Integrated Systems Research for Sustainable Smallholder Agriculture in the Central Mekong

Achievements and challenges of implementing integrated systems research

Edited by: L. Hiwasaki, A. Bolliger, G. Lacombe, J. Raneri, M. Schut and S. Staal

CGIAR RESEARCH PROGRAM ON Integrated Systems for the Humid Tropics

World Agroforestry Centre

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November 2016

Printed in Viet Nam

ISBN 978-604-943-434-1

Citation
Hiwasaki L, Bolliger A, Lacombe G, Raneri J, Schut M and Staal S, eds. 2016. *Integrated Systems Research for Sustainable Smallholder Agriculture in the Central Mekong: Achievements and challenges of implementing integrated systems research*. Hanoi, Viet Nam: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

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Front cover, from top in clockwise order:
Landscape in Son La, Viet Nam (ICRAF/Lisa Hiwasaki); A family of *Hmong* farmers thresh their maize harvest in rural Northwest Viet Nam (ILRI/Jo Cadilhon); Home-based production of vegetables in Son La, Viet Nam (ICRAF/Pham Duc Thieng); Woman cutting broomgrass in Luang Prabang, Lao PDR (ICRAF/Lisa Hiwasaki)

Back cover, from left to right:
E De children playing with forage grass in Dak Nong, Viet Nam (ICRAF/Lisa Hiwasaki); Cattle in Dak Nong, Viet Nam (ICRAF/Pham Duc Thieng); *Thai* woman harvesting tomatoes in Son La, Viet Nam (ICRAF/Lisa Hiwasaki)

Copy editing and proofreading
Claire Miller

Layout and design
Riky Mulya Hilmansyah and Tikah Atikah

Humidtropics is a CGIAR Research Program led by IITA. It seeks to transform the lives of the rural poor in tropical America, Asia and Africa, and uses integrated systems research and unique partnership platforms for impact on poverty and ecosystems integrity. Research organizations involved in core partnership with Humidtropics are AVRDC, Bioversity International, CIAT, CIP, FARA, *icipe*, ICRAF, IITA, ILRI, IWMI, and WUR. www.humidtropics.cgiar.org

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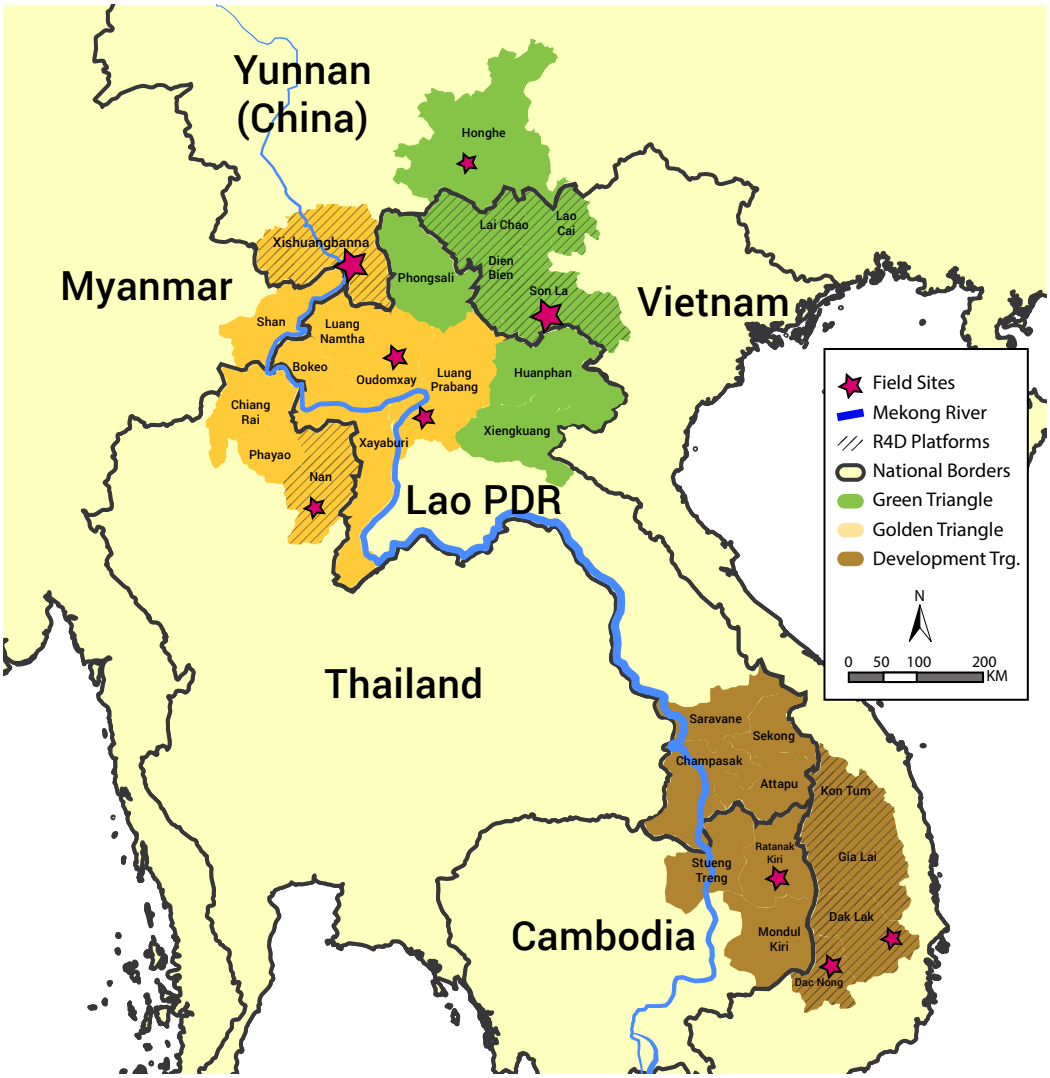
Map of Humidtropics Central Mekong Action Area



Acknowledgements

This book was developed under the CGIAR Research Program on Integrated Systems of the Humid Tropics (Humidtropics). We would like to acknowledge Humidtropics and the CGIAR donors for providing core funding, without which this book and the research published would not have been possible. We would also like to acknowledge the bilateral projects, which constituted an important part of Humidtropics, and their donors; building on such experiences and networks has contributed to the deliverables and achievements of Humidtropics in the Central Mekong Action Area during the program's (too) short duration (2013–2016).

Humidtropics in the Central Mekong Action Area brought together a wide range of people committed to improving the sustainable livelihoods of smallholder farmers living in the Mekong Basin. Humidtropics would not have existed in this region were it not for Jianchu Xu, who developed the Central Mekong Action Area in the Humidtropics proposal, played an instrumental role in its planning, and who was the Action Area Coordinator during Humidtropics' initial phase. The following ICRAF colleagues who supported the Action Area coordination are acknowledged: Ingrid Öborn, Delia Catacutan, Jim Hammond, Jonathan Teichroew and Yurdi Yasmi. People who served as members of the Central Mekong Action Area's Core Team at different times are also duly acknowledged: Simon Attwood and Jessica Raneri (Bioversity International); Tassilo Tiemann and Adrian Bolliger (CIAT); Kaiyun Xie (CIP); Jianchu Xu, Jim Hammond and Prasit Wangpakapattanawong (ICRAF); Steve Staal (ILRI); Guillaume Lacombe (IWMI); Marc Schut (WUR); and, Fenton Beed and To Thi Thu Ha (WorldVeg). The Core Team members played a key role in developing the book chapters.

We thank the national and local partners who contributed to Humidtropics' research for development activities in the Central Mekong:

China: Centre for Mountain Ecosystem Studies, Kunming Institute of Botany; Yunnan Tropical Crops Research Institute; Xishuangbanna Bio-Industrial Crops Office; Nabanhe National Nature Reserve; Xishuangbanna Tropical Botanical Garden; Agricultural Environmental and Resources Institute of Yunnan Academy of Agricultural Sciences; and, Yunnan Agricultural University.

Laos: National Agriculture and Forest Research Institute (NAFRI); Department of Agricultural Land Management (DALAM) under the Ministry of Agriculture and Forestry (MAF); and, Institut de recherche pour le développement (IRD).

Thailand: Chiang Mai University; Muang Jung Subdistrict Administrative Organization; and, Mae Fah Luang University.

Viet Nam: Research Center for Development and Agricultural System (CASRAD); Son La Province Department of Agriculture and Rural Development (DARD); Fruit and Vegetable Research Institute (FAVRI); Forest Science Center for the Northwest; Institute for Social Development Studies (ISDS); Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI); Soil Fertility Research Institute (SFRI); Tay Nguyen University (TNU); Viet Nam National University of Agriculture (VNUA); and, Western Highlands Agriculture and Forestry Science Institute (WASI).

We would like to thank the contributing writers for their time and effort, as well as the many people who provided constructive feedback on drafts. We are particularly grateful to the individuals who contributed their time and effort to review the chapters and provided helpful comments and suggestions: Simon Attwood, Fenton Beed, Jim Hammond, Guillaume Lacombe and Ingrid Öborn.

Special thanks are due to Rob Finlayson and Tran Ha My for their support on communications; Tikah Atikah and the ICRAF Southeast Asia team for designing the book; Pham Duc Thieng for his support on data collection; Terry Erle Clayton for his facilitation of our write-shop in Nairobi; Claire Miller for copy-editing and proof-reading; and, last but not least, the ICRAF Viet Nam administration and finance team for their administrative support throughout the lifetime of Humidtropics in Central Mekong Action Area.

