnership on Avian and Human Influenza (PAHI), and Vietnam One Health University Network (VOHUN)

Policy alliance groups were formed in each FBLI country to facilitate dissemination and uptake of research findings. Members include mid-level policy makers, and FBLI senior researchers and networks. At the country level, researchers used common dissemination techniques, including policy briefs, website publications, newsletters, international professional

conference presentations, presentations to community meetings and policy makers, and peer-reviewed publications. Key messages were also disseminated in study communities including local newspapers (Indonesia), loudspeakers (Vietnam), street theatre (China), and calendars and posters (China, Vietnam). References to some outputs are provided in **Appendix A**. The target group, while varied from country to country, generally included farmers, health care workers, policy makers, local authorities and the general public. A summary of knowledge translation activities at the country level is provided in **Appendix B**.

Monitoring and evaluation

Monitoring and evaluation activities have been carried out by the Coordinating Unit (CU) since July 2013. The purposes of these activities are to report on the progress of the program through outcomes and as such provide lessons learned for the research team. Early evaluations have been carried out in Indonesia, Vietnam and China in November 2013, October 2014 and October 2015, respectively.

Monitoring

The CU collects information from the teams on all FBLI activities every 6 month and compiles the information into different forms of outputs such as bulletins and newsletters. The publication is then circulated among the teams and networks via websites, social media or printouts. Soft versions of these outputs can be found at ecohealthasia.net.

Evaluation

Approach and Methodology

The evaluation used qualitative tools such as focus group discussions, in-depth interviews and literature and documents (such as reports and field notes) were used to formulate outcomes. Outcome harvesting approach was chosen to guide the evaluation of the program. This approach works backward and allows the teams and stakeholders to understand the progression of change, what worked and did not work, to learn and adapt from results (Wilson-Grau, 2012). An adaptation of the approach has been used. Five adapted steps include:

Step 1 – Review documents from FBLI country team including technical reports, meeting notes, field notes and other documents. Outcome descriptions will be formulated.
Step 2 – Discuss with participants about the above outcomes descriptions formulated. Participants will confirm, reject or add details to those outcomes, and formulate additional outcomes.
Step 3 – Analysis and draft of outcome descriptions.
Step 4 – Harvesters verified information by reviewing again the necessary documents (updated) and interviews
Step 5 – Finalize the report

Evaluation criteria and indicators

From a set of expected outcomes from the proposal, evaluation criteria were built up. The evaluation indicated a group of changes that the program hopes to see in the targeted stakeholders. As the evaluation focuses on the changes in behaviors, relationships, actions, policy, regulations and so on, a set of indicators are set to capture these changes.

Ecohealth field building is an outcome building process. To evaluate whether the program achieve its ultimate goals, outcomes need to be captured as soon as possible. Evaluation work support the mapping of outcomes that lead to the final field building outcomes.

Roles and responsibilities in the evaluation process

- Research team members, local community, academic fellows, and policy makers who are directly or indirectly benefit from the program's activities involved in the evaluation process. The participatory process allows these stakeholders to define and formulate outcomes, identify challenges of doing Ecohealth and draw out lessons learned.
- The CU plays the role of facilitating the evaluation activities. The Unit conducts literature and document reviews, focus group discussion and in-depth interviews among stakeholders.

Presentation of evaluation report

- **Outcome statement** describes who changes what, when and where
- **Significance** of outcome answers the question of why the change matters, how the change addressed the solution for the research issue, or how are the changes relevant to the ultimate outcomes of the project.
- **Program's contribution** explains how the program's activities contribute to these changes.

Results and findings so far

Eight (8) outcomes in four groups of researchers, local farmers, local authority, and local institutions have been found in two research teams of Vietnam and China. Outcomes are categorized in three main areas. The first outcome area marked the enhancement in doing Ecohealth research of the FBLI researchers. The researchers who take part in the evaluation identify that the process help them change their way of doing research toward transdisciplinary which involves different stakeholders and sectors. Besides, the increasing active involvement of local community i.e., the farmers and the local authority, is also noted in the evaluation. Local farmers and authority in the two studied sites have been gradually in involved in solving the research issues of which had been identified collectively among research team and the community in the previous phase. Also, the acknowledgement of Ecohealth in elective courses in the curriculum of both Hanoi School of Public Health and Kunming Medical University also

illustrated the outcomes in capacity building. Those outcomes are seeding ones and will contribute to the ultimate outcomes of the program. Detailed reports of OH exercises in two countries of Vietnam and China can be found at ecohealthasia.net.

Example of outcome description from the harvesting with FBLI China team – October 2015

Outcome statement

In the intervention phase, FBLI China researchers gained new ideas on how to improve their health education calendars when they interacted with local farmers. Farmers thought that it would be good to use the calendar as a diary to mark what kind of pesticides were used, and when. The research team integrated the diary as part of the calendar to make the product more useful.

