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Understanding agrichemical use in Southeast Asian agriculture – Vietnam and Laos

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1 Acknowledgments

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2 Executive summary

The use of pesticides for controlling pests, disease, and weed infestation has been an important tool to increase agricultural yields, and a necessary contributor to food and nutrition security. However, off-label use of pesticides can have significant impacts on human and environmental health.

Understanding agrichemical use in Southeast Asia proposed a human-centred approach to understand the interplay between agrichemical use, institutional and regulatory frameworks that are intended to safeguard against off-label use, and the formal and informal networks which enable or hinder access to chemicals, information, and training.

Using a case study approach, two distinct agroecological areas in both Vietnam and Laos were selected to identify the broader drivers of use, along with specific factors which might influence increased and off-label use. Access to agrichemicals and the systems which supported container disposal were also of interest to the study.

Approaching pesticide use as a human-centred problem will deliver new insights on how to shift practices toward safer, more efficient and effective use.

A comprehensive literature review revealed multiple and interrelated institutional, economic and social drivers which continue to influence off-label agrichemical use. These include: market drivers which create incentives to use chemicals contrary to acceptable guidelines; farmers' own values and evaluations of risk, irrespective of awareness of potential harms and; the broader social and economic transitions that play into household practices including out-migration, land-use changes and increased agricultural commercialisation.

The case studies revealed these same drivers are at play across the four sites to varying degrees. Many of these drivers enabled agrichemical use at the farm level and, in some cases, strengthened farmers' dependence on its continued use.

Farmers across all sites understood the risks of overuse for themselves, their consumers and the broader environment. Yet, immediate livelihood pressures trumped all other considerations. Farmers accessed information and products from a range of trusted sources, most commonly family, neighbours, peers and input suppliers. The training gaps identified by farmers most commonly related to program access, perceived information relevance, and a lack of trust in the information provided. Personal protective equipment is almost never worn in its prescribed form (a full set of protective equipment) and disposal of chemical packaging containers can be haphazard in upland areas. Despite existing policies in both countries regulating and guiding safe use, local extension was perceived to lack capacity for strengthening safe use. Competing priorities was highlighted as a key obstacle, especially in Laos.

The topic of agrichemical use remains a sensitive topic among local leaders and farmers, even when use appears to be in compliance of regulations. This project provides further support for the re-framing of the problem of agrichemical use being the primary responsibility of farmers and users and instead situates the challenge in a wider, complex system of actors, institutions and drivers.

3 Introduction

The use of agrichemicals for controlling pests, diseases, and weeds, as well as facilitating crop growth, has been an important tool to increase agricultural yields and a necessary contributor to food and nutrition security. However, off-label use[1] of agrichemicals can have significant impacts on human and environmental health. There is considerable evidence for continued off-label use of agrichemicals in Southeast Asia, posing health risks for the farmers using them, the broader community, consumers, and the environment (Gupta 2012). At the farm level, over-reliance on chemical fertilisers contributes to soil degradation (Nguyen and Böhme 2013; Ngoc 2019); while off-label use and non-target exposure of pesticides can contribute to pesticide resistance in pest and diseases (Loc et al. 2015). While there is substantial literature on best practice, including how agrichemicals should be used from agronomic, human and environmental health perspectives, there remains a gap between recommended and actual practice.

Ensuring safe agricultural production is a priority in both Vietnam and Laos. Vietnam's ACIAR country plan includes a priority to 'reduce inputs of chemicals and fertiliser, for a cleaner environment, safer produce, improved soil health and more profitable sustainable production systems' (ACIAR 2020, pg. 120). In Laos, The 8th Five-Year Socio-Economic Development Plan outlines Lao PDR's 2030 vision of green and sustainable economic growth, and sets a direction to increase 'clean and organic' agricultural production to 2030. This concern for developing clean, safe and sustainable agriculture while ensuring food security and modernising production systems is also evidenced in the ACIAR operational plan (ACIAR 2020).

While regulatory frameworks and extension systems to support safe use of agrichemicals are in place in both countries, research conducted across several South East Asian countries suggests significant discrepancies between the regulations and capacity for governments to enforce safeguards, or ensure adequate training and extension for both sellers and users of agricultural pesticides. This results in significant human and environmental health risks and impacts (Schreinemachers et al., 2015; Hoi et al., 2016).

This SRA applied qualitative research methods to explore patterns of agrichemical use in different production systems, cultures and regulatory environments in Laos and Vietnam, as a baseline to identify potential pathways for safer, more effective and efficient use of agrichemicals.

The project brought together key partners in each country with expertise in agricultural economics, social science, and pest and disease management. In Vietnam, this included the Plant Protection Research Institute, Vietnam National University of Agriculture, National Institute of Medicinal Materials, and Vietnamese Academy of Agricultural Sciences. In Laos, the project brought together the National Agriculture and Forestry Research Institute (NAFRI) - Economic and Rural Development Research Centre and NAFRI Rice Research Centre - and National University of Laos. In-country teams were supported by the CSIRO in Australia.

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[1] In this context, we use the phrase "off-label use" to describe unsafe and/or inefficient use of agrichemicals by farmers and agricultural labourers. Our preference for using this phrase over other more common descriptions such as "indiscriminate use", "overuse" or "misuse" reflects our intention to avoid normative judgements which tend to imply poor decision making and irresponsibility on the part of farmers. However, we acknowledge that "off-label use" carries an assumption that labels are true, accurate and convey scientifically validated information – which is not always be the case.

Two case studies were conducted in Laos and Vietnam which aimed to uncover and analyse the practices of agrichemical use in selected agricultural activities. The case studies were designed to be indicative of common practices and captured perspectives from different actors in the chain, such as farmers, input sellers, community leaders, traders and government extension officers. Capturing insights from a range of different perspectives provided a basis for understanding farm-level patterns of access and use, in the context of the broader agricultural system. In-country reference groups in Laos, Vietnam, and Australia guided the research, provided advice, and acted as a mechanism for fostering relationships and ongoing involvement in research outcomes.

The project applied a human-centred approach to understanding the interplay between agrichemical use, institutional and regulatory frameworks that are intended to safeguard against off-label use, and the formal and informal networks for access to chemicals, information, and training. To this end, in early project stages the team developed a systems framework (see section 4) to conceptualise various components of the agrichemical use system. The development of this framework has guided our problem framing, our selection of case studies, and our research methods.

A simplified systems framework to conceptualise the broader drivers, dynamics, impacts, and actors involved in agrichemical use and their interactions appears in 1. The original, slightly more detailed version appears in the literature review document submitted as a milestone in June 2021.

3.1 Research objectives and impacts

This project aimed to develop an understanding of agrichemical use in Laos and Vietnam, through cross-country comparison of institutions and practices. It aimed to shine a light on the many different factors that influence or drive off-label use. As an SRA, the project sought to contribute a baseline understanding of agrichemical use to inform pathways to safer, more effective and efficient use of agrichemicals for future ACIAR research. The key research questions posed were:

- What are the key drivers and considerations that shape agrichemical use in Laos and Vietnam?
- How can this information inform actions to improve social, environmental and economic outcomes from agrichemical use?

The SRA had three key objectives:

1. Assess available frameworks (including One Health) to guide an integrated, systems-based understanding of agrichemical use within a broader social and environmental context (see section 4)
2. Provide a detailed understanding of farmer practices relating to agrichemical use through case studies in Laos and Vietnam (see sections 5-7)
3. Develop relationships with government and non-government stakeholders as a foundation for future change processes (see section 8).

The work was carried out in three phases. The first phase focused on a desktop literature review to define an appropriate framework for the scope of research in terms of farming systems and agricultural pesticides. Each country team conducted a synthesis of

government policies and regulations which governed safe use. The output created in this first phase is Williams et al., unpublished report, submitted as a key milestone and a summary is provided in Section 4. The insights from this preliminary work were used to inform the design of the next phase of work which included the case study design, building capacity in qualitative research methods and data collection. The output from this phase was a Case Studies Research Plan, available on request. A final phase focused on consolidation of research findings, cross-country comparison and communication of research findings. These details are incorporated into this final SRA report and the individual country case study reports, included as separate Appendices.

3.2 Impact pathway

It has been important for the team to share a collective understanding of the project objectives and its impact pathway. We began this discussion by acknowledging that our project is relatively small, and short term. We identified the long-term goal of the project to contribute to:

- Farmers and industry using agrichemicals more safely, efficiently, and effectively. Which will support reduced negative impacts on the environment and health.

A premise of the project is that, in order to facilitate this change, a better understanding of the system, and broader drivers of agrichemical use is needed. It was not clear what kinds of outcomes a changed understanding would inform, but this could include changes to regulation, extension, private sector regulations and incentives, or the design of agricultural research projects.

Based on the project proposal, there were two ways the project could contribute to this broader goal:

1. Developing new knowledge and approaches to understand drivers of agrichemical use

2. Building relationships and networks with key people and agencies who can champion change

The team focused discussion on the specific ways in which the project activities and outputs would contribute to these changes.

Figure 1 shows the impact pathway developed for the project. Yellow boxes highlight the activities and outputs relating to the outcome of new knowledge and approaches. The systems framework (Section 4) provides a new way of thinking about and understanding agricultural chemical use.

relate to the outcome of new relationships and networks to champion change. The main activity contributing to this outcome was the reference group panels (one each in Australia, Vietnam, and Laos) in addition to networks built in the conduct of the research. Reference group meetings served two key purposes. First, they provided guidance and

feedback to the team at key intervals of the project, allowing the team to tap into the vast number of experts in this area. Second, they provided a mechanism to socialise and disseminate our findings. The aim of the panels was to help bring together a loose community of practice from multiple sectors with an interest in thinking differently about agrichemical use challenges as a foundation to future collaboration and/or facilitating change in regulations or policy.