Lisa Hiwasaki
On behalf of the editorial team

Preface

The Mekong region covers several mainland Southeast Asian countries. The region has a huge heterogeneity in its topography, farming systems, ethnic populations, markets and sociopolitical systems. It is moreover undergoing intense social, economic and ecological changes that offer many economic opportunities, and at the same time pose potential threats to the livelihoods of rural populations and smallholder farmers. Expanding infrastructure and markets, and government policies and programs that promote rural and agricultural development, present opportunities for improving these livelihoods. At the same time, rapid conversion to specialized and intensified forms of agriculture and other land uses, in addition to rapid population growth, have created significant challenges in upland agricultural systems including environmental degradation; limited and inequitable access to markets; decreasing productivity and total farm income; inequitable access to natural resources such as land and water; and, marginalized ethnic minorities.

Any successful attempt to understand and address the complex challenges or grasp the opportunities requires an integrated systems research approach. Integrated systems research seeks to comprehend the different dimensions of complex agricultural problems, e.g. technological, economic and institutional challenges, and how these are affecting or require addressing across farm, community or policy levels. This automatically implies that stakeholders across different levels – e.g. farmers, the private sector, national institutions, development actors and governments – need to be involved in identifying, analysing and prioritizing problems, as well as in designing and implementing innovative solutions to overcome the problems. Another key characteristic of integrated systems research is that it seeks to explore trade-offs and synergies across dimensions, levels and stakeholder groups. For example, in terms of how new technologies could affect the natural resource base or land health, interventions at policy levels could enable or constrain actors at community or farm levels. Similarly, positive changes for specific stakeholder gender or age groups could imply negative changes for others.

The CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics) was an agricultural research for development program that aimed for sustainable intensification of agricultural systems to improve the livelihoods of farm households. Humidtropics was implemented in Central America, West Africa, East and Central Africa, and in the Central Mekong. The Central Mekong Action Area was primarily focused on the complex of rice and non-rice farming systems (plus areas with other land uses) in the non-flood-prone lowlands, uplands and highlands. The Action Area covered six countries (Cambodia, China, Laos, Myanmar, Thailand and Viet Nam). Since mid-2013, the Humidtropics partners have implemented a broad range of research for development activities. These include agricultural system characterization through situational analyses and identification of entry points for interventions; participatory research to improve nutrition and dietary diversity; and, capacity development of farmers and local stakeholders. So-called

multistakeholder platforms, which bring together farmers and representatives from the research, business, development and government sectors, were established to facilitate the responsible scaling of technological and institutional innovations.

This book summarizes the achievements as well as some of the challenges faced while implementing integrated systems research to support the sustainable development of smallholder farming in the uplands of the Mekong region. It describes how CGIAR centres and national and local partners collaborated to test options to increase farm productivity in the Central Highlands of Viet Nam, and how field trials in Xishuangbanna, China; Son La, Viet Nam; and, Luang Prabang, Laos, showed that agroforestry and home-based vegetable gardens, among other interventions, could contribute to reduced land degradation and erosion. Efforts were also made to address the marginalization of ethnic minority farmers from agricultural and rural development. The book also discusses lessons learned in the research, including what did not work and possible reasons for that. Integrated systems research often requires 'doing things differently', which can lead to resistance among those involved. Also, implementing multistakeholder processes such as establishing and working together through multistakeholder platforms, was challenging and not always easy. However, some interesting new partnerships have emerged from this experience.

We hope the Humidtropics' experiences and learning will be of use for research, development and business professionals at local, national and international level as well as for government and regional officials who have the challenging task of designing and implementing effective research, business and policies that will contribute to achieving sustainable development goals and improving livelihoods for rural women, men and youth.

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Ingrid Öborn, Southeast Asia Regional Coordinator, World Agroforestry Centre (ICRAF)

A boy's happy smile in Son La, Viet Nam. Photo credit: ICRAF/Pham Duc Thieng

Humidtropics in the Central Mekong Action Area

Chapter 1

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Summary

This chapter introduces Humidtropics, the CGIAR Research Program (CRP) on Integrated Systems for the Humid Tropics, and the research for development (R4D) activities implemented from 2013 to 2016 in the Central Mekong Action Area. The chapter also provides an overview of the other book chapters.

1. Introduction

Humidtropics was a CGIAR Research Program on Integrated Systems for the Humid Tropics that aimed to help poor farm families in tropical Africa, Asia and the Americas boost their income and livelihoods through agricultural development. The CRP used participatory and collaborative approaches involving a wide range of local stakeholders as partners in R4D. As one of the three CRPs[1] that undertook integrated systems research, Humidtropics, along with drylands and aquatic systems, had the challenging task of looking at agriculture in a holistic manner. This meant identifying, understanding and addressing the multiple issues of productivity, natural resources management and institutional constraints across the entire system (Humidtropics 2012), as well as the interactions, trade-offs and synergies of potential innovations at household, community and policy levels (Öborn et al 2017). To facilitate this, Humidtropics adopted a multistakeholder approach that focused on bringing research, government, development and business partners together to identify key constraints, and to prioritize, design and implement innovative approaches to overcome them. Multistakeholder platforms were established, operating either at the local community level and focusing on concrete issues (e.g. the platform on commercial vegetables established in Northwest

[1] Following a comprehensive review of the CGIAR system's structure and activities in 2008, 15 research programs were implemented in the first CRP phase (2012-2016): seven CRPs that focused on a particular crop or commodity; five cross-cutting CRPs; and, three agricultural systems CRPs. The second CRP phase (2017-2022) will have eight agrifood systems (AFS) CRPs, four global integrating programs (GIP), and three technology and data platforms.

Viet Nam), or operating at a higher regional level and targeting the more structural policy barriers for agricultural innovation in the agricultural system. Working with multiple stakeholder groups was proposed for three main reasons (Schut et al 2016). First, different stakeholder groups can provide a diversity of insights about the biophysical, technological and institutional dimensions of the problem, and what type of innovations are technically feasible, economically viable and socioculturally and politically acceptable (Schut et al 2014). Second, stakeholder groups become aware of their fundamental interdependencies and the need for concerted action to overcome common constraints and reach their objectives (Leeuwis 2000). Third, stakeholder groups are more likely to support specific solutions when they have been part of the decision-making and design process (Faysse 2006).

Originally conceived as a 15-year research program, the Humidtropics' R4D activities began in 2013. Two years later, the CGIAR announced that in its second CRP phase starting 2017, the systems CRPs would be absorbed into the more value-chain oriented agrifood systems CRPs. Although it is unfortunate that Humidtropics as an independent research program was to last less than five full years, numerous and significant R4D activities were implemented and partnerships were forged at field sites in Sub-Saharan Africa, Central America and the Caribbean, and Southeast Asia. This book provides readers with a glimpse of the R4D activities and partnerships in the Humidtropics Central Mekong Action Area[2] led by the World Agroforestry Centre (ICRAF) in close partnership with international and national partners in five countries in mainland Southeast Asia. In doing so, our goal is to provide the results of our endeavours to support ongoing and future integrated agricultural systems research in Central Mekong and elsewhere.

2. Humidtropics, the CGIAR Research Program on Integrated Systems for the Humid Tropics

A systems research program that focuses on the humid tropics has several significant aspects. The humid tropics are important for their biodiversity and constitute many of the world's biodiversity hotpots (cf. Myers et al 2000). Covering almost 3 billion hectares of land, the humid tropics are home to approximately 2.9 billion people, most of whom are poor smallholder farmers (Humidtropics 2012). Considering that agriculture is a major livelihood in the humid tropics, sustainable agricultural development is essential to enable numerous challenges to be addressed, not just in environmental conservation but also in dealing with the human element in the equation. Without addressing issues such as poverty, food security and market access in these regions, it is not possible to address threats to the environment and to adapt to global changes including climate change. The Humidtropics CRP thus aimed to take a systems perspective to deal with such issues comprehensively by implementing

[2] Situated within the larger 260 million ha geopolitical boundary of the Greater Mekong subregion, the Central Mekong Action Area covers an area above the Mekong delta and below the high mountainous temperate zone (Humidtropics 2012). See also map on page ix of this book.

R4D that contributes to enhancing agricultural production and productivity while at the same time improving smallholder livelihoods and reducing the environmental degradation that often arises from intensified agriculture.

The theory of change within the Humidtropics CRP was based on the hypothesis that the region's inherent potential is best realized through an integrated systems approach involving participatory action across stakeholder groups. Humidtropics addressed this by enhancing capacity to innovate at farm, institutional and landscape levels, and engaging with women, youth and marginalized groups. The increased innovation capacity would result in systems interventions that improve productivity and natural resource management and links to markets. This way, Humidtropics contributed to delivering on the three main goals of the Strategy and Results Framework of the CGIAR (CGIAR 2015):

- ***Reduced poverty:*** through increased productivity and resilience to shocks, leading to increased incomes and employment opportunities. Enhanced access to markets for smallholder farmers and increasing the resilience of the poor are also important components.
- ***Improved food and nutrition security:*** through improved diets, food safety, and human and animal health through better agricultural practices.
- ***Improved natural resource systems and ecosystem services:*** by ensuring that natural capital is enhanced and protected from climate change and overexploitation, as well as other forms of abuse. Enhanced benefits from ecosystem goods and services, and more sustainably managed agro-ecosystems, are also key components.

Ultimately, the Humidtropics objective was to contribute to achieving these outcomes by 2023 by increasing staple food yields by 60 percent, increasing average farm income by 50 percent, lifting 25 percent of poor households above the poverty line, reducing the number of malnourished children by 30 percent, and restoring 40 percent of farms to sustainable resource management (Humidtropics 2012). In the extension proposal for 2015-2016, Humidtropics was further developed and its goals and targets refined in three, six, and nine-year targets (Humidtropics 2014).