Significance

This outcome marked the difference between Ecohealth and other traditional research approaches. In traditional approach, issues and solutions often come from scientists as the result of reviewing literature, but in Ecohealth, issues and solutions are raised from interaction with the community. The idea of "diary calendar" was formed through interaction with local community.

Contributions of the FBLI

In its design, by accepting an open research proposal, FBLI provided an opportunity for researchers to work with the local community from the very beginning phase of defining research issues. Through various interactions with the community over years, in the intervention phase, the change in the attitude of local community, from passively take part in the research to actively propose solutions of the farmers at Yuanmou County in this case, gave the research team the experience of doing Ecohealth in practice.

Summary

This booklet presented activities using Ecohealth approach to better understand health risks of agricultural intensification in Southeast Asia and China. In addition to creating new knowledge, research has supported the development of interventions to enable people to achieve better health and sustainable development. Further, capacity building and knowledge translation efforts helped to build the Ecohealth field in the region.

Overview of research

Agricultural intensification issues are widespread in Southeast Asia and China. For example, human and animal waste management is not just an issue in Vietnam and Indonesia, but also in rural areas in China. Like China, Vietnam also shares challenges in pesticide use, handling and disposal. While Thailand is the largest producer of rubber, China is a main driving factor for rubber demand. China, Vietnam and Indonesia are also large producers of rubber, and face similar challenges to Thailand including rubber price fluctuations, land use changes, and global rubber demand. FBLI research in a country is relevant not just to that country, but to neighbouring countries as well.

The main focus of the research was health problems or risks linked to agricultural intensification, and the process of understanding these problems or risks, together with the participation of stakeholders, led to the development of locally appropriate interventions and innovations. For example, cow waste management in Pangalengan was improved by converting cow waste to innovative by-products. Engaging stakeholders in the process led to its uptake in the community and beyond. In another case, community engagement helped to adapt existing health promotion tools to the community context. For instance, in Yuanmou, community-led ideas resulted in the design and implementation of calendars, posters, and playing-cards to provide key messages on pesticide risks and safe handling practices. Most case studies presented anecdotal evidence of better health outcomes from interventions based on Ecohealth research. Some changes in health status and behaviours from the Ecohealth activities will be reported at project conclusion as indicators from monitoring activities are analyzed.

While some evidence was provided to inform decision making, the influence on policy is not yet clear. In most cases, interventions have just begun; the direct influence on policymaking may be clearer as the project matures. However, initial progress can be seen as facilitated by word-of-mouth processes and networking. For instance, in Hanam, key messages from FBLI research were incorporated in the village's traditional regulation document and community members helped to "spread the word". It appeared that positive experiences together with evidence can help promote policy change at the local level.

Through these experiences, the Ecohealth field has advanced. The process of community engagement together with evidence generated by the research, motivated communities and

organizations to be involved. In Yuanmou, CDC-China actively participated in field activities. In Hanam, farmers (mostly women) worked together to help advocating for changes in waste management practices. FBLI also helped to improve the capacity of researchers in using an Ecohealth approach through trainings and workshops, and contributed to the field of literature.

Challenges in applying Ecohealth approaches

Incorporating principles of Ecohealth approaches in research, in particular, systems thinking, was challenging. In these case studies, research was focused mainly on human, environment, and animal health. The consideration of ecosystems and ecological changes on health was not explicitly addressed as it was largely outside the scope of projects, and capacity of some researchers who were mainly from the health and environment background.

Livelihoods of people can lead to exposure to health risks, and are key to successfully and sustainably implementing interventions (Charron 2012). As such, economic analysis is an important tool to consider. While some economic analysis was incorporated in the initial design phase of some projects (e.g., Vietnam, China), it was not conducted during implementation phase due to constraints in scope and time. Equity was also considered in the initial design stages, but the depth of gender and social analysis conducted thus far was minimal.

Researchers also faced the challenge of doing rigorous science for peer-review versus conducting practical community-development interventions. This challenged was raised during outcome harvesting activities, where the project seemed to be focused on outputs (e.g., publications), rather than outcomes (e.g., changes in community practice, health). However, outcomes may have been sought too early as interventions recently started.

Moving forward

Agricultural intensification is a profound development challenge in Southeast Asia. The FBLI helped to address this challenge through research, capacity building and networking. Information has been shared through networks, publications, and conference presentations. Some notable achievements include preliminary changes observed in behaviours and practices of farmers towards more sustainable agricultural development, and awareness and application of Ecohealth approaches to research in the region. Still, more work is needed, especially regarding engagement with individuals involved in policy and decision making, in generating stronger evidence (economic, social, gender), capturing results and outcomes of Ecohealth research, and translating research to policy action. As FBLI progresses to its final year, FBLI will focus on data analysis and reporting, monitoring and evaluation, and influencing policy through knowledge translation efforts. The FBLI is committed to sharing knowledge and lessons learned, for example through this synthesis booklet.