Further information on the composition of the reference panels, and some key themes of discussion from the final meetings are included in Section 8 below.

4 Assessing available frameworks to guide an integrated, systems-based understanding of agrichemical use.

This section provides an overview of work to fulfill the first objective of the SRA: to assess available frameworks (including One Health) to guide an integrated, systems-based understanding of agrichemical use within a broader social and environmental context. This provided the basis for the research design and analysis.

4.1 Framework review and development

A literature review informed the general design of case studies including the shaping of research themes for subsequent data collection. The literature review summarised:

- Current policies, regulations, and institutions in Laos and Vietnam that are relevant to agrichemical use;
- Existing information on patterns of agrichemical use (i.e., the extent of use), practices (i.e., how they are used) and drivers determining agrichemical use in Vietnam and Laos; and
- Available systems-based frameworks for conceptualising agrichemical use in Southeast Asia.

Project partners met virtually in December 2020 to agree on a shared approach for conducting the review. Based on these discussions, broad guidance questions for each topic of the literature review were developed, and search strings[2] and criteria created to help narrow down relevant items. Country-specific searches used Web of Science and Google Scholar search engines to locate initial literature for sorting. Vietnamese and Laos language articles were included in searches. Policy documents were retrieved from relevant Departmental websites or in-person visits to Departmental offices. As the review progressed, partners met (as in-country teams, and as whole-of-project) to discuss challenges and progress. This process ensured a broadly similar approach in each country, though partners have used expert judgement to ensure relevance to their country context and feasibility given time and resources.

It is worth noting that, though the review did not exclude agrichemical use relating to livestock or aquaculture, the bulk of the literature reviewed focused on crop and horticulture production. Similarly, studies considering the use of rodenticide and chemical fertiliser were relatively thin in our review. This could be due to the parameters of the search and criteria (e.g., the decision not to review IPM literature[3]) and the disciplinary strength of the team leaning towards crops and horticulture. This was managed through the research design. The review provided an important foundation for the remainder of the

[2] E.g., the search string for Vietnam: Viet AND (agri*chemical OR agro*chemical OR pesticide OR fertilizer OR fertiliser OR rodenticide OR herbicide) AND (use OR application OR adoption OR adapt OR practice OR method OR framework)*
*Syn. of agrichemical: agri-chemical // agro*chemical // pesticide // fertilizer / fertiliser // rodenticide // herbicide*
Syn. of use: application // adoption // adapt // practice // method // framework

[3] To keep the scope of the review manageable, IPM literature was excluded unless it specifically addressed drivers of agrichemical use.

project, defining an appropriate framework to guide the research, and provide guidance on case study design and selection.

The review presents key details from Vietnam and Laos regarding policy, regulation, and current patterns of use. The latter sections of the review draw out broader considerations for case study design. The review document is available as a separate output (submitted as a first deliverable). In this section, we provide a brief description of the agrichemical use system framework that was developed through this review.

4.2 A systems framework to understand agrichemical use

The vast literature on agrichemical use has focused on: (1) quantifying rates of chemical application in farming systems; (2) identifying optimal application practices; and (3) designing behaviour change and communication strategies to motivate farmers to use chemicals according to acceptable criteria (defined by governments, researchers, and agrochemical companies)[4].

The bulk of this literature carries a number of assumptions. These include that: (1) the responsibility (and power) to shift to safe use lies chiefly with farmers and primary users of agrichemicals; (2) improved information provision (e.g., product labelling and extension support) is key to changing practice (despite mixed evidence of the effectiveness of a knowledge deficit model of behaviour change) and; (3) continued promotion of a 'safe model of use' as an overarching goal for reducing harm will alone be sufficient to change outcomes.

While we acknowledge the merits of each of these lenses, the complexity of the social, institutional, and economic context in which agrichemicals are accessed and used has prompted us to search for more holistic approaches to define and examine the problem.

Agrichemical use sits at the interface of multiple science domains including agriculture, health, and sustainability. Across these science areas, a few notable frameworks and research approaches exist which could help explain the complexity of off-label agrichemical use. Our initial systems review focussed on One Health; Agricultural Innovation Systems; and political ecology as three distinct approaches which have different emphases and strengths, and different degrees of existing application to agrichemical use issues[5]. While each offers conceptual, theoretical, and analytical explanations of aspects of the agrichemical use problem, our review has identified gaps in each of these that fail to fully explain the dimensions, dynamics and interactions that make up the agrichemical use system[6]. For a fuller discussion of the merits and limitations of selected systems approaches, please refer to Williams et al., (2021) unpublished report.

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[4] A clear exception to this generalised classification is the large body of applied research in integrated pest management, and other organic-production systems.

[5] There are other frameworks (e.g., Health Promotion and Health Systems) which contain elements potentially useful to the agrichemical use topic such as the recognition of structural inequalities and their effect on health outcomes. Given these elements overlap with existing frameworks embedded in the agricultural domain, we have acknowledged them without going into detail.

[6] There are few papers which take account of the socio-economic and political aspects of agrichemical use but do not use 'systems' framing to describe the dimensions and dynamics of chemical use. Of note is Hu (2020) who discusses some of the broader social and industrial transitions which have influenced contemporary

In constructing a framework that captures the key dimensions, dynamics, and interactions of the agrichemical-use system, each of the three existing systems frameworks mentioned above offer valuable insights. Drawing on these frameworks and existing studies of agrichemical use and agricultural development more broadly, elements that are useful to understand agrichemical use as a foundation for identifying future intervention points are summarised in Table 1. These features or themes of analysis are relevant to agrichemical use, but also broadly applicable to agricultural change and innovation.

Table 1 Critical elements of existing systems approaches useful to understanding agrichemical use

Useful features from existing frameworks	Relevant framework/approach
Integrates understanding of social, agricultural, and ecological systems and their inter-relationships	One Health; EcoHealth; Social Ecological Systems; Agricultural Innovation Systems
Considers how formal and informal institutions (norms, culture, practices, policy, regulations, markets) and social relationships frame feasible actions	Agricultural Innovation Systems; Political ecology; Health Promotion and Health Systems; Social Ecological Systems
Explicitly considers how structural inequalities and power dynamics influence practices, and how they differ for different groups (e.g., women, youth, labourers)	Political ecology; Health Promotion and Health Systems
Explicitly acknowledges that stakeholders have diverse goals, priorities, and motivations; and vary in their perceptions of and exposure to risk	Political ecology; Health Promotion and Health Systems
Considers outcomes and impacts of system change, and distribution of costs, benefits, risks	Political ecology, One Health
Considers interactions and relationships across scale.	Agricultural innovation systems, Political ecology.

In the case of One Health, a focus on the importance of cross-disciplinary approaches allows for the consideration of cross-sectoral linkages (e.g., agriculture and health), which is potentially useful to understand the interplay between, for example, chemical use practices and health risk perceptions (cf. Shattuck 2019). In addition, the One Health research approach promotes the identification of direct and indirect links between humans and their natural/physical environment, and outcomes from those links. This has particular relevance in this context, given the issues across agrichemical storage, use and disposal activities.

Agricultural Innovation Systems is process-focused, looking at enablers and constraints in the process of translating knowledge to action, with attention to scale dynamics and

pesticide dependence. While not explicitly mentioned here, these handful of papers have contributed to our thinking about the ideal scale and context of the framework we present in this report.