The research program was organized into three Strategic Research Themes (SRTs) as demonstrated in Figure 1.1:

1. SRT1 focused on systems analysis and global synthesis, by establishing the baseline situation and synthesizes progress towards the expected outcome situation.
2. SRT2 worked on integrated systems improvement, by researching and mainstreaming promising systems interventions related to productivity, natural resource management, and markets and institutions. This theme also included use of modelling tools and analysis, gender considerations, research-development interactions, and scaling-out dimensions. Sustainable intensification and diversification are key drivers.

3. SRT3's research on scaling and institutional innovations focused on co-evolving institutions via social innovation with the technologies emanating from the integrated systems improvement theme. As such, it aimed to improve stakeholders' capacity to innovate and support the scaling of interventions at farm, national and global levels.

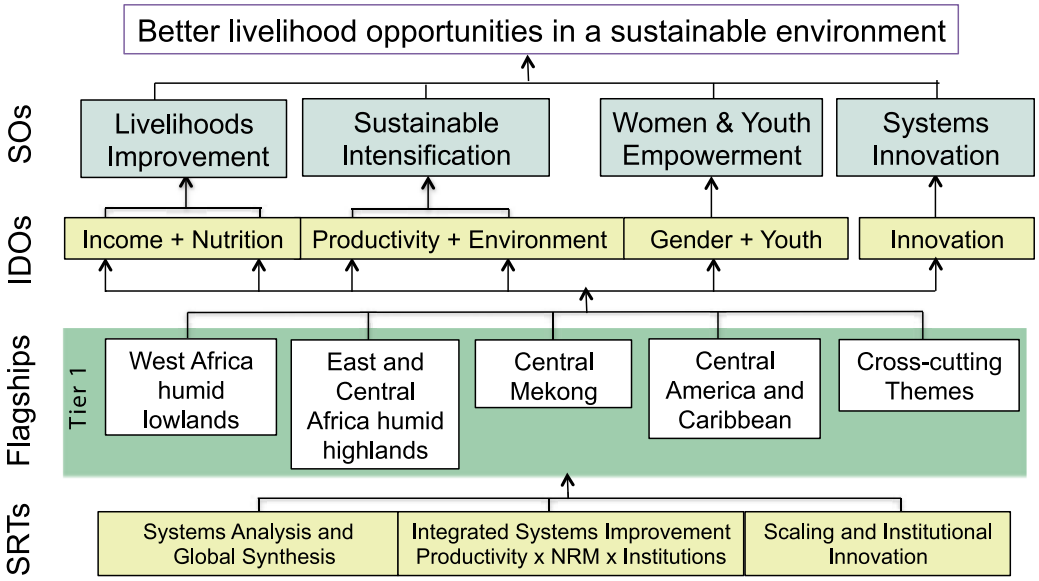

Figure 1.1 Humidtropics program framework (Humidtropics 2014)

SRT: Strategic Research Theme; IDO: Intermediate Development Objective; SO: System Outcome; NRM: Natural Resources Management

In addition to the SRTs, five cross-cutting research themes were identified and implemented:

1. Innovation systems research
2. Capacity development
3. Gender
4. Nutrition
5. Global synthesis and analysis on key outcomes from Humidtropics research

Although this ambitious program intended to encompass much larger areas across the humid and sub-humid tropics, four geographically defined Action Areas were chosen to begin with:

1. East and Central Africa Highlands, covering humid and sub-humid tropics of western Kenya, southern Uganda, the Ethiopian Highlands, eastern Congo, Burundi and Rwanda;
2. The West Africa Humid Lowlands, covering the humid and sub-humid tropics of Cameroon, Nigeria, Ghana and Cote D'Ivoire;

3. Central Mekong, situated within the larger geopolitical boundary of the Greater Mekong sub-region and including Cambodia, Lao PDR, Myanmar, Thailand and Viet Nam plus the two southwest provinces of China; and,
4. Central America and the Caribbean, including three main sites in the humid and sub-humid tropics of Nicaragua, Honduras, Guatemala, El Salvador, Haiti and the Dominican Republic.

3. Central Mekong Action Area: An overview

The Central Mekong Action Area covered six countries in mainland Southeast Asia (Cambodia, China, Laos, Myanmar, Thailand and Viet Nam), with diverse topography, farming systems, ethnic populations, markets and sociopolitical systems. The region is undergoing intense social, economic, and ecological changes that offer many economic opportunities, yet also pose potential threats to ecologically sustainable livelihoods. The area is characterized by expanding infrastructure and markets, and government policies and programs that promote rural and agricultural development; all these present opportunities to improve livelihoods. At the same time, government policies that enforce rapid conversion to specialized and intensified forms of agriculture and other land uses (Than 1998, Rerkasem et al 2009), and rapid population changes, have created significant challenges in upland agricultural systems. These include: sedentarization of agriculture and settlements; environmental degradation, including rapid deforestation and erosion of farming lands; limited and inequitable access to markets; decreasing productivity and total farm income; inequitable access to natural resources, including water; ecosystem services that do not benefit the poor; and, marginalized ethnic minorities (Rerkasem et al 2009, Friederichsen and Neef 2010, Drahmoune 2013, Fox and Castella 2013).

Humidtropics activities in the region were officially launched at a workshop in Hanoi in May 2013. Field implementation was planned within three transnational Action Sites sharing common agro-ecological and sociocultural systems and challenges, as delineated in the map of the Central Mekong Action Area on page ix of this book.

1. ***Green Triangle Action Site,*** composed of Northwest Viet Nam, northern Lao PDR, and Honghe Prefecture, Yunnan, China;
2. ***Golden Triangle Action Site,*** composed of northwest Lao PDR, northern Thailand, eastern Myanmar, and Xishuangbanna Prefecture, Yunnan, China; and
3. ***Development Triangle Action Site,*** composed of southern Lao PDR, northeast Cambodia, and Central Highlands, Viet Nam.

Delineating the action sites took into consideration the potential for cross-border learning and transboundary research, and also existing research activities by the Humidtropics core partners.

A timeline of the main events in the Action Sites (Triangles) and field sites in the Central Mekong is shown in Figure 1.2 below.

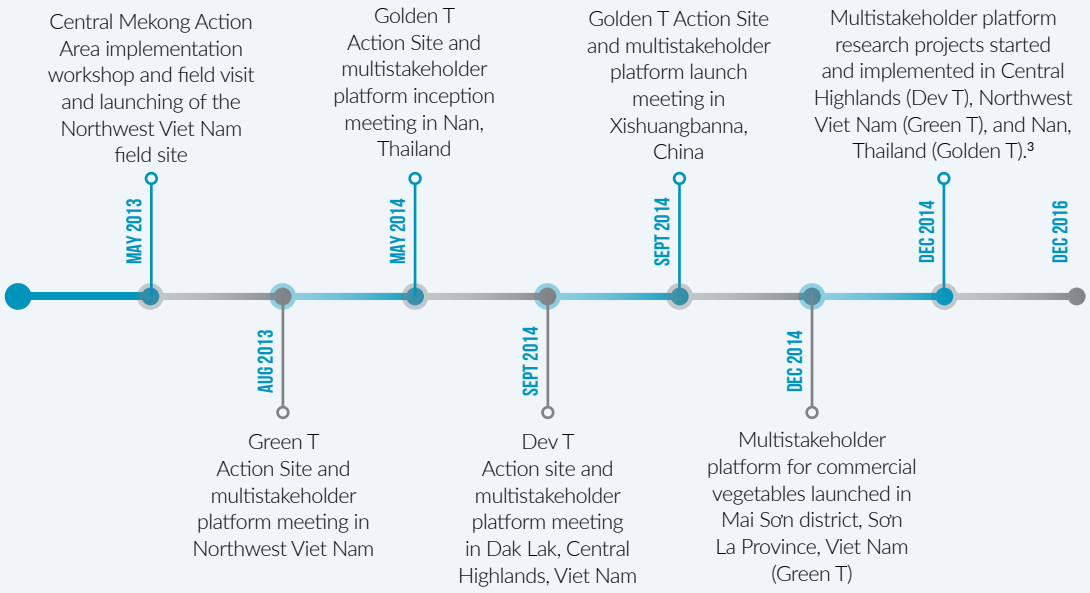

Figure 1.2 Timeline of key events in Central Mekong 2013-2016.

ICRAF coordinated the R4D activities in the Central Mekong. The Action Area Coordinator was initially based in Kunming, China, and then in Hanoi, Viet Nam from April 2013. A Core Team was formed with a representative from each of the eight Humidtropics core partners in this region. These were:

- Bioversity International
- International Center for Tropical Agriculture (CIAT)
- International Potato Center (CIP)
- The World Agroforestry Centre (ICRAF)
- International Livestock Research Institute (ILRI)
- International Water Management Institute (IWMI)
- Wageningen University (WUR)
- World Vegetable Center (WorldVeg)

The Core Team met twice a year to provide a) a coherent and effective management structure across partner organisations; b) a transparent and auditable joint decision-making process to prioritize, plan and implement the R4D activities in line with Humidtropics objectives and impact strategy; and, c) facilitate the effective implementation of cross-cutting

[3] Multistakeholder platform research projects were based on broader partnerships involving both CGIAR and non-CGIAR entities, and were launched in 2014. Emerging out of platform interactions and led by local institutions and organizations, modest amounts of financial resources were provided to generate collaborative systems research. See Table 1 below for more information on each research project.

activities within the Central Mekong Action Sites. In addition to the regular Core Team meetings, the researchers gathered in November 2013, 2014 and 2015 to plan activities and budget for the following years. Regular monitoring and evaluation (M&E) based on result-based management were implemented by an M&E officer based at ICRAF Viet Nam.