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Appendix A: Examples of FBLI outputs

International papers

1) Richter, C. H., J. A. Steele, H. Nguyen-Viet, J. Xu, Wilcox, B.A. Toward Operational Criteria for Ecosystem Approaches to Health. *Ecohealth*. 2015, 12(2), 220-226.
2) Nguyen-Viet, H., Doria, S., Tung, D.X., Mallee, H., Wilcox, B.A., Grace, D. Ecohealth research in Southeast Asia: past, present and the way forward**.** *Infectious Diseases of Poverty*. 2015, 4:5.
3) Lam, S., Nguyen-Viet, H., Tuyet-Hanh, T.T., Nguyen-Mai, H., Harper, S. Evidence for public health risks of wastewater and excreta management practices in Southeast Asia: A scoping review. *International Journal of Environmental Research and Public Health*. 2015. 12(10): 12863-12885.
4) Fèvre, S. Waltner-Toews, D., Jing, F., Kittayapong, P., Adisasmito, W., Tung, D.X., Jianchu, X., Nguyen-Viet, H. Création d'un manuel pédagogique comme action collaborative de promotion de l'écosanté en Asie du Sud-Est. *VertigO*. 2015. http://vertigo.revues.org/14935

National papers

1) Liu Yan-Fang, Fang Jing. Research development of effect of pesticide pollution on health. Soft Science of Health. 2014, 28(10):673-676.
2) Liu Yan-fang, Fang Jing, Zhu Min,et al. Investigation of organophosphate and carbamate pesticide residues in vegetables in county of Yunnan Province. Chinese Journal of Food Hygiene. 2015, 27(2): 164-167.
3) Wang Yi-Yang, Fang Jing, Zhu Min,et al. The influence of plantation production mode on the behaviours of pesticide using in county of Yunnan Province. Journal of Environmental & Occupational Medicine. 2015, (8): 758-761.
4) Liao Sheng-Lin, Wu Xi-Nan, Fang Jing. Analysis of relevant factors for occupation protection and exposure symptom of peasant-workers in Yuanmou county, Yunnan Province. Journal of Kunming Medical University. 2015, 6: 18-21+84.

Briefs and Bulletins

1) FBLI Bulletin Issue # 3. June 2015. http://ecohealthasia.net/images/Bulletin__3_FBLI_final.pdf.
2) Addressing the Impact of Agricultural Intensification on Health in South East Asia and China - An Update on the Progress of a Regional Research Network. Brief. 14th World Congress on Public Health. Kolkata. India. February 2015. http://ecohealthasia.net/news/26-addressing-the-impact-of-agricultural-intensification-on-health-in-south-east-asia-and-china-an-update-on-the-progress-of-a-regional-research-network.html

Presentations at the conferences

1) Liao Sheng-ling, Fang Jing, Wu Xi-nan, Zhumin, Wangyiyang. The Influence of Plantation production Mode on the Behaviors of Pesticide Using [C]. The 6th International Conference on Medicine of Environment and Occupation, Shanghai, November, 2014.
2) Wang Yi-yang, Fang Jing, Zhu Min, Liao Sheng-ling.The Influence of Plantation Production Mode on the Behaviors of Pesticide Using [C]. The 6th International Conference on Public Health among GMS Countries Khon-Kaen, Thailand, November, 2014.
3) Hung, Nguyen Viet. EcoHealth Research in South East Asia: Regional Synthesis and Examples from Key Programs. The 4th Food Safety and Zoonoses Symposium for Asia Pacific, Chiang Mai, August 2015.
4) Liao Sheng-ling, Wu Xi-nan and Fang Jing. Analysis of Relevant Factors for Occupation Protection and Exposure Symptom of Peasant-Workers in Yuanmou County, Yunnan Province. 6th international conference on Public Health among the Greater Mekong Sub-regional Countries, KhonKaen, Thailand, November 2014.
5) Liao Sheng-ling, Wu Xi-nan and Fang Jing. The Influence of Plantation Production Mode on the Behaviors of Pesticide Use. The 6thInternational Conference on Public Health among the Greater Mekong Sub-regional Countries, KhonKaen, Thailand, November 2014.
6) Chitti Chansang and Pattamaporn Kittayapong. Micro-Spatial Analysis of Chikungunya Incidences in Association with Rubber Plantations during an Outbreak in Eastern Thailand. The 9th European Congress on Tropical Medicine and International Health (ECTMIH), Basel, Switzerland, 6-10 September 2015.
7) Suporn Thongyuan, Phitsanu Tulayakul and Pattamaporn Kittayapong. Environmental Contamination and Effect on Domestic Animals in Relation to Rubber Plantation Activities in Eastern Thailand. The 9th European Congress on Tropical Medicine and International Health (ECTMIH), Basel, Switzerland, 6-10 September 2015.
8) Pongsri Maskhao, Suwannapa Ninphanomchai, Supaluk Khaklang, Suporn Thongyuan and Pattamaporn Kittayapong. The Living and Working Conditions Including Accessibility to Health Care of Migrants Working in Rubber Plantations in Eastern Thailand. The 9th European Congress on Tropical Medicine and International Health (ECTMIH), Basel, Switzerland, 6-10 September 2015
9) Uruyakorn Chansang, Chitti Chansang, Somchai Sangkitporn and Pattamaporn Kittayapong. Distribution of Target Site Resistance to Pyrethroids in Field Population of *Aedes aegypti* in Thailand. The 9th European Congress on Tropical Medicine and International Health (ECTMIH), Basel, Switzerland, 6-10 September 2015.
10) Hung Nguyen-Viet, DinhXuan Tung, Pham Duc Phuc, Pattamaporn Kittayapong, Wiku Adismito, Fang Jing. Ecohealth research to regionally address agriculture intensification impacts on health and the environment in Southeast Asia and China.The 9th European Congress on Tropical Medicine and International Health (ECTMIH), Basel, Switzerland, 6-10 September 2015.
11) Hung Nguyen-Viet. 2015. Building Institutional Research Capacity for Integrated Approaches: An Example from Vietnam. Invited seminar at the Chrono-environnnement, University of Franche Comte, Besancon, France, 14 September 2015.
12) Hung Nguyen-Viet, Scott Newman, Pham DucPhuc, Dao Thu Trang, Dave Payne, MahoIimanishi. 2014. Inter-sectoral collaboration for One Health implementation in Vietnam: Training, research and EIDs control polices. One Health Conference of China, November 2014.