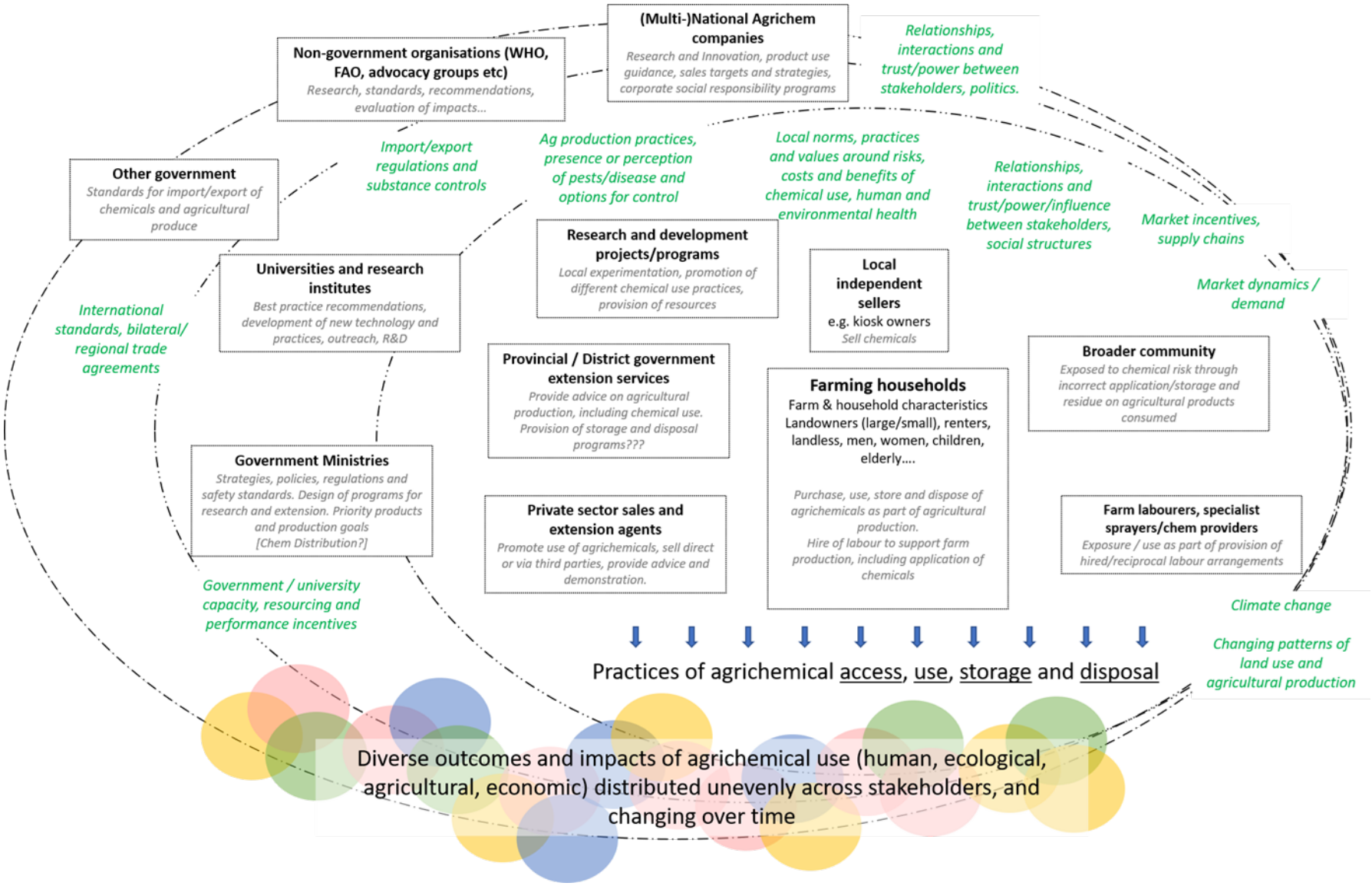
dynamics across sectors. In the context of agrichemical use, it draws our attention to the interplay between regulatory and policy environments that seek to control agrichemical use; government, NGO and private sector actors that play a role in education, advocacy, and promotion of agrichemical use; and the range of individuals and organisations involved in the supply, use and disposal of agrichemicals and related equipment. An added advantage of Agricultural Innovation Systems is that it is broadly familiar to, and accepted within, the agricultural research community and provides a familiar grounding to introduce different perspectives.

Political ecology is also process-focused but brings particular attention to structural inequalities, marginalisation, and distribution of costs and benefits. In the context of agrichemical use, it provides a useful lens to highlight and explore how different actors perceive and bear risk differently, as well as the structural issues that reinforce some of these disparities.

Figure 1 summarises a blended framework, based on the themes in Table 1. It shows a generic picture of agrichemical use, including institutional or structural influences (green text), and identifies key actors/stakeholder groups (boxes) across levels (local through to international, dashed ovals). It also explicitly notes the multiple aspects of chemical use, including access, use, storage, and disposal. It does not explicitly include interactions or links between stakeholders across levels, partly for legibility and partly as this is likely to be context-specific and needs to be explored more deeply through application. Similarly, outcomes and impacts of agrichemical use (coloured circles) are left deliberately broad.

Formal exploration of outcomes/impacts of agrichemical use is challenging due to the expertise and timeframes required to observe and collect data on ecological and human health implications. It is out of the scope of our research project to formally consider outcomes and impacts of chemical use. However, perceptions, experiences, and understanding of impacts of agrichemicals are part of stakeholder decisions to use, promote or abstain from agrichemical use and to this extent, are relevant to our work.

Figure 1 A systems framework for understanding agrichemical use



5 Case study design

Objective 2 of this SRA was to provide a detailed understanding of farmer practices relating to agrichemical use through case studies in Laos and Vietnam. This section outlines the research design and methods to achieve this objective. A case study approach was taken as this would allow a rich understanding of some of the dynamics of agrichemical use to be explored from multiple perspectives including farming households, traders, extension officers.

The project was initially scoped and planned in 2019. With the onset of the COVID-19 pandemic, the teams plan for in-depth research with communities had to be adjusted to manage the risks of exposing the research team to COVID-19, and to the research team inadvertently bringing COVID-19 into vulnerable rural communities with limited health support. The shift to online- and remote data collection proved challenging for all teams, particularly in a context where the research explored potentially sensitive activities for farming households (refer to section 10.2 Recommendations - for team reflections on using remote data collection in this context). To manage these difficulties, Lao, Vietnam and Australian research teams met regularly online to problem-solve, share experiences and lessons as part of learning to do remote social science research.

5.1 Research questions and methods

A case study is an in-depth study on a particular issue, in context. They are excellent for understanding what, how, and why something happens. Case studies allowed the team to undertake a detailed description and analysis of processes, events, and relationships, that help us understand why farmers use agrichemicals the way they do.

Online workshops and meetings between the Australian, Lao, and Vietnam research teams helped to ensure a similar research approach across the case studies. Four broad topic areas or components were defined based on the framework review (section 4).:

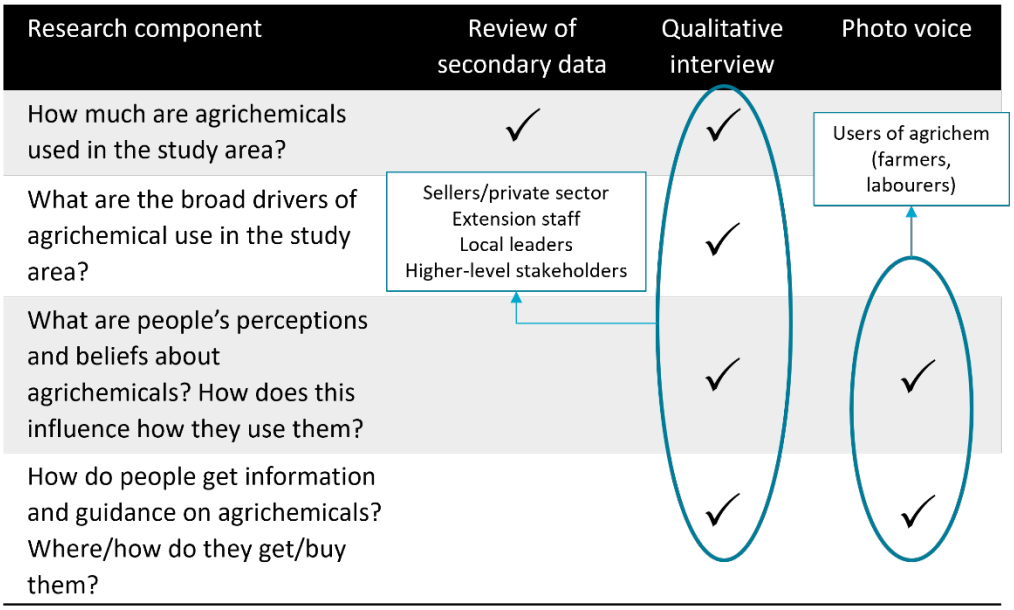
- The extent of agrichemical use in the case study area
- Farmer beliefs and practices relating to agrichemical use
- How people access information and resources relating to agrichemical use, and
- Broad drivers and motivations surrounding agrichemical use

In collecting information about agrichemical use, the risk that participants would share information about practices that were not aligned to local recommendations or expectations was identified. To protect agrichemical users and local officials from shaming or punishment as result of disclosure, additional care was taken to ensure confidentiality of information provided. Careful consideration of what information was needed from individuals (and what information could be obtained from other sources) was also given. The potential to use innovative data collection methods amenable to sensitive, remote-based research was also considered as means to reduce the risks identified.

The task of creating trust and rapport with participants was identified as a significant project challenge given the shift to remote data collection. The application of the Photo voice method was chosen to reduce the risks identified above, including the potential for this method to create a comfortable atmosphere.

Data to inform the case studies was drawn from secondary data, interviews, and Photo voice (Table 2). More detail on each method is provided below.

Table 2 Research components and the methods used



In choosing different methods, we considered:

- Whether certain questions or methods put participants at risk or discomfort. For example, it may be risky and time consuming to ask farmers in detail about which chemicals they use and how they apply them.
- What information different respondents are best suited to provide. For example, we can most likely get broad information on farmer practice from other sources such as the local extension officer or statistics, which would not put individuals at risk (or are less likely to put them at risk).
- Expected 'comfort' with remote forms of data collection, like phone interviews. We assumed that people with official positions (like village heads, or local extension) may be more comfortable or confident with phone interviewing, and more used to direct questions proposed.

Table 3 outlines the sampling strategy based on field work budgets. Precise numbers for each group were largely depended on site circumstances and available flexibility. A mix of gender, age and roles was prioritised. (Refer to individual country reports for further details).

Additional opportunities to speak with other actor groups were embraced as the research progressed. For example, agribusiness export agents (Doveco and Nafoods) were interviewed in Vietnam, and civil society representatives (from SAEDA and LURAS) joined workshop discussions in Laos. (For more details, please refer to individual case reports in the appendix).

Table 3 Target number of interviews by participant group, per country

	WHO (EXAMPLES)	METHOD	NO. OF PARTICIPANTS (GUIDE)
Input suppliers	• Kiosk owner • Traders • Company reps	Interview	4

Local leaders	• Village head • Farmer group leader • Others …	Interview	2
Extension officers	• Provincial, district and/or village extension officer • Company extension officer	Interview	2
Higher-level stakeholders	• National or provincial officials • Regional company representative • Export companies* • Researchers	Interview	2
Agrichemical users	• Farmers • Labourers • Sprayers	Photo voice	10

*Note: Two export company directors were interviewed by the Vietnam team to link with the Vietnam Agribusiness Reference Group established by Howard Hall (Agribusiness RPM, ACIAR) and Do Thanh Lam (ARG Group Coordinator).