Table 1.1 Overview of research for development activities implemented in Central Mekong

Action Site / R4D activity	Development Triangle	Green Triangle	Golden Triangle
1. Site characterization and systems analysis	Situational analysis to broadly characterize important system aspects in Action Sites, to develop a shared understanding of the issues that need to be addressed among partners, and to initiate and facilitate stakeholder engagement (Cadilhon et al 2015). Reports published for Northwest Viet Nam (Green Triangle); Nan, Thailand and Xishuangbanna, China (Golden Triangle). Draft reports prepared for Central Highlands, Viet Nam (Development Triangle) and Honghe, China (Green Triangle).		
	Identification and analysis of potential entry points for interventions to improve rural household livelihoods in the Central Highlands of Viet Nam (Development Triangle) and Northwest Viet Nam (Green Triangle) through the EXTRAPOLATE (EX-ante Tool for RAnking POLicy AITErnatives) tool. EXTRAPOLATE is a decision support tool that assesses the impact of different policy measures. For more information: http://www.fao.org/ag/againfo/programmes/en/pplpi/dsextra.html.		Analysis of complex agricultural problems and innovation capacity by stakeholders in the agricultural system using the Rapid Appraisal of Agricultural Innovation Systems (RAAIS) tool in Xishuangbanna, China (see Schut et al 2015)
	Baseline survey to characterize farms and farmers using Rural Household Multi-indicator Survey (RHoMis) tool in Central Highlands, Viet Nam, Laos and Cambodia.	Baseline survey to characterize farms and farm households using IMPACT-Lite tool in Northwest Viet Nam.	
2. Integrated systems improvement		Identification and testing innovations to grow and market 'safe'[4] vegetables and off-season vegetables; field testing of crop and water management practices of home-based production of vegetables in Northwest Viet Nam.	

[4] In Viet Nam, the term 'safe' is used to signify vegetables produced under a process that ensures safety for consumers. The concrete details of such processes tend to differ according to the producers, but the standards set by VietGAP (Vietnamese Good Agricultural Practices, a national certification for agricultural products), is what farmers generally strive to follow.

Action Site / R4D activity	Development Triangle	Green Triangle	Golden Triangle
		Identification and assessment of food and nutrition gaps; identification and testing of best-bet systems innovations to improve dietary diversity and diet quality; and development of R4D tools to integrate nutrition into systems research in Northwest Viet Nam.	
	Research implemented to promote eco-efficient agriculture for poor smallholder farmers in Cambodia, Laos and Viet Nam.	Research implemented to better understand land-use change and erosion and water resources in northwest Laos and northern Viet Nam.	
		Sustainable agroforestry options with market potential identified and tested among smallholder farmers in Northwest Viet Nam.	Interventions identified and tested for diversified and sustainable rubber ('green rubber') in Xishuangbanna, southwestern China, northern Thailand, and northern Laos.
3. Institutional innovation			Testing of PRactice-Oriented Multi-level perspective on Innovation and Scaling (PROMIS) on scaling environmentally friendly rubber practices in southwest China (Wigboldus et al 2016)
	Multistakeholder platforms launched and functions supported to implement integrated agricultural R4D and to foster agricultural innovations in different triangles: Central Highlands, Viet Nam (Development Triangle); Northwest Viet Nam (Green Triangle); Nan, Thailand and Xishuangbanna, China (Golden Triangle).		

Action Site / R4D activity	Development Triangle	Green Triangle	Golden Triangle
	Multistakeholder platform research projects		
	Enhanced livelihoods and better natural resource management through appropriate integration and diversification through home gardens, forage grass, and local pig-raising by smallholder farms in the Central Highlands of Viet Nam.	Research for development of interventions such as intercropping coffee-fruit trees-grass strips and fruit trees-vegetables in a predominantly maize monocropping system on sloping and lowland for scaling up in Northwest Viet Nam.	Assessment of different opportunities for agricultural diversification such as fruit trees-vegetables, mushroom production, and home gardens in Nan, Thailand.
4. Capacity development	Support provided to set up and maintain functions of multistakeholder platforms through training sessions targeting platform facilitators and CGIAR partners supporting them, held in November 2014 and November 2015.		
5. Gender and marginalized groups	Equity and social inclusion in agricultural R4D promoted through drafting 'Guidelines to Engage with Marginalized Ethnic Minorities in Agricultural Research for Development in the Greater Mekong' (Hiwasaki et al 2016, see Annex II).		
	Qualitative research implemented to understand gender norms and agency of ethnic minorities, and their relations with innovation, in Northwest and central Viet Nam. Qualitative impact assessment of R4D platform research projects implemented in Northwest Viet Nam and Central Highlands, Viet Nam.		Qualitative research to understand how agricultural practices have different impacts on livelihoods of men and women from different ethnic groups in northern Laos.

4. Achievements and challenges of integrated systems research in Central Mekong

This book's primary objective is to describe the achievements as well as some of the challenges faced while implementing integrated systems research to contribute to livelihood improvement and sustainable development of smallholder farming in the Mekong uplands. The target audience is professionals working in national and international (including CGIAR) agricultural research for development organizations, as well as international donors, national and local government officials, other research organizations, and NGO project staff. The book is organized around three research themes:

1. Systems analysis and synthesis, establishing baselines and conducting situational analysis to characterize the target systems to better identify interventions.
2. Integrated systems improvement in practice, the various interventions undertaken to contribute to economically, socially and environmentally sustainable smallholder agriculture.
3. Nutrition dimensions, the challenges of ensuring incorporation of nutrition within the food security, agricultural production and livelihood systems.

Chapter 2 summarizes and compares the findings of site characterization research (situational analysis, baseline and household surveys: see 1. in Table 1 above) implemented in different Central Mekong Action Sites. The authors identify patterns in rural agricultural systems in Central Mekong that help guide the priority setting and targeting of ongoing and future investments in agriculture research. It also reviews methods used, with an analysis of what worked and what did not.

Chapter 3 reviews the main causes and effects of land degradation and erosion in the Central Mekong, and presents case studies of recent land-use changes caused by economic, political and institutional transitions, such as the expansion of teak plantations in northern Laos, rubber plantations in southwest China, and coffee monocropping in the Central Highlands of Viet Nam. The chapter explains how these disturbances alter water and soil resources across different geographical scales, from the agricultural plot to the headwater catchment level. Using examples from R4D activities conducted in Viet Nam and China's Yunnan Province (see 2. and 3. in Table 1 above), coping strategies combining field trials and participatory approaches are described. The authors conclude that to ensure productive agriculture and food production for future generations, the central challenge is how to best harmonize income generation from commercially-oriented, specialized tree and monocropping systems with the benefits of more diversified farming systems that allow soil and water to be better conserved. Solutions that address this challenge require long-term commitment in field sites, working especially closely with ethnic minority communities.

Chapter 4 summarizes and evaluates tools and approaches used to address nutrition in Central Mekong and presents diet and nutrition data and analysis from four case studies from Northwest Viet Nam and the Central Highlands of Viet Nam. After a review of R4D activities implemented in Central Mekong (see 2. and 3. in Table 1 above), the authors conclude that nutrition was not prioritized by the multistakeholder platforms or during the situational analyses, which led to R4D projects and activities that did not work directly to improve nutrition. Furthermore, the wide range of nutrition indicators and data collection methods applied in the nutrition-inclusive R4D activities highlights the need for more coordinated guidance and design at the program level.

In the final chapter, the conclusions and lessons learned from the three thematic chapters are synthesized, and the key achievements of more than four years of active integrated systems R4D implemented under Humidtropics along with some of the major lessons learned are presented. Despite numerous challenges, we conclude that our four years of integrated agricultural R4D activities in the Central Mekong resulted in significant research and development achievements. The partnerships and collaborative relationships made through our work, and our collaborative work with local partners on the ground to identify and test innovations, will continue beyond Humidtropics, and may be scaled up in other CRPs in the second phase. We believe lessons learned through our experience will contribute to strengthening our collective effort towards improving the income and livelihoods of poor smallholder farmers through sustainable agricultural development.

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Fertilizer application by a farmer in Son La, Viet Nam. Photo credit: ICRAF/Pham Duc Thieng

Site characterization and systems analysis in Central Mekong

Chapter 2

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1. Introduction

The systems addressed in this chapter and in the CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics) broadly include natural systems comprising biophysical, resource and climate realities; social systems made up of people, societies and their institutions; and, what some term as artificial systems built on elements of the first two (Checkland 1981). Agricultural systems, for example, modify natural systems for productive use, add infrastructure to provide markets, and modify human institutions to organize labour and services to enable the agricultural system to function. Regardless of how systems are categorized, they can be simplistically deconstructed into components and the interactions between them. In this chapter we characterize some of the Central Mekong systems, and also address some of the system dynamics, at two basic levels of resolution.

Section 2 addresses regional agricultural systems consisting of one or more districts within a country, and includes variations in natural and social systems in addition to agricultural systems. Five regional cases that reflect the diversity across the Central Mekong Action Area are examined and compared. The authors focus on systems at the community or local landscape level, particularly the individual farm household component, and the variation between households within the landscape. Variables include household agricultural practices, household resources, capacity, and links to markets and institutions.