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1) Citra Pratiwi Sidebang (2015). Measuring the Impact of Smallholder Dairy Farming on Health Using an Ecohealth Approach: A Case Study in the Highlands of West Java. Universitas Indonesia.
2) Sinar Cahya (2015). An Ecohealth Study of Smallholder Dairy Farmers in Indonesia: Which Farm Management Practices Most Impact Health and What Can Be Done About It? Universitas Indonesia.
3) Nguyen Thi Van (2015). Assessment on willingness to pay of livestock household for improving their Biogas system in Le Ho commune, Kim Bang district, Ha Nam province. Hanoi University of Natural Resources and Environment.
4) Tran Thi Quynh (2015). Assessment on current quality of wastewater after treated by Biogas system in Le Ho commune, Kim Bang district, Ha Nam province. Hanoi University of Natural Resources and Environment.
5) Le Thi Thu (2015). Health Risk assessment of exposure to human and animal waste and waste water in agriculture by Microbial quantitative risk assessment in Ha Nam province. Hanoi School of Public Health.
6) Dinh Thi Phuong Hoa (2015). Assessment of Knowledge, Practice of using pesticide in agriculture and related factors of farmers in Ha Nam province. Hanoi School of Public Health.
   Mac Thi Cong Ly (2015). Factors that affect to livestock waste management and reuse: a case study in Hoang Tay commune, Kim Bang district, Ha Nam province. University of Social Science and Humanity.

Media publications

1) Global Health Future Leaders event (https://www.youtube.com/watch?v=W4grRSo8ANs)
2) Global Health Future Leaders Newsletter (http://www.indo-oh-university.net/blog/category/news/national-news/)

For a full list from 2011-2014, see www.ecohealthasia.net

Appendix B: Summary of KT activities in four FBLI participating countries

Indicators	China	Indonesia	Thailand	Vietnam
Target audience	- Farmers and planting workers - researchers with links to policy makers	-Dairy farmers	- Rubber plantation workers - Policy makers	-Policy makers at ministerial levels -Local authorities - Pig farmers, - Villagers
Communication products produced	- Calendars and posters sharing key messages - Street theater for health education -National peer-reviewed publications - International conference presentations - Presentations during annual meeting of Forhead (network) in 2015	- Policy brief "Collaboration on Multidisciplinary Research and Zoonotic Surveillance" - Written a public opinion in a national and local newspaper - National peer-reviewed journal publications - International conference presentations	- International workshop presentations	- Calendars, posters, newsletters, and community loudspeakers sharing key messages - Research synthesis reports - International conference presentations
Timeline of past activities	Q4/2015	Q2,3,4/2015	Q4/2015	Q4/2015
Communication products planned	Policy briefs	Completed	- International publications - Research synthesis reports - Policy briefs - TV news	- Policy brief - Newsletter - International publications - Video clips
Timeline of future activities	Q1-2-3/2016*	Completed	Q1-2-3/2016	Q1-2-3/2016

*Q = quarter period (3 months)