5.1.1 Qualitative interviews

Qualitative interviews were the main method for engaging with extension officers, local leaders, and agrichemical suppliers. Specific interview guides were developed for different types of participants. The types of questions differed slightly based on the actor's role and expertise. Broad themes for the interviews are shown in Table 4.

Table 4 Generic themes for interview guides

THEME
About the participant / their role in agrichemical use
• About them, e.g., their role and length of time in the role • General description of agriculture in their village/commune • Observed changes in agricultural practices?
Observations of how agrichemicals are accessed, used, and disposed of
• Types of disease and pest problems in the area • How pests and diseases are managed • Who is using agrichemicals? What type of farmer/labourer? • How they are used, and what types of things are considered?
How people get information about agrichemicals, and how they get agrichemicals
• Where people get information / learn about agrichemicals and how to use them • Where people get information / learn about agrichemicals and their use? • How people make decisions on what to use / stock • How people manage and dispose of agrichemicals • What are the challenges or difficulties?

Role / involvement of government and companies
• Are there programs or projects in the case study area on agrichemical use? • Who is responsible for these projects? • What type of project? What are the aims etc?
Risks and benefits
• What are the different opinions about agrichemicals in the community? • How do people see the main risks and benefits of agrichemical use?

All interviews for the Vietnam case studies were conducted by telephone and detailed notes taken, with RA support. The Laos team decided to conduct a mix of telephone and in-person interviews, where this was possible. The interview notes were analysed using NVIVO for the Vietnam team, while the Laos team conducted their analysis manually.

5.1.2 Photo voice

Photo voice was the main method for engaging with farmers and labourers as it provided the participant more control over what was discussed and helped to manage risks relating to illegal activity. Participants were invited to take a number of photos based on a broad prompt or instruction from the researchers. Researchers then had a structured discussion with the participants about the photos that were taken.

Photo voice allows the participant to define the focus of the interview. This means we hear what is important to them, and what they are interested in talking about. Therefore, it can show new interesting information the researcher may have not thought to ask.

In the context of remote data collection, it also provided the opportunity for researchers to see part of the participant's world/reality, without physically being in the village. The photos can also create a more comfortable environment for participants (there is something else to focus on). The photos themselves are also part of the data, and may provide additional information or insight that we would not have otherwise seen.

A detailed guide was developed to guide the team in using the Photo voice method. The team's approach included an introductory conversation with the prospective participant to enable some rapport and trust to be built before an explanation of the project was provided and consent for participation sought. Participants were asked to take 2, up to 5 photographs of an aspect of agrichemical use that depicted something they liked, appreciated, benefited from using agrichemicals, and something that they disliked, had concerns about, or found challenging in relation to their use of agrichemicals. Participants needed to have access to a digital camera (we assumed smart phones were common) and data/Wi-Fi to return photos to the research team.

Care was taken not to include photos of children, and to ensure permission was granted from individuals who appeared in the photos taken. A follow up conversation was arranged where the participant shared and discussed the photo they took. Prompt questions were designed to guide the researcher in encouraging a 'story-sharing' discussion rather than a question-and-answer type of research interaction. The discussion prompts included: *Tell me about the photo that you took, what does it show? What does it mean to you? How has this situation [in the photo] come about? Is there anything you wanted to add?*

5.1.3 Secondary data

Where available, secondary data (e.g., on product sales, use, training) was used to contextualise information gathered in interviews, in addition to the data retrieved during the literature review. Specific details are accessible in the individual country reports, but include for example information on the types of chemicals used, how much, and for what pest and disease problems. Contrasting secondary data against information provided in interviews provides an important check on the official narrative of agrichemical use against the on-ground reality.

5.2 Case study site selection

The initial literature review, in combination with country reference panel discussions (see Section 8 below) informed case study site selection.

Study sites aimed to explore and compare different conditions including:

- A mix of farming activities, including farming activities that are known to include use of agrichemicals
- Interest and willingness of local leaders (village, district and provincial) to conduct the research
- Existing relationship or knowledge of the research team to the location
- A mix of geographic characteristics (upland/lowland, urban/rural, remoteness, agroecological zones)
- Socio-economic considerations (subsistence/commercial production; landlessness, ethnicity).
- Government priority crops or production areas.

In Vietnam, Dong Anh and Moc Chau districts were chosen as suitable case sites for this project. Dong Anh in Hanoi province was selected as it belongs to a lowland area, representative of urban agriculture. Horticulture production is highly commercial, especially leafy vegetables. Farmers also have deep experience in vegetable production which is a major crop commodity in the district.

Moc Chau in Son La province was chosen as being of upland, rural agriculture now in transition to commercial production, especially fruits and vegetables. The majority of population in the district of Moc Chau is ethnic minority.

For Laos, a mix of farming activities, including those that included high use of agrichemicals, as well as existing relationships and trust already established were pivotal in selecting Hadxayfong (Vientiane province) and Nonghed district (Xiangkhouang province) as study sites.

Figure 2 Case study sites in Vietnam and Laos

6 Understanding farmer practices relating to agrichemical use: Vietnam

This section outlines key insights from the Vietnam-based case studies. For a fuller discussion of each case study, see separate appendices.

6.1 Van Noi commune, Đông Anh district, Hanoi

Study area context

- Dong Anh is a leading vegetable production area in Hanoi, known for safe vegetable production. Several good practices in crop production have been introduced including IPM, safe vegetable production protocols[7], organic farming, and VietGAP. A shift from rice to cash crops (vegetables, flowers, fruit trees), and from conventional and local varieties to higher quality varieties is underway. Cooperatives are established and produce can be sold in the local wholesale market (Chợ rau an toàn Vân Nội – Van Noi safe vegetables market), local wet markets, cooperatives, collectors, vendors, and even hospitals, supermarkets and airport kitchens.

- With high intensity of land use, and pressure from decreasing land availability for agriculture due to urbanisation, the challenges in managing and using agrichemicals in crop production in the district include: (1) land degradation due to exploitation; (2) negative impacts of agrichemicals on farmers and communities (due to the proximity of residential area to fields), especially leafy vegetable being the main vegetable in the district; (3) maintaining produce quality to meet contracts with larger buyers and retaining the district's reputation, and; (4) aging agricultural labourers, which might influence the uptake of new technologies in agricultural production.

Agrichemical use, access, and practices

- Access to agrichemicals (chemical fertilisers and pesticides) is ubiquitous in Dong Anh, although high prices and perceived mixed quality of products (i.e., doubts about product effectiveness) have influenced their use among interviewed farmers. The majority of Dong Anh farmers used organic fertiliser or (poultry) manure to improve soil due to high frequency of land use.

- Farmers both approached and relied on input suppliers for information about pesticides but information about fertilisers was not usually sought, with farmers having sufficient confidence in their own knowledge. Farmers reported mixed levels of trust in the information provided by input suppliers often believing that older experienced farmers possessed more knowledge. Products containing foreign language labels were purchased and, in some cases, recommendations

[7] Safe vegetable was first introduced in 1998 in Vietnam as "meet all minimum requirements that defined by WHO and FAO". In 2012, safe vegetable is defined as (I) meet national technical regulation on food safety, of (ii) is produced aligned with protocols guided by Provincial DARD (safe protocol), or vegetable is certified VietGAP or equivalent.

relating to their use was sought from suppliers. In some cases, foreign-labelled products were referred to as 'fake' products.

- An emerging trend of switching from chemical fertiliser and pesticides to organic fertiliser and bio-pesticide was confirmed by local agricultural staff and an input supplier. However, bio-organic fertiliser is only used by farmer cooperatives in some pilot areas that are supported by extension programs. Some doubt remains about the sustainability of this shift given the increased cost to producers.

- Local staff and input suppliers considered agrichemical use by farmers in the commune as appropriate and no cases of off-label agrichemical use had been found in the commune. In fact, off-label agrichemical use by farmers is not possible to detect, because agricultural staff do not have a duty to inspect farmers' fields. It was reported that regular inspections from government agencies of agrichemical shops, have prevented the open trading of illegal agrichemicals.

- The majority of farmers do not rely on knowledge gained solely through formal training, but combine information from their own experience and the experience of other farmers with stockists' consultations. For farmers who had participated in formal training provided by the Provincial Plant Protection Department (PPD) or agrichemical companies, some explained that the training content was theoretical, and very different from reality in their field, or that they simply felt confident with their own experience.

- Farmers rarely stored agrichemicals at their homes because availability was commonplace and storage was considered a hazard.

- The disposal of agrichemical containers is organized by the district people's committee. There are trash bins and tanks placed in the field that are convenient for farmers to dispose packets of agrichemical inputs (mostly pesticide). The containers are collected and treated separately from other waste. There were reports of farmers perceiving that agrichemical containers were not collected appropriately.

- Farmers reuse empty bags of fertiliser as garbage bags, burned them, or placed the bags at the field corners to limit grass growing/weeds.

Perceptions and beliefs about agrichemicals

- Some farmers believed that pesticide use would increase in the future because of pest resistance problems. They also believed that the intensive use of chemical fertiliser would increase the incidence of pests and diseases in crops and decrease the fertility and porosity of the soil.

- All farmers reported that they used protective measures, including plastic raincoat, hat, mask, boots, gloves and glasses. However, in the photos sent by one farmer to the research team, it could be observed that the female farmer was not wearing adequate protective clothing. Farmers reported experiencing health effects from exposure to toxic odours while using chemical fertilisers if protective clothing was not worn.