Section 3 looks at diversity in the variables among farm households and the implications for livelihoods and well-being. Section 4 examines food security levels arising from specific farm household strategies and performance, how the two are related, and the implications for potential farm interventions. We conclude by comparing the types of systems examined, the differences in types of tools needed, and the differences in questions asked and learning generated.

Throughout this chapter, authors refer to data from reports and articles that interested readers can find in Annex I.

2. System characterization through situational analyses

2.1 Situational analyses for priority setting and shared ownership

A situational analysis under Humidtropics was the starting point for characterization and all further analysis of an agricultural setting or landscape. The situational analysis aimed to provide a broad body of data to inform and tailor the subsequent exercises, which were expected to be more detailed and in some cases focused on specific system components or addressing specific issues. Also, because Humidtropics by definition worked in a consultative manner through partners, the situational analysis also aimed to both create a joint and common understanding among all partners of the issues at hand, as well as support the process of establishing strong and sustained linkages with stakeholders at multiple levels.

Given this context, the situational analysis had three primary objectives.

The first objective was to characterize broadly all important system aspects relevant to the program within the target areas (in this case, Action Sites in the Central Mekong) and through that, generate data to inform all other program activities to better attain the intended outcomes.

The second was to harness various partner skills and experiences to develop a common and shared understanding of the issues needing to be addressed and their potential solutions, particularly between international and national partners, allowing local and global expertise to play complementary roles.

The third was to initiate and facilitate engagement with stakeholders and partners as part of developing the multistakeholder platforms needed for the program's long-term success and scalability.

This section describes the results of five separate situational analyses conducted in selected sites in Viet Nam, Thailand and China, which in turn represent the three Triangles, or Action Sites, described in Chapter 1. The sites were selected in consultation with national partners. Before describing the situational analyses, we offer a brief note on methodology.

2.2 Methodology

Each situational analysis comprised four parts: i) Development Overview, which presents a broad overview of generic rural and human development characteristics, infrastructure and the institutional and policy context in which rural development was occurring in the target provinces; ii) Production Systems, which describes the agricultural setting, types of crops, livestock and trees, technologies employed, and returns to agricultural enterprises; iii) Markets and Institutions, which describes agricultural market structure and practices, but also collective enterprises and public institutions that support agricultural development; and, iv) Natural Resources, which describes the land, water and other natural resources.

The analyses were conducted by national agricultural research and development partners in each site with backstopping and participation by CGIAR researchers. Although the methodology varied slightly, the information gathered was generally from six different sources. These were secondary data at local/regional administrative unit level; key informant interviews; focus group discussions; household surveys in some cases; market visits; and, stakeholder consultations. The multiple data sources provided for the triangulation and validation of data collected from different sources.

Key informant interviewees were selected on the basis of their knowledge, expertise, and professional affiliation, and discussions were based on semi-structured checklists. The focus group discussions were also guided by semi-structured checklists, together with the complementary use of Participatory Rural Appraisal (PRA) tools such as Community Mapping and a Seasonality Calendar. In some cases, transect walks were conducted through the village where each focus group discussion was held. Participants included various types of agricultural producers, market agents and entrepreneurs. Villages for the focus group discussions were selected by local officials in consultation with the research teams. The findings were directly used to provide qualitative information to the report.

After the focus group discussions were completed, information gaps were still evident. In an attempt to extract more detailed information and provide an additional opportunity to triangulate the information already found, in some cases short household surveys were developed and administered to a small sample of households in the same communes where the focus group discussions were held. In addition, market visits were conducted to observe the types of agricultural products sold, types of market agents, transport infrastructure, origin and destination markets. Draft results were presented to stakeholders comprising government officials, research and development NGOs, and others. Participants were asked to review and confirm or comment on the preliminary results of the situational analyses. In addition, stakeholders were asked to provide inputs with respect to underlying system problems in the area and what possible solutions may be offered. This information was used to complement and validate the issues raised from the preliminary assessment.

2.3 Situational analyses

2.3.1 Central Highlands, Viet Nam

Development overview

The Central Highlands of Viet Nam (Tây Nguyên) are a series of plateaus 500–900 m high. The Highlands can be divided into three subregions according to topography and climate, (north, middle, south). The area consists of four provinces: Dak Lak, Dak Nong, Gia Lai and Kon Tum (Khanh et al 2015). The population is youthful but with a fairly steady elderly population. Birth rates have been slowly declining over the last 10 years while the death rate has been constant, although the infant death rate is still high. The population density is relatively low compared with other parts of Viet Nam. Ethnic minority groups are numerous and vary across the districts. Literacy is generally high with men being more literate, and many women attaining only a primary education. Some 70 percent of the total population reaches high school.

Agriculture plays a critical role. At least 85 percent of the households depend on agriculture, forestry or fisheries as major economic activities, 8–10 percent of the population is engaged in the service sector, and 1.5–3 percent in industry and construction. Many youths are employed in the latter sectors. The average income increased sharply between 2008 and 2012 but the gap between rural and urban incomes has widened rather than diminished. In addition, income levels greatly determine the household size. Malnutrition is still high. Twenty-five percent of five-year-old children are underweight, of which 2–4 percent are severely undernourished, while between 35 and 41 percent show signs of stunting.

The infrastructure is generally poor and road systems underdeveloped. While commune (village) electrification has improved, only 1–4 percent of households are connected to the grid and many do not have access to electricity. Ninety percent of households have clean water, but the proportion is lower in rural areas than in urban areas.

Production systems

Households typically hold small plots of land, between 0.5 ha and 2 ha. The agricultural production area for cereal crops did not significantly change between 2009 and 2012. Agricultural commodities include rice, maize, cassava, coffee, pepper and rubber. Yields vary among provinces and crops. Kon Tum Province has 175 irrigation schemes that can water around 5500 ha of paddy rice and 650 ha of other industrial crops, but most crops are rainfed. Crop farms seem to be evolving towards specialization due to robust coffee and pepper value chains in the area.

Livestock (cattle, pigs and poultry) is also produced, although production shows a diverging pattern. Aquaculture is also developing but differs across the provinces. Specialization levels are low, especially in livestock and fish. Crossbred cattle and pigs are common but local breeds are still widely in use, especially among more traditional smallholders and ethnic minority communities.

The agricultural sector is not highly mechanized, with many traditional practices still in use, although some value chains use sophisticated mechanization. Fertilizer and pesticides are being used but often without following established technical protocols. Risks for income losses and food insecurity are high due to drought, flooding and high postharvest losses.

Markets and institutions

Rubber, peppercorns, cassava flakes and timber products are exported from the region. While coffee and cassava flake exports strongly expanded between 2008 and 2011, rubber and peppercorns have reduced their volume in tons as has timber. Cashew nuts and sawn wood are imported, as well as machinery. Fluctuations for all these commodities were dramatic between 2007 and 2012.

Numerous institutions promote production and marketing of commodities including the International Committee of the Red Cross and local cooperatives. Vietnamese NGOs are working on research or as consultants. International NGOs and informal community-based organizations such as farmer groups are also active. Nonetheless, information is inadequate on suitable varieties and good agricultural practices for soil and crop management.

The Central Highlands has only a few large private investments in agricultural production, in part because policies for private investments are not attractive. A major constraint is poor connections among value chain actors and dysfunctional or inefficient cooperatives and farmer clubs. Additionally, markets and marketing systems are poorly developed and the poor road network adversely affects smallholders in accessing markets to sell their produce. Many producers also have limited knowledge of marketing or production.

Natural resource management and the environment

Natural forests cover a large area of the region. However, forests are declining due to destruction from extreme weather events, and in 2011 large areas were converted into agricultural land mainly for maize, cassava and sugarcane. Land degradation, soil erosion and soil infertility are serious issues.

2.3.2 Xishuangbanna Dai Autonomous Prefecture, Yunnan, China

Development overview

Xishuangbanna is a small area (20 000 km^2) in a mountainous region. There is great cultural and biological diversity, with more than eight major ethnic groups and many other small ethnic groups and subgroups. The area has a subtropical climate. Infrastructure is well developed. More than 95 percent of villages have a road, running piped water and electricity. Access to affordable health care is reported to be very high, and the average life expectancy is 71 years. There is a cultural awareness of nutrition but little distinction between medicinal plants and food (Hammond et al 2015).

Formal education is low and, depending on the location, 20–40 percent of household heads are illiterate. Most women are less well-educated than their male counterparts, although among the most educated (college and university), women make up a greater proportion

than men. Many youths drop out of school because income from rubber is high and Chinese State education does not accommodate minority languages and culture. People living at high elevations tend to have less formal education.

Diversified agriculture is common where rubber or tea production dominates (90 percent of households). Other crops include rice, vegetables, fruits and maize. Livestock production is also common. Less than 10 percent of householders work in wage or salaried jobs. The average income for a rural person is approximately USD 1100 per year with great variation between the wealthiest areas (USD 3000 per person per year) and the poorest areas (USD 600 per person per year).

Production systems

The majority of agricultural land is managed by smallholder farmers with about 3 ha each for agriculture and forest cover, although there are also State-managed forest lands, village-managed community forest lands, and State-managed nature reserves. Rubber is the main cash crop grown in lowlands and sloping areas, however, forest land is still the largest area. Other crops include tea, which is usually intercropped, and bananas, which are a threat to forest land as many smallholders clear forest for its production.

Mixed farming systems are common. Although households tend to rely heavily on one or two major cash crops, they usually also raise some staple crops and livestock. The Xishuangbanna Bio-Industrial Crops Office has outlined plans for niche market high-value crops, many of which can be intercropped with forest or agricultural systems. Agricultural technology is well developed and widely available. Sixty to 70 percent of households own a small hand-operated tractor, although this is lower in the poorest areas. Modern cultivars such as rubber varieties suited to local conditions were developed and were subsidized. Fertilizer and pesticide use has increased steadily over the past 25 years. Over-fertilization is a common concern.