- Farmers varied in their beliefs about agrichemical use effects on health but many believed the risk of agrichemicals was much greater for producers than consumers. Interviewed farmers were quite confident about agrichemical use in their own fields, but worried about the overuse of agrichemicals by other farmers

for both chemical fertiliser and pesticides. Observing preharvest intervals was considered important to protect consumers' health.

- All interviewees reported that their use of agrichemicals was appropriate, however reflected on the level of overuse by surrounding farmers. It was noted that farmers who sell vegetables to traditional markets do not have to comply with standards, and in many cases (normally at time of high vegetable price), farmers might apply more fertiliser to create a faster vegetable harvest and good appearance. Both farmers and local cadres (commune-level official) believed that agrichemicals are indispensable to crop production.

- The sustainability of soil productivity was mentioned by farmers as excessive use of fertilisers was believed to damage and harden the soil. Farmers also discussed the effects of agrichemical use on water resources. They believed that in the long run, the residue of chemical fertilisers and pesticides would penetrate deep into the water bodies and affect the quality of groundwater.

- The quality of fertiliser and pesticides was mentioned during discussions and several farmers found pesticides ineffective. Reasons offered for their ineffectiveness varied and included foreign or missing labels, illiteracy, or perceived 'fake' products. No quality issues were raised by local agricultural staff.

Role of government and private sector

- Training on agrichemical use is provided by both line agencies (formerly District Department of Plant Protection – DDPP, now the District Center of Agricultural Services – DCAS), extension, and private companies via demonstration farms to build capacity in techniques such as adoption of VietGAP, organic production, adoption of new techniques, practices, and inputs (fertiliser, pesticide). Private companies usually organize workshops to introduce their products to farmers and guide farmers in using their products.

- Some research institutes and universities (VNUA) also work with DDPP and provide trainings to farmers in nutrient and pest management. However, access to and participation in training was not consistent across farmers interviewed.

- The DDPP – now known as DASC, along with extension staff inspect the incidence of pests and diseases once a week for major crops in the district. If the situation is serious, it will be announced to farmers and recommendations made along with solutions.

- Pesticide retailing is a conditional business in Vietnam, with specific requirements for registration, physical assets, and products. Interdisciplinary inspectors coordinate with other functional departments to inspect and detect problems with pesticide brands, quality of pesticides and fertilisers.

6.2 Tân Lập and Hua Păng in Mộc Châu district, Sơn La

Study area context

- Moc Chau is located in the South of Son La, in North West Vietnam. The district is home to multiple ethnic groups, including Kinh, Thai, Muong, H'Mông, La Ha, Sinh Mun, Khơ Mú, Dao, and Tày people. The contribution of the agricultural sector to total GDP of the district is about 30%.

- The main crop farming systems in the district are: rice; rice-rice; rice–cash crop (vegetable, winter crop) and; vegetable only. Fruit trees are planted in all communes, with plum, and avocado in the cooler sub–region, mango and longan in the warmer sub-region. Cultivation areas of interviewed farmers range from 200m^2 to 23,000m^2 (2.3ha).

- Although many farmers have heard about different production practices like safe, organic, VietGAP, etc., they have not applied them. Crop cultivation is still largely based on their own (or parental) farming experiences. Marketing channels for Moc Chau farmers are dependent on traders and local collectors. Produce is often collected directly from farms and orchards.

Agrichemical use, access, and practices

- Moc Chau farmers have fair access to agrichemicals, with about 20% of respondents still finding it difficult to buy pesticides at the desired quantity and quality, this figure drops to about 10% for fertilisers. Better access is reported closer to main roads or as part of specialized production. Sporadic shortages of supply continue to occur for both fertilisers and pesticides.

- Moc Chau farmers used both chemical and bio-pesticides. Some produced herbal pesticides, such as a mix of grounded garlic and chilli, which is quite expensive.

- Farmers purchase fertilisers and pesticides in local (often communal) agrichemical outlets but access varies between farmers. For small scale farmers, agrichemicals are purchased from shops in the centre of the commune. For larger scale farmers, direct ordering from companies is available. When a farmer does not trust a village- or communal outlet due to perceived low quality or ‘fake’ product, they travel to larger or provincial outlets in Moc Chau town.

- Many farmers relied on input suppliers as the primary source of information when applying pesticides. Input suppliers also provided informal credit access to farmers for purchases of agrichemicals. Ninety percent of farmers reported reading the labels of products. For pesticides, they read recommended use dosage and other information on the label, however only a few farmers could specify what information they looked for. Many were simply guided by pictures or symbols on labels, or the advice of the retailer.

- A shop owner interviewed reflected that some farmers were often swayed by the professional appearance of pesticide packages. For fertilisers, in all cases farmers used familiar trusted products, often guided by those used by neighbours or other farmers in their village.

- All stockists interviewed understood the negative impacts of agrichemicals on human health and the environment.

- About two-thirds of farmers reported they had participated in training for fertiliser application while some farmers revealed they had not been invited since local extension cadres often select farmers to participate. For those who received training, confidence in their own experience was the primary guiding source of information when applying fertilisers.

- As in Dong Anh, local staff report that agrichemical use by farmers in the commune is appropriate and no case of off-label pesticides was known to occur in the commune. However, some farmers communicated that they still observed other farmers using banned herbicides, especially “burning grass”. Agrichemical

overuse was confirmed by interviewed stockists, for both chemical fertiliser and pesticide. Underuse of agrichemical due to low accessibility (affordability) was also mentioned by district officers.

- All farmers reported that they used protective equipment during pesticide application, but not all of them used the complete set, despite receiving training. Comments about discomfort were heard. The majority of farmers did not record the timing and quantity, or the name of pesticide application.

- For most farmers, storage of agrichemicals at home was not an option often due to limited availability or cost limitations. Local staff reported ad hoc use of trash bins for disposal of empty containers, where they were available. Disposal of packages in the environment was reported, as was rinsing containers in local water sources. Burning of containers or bringing them home to mix with domestic waste was a practice for some.

Perceptions and beliefs about agrichemicals

- Like in Dong Anh, Moc Chau farmers showed many key advantages of chemical use through their photos. Most farmers interviewed used chemical fertilisers because they provided nutrients for all fruit trees to grow stronger, faster, and better fruit productivity and better appearance.

- About a third of farmers interviewed believed that chemical fertiliser would be reduced in the future, with bio-fertiliser and manure replacing its use, mostly because of the harmful impacts of chemical fertiliser on soil but also its high cost. Other farmers believed chemical fertiliser use would increase in the future due to higher crop intensification, especially fruit trees, plus the consumer preference for attractive appearance of produce.

- The trend of switching from chemical fertiliser and pesticides to organic fertiliser and bio-pesticide was confirmed by most local agricultural staff and input suppliers. However, some local staff doubted that farmers would increase the use of organic fertiliser and bio-pesticide because agrichemicals are extensively used by most farmers.

- On the health effects of agrichemical use, interviewed farmers gave diverse responses. For fertilisers, some farmers felt uncertain about or considered little or no effects since they used protection (e.g., clothes, gloves, boots, masks). A few farmers believed that once chemical products were allowed for sale in the market, they must be regulated to bring no harm to users.

- Many farmers believed pesticides could be harmful when in direct contact with the skin or when inhaled. Itchy skin, vomiting, headaches, dizziness, and tiredness were among symptoms which farmers reported after spraying.

- Many farmers also realized the possible effects on consumers' health ranging from mild to severe consequences. Few farmers thought there would be no effects to consumers.

Role of government and private sector

- Plant protection staff from the District Center of Agricultural Services (DCAS) inspect pests and diseases on the main crops once a week, and inspection could be expanded to other crops if the situation of pest and diseases became serious. DASC is responsible for providing trainings to farmers, transfer techniques and

technologies in agriculture for farmers, and build demonstrations at farms (new varieties, new fertiliser, pesticides). They also provide information on new/advanced inputs, including fertiliser and pesticides.

- Some research institutes from Hanoi provide trainings for farmers. Agrichemical companies organize workshops to introduce their products and guide farmers to use. Private companies such as Vietfarm and tea companies who buy agricultural products from farmers also provide training to meet required standards. Vietfarm is reported to provide pesticides for their supplied farmers as well.

- However, many farmers did not participate in any training. The leader of a cooperative and the farmer union added that there had not been any training on pesticide application provided yet.

- Availability of agrichemical is dependent on local infrastructure and demand. Government and line agencies are responsible for executing the state management of fertiliser and pesticides, as in Dong Anh district. However, this task is more difficult because of farmer's limited knowledge of agrichemicals, and large areas with low population density.

6.3 Key insights from additional interviews with the private sector – Nafoods Group and Doveco (Vietnam)

The Vietnam team embraced an opportunity to conduct two additional private sector interviews to understand the perspectives of large-scale export businesses on the challenges of agrichemical use in Vietnam. High-level representatives from Nafoods and Doveco participated in the interviews. The opportunity to interview these actors arose in connection with the creation of the ACIAR Vietnam Agribusiness Reference Group led by Do Thanh Lam and Howard Hall (Agribusiness RPM).

- Agrichemical use at primary production level (farm level) is a key challenge for both companies to meet the requirements of importing countries who require proof of compliance with accepted standards.

- All production chains of the companies are strictly organized - from primary production, to transport, processing and export, especially training farmers during crop seasons, monitoring agrichemical use, and providing agrichemical inputs in selected cases. Tests of agricultural products before procurement from farmers is required.

- Other farmers (outside the company's chain) are heavily dependent on stockists for how to use agrichemical. They considered dependence a vicious cycle where no solution might ever be found. Misuse of agrichemicals by other farmers was also mentioned.

- Both external and internal factors affecting farmers' agrichemical use were mentioned, including the availability of too many brands of chemicals and state management of inputs, as well as farmers' preference for short-term benefits.

- The potential for use of manure from cattle production in Son La to achieve a more balanced use of agricultural inputs was also mentioned.

7 Understanding farmer practices relating to agrichemical use: Laos

This section outlines key insights from the Laos-based case studies. For a fuller discussion of each case study, see separate appendices.

7.1 Nonghed district, Xiengkhouang province (Upland)

Study area context

- Nonghed district in Xiengkhouang province is well-known for high levels of chemical use in agriculture, especially for maize production. The district is located in the north-eastern part of Laos, approximately 400km from Vientiane capital. According to the Provincial Agricultural and Forestry Office (PAFO) in 2019, Nonghed's development focus is maize production and livestock. Maize plays an important role in household income generation and food security for smallholders in this district where it is typically sold to purchase rice for household consumption. Vegetables are largely grown for household consumption in the district.

- Nonghed district is home to several ethnic minorities including Hmong, Phuan, and Khmu groups.

Agrichemical use, access and practices

- Discussions with farmers, sprayers and shop keepers revealed prohibited chemicals are highly accessible and valued as being very effective. For maize growers especially, chemicals help to address labour shortages. There is evidence of dependency around their use.

- Banned chemicals including Paraquat (herbicide) and Parathion ("Folidol" insecticide) are in common use although discussions around their use remain sensitive. With the expansion of maize production since the mid-2000s, increased access to highly hazardous products and related information is easy to find.

- Information sources about chemicals are diverse and farmers and sprayers obtain advice from neighbours, government officers, family members, the internet, shop keepers and individual product labels.

- Peak herbicide sales are from April to June during land preparation; while peak sale of fertiliser is May to June. Farmers can buy agrichemicals from shops in the district where they have good relationships with sellers and can access credit for a 3–4-week period.

- Agrichemical products are brought into Laos across borders from Thailand, Vietnam and China. Chemical fertilisers come mostly from Thailand, while pesticides and herbicides are brought over from China and Vietnam. Thai herbicides and pesticides are more expensive and less popular.

- The team observed some gender differences in buying behaviours and application practices. Women preferred to buy the same products and hesitated to buy

unfamiliar products. Men were more willing to experiment with new products. During chemical application, men are often responsible for mixing and spraying while women collect water and manage the pipe during the spraying.

- Evidence of unsafe handling practices was observed including the use of large herbicide mixing pools without protection fencing, re-using chemical mixing tarps for other purposes and chemical containers being re-purposed for non-agricultural uses including storage of drinking water for cattle or as a fishing tool.

- Farmers mixed chemicals along the river. In addition, children were observed assisting their parents in agrichemical application.

Perceptions and beliefs about agrichemicals

- Interviewees shared their experiences and observations of incomplete personal protective equipment (PPE) being worn during application along with unsafe handling of mixing equipment. Stories from the village leader about deaths as a result of unsafe herbicide use were shared with the research team.

- Key drivers for unsafe use in this district include perceived effectiveness, labour efficiency, and their widespread availability.

Role of government and private sector

- District Agricultural and Forestry Officers (DAFO) train input sellers to provide information to farmers on correct application of agrichemicals and appropriate PPE use.

- Extension officers have limited resources to carry out regular inspections. They do not carry equipment or tools for testing. Meanwhile, expansion of commercial production continues to increase farmers reliance on agrichemicals. For example, in contract farming, companies provide farmers with seeds and chemicals so that farmers could ensure productive yields.

- Discussions with PAFO representatives highlighted the important role agrichemicals play in livelihoods and economic development in the region. Identifying options for alternative commodity production was identified as a potential solution.

7.2 Hadxayfong district, Vientiane (Lowland)

Study area context

- Hadxayfong district is located along the Mekong River, 50 km from Vientiane capital. The lowland district is a large producer of vegetables and rice, grown for household consumption as well as sale in markets to meet the demands of restaurants and hotels in Vientiane. Farmers in Hadxayfong district have less area to farm than those in upland areas, allowing for less pesticide and herbicide application in general.

Agrichemical use, access and practices

- The majority of agrichemicals in the district can be traced back to Thailand, especially fertilisers. Thai products are more popular than Chinese products which are not trusted by farmers who consider them to leave chemical residues on crops.
- For vegetable growers, men were largely responsible for applying chemicals while women took charge of harvesting.
- Use of banned chemicals was evident in the district (esp. Folidol), and informants reported their widespread use. However openly speaking about the use of these chemicals was very sensitive. Interviewees were quick to inform the research team that they did not use any banned chemicals themselves.
- Increasing reliance on higher quantities of pesticides was reported by several farmers.
- Farmers in Vientiane province have access to a wider selection of products when purchasing chemicals with more distributors and products being available. Farmers and users were also more confident in reading labels of products than those in the upland province.
- Farmers largely manage the disposal of agrichemical containers themselves. Reports of users burying containers in fields, burning containers and disposing alongside household waste were common.

Role of government and private sector

- Improving capacity and resourcing for the agricultural extension workforce including technical knowledge and skills for working with farmers was identified as an important gap in improving practices. A balance in promoting good agricultural practice and organic agriculture alongside conventional agriculture was another potential avenue identified for safer use.
- Financial support for officers to work and regularly carry out training and awareness raising in villages and schools was considered an important factor for promoting safer use.

8 Developing relationships with government and non-government stakeholders

An expert reference panel was established for Laos, Vietnam, and Australia to ensure the project's direction was responsive to current research gaps and situated to link with policy experts as opportunities arose. The panels also contributed to the project's goals in developing relationships with key stakeholders and provided a mechanism to promote the research findings (see **Error! Reference source not found.**).

Table 5 shows the membership of each country-based panel. Members were invited based on their expertise and their organisations interest/mandate in managing agrichemical use. A Terms of Reference (TOR) was developed to guide the membership and role of each panel. Members were selected using broad criteria and were formally invited to join. The panels had three functions: (1) to provide feedback on the case study design prior to commencement of field work; (2) to consider preliminary findings of the case studies and (3) to discuss avenues for policy links and future research opportunities. The feedback received during initial meetings was incorporated into the case study design. The final panel meetings responded to the results shared and provided recommendations for the direction of further work. A summary of discussion outcomes appears in Discussion and Conclusions, section 9 below.

Table 5 Country-based reference panels

VIETNAM REFERENCE PANEL	LAOS REFERENCE PANEL	AUSTRALIA/INTERNATIONAL REFERENCE PANEL
• **Hoàng Văn Hồng, National Agriculture Extension Centre (NAEC, Vietnam)** • **Bùi Xuân Phong, Plant Protection Department (PPD, Vietnam)** • **Ngô Việt Cường, Loc Troi Group (Agricultural Enterprise)** • **Nguyễn Văn Bộ, Vietnam Soil Science Association, former President of VAAS** • **Phùng Hà, Vice President, General Secretary of Vietnam Fertiliser Association** • **Trần Minh Tiến, General Director of Soil and Fertiliser Research Institute** • **Nguyễn Văn Sơn, (Vietnam Pesticide Association)**	• **Dr. Phanxay Inxay, Department of Policy and Legal Affairs** • **Mr. Souliya, Department of Agriculture** • **Khamkon Nanthaepha (Former project manager, Lao Upland Rural Advisory Service)** • **Chanhsay Phommachack (Ministry of Health)** • **Phoupasisth Phittayaphone (Minstry of Natural Resources and Environment)** • **Thongdam Phongphichith (Sustainable Agriculture & Environment Development Association)**	• **Stephen Harper, School of Agriculture and Food Sciences, The University of Queensland.** • **David Guest, School of Life and Environmental Sciences, The University of Sydney and the Sydney Southeast Asia Centre.** • **Daniel Tan, School of Life and Environmental Sciences, The University of Sydney and the Sydney Southeast Asia Centre.** • **Rica Flor, International Rice Research Institute, Cambodia.** • **Jane Muller, Health and Biosecurity, CSIRO.**

9 Case studies discussion and conclusions

Across both countries, there are a range of common factors that play varied roles in agrichemical use decisions. Our initial literature review revealed clear laws, policies and agricultural extension programs in place across both countries, intended to guide safe agrichemical use. Several national agricultural strategies were also focused on reducing unsafe agrichemical use[8]. Despite the existence of these formal structures, our field research revealed local and regional governance in relation to chemical access and use remains generally weak, especially in upland areas. Informal (and at times illegal) channels of product trade and information are present in both countries and mechanisms for container disposal are functioning in some areas yet fragmented in others.

In both countries, a number of social and economic transitions play into household decisions and practices around agrichemical use. Agricultural intensification, increased commercialisation and land-use change, and climate uncertainty has increased farmers' reliance on agrichemicals. Poverty, while influencing agrichemical use in different ways, is also a factor for households in both countries. For both Vietnam and Laos, the management of pests and diseases, satisfying consumer expectations and meeting commercial demands are key drivers of risk-taking in relation to agrichemical use. In upland areas of Laos, production pressures presented by labour shortages especially in maize production areas have intensified reliance on agrichemicals. Across both countries, sustaining a livelihood is a primary driver of household decision-making around agrichemical use.

Across the literature, and in current international forums, the majority of training programs designed to strengthen safe use tend to view farmers and users as having key responsibility for improving practice. Training in safe practice is considered a primary mechanism to enable practice change. Our case studies showed that formal training programs captured some farmers but not others. The information retained in these forums was also mediated by a farmer's own experience, a neighbours' or family member's advice, and a farmer's level of trust in the training provider. Perceptions of poor quality, ineffective and 'fake' products, were descriptions commonly attributed to products originating from China, and these also influenced farmers' use decisions more broadly.