Markets and institutions

Land-use planning and management are disseminated to land managers via two well-organized routes: the government system and the market system. Well-established and capable research organizations also provide guidance to both government and market institutions.

There are four main classes of land management. First, smallholders who are generally free to make their own decisions. Second, community forest land managed by village leaders. Third, nature reserves under the authority of the Xishuangbanna Environmental Protection Office, and finally State forests under the authority of the Xishuangbanna Forestry Office.

The government system is hierarchically organized from province level down to individual villages, with plans made at prefectural level and passed down all the way to village leaders. However, only rules and instructions are passed through the system. Enforcement of rules is weak, contributing to illegal village-level land-use practices (e.g. clearing forest) which are not

reported back to higher levels. The market system has greater influence over farmers, who respond either to price signals or to requests and training from large-scale buyers. Newer products are introduced to farmers by companies via contract farming.

A key stakeholder is the governmental Bio-Industrial Crops Office, which works with research and business organizations in an attempt to balance the demands of the economy and the environment. A State extension service manages Agricultural Technology Stations at the township level. However, station staff are few in number, poorly trained, and can usually only provide advice on major cash crops.

Market penetration and access is good in Xishuangbanna, with four main types of value chains. For the main cash crops (rubber, tea, sugarcane) there is smallholder production with self-transport to the processing factory of the producer's choice. Banana production is informally contracted by outside entrepreneurs who pay upfront costs, sometimes encouraging illegal landclearing, and who return later to collect produce in large trucks for direct export. Contract farming systems are in place for emerging niche and high value crops. Produce for local markets such as rice, vegetables and meat is either sold directly by farmers to consumers or passes from farmers to individual market traders to consumers.

A disconnect exists in the knowledge transfer process. High-quality knowledge, techniques and strategies are developed at higher levels, but the mechanisms by which these are passed down to smallholders are neither reliable nor quick. Extension services have limited capability and the contract farming companies have a localized effect targeting only farmers in small areas.

Natural resources management and environment

Biodiversity is the major unique natural asset of Xishuangbanna, and is in decline. Xishuangbanna was originally heavily forested, but its forest cover has shrunk from 69 percent to less than 50 percent in recent years, and the important tropical seasonal rainforest shrank from 11 percent to four percent. Forest fragmentation has increased significantly, with land conversion to rubber cited as the major driver of natural resource decline. The tropical forest landscape contains large carbon stocks in the form of biomass and soil carbon. Carbon stocks are estimated to be in decline due to land conversion. Nature reserves cover 12 percent of the land area. A recently completed (2011) initiative designed and established connectivity corridors between all nature reserves in the prefecture, although the ongoing governance of these corridors is questionable. A well-established tourist industry showcases both cultural and biodiversity. However, sustainable and equitable tourism is not common and most profits benefit neither the general population nor conservationist causes.

2.3.3 Upland areas of Nan Province, Thailand

Development overview

Nan has a population of 478 264, with almost no growth (0.06 percent) over the last 10 years (2004–2014). Most of the population is Northern Thai (80 percent) who live mostly in the lowlands; the rest is composed mainly of five ethnic minority groups (Lau, Hmong, Mien, Khmu and Mlabri). The biggest group is the Lau (42 percent), followed by the Hmong (32 percent) (Kitchaicharoen et al 2015).

The urbanization rate is low, with 88 percent of the population living outside municipal areas. Most of the population is of working age (70 percent). The dependency ratio is 0.43. The poverty level in Nan Province has been declining in recent years, falling from 212 700 (46 percent) in 2000 to 94 400 (21 percent) in 2012, although at a slower rate than the national poverty level. However, household debt in Nan has risen quickly over the last two decades, growing 22 percent with average debt levels being higher than the national average. The debt-to-income ratio has also been increasing over time, and stood at 0.89 in 2013. Maize production activities have contributed to the increased debt burden in the highlands.

Efforts to reduce malnutrition at the provincial level have been successful with the malnutrition rate in children under six lower than the targets set out in the provincial plan. The situation with malnutrition in the highlands is not clear, and especially in relation to micronutrient deficiencies which can usually be found in such remote areas. Gender inequality is related to ethnic traditions and family life. Within the Mien and Hmong ethnic groups, men have much more power than women in decision-making, as well as access to and control over resources.

Production systems

In 2012, the total agricultural holding area was around 0.18 million ha. Most of this was devoted to field crops (mainly maize, tobacco, beans and cassava), followed by rice, permanent crops, vegetables and flowers. The area of agricultural land under maize and rubber has increased in recent years, while that under rice has fallen (based on data from 2002 to 2013).

Rice is grown using two production systems: irrigated paddy rice and rainfed upland rice. Modern technology is used to produce hybrid maize to increase production. However, maize production requires heavy use of chemicals. Also, vegetables and mushrooms are produced. Livestock is produced on a small scale with a total of 52 360 households carrying out livestock rearing activities. Chickens are the most reared (1 829 938), followed by pigs, ducks and beef cattle (52 011, 47 629 and 32 307 respectively). Privately owned land for pasture covers 955 ha and publicly owned covers 1687 ha.

Markets and institutions

The main marketing channel for vegetables is the local markets in the province, but some farmers sell their produce to entrepreneurs from other provinces. The market channel for vegetables can be divided into fresh vegetable and agroproduct processing markets. For the

processing market, deals are done through local entrepreneurs and agricultural cooperatives. Shopkeepers or small companies operate the agroproducts market in Nan. Most of the crops purchased are field crops such as maize, which is grown as food for livestock. Market channels exist for fruit, but there are not many fruit traders. The fruits most in demand are the Nam Dok Mai mango and sweet tamarind, both of which are exported.

The private sector has played an important role in developing agriculture in the province. It has focused on agribusinesses and has established strong forward and backward linkages for agricultural products. Such linkages have helped farmers improve production through the delivery of inputs and technology, and by providing markets. Nan has 23 local agricultural cooperatives which offer small agricultural producers a wide range of services, including improved access to markets, information, communications, technologies, credit, training, and warehouse operations. These cooperatives also negotiate better contract farming terms and lower prices for agricultural inputs such as seeds, fertilizers and equipment.

Natural resource management and environment

Areas for growing maize and other cash crops have been expanding in recent years, leading to a major decline in natural forest areas. Forested areas can be broken down into five classes: dense evergreen forest, dense forest plantations, dense deciduous forest, disturbed evergreen forest, and disturbed deciduous forest. Deciduous forest covers the largest area with 667 193 ha, followed by evergreen forest (103 201 ha). Land degradation is a thorny issue as deforestation is the main cause. However, individual and group efforts have been made based on the Nan Strategic Plan, which embraces the province's new vision of achieving green growth and where economic advancement is achieved through the sustainable use of natural resources. Rubber trees and other cash crop plantations have been promoted over maize in an effort to establish crops that have comparatively less negative impact on the environment. However, the suitability of such a promotion has been questioned, stirring up controversy among stakeholders.

2.3.4 Honghe Prefecture, Yunnan, China

Development overview

Honghe Prefecture is in the southeast of Yunnan Province adjacent to Viet Nam, and covers an area of 32 931 km^2, of which 80 percent is mountainous. The total population is nearly 4.5 million people, with approximately 80 percent living in rural areas. The annual population growth rate was 0.86 percent from 2001 to 2010. The majority (80 percent) depend on agriculture for their livelihoods. The province has the largest number of ethnic minorities and is home to 52 of China's 56 ethnic groups, 49 of them in Honghe Prefecture. Population density is high at about 136 persons per m^2 in Honghe Prefecture and 118 persons per m^2 at the provincial level. Most of the population is male. Honghe Prefecture is a socially complex region with strong traditions and heterogeneous communities. In the situational analysis, data from five counties in the prefecture (Jianshui, Hekou, Honghe, Jinping, and Yuanyang) were collected (Kaiyun et al 2016).

The education system has improved and expanded to reach children in remote areas, providing education at all levels. The number of pupils enrolled in middle and high schools has increased. However, significant illiteracy remains, particularly in rural areas, and the quality of education is comparatively low.

Although the national economy has developed significantly, poverty levels are high (38 percent), which is higher than both the provincial and national levels. Income is lower in rural areas (threefold to fivefold).

Infrastructure is poor since the area is mountainous and has an underdeveloped road system. The rate of rural household access to clean water and electricity is also low. Women are more disadvantaged and continue to lose out in the job market due to low education levels and low skills, in part through lack of access to or participation in vocational training.

Production systems

The average cultivated area per capita is relatively small (0.059 ha), much lower than the provincial level (0.091 ha). Honghe Prefecture has six State farms, where rubber and rice are produced.

Crop production and livestock are the main income sources for local farmers and account for more than 80 percent of the region's agricultural GDP. Grain, vegetables and fruit are the main agricultural products, and Honghe Prefecture is the largest fruit production region in Yunnan. Pig production (both number of animals and volume of pork) accounts for nearly 40 percent of the provincial production.

Forests, which make up a large part of the area, mainly benefit ethnic minorities in high-elevation areas. The fishery plays a relatively small part in overall production. Fish are raised in rice and winter paddy fields. Mechanization is limited. Low use of improved technologies and inappropriate use of agrochemicals further contribute to low productivity.

Honghe Prefecture has a complex topography, a distinct altitude gradient, a climate, and significant seasonal rainfall that provide unique opportunities for agricultural production. However, production systems face challenges, including a relatively low percentage of cultivated land, an increasing rate of soil erosion and degradation, pollution, disappearing natural resources, and the lack of a skilled labour force.