While personal protective equipment (PPE) is internationally recognised as important for risk reduction, and mostly inexpensive and easily accessible across both countries, our case studies revealed equipment oftentimes was substandard, advice not consistently followed, nor aligned with farmer comfort, especially in humid environments. This was despite farmers knowledge of the risks of not wearing full protective equipment during application. Farming families in Laos shared stories of illness and death in their communities, attributed to mixing or spraying highly toxic chemicals without adequate protection. This finding is consistent with the literature where users of agrichemicals are often aware of risks, but do not evaluate these risks and options in isolation (Flor et al., 2020; Shattuck, 2019). Rather, farmers and sprayers considered these risks against a much larger set of risks, values, and needs that shaped individual agrichemical use. Primary among these was an immediate need to sustain a livelihood.

At all sites, farmers' dependency on input sellers and stockists was pronounced. Sellers often had multiple roles as input providers, expert advisors and knowledge translators, and in many cases also acted as proxy trainers (for safe application and appropriate PPE

[8] *In Vietnam, some agribusinesses also have programs that link with provincial agencies to promote responsible pesticide use.*

use). Farmers generally placed significant trust in the knowledge held by vendors, despite the absence of consistent training undertaken by sellers. This relationship placed some input sellers in a position where they acted both as providers of effective product, and risk communicators. While enabling input sellers to communicate risk advice appears to be an efficient information pathway for reducing unsafe use, the relationship between sellers and farmers is not one founded upon the exchange of health-related information. Involvement of other sectors, like health for example, may provide additional support for communicating health risk-related messages.

Improper, inaccurate or foreign language labelling on agrichemical products has previously been suggested as a significant obstacle for safe use. In the Laos case study, product labelling in local language was usually present on those products legally imported and of a particular size. For products found in smaller community-based shops, especially for chemicals available in smaller, limited use containers, labels did not contain appropriate use instructions in local language.

Insights from country reference panels augmented the case study findings in the generation of ideas for further engagement and research, especially in relation to policy links and future science planning. The panels provided a broader set of experiences during various stages of the project. In the project's final stages, the reference panels provided a sounding board for the case study findings.

In their final meeting, the Vietnam reference panel highlighted the role of state management in promoting safer practices as well as the potential role of agrichemical businesses to improve access to safer products and improved practice. The group found it interesting that farmers were knowledgeable about agrichemical use yet did not always follow correct procedure. The need to reduce farmers' dependence on retailers was also highlighted as a future avenue for strengthening safe use, and an identified opportunity for action. A reduction in import tariffs to increase availability of biopesticide was also suggested from members as a possible mechanism to strengthen safe use.

The final Lao reference panel meeting was organised as a broader stakeholder workshop and focussed discussion on two key questions. *What aspects of the results do you find most useful to promoting a One-Heath approach to agrichemical use? In your own roles, what opportunities do you see for strengthening appropriate agrichemical use?*

While the findings were difficult to receive for some panellists - given the team's presentation of evidence of widespread distribution and use of prohibited product - the discussion remained focussed on addressing the broader challenge. Panellists concluded that in order to ensure sustainable agrichemical use in Laos, viewing the whole problem, across the full chain of distribution, access, use and disposal, was necessary.

The Laos panel discussion also emphasized that one of the solutions to promoting safer use of chemicals was to empower the consumer (end-user) to be more aware of and concerned about safe food. The panel considered consumers were an influential factor in farmers using agrichemicals safely.

The Australia/International reference panel reflected that a primary driver for agrichemical use, for all actors – not just farmers - was the need to sustain a livelihood. The group considered an alternative frame for safe agrichemical use might be to focus on maximising incentives or support for good practice. A broadening of the problem framing as one related to sustainable livelihoods was considered more likely to generate system-linked solutions. Understanding how farmers balance risks, production pressures and family wellbeing as part of their livelihood is recommended for future research directions.

The Australian reference panel also considered the potential value in exploring drivers of change from other countries who have undergone similar transitions as a learning opportunity to capture both the enabling and hindering drivers of safer agrichemical use. Uncovering these might reveal potential levers, pitfalls and challenges of change.

Engaging input sellers (and chemical companies) as key actors in the agrichemical use system is a critical next step. Chemical suppliers at all levels act as input providers and sellers, as well as advertisers of product – including highly toxic chemicals. As key actors for product supply and information provision, responsibility for improving safe use also lies in large part with this group of actors.

A system framing in this project allowed the research to be open to uncovering the full set of drivers, interactions and actors that was considered to be influential to agrichemical use. While the literature review identified some shortcomings with application of the One Health approach, the project recognises One Health as a sensible starting point from which to recognise the multiple sectors, disciplines and approaches that a systems perspective offers in guiding the initial research approach and impact planning.

Finally, the challenges experienced by the project in shifting to remote methods as a result of disruptions presented by the pandemic highlights the centrality of local and trusted relationships in development initiatives, especially with respect to adoption and dissemination. This was especially apparent when discussing the highly sensitive topic of agrichemical use. Even when research participants perceived themselves to be acting in compliance with local rules, the topic generated some unease across most actor groups. Initiatives designed to build on existing trusted relationships, or those designed to create trust over the long-term, will be best suited to future investment in this space.

10 Recommendations

Considerations for future research

1. **Repositioning the problem of unsafe agrichemical use away from being the primary responsibility of farmers is necessary to improve current practices and outcomes.**

   This could be achieved in a number of ways. For example, a broadening of the problem framing as one related to sustainable livelihoods is more likely to generate system-linked solutions. Understanding how farmers balance risks, production pressures and family wellbeing as part of their livelihood is recommended for future research directions. Our research has highlighted that a total focus on improving training opportunities for farmers, or improving knowledge around safe use will unlikely be an effective lever in practice change.

2. **Future research opportunities could focus on intensive (social science-led) study of agrichemical use in specific agroecological or socio-cultural settings, including alternatives to agrichemical applications including traditional pest and weed management knowledge**.

   For example, the extensive use of agrichemicals in commercial production systems (e.g., maize farming in Laos) would offer a contextually rich understanding of the drivers and impacts of use in systems in contexts where extensive use is normalised. Combining quantitative information to understand the true extent of the problem could support future research. A targeted investigation of one aspect of the agrichemical use system would also provide valuable insights (e.g., mapping the informal chemical distribution system; or trialling incentives for safe use, or; private sector engagement for innovation). Such research would benefit from partnering with non-government research bodies with an established presence in country that could support capacity development locally.

3. **For remote qualitative research settings, we recommend considerable time is set aside for selection of novel data collection methods which suit the research question but also the needs of participants involved.**

   The research project began during a period of uncertainty and disruption as SE Asia experienced its first wave of COVID. The project needed to pivot constantly as it responded to the challenges of ongoing COVID impacts. It did this initially by reconsidering research methods. The use of remote qualitative methods like Photo voice was considered by project leads to be potentially suitable for addressing the multiple challenges presented by the COVID-related risks of travel. The method was also considered appropriate to potentially reducing farmer burden related to research participation. Photo voice was also selected as a method that could potentially empower farmers/labourers to discuss the topics most relevant to their own experience of agrichemical use.

   The Photo voice method was piloted. While the method worked in some instances, it was not suitable for many others. The team concluded that: the sensitivity of the research topic (i.e., unsafe/illegal agrichemical use); as well as mixed confidence among diverse phone users to take and send photos to researchers, and; limited opportunity to build rapport with researchers due to remote research interactions, all contributed to mixed success in using this method in this particular context. The novelty of the method among the research team also presented challenges.

4. **The ethical and cultural sensitivities of conducting research on the topic of unsafe agrichemical use should not be underestimated.**

   The supply and use of agrichemicals (in many cases their overuse or illegal use) raises many risks for research participants and research staff, who are often balancing competing and challenging roles. Initial CSIRO research ethics review of this project raised concerns about the balance of risks in exposing participants to disclose information about illegal use. The project team needed to demonstrate that protections were in place as part of the research protocol. The quality of outcomes for research of this kind is dependent on the capacity for field staff to build trust and understanding with research participants. This requires in-person engagement and sufficient time for building relationships.

   The challenge is also carried through to the risks and capacity of next and end users of the research information. In this case, government officials who have responsibility for regulation and extension/training associated with agrichemicals. There was a degree of sensitivity relating to presentation of findings that were not in line with government policy.

5. **Projects that seek to investigate agrichemical use require strong and trusted relationships between research staff and research participants**.

   Investigating practices around use was easier than uncovering perceptions and beliefs, particularly when using remote methods. Without strong and trusted relationships, it is difficult to uncover information that is personal (like beliefs) or that relates to unsafe/regulated practices.

Developing stronger research-policy-industry links

6. **Identifying opportunities to build on new research collaborations and partnerships is important to ensure momentum is not lost.**

   The project made links with the ASEAN FAW Action Plan as well as the ACIAR Agribusiness Reference Group in Vietnam, along with policy and research representatives who provided advice and connection via the reference panels. There were positive intentions but limited capacity within an SRA to identify concrete next steps.

   Consideration should be given to utilising established reference panels (or their recommendations) for future research-policy-industry discussions. In all countries, a reference panel of key research and government representatives was established to support the project. While these groups functioned slightly differently in each country, in all instances, insights from these discussions were considered valuable co-learning opportunities by the research teams and have been documented.

Strengthening research capacity in-country

7. **Building core organisational capability in social science (esp. qualitative methods) is required if research questions are to move away from quantifying dosage rates and application techniques**.