Markets and institutions

Monthly consumption of agricultural commodities (grain, vegetables, fruits and meat) has changed slightly during 2008–2011. Demand for grain increased and more grain was imported to meet this demand in 2012. Most agricultural products are sold in local markets or at the prefecture level, but some high-value products such as vegetables and fruits are exported to other countries in Southeast Asia, Viet Nam in particular. While prices increased from 2011 to 2013, so did prices for agricultural inputs (chemical fertilizers, pesticides, plastic farm films and agricultural electricity). Many exhibitions and trade fairs were organized to promote local agricultural products sold outside the prefecture as well as constructing new markets.

Farmer groups, including professional cooperatives and agricultural associations, have played important roles in promoting agricultural industrialization and boosting the rural economy, but many constraints limit their development and effects, such as a lack of market management knowledge, low level of team organization, and little support from policy and finance.

Natural resources management and the environment

Honghe Prefecture has ample and reliable water resources, but distribution varies by region. The Environmental Protection Agency is ensuring that water pollution is reduced. There are rich forest resources, especially natural forest resources. Forest area per capita and the forest coverage rate of the prefecture and the five counties studied are larger than those of China, though forest resources differ in each county. The Forest Department has improved forest management by regulating deforestation and punishing illegal deforestation. The area is also rich in biodiversity and agricultural genetic resources.

Land degradation and soil erosion are serious concerns caused mainly by the excessive or inappropriate use of chemical fertilizers, pesticides and plastic films. The heavy metal content in the soil is above recommended limits and is caused by discharge from various enterprises. Indigenous knowledge, which contributes to biodiversity protection, is gradually being forgotten with the passing of the older generation, and frequent natural disasters threaten the local ecosystem.

2.3.5 Northwest Viet Nam

Development overview

Rural roads and electricity: Viet Nam has implemented national programs to improve rural infrastructure, particularly rural roads and electricity systems under the auspices of Programme 135. From 1999 to 2005, the rural road system was rehabilitated, improving connectivity between communes and district towns as it finally became part of the national and provincial road network. Electricity systems were upgraded and expanded, increasing the access of communes to the national electricity grid system by 60–79 percent. The proportion of rural households with access to electricity jumped from 74 to 95 percent (ILRI 2014).

Access to piped potable water: From 2001–2010, a clean water program was widely implemented in the rural areas of the northern provinces. Approximately 90 percent of households in the urban area had access to clean water. Clean water sources were installed in more than 75 percent of rural communities. However, the rate of household access to a clean water source was still relatively low in three provinces (Lai Chau, 18 percent; Son La and Dien Bien, approximately 41 percent). Lao Cai had better access, at 77 percent.

Ethnic and cultural diversity: Viet Nam is a country where many ethnic groups live together in the same area. In the northwest provinces, more than 20 minority groups are settled in various places from the high mountainous area to the downtown areas of districts or city zones at the provincial centre.

Income levels and trends: A clear income disparity exists between urban and rural areas. The gap in average income per capita in these provinces was wide, with urban income double or triple that of rural areas. This inequality is considered a social problem, especially among ethnic minorities in remote areas.

Education and literacy: Based on official statistics, primary education is near-universal, and equality in education opportunities has improved in multiple ways. In the provinces studied, the school systems have newly built or renovated classrooms to cope with the increasing demand at all education levels. Every commune has nursery and primary schools, and lower secondary and upper secondary schools operate in every district. While the literacy rate is approximately 94 percent, it is lower in mountainous provinces.

Employment: Agricultural modernization, urbanization and industrialization have brought about dramatic changes in the lives of many Vietnamese farmers. However, farmers' livelihoods in the mountainous provinces, especially of those in remote rural areas, have been less affected.

Production systems

These northwest provinces of Viet Nam are characterized by some challenging terrain, including steep slopes in many areas and elevations reaching more than 1500 m. Nevertheless, slope and elevation do not entirely dictate where agriculture is carried out. Agricultural production is done on both small and large farms and uses mechanized, human and animal power, with differences closely associated with type of terrain and also ethnic group. Ethnic minority communities tend to adhere to traditional agricultural practices, which can constrain innovation within these significant groups. Livestock technologies are not well developed, relying mostly on traditional breeds and technologies, leading to low yields. An important and evolving feature is the rapid increase in the land area planted with maize on steeply sloped terrain, as a result of demand for feed for poultry and pigs in Viet Nam and further afield in China. Extreme erosion can be observed as a result, threatening the long-term sustainability of the land resource base.

Markets and institutions

Essential commodities in the provinces being studied were rice, vegetables, fruit, pork, chickens, beef, shrimp, fish, tea and alcohol. Some local traditional varieties of livestock and fruit are regarded as unique to the area, and attract high prices in urban markets. Consumption of fruits and vegetables is low, whereas monthly average per capita consumption of alcohol is relatively high. Many commodities are sold locally and the surpluses sent to urban areas, as some specialized products are exported to other countries. Farmers either sell directly to consumers or indirectly through collecting agencies or wholesalers. By selling directly, producers have a higher income and consumers are better informed of the product origin. State-owned institutions such as Plant Protection Units of the Provincial Department of Agriculture and Rural Development are in charge of distributing inputs and extension services to farmers. However, compared with the needs, staffing is limited and staff capacity is low.

Natural resource management and the environment

Northwest Viet Nam is a mountainous region that comprises steep mountain ranges, highland and dense river systems. Forest land accounts for the largest proportion of available land with approximately 80 percent in Lai Chau, Dien Bien and Son La and 70 percent in Lao Cai. An increasing proportion of that is under managed forests such as rubber, the production of which is growing rapidly, threatening biodiversity and other resources such as water and soils. Nevertheless, the Vietnamese Government is committed to managing natural resources and the environment and has issued a number of laws and decrees to preserve biodiversity and protect the environment as well as program 'thrusts', which have significantly increased forest acreage.

2.4 Concluding remarks

These short descriptions of the situational analyses results clearly illustrate the diversity of agricultural and rural development settings across the target sites in the Central Mekong Action Area. However, the sites also share some strong commonalities, which reflect some of the shared cultural history as well as similar physical terrain and agricultural traditions. Among the commonalities are: i) mountainous terrain characterized by some relatively remote and thinly settled locations in elevated areas, but also settled valley locations with better market access; ii) linked to this, a strong disparity in income between urban and rural populations; iii) a relatively strong presence of ethnic minority communities, many of which are politically, economically and geographically marginalized, particularly in the case of women; iv) a mix of agricultural market types, including both strong local demand but also longer distance and cross-border markets for specific products, some of which are high value; and, v) the relatively strong role of the State. In all sites, most of the population is rural and agriculture still plays the dominant role in livelihoods.

Contrasting features across the sites include: i) differential levels of development, including both infrastructure and agricultural technology, which are somewhat based on national-level development differences; and, ii) in some cases (Thailand, China) populations levels have stabilized while elsewhere such as in Viet Nam, population growth continues.

Some guidance for research and development can be obtained from these assessments, including:

- The relatively rapid changes in land use, and agricultural intensification in a region characterized by steep terrain requires investment in technologies and strategies to improve soil conservation within evolving production systems.
- The large presence of ethnic minorities with relatively poor access to extension services and to markets, and who are also characterized by lower income and literacy levels, suggests that special attention should be devoted to increasing their capacity for agricultural innovation and market access. Services need to be tailored specifically for their needs, while infrastructure development continues.

- There may be opportunities for agrotourism among ethnic minority communities, if appropriately designed to suit their interests.
- Local traditional products, crops and livestock exhibit untapped potential for high-value markets beyond the region, due to their unique characteristics and the value placed by consumers on their origin. Market-driven branding and certification systems may need to be developed, taking a public-private partnership approach.

3. Diversity among smallholder farmers in Northwest Viet Nam

3.1 Introduction

The situational analyses helped to identify some of the variables that account for the diversity among sites. This allowed us in turn to examine some of those variables among farm households and the implications for livelihoods and well-being.

A considerable variety of farm production systems are found across various cultures and landscapes, operating in differing socioeconomic, institutional, demographic and political contexts. Many external and internal factors affect farmers' decision-making on resource allocation, production and marketing. One efficient and useful approach to initially gain a clearer understanding of important farm characteristics in heterogeneous systems involves cluster analysis of farming households. Cluster analysis provides a clear descriptive picture of the existing farming structure with distributions of assets and livelihood indicators. These results may provide a basis for identifying best-bet and best-fit farm interventions and innovations in the associated product value chains with the aim of increasing smallholder productivity, thereby reducing poverty and food insecurity in the rural areas to improve household well-being. Some of these interventions are mentioned in chapters 3 and 4.

In many cases, smallholders not only show a strong heterogeneity among themselves, but are also characterized by considerable diversity of income sources and production activities. This may be due to their subsistence orientation, which is often associated with various objectives determining resource allocation and production. These objectives may include nutrient maximization, labour smoothing, consumption preferences or reducing various risks, in addition to maximizing income. As well as comparing various smallholder classes on their internal diversity, econometric analysis can further improve the understanding of how production diversity is associated with resources, income sources and livelihood indicators. A crucial indicator is the diversity of individual diets. An improved understanding helps with identifying causes, constraints and opportunities for diversification among poor smallholders who are especially vulnerable in marginal rural areas, and may deliver important information

for policy makers. The specific results from smallholders in Northwest Viet Nam will also contribute to the global discussion and the growing body of literature on farm household diversification.