   Both country teams were dedicated to the research approach chosen and both committed to strengthening their capacity in qualitative research methodologies more broadly. Confidence in using these skills grew after participating in several learning events offered by the project leads. We recommend that sufficient time is allocated in future workplans to accommodate additional skills development and support as required.

11 Capacity Building

A number of capacity building workshops designed to build team confidence in qualitative research methods and research ethics requirements were delivered during the project.

A combined Laos-Vietnam teams' workshop was held over 2 days in August 2021. This event included discussions on Qualitative Research Methods and Research Ethics Considerations. Data management was also discussed. The workshop was based on the Case Study Research Design document created for the project teams earlier in the year.

A follow-up workshop was also held for the Laos research team in September 2021. Co-led by Dr Phonevilay Sinavong, (Laos team coordinator NAFRI), this event specifically focussed on in-depth discussions of interview methods including note-taking approaches and qualitative data analysis.

Both teams utilised research assistants (RAs) to assist in data collection and analysis and all RAs involved in data collection participated in the training offered.

Undergraduate students also benefitted from this project as we applied methods and knowledge learnt from the project in guiding students theses.

12 Research Impact

Given the importance of multisectoral cooperation in reducing off-label agrichemical use, the project sought to involve research, policy and civil society sectors at every opportunity. The project was able to share the outcomes of the original literature review and case study design at an ASEAN FAW workshop in September 2021 (see details below in section 12.1).

The International Life Sciences Institute SE Asia region (an industry-funded international research collaboration focussed on health) has shown strong interest in the results of this research informing the organisation's own safe agrichemical use agenda and priorities. The PL has made links with Sushila Chang, a key advisor and current member of the International Life Sciences Institute (ILSI) board in the course of this project. ISLI South Asia Region is currently organising a forum to discuss safe agrichemical use in Vietnam later in 2022. The PL has agreed to contribute to this forum. A connection has now also been made between Dr Sushila Chang (ILSI) and Dr Liem (PPRI) who are discussing avenues for future collaboration.

In addition, the Vietnam team leveraged their own research contacts to conduct private sector interviews with the Directors of Nafoods and Doveco to understand the perspectives of large-scale export business and the challenges they face with agrichemical use. The activity aligned with the goals of the ACIAR Vietnam Agribusiness Reference Group led by Do Thanh Lam and Howard Hall (Agribusiness RPM).

In Laos, the final reference panel meeting was considered an ideal opportunity to broaden involvement of development partners in ongoing discussions by inviting their participation as panel members in a full-day workshop. Representatives from the Sustainable Agriculture & Environment Development Association (SAEDA) and the Laos Upland Rural Advisory Service (LURAS) were invited to hear project results and participate in panel discussions.

12.1 Research communications

Mid-way through the project, and prior to the completion of data collection, the PL was invited to present the findings of the initial literature review along with the case study research design to the ASEAN FAW Action Plan Farmer Communication Workshop Series (session 3B). This meeting, held in October 2021, was an opportunity to link with a range of research and government stakeholders who had an interest in this space. The presentation was attended by more than 130 participants globally. Vietnam project team members were on hand to answer questions from the audience.

The project also drafted an article (in English and Vietnamese) for the ACIAR Vietnam newsletter in the form of a project update. A Laos version was also created and shared with the Laos ACIAR country office.

A long-form social media post was drafted and posted in consultation with Currie Communications (August 2021) as part of ACIAR outreach.

An ACIAR website news story is currently in preparation (April 2022).

12.2 Policy (and research) links

Opportunities to create policy links were generated via multiple avenues including:

- Establishment of country reference panels to ensure links with research, government, civil society representatives and the private sector;
- Presentation to the Grow Asia ASEAN forum enabled a broad set of research and policy professionals to learn about the human-centred approach we took in this project;
- Linking with export agribusiness representatives (Doveco and Nafoods) via the ACIAR Agribusiness Research Group (ARG) enabled the Vietnam team to conduct research interviews to include private sector perspectives of agrichemical use in the project.
- The Laos team extended their final reference panel meeting to include a broader set of development actors in results discussions. Representatives from SAEDA and LURAS participated in panel discussions during the event. The focus of final panel discussions was to explore concrete opportunities for strengthening appropriate agrichemical use in both Laos and Vietnam. Attendees were asked to consider their own capacity and role in facilitating safer use.
- The International Life Science Institute (ILSI SE Asia Region) (contact: Sushila Chang). The PL has been invited to speak at/participation in an upcoming pesticides workshop, to be held in Vietnam, later in 2022. This event is currently being organised.

13 References

13.1 References cited in report

ACIAR (2020). Annual Operational Plan 2020-2021.

Flor, RJ., Maat, H., Hadi, BAR., Then, R., Kraus, E., and Chhay, K. (2020). How do stakeholder interactions in Cambodian rice farming villages contribute to pesticide lock-in? *Crop Protection*, 135: 104799.

Gupta, A (2012). Pesticide use in South and South-East Asia: environmental public health and legal concerns. *American Journal of Environmental Sciences*, 8:152.

Hoi, PV., Mol, APJ., Oosterveer, L., van den Brink, PJ., and Huong, PTM. (2016). Pesticide use in Vietnam vegetable production: A 10-year study. *International Journal of Agricultural Sustainability*, 14(3): 325-338.

Loc, PM, Tung, TT, Dieu Trang, LT, Adati, T (2015). Hiện trạng sử dụng thuốc bảo vệ thực vật của nông dân trong phòng trừ rầy nâu ở một số tỉnh đồng bằng sông Cửu Long. Bảo vệ thực vật

Ngoc, LH (2019). Phát triển bền vững sản xuất cam trên địa bàn tỉnh Nghệ An. Học viện Nông nghiệp Việt nam.

Nguyen, LT, Böhme, MH (2013). Good Agricultural Practice - A strict direction in future for sustainable vegetable cultivation systems in Red River Delta, Vietnam. (International Society for Horticultural Science (ISHS), Leuven, Belgium. Available at https://doi.org/10.17660/ActaHortic.2013.1006.34

Shattuck, A (2019) Risky subjects: Embodiment and partial knowledges in the safe use of pesticide. *Geoforum*, 123:153-161.

Schreinemachers, P, Afari-Sefa, V, Heng, CH, Dung, PTM, Praneetvatakul, S, Srinivasan, R (2015). Safe and sustainable crop protection in Southeast Asia: Status, challenges and policy options. *Environmental Science & Policy* 54: 357-366.

13.2 List of publications produced by project

Williams, LJ., Carter, L., Van Liem, N., Van Tuat, N., Hien, PT., Duong-Nga, NT., Anh-Duc, N., Van-Hung, P., Phouyyavong, K., Xangsayasane, P., Phommalath, S., Sisaphaithong, T., and Bouphakaly, O., Literature review synthesis: Understanding agrichemical use in Southeast Asian agriculture SSS/2020/143. *Unpublished literature review.*

Carter and contributors (*in preparation*- targeting *Asian Journal of Agricultural Development* - SEARCA).

14 Appendix

14.1 Appendix 1: Achievement against milestones

Phase 1: Scoping and detailed design (Months 1-8)

No	Activity	Outputs	Completion date
1.1	Assemble Aus/international reference group.	First meeting (and/or targeted discussions)	November 20
1.2	Form in-country reference groups (one each Vietnam and Lao PDR)	Groups established (members agree to participate) and date set for first meeting	November 20
1.3	Review of available published and grey literature on framework options	Combined output (e.g., report) for 1.3-1.5 summarising key findings	March 21
1.4	Review of available published and grey literature on agrichemical use, regulations, institutions in each country and SE Asia more broadly to inform scope of case studies		
1.5	Scoping interviews with regional experts (Exporters - accessed via VN ACIAR-assembled Agribusiness group)	As part of final SRA report	Jan-Mar 2022
1.6	Regular update and feedback meetings with in-country partners	Minimum monthly, additional if needed.	Ongoing
1.7	Virtual workshop with in-country reference panel. Meeting purpose (1) team to provide summary of 1.3-1.5 (2) get panel feedback on case study design / selection	Workshop report/notes	April 21
1.8	Virtual team meeting on case study design and selection		August 2021

Phase 2: On-ground research (Month 9-12)

No	Activity	Outputs/ Milestones	Completion date

2.1	Agreed case study research design for each country (will include scope, and proposed farming systems/locations)	Design doc and draft research materials	September 21
2.2	Virtual meeting / training as needed to support in-country teams prepare for case studies.		October 2021
2.3	In-country data collection for case study 1 (Laos and Vietnam)	Interview data /summary	Nov-Dec 2021 (VN) Dec-Jan 2022 (Laos)
2.4	Virtual meeting to discuss initial findings and review methods etc		Jan 2022 (VN) Feb/March 22 (Laos)
2.5	In-country data collection for case study 2 and initial analysis (Laos and Vietnam)	Interview data / summary	Nov-Dec 2021 (VN) Dec-Jan 2022 (Laos)
2.6	Virtual meeting / workshop to discuss initial findings, review methods etc		Jan 2022 (VN) Feb/March 22 (Laos)
2.7	In-country Reference group meeting to present initial findings.		Decision made to postpone this discussion to final meeting given CV-19 disruptions

Phase 3: Consolidation (Month 13-18)

No	Activity	Outputs/ Milestones	Completion date
3.1	Finalisation of analysis and cross-country comparisons		March 22
3.2	Reference group meeting to present findings and discuss recommendations	Workshop notes	March 22 (Vietnam) April 22 (Laos and Aust/Int)
3.3	Final write up of findings and report to ACIAR	ACIAR final report Journal paper	April 22 In preparation