3.2 Methodology

Survey background

The results presented here come from a baseline household survey conducted in Son La and Dien Bien provinces, which had initially been identified as field sites within the Humidtropics Central Mekong Action Area. A list of all communes with census data structured by administrative units (province, district) for these two provinces formed the first-stage sampling frame. Unsuitable communes, identified by extreme values for population density or classified as urban by local administration, or with extreme political and social issues, were dropped from the sampling list. These criteria led to the exclusion of 173 out of 314 communes. Based on the ratio of province populations, 10 communes were randomly selected from Son La and six communes from Dien Bien. After generating settlement and household lists for the selected communes, a total of 400 households were randomly selected. Relevant baseline data were collected using the ImpactLite survey tool (Douxchamps et al 2016) in early 2015.

Classification

Farm households were categorized into meaningful clusters by using two sequential multivariate statistical techniques: factor analysis and cluster analysis (Pacini et al 2014). With factor analysis the number of variables (most of which are correlated to each other) was reduced to a smaller set of factors that captured most of the variation within the observed variables. The retained factors from the factor analysis were then employed for cluster analysis to identify relevant farm household categories. The variables selected for classification captured three categories of important development assessments: wealth and income; productivity and innovation; and, nutrition. In particular they were:

- Wealth and income: area of cultivated land, livestock assets (measured in tropical livestock units), domestic asset index, off-farm income, household expenses.
- Farm productivity and innovation: crop and livestock productivity (production value/cultivated land), market integration (sales value/production value), land tenure status, use of innovations on cropland, use of innovations in livestock herds, period of innovation use, contacts with agricultural information providers.
- Nutrition: Individual Diet Diversity Score (IDDS), food supply sufficiency (calories consumed/calories required), food self-sufficiency (calories produced/calories consumed).

The IDDS is calculated according to Kennedy et al (2010). Accordingly, the 17 food groups included in the questionnaire are aggregated to nine groups, reflecting the probability of micronutrient adequacy of the diet. The nine groups are: starchy staples, dark green leafy vegetables, other vitamin-rich fruits and vegetables, other fruits and vegetables, organ meat, meat and fish, eggs, legumes, nuts and seeds, milk and milk products. The IDDS scores are calculated separately for the household head, the spouse and the eldest child under five years of age within the household.

Diversity indices

For this study, diversity is first determined separately for crop production, livestock production, income sources and diets. The Simpson's Index of Diversity (SID) is used to measure crop, livestock and income diversity. In effect, the SID measures the probability that two individuals randomly selected from a sample will belong to the same category. It was originally developed for measuring biodiversity, focusing on species (Simpson 1949) and was initially defined as:

$$D = \frac{1}{\sum_{i=1}^{s} p_i^2} \quad \text{Eq. 1}$$

Where p is the proportion (n/N) of individuals found in one particular category (n) divided by the total number of individuals (N); Σ is the sum over the categories; s is the number of categories.

With this index, 0 represents infinite diversity and 1, no diversity at all (all individuals belong to the same category). Therefore, the higher the value of D, the lower the diversity. This is neither intuitive nor logical. Therefore, D is often subtracted from 1 to produce the Simpson Index of Diversity (1-D). The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different categories. The lowest possible value, 0, would represent a community containing only one category. In this study, crops and species formed the categories for crop and livestock diversity, respectively, while seven income categories were defined for determining income diversity.

For dietary diversity, we employ the IDDS of the main survey respondent, irrespective of gender or household position, following the methodology described above.

Diversity analysis

To assess factors influencing various diversity indices, the Seemingly Unrelated Regression (SUR) approach, introduced by Zellner (1962) and later advanced by others (Fu et al 2016), was adopted, controlling for cross-equation correlation across the four diversity equations.

Correlation of error terms was also tested across equations using the Breusch-Pagan test of independence. Since the Simpson Index of Diversity is a fraction ranging between 0 and 1, and IDDS is a count ranging from 1 to 9, the Simpson Reciprocal Index (SRI) was employed to ensure similar distributions among all diversity measures. The SRI is the reciprocal of the original diversity index D (SRI = 1/D). The higher the SRI value the greater the diversity.

3.3 Results

Classification

Classification based on factor and cluster analysis generated four clusters of farm households. Table 2.1 presents the farming and household characteristics of these clusters.

Cluster 1 was labelled 'wealthy' and accounted for 10 percent of the total sample. Although the households in this cluster cultivated the least amount of land, they owned the largest livestock herds and had the highest non-farm incomes and household expenses. They also showed the highest diversity in income sources. It does not surprise that they also had the highest level of education and the smallest families. Their crop production was the most productive as measured by output value/ha, almost three times higher than the figure of the lowest cluster (Cluster 2). With livestock production, compared to the other clusters, these households produced at a larger scale, mainly focused on non-ruminant species, and attained the highest livestock productivity, also nearly three times the lowest productivity cluster. These households secured high production returns from rice, chickens and pigs, while showing only moderate levels of diversity in crop and livestock production (although livestock diversity does not differ greatly between clusters). This corresponded with these households being the most market-oriented, selling the highest proportion of their products, approximately one-third in the case of rice and chickens, and up to three-quarters in the case of pigs. Innovative technologies were applied widely in crop production, but only at a moderate level in livestock. This cluster showed the highest values of Individual Dietary Diversity Scores (IDDS) which together with food supply sufficiency reflect the high probability of an adequate diet.

Cluster 2 was labelled 'poor' and comprised about half of all farm households (49 percent). It was ranked lowest on almost all indicators. These households showed the lowest annual expenses among the four clusters and were headed by the youngest farmers with the lowest educational levels and farming experience. In agricultural production, this cluster was characterized by low levels of diversification, productivity and net returns. Farm products were mainly used for household consumption. The application of innovations was still at an early stage, as they had not really become accepted in this cluster. This may partly be explained by their limited exposure to agricultural information, evidenced by the low number of visits by agricultural extension agents. Diet diversity was also the lowest in this cluster by a considerable margin.

Cluster 3 was characterized as 'innovative' and constitutes 24 percent of the total sample. These households were likely to have more female heads and more farming experience than in the other clusters. They exceeded all other clusters in applying innovations in crop and livestock production, both in current extent and period of application, although the 'wealthy' cluster came close. However, this was not sufficient to allow these households to achieve the productivity levels of the 'wealthy' cluster, perhaps because they could not invest as much from non-farm incomes, which were the lowest among the four clusters, despite having the joint-highest income diversity. Nevertheless, diet diversity was nearly as high as in the 'wealthy' cluster. The caloric data on food supply, however, indicated a more precarious situation.

Finally, cluster 4, identified as 'crop-oriented', comprised 16 percent of the sample. It was characterized by the largest land holdings supporting large family sizes, but at relatively poor educational levels. Their land endowment allowed these farmers to grow the most diverse selection of crops and produce the highest value of rice and maize. Similarly, they kept the most diverse livestock. However, crop productivity was only moderate while livestock productivity was the lowest among the four clusters. Despite high production levels, more than 80 percent of the rice grown was consumed at home. Maize was the most important crop. Selling 60 percent allowed these households to achieve household expenditure levels similar to the 'wealthy' cluster at the lowest level of income diversity. Nevertheless, diet diversity was only moderate in these households.

Table 2.1 Characteristics of identified farm household clusters

Variable	Wealthy (n=39)		Poor (n=190)		Innovative (n=93)		Crop-oriented (n=62)	
	mean	se	mean	se	mean	se	mean	se
Household characteristics								
Number of household members (no.)	3.8	(0.24)	4.29	(0.10)	4.53	(0.17)	5	(0.24)
Gender of hh head (1=male, 2=female)	1.1	(0.04)	1.1	(0.02)	1.1	(0.03)	1.1	(0.03)
Age of hh head (yrs)	48.3	(1.77)	41.9	(0.99)	47.3	(1.18)	43.2	(1.13)
Education level of hh head (yrs)	7.6	(0.58)	5.4	(0.29)	6.1	(0.34)	5.7	(0.44)
Years of farming experience (yrs)	20.3	(1.87)	18.6	90.86)	23.0	(1.00)	21.7	(1.17)
Annual off-farm income (M VND)	80.2	(24.03)	26.1	(7.28)	18.1	(2.83)	33.4	(10.94)
Annual hh expenses (M VND)	47.0	(5.92)	15.5	(0.83)	30.1	(2.32)	42.9	(3.91)
Income diversity (SID)	0.47	(0.03)	0.40	(0.02)	0.47	(0.02)	0.38	(0.02)
Crop production								
Cultivated area (ha)	0.4	(0.06)	0.9	(0.05)	1.1	(0.08)	3.1	(0.24)
Share of land owned (%)	94.6	(3.06)	97.1	(0.95)	90.5	(2.49)	87.6	(2.87)
Number of crops (no.)	3.0	(0.34)	3.3	(0.14)	4.3	(0.24)	4.0	(0.29)
Crop diversity (SID)	2.9	(0.69)	2.5	(0.21)	3.2	(0.39)	4.0	(0.30)
Production value of rice (M VND/yr)	12.2	(2.08)	7.1	(0.54)	11.3	(1.14)	13.1	(2.67)
Production value of maize (M VND/yr)	13.9	(5.42)	18.5	(2.06)	19.9	(3.70)	108.4	(10.72)
Crop productivity (M VND/ha)	133.5	(1.39)	45.3	(0.21)	53.3	(0.28)	55.0	(0.30)

Variable	Wealthy (n=39)		Poor (n=190)		Innovative (n=93)		Crop-oriented (n=62)	
	mean	se	mean	se	mean	se	mean	se
Livestock production								
TLU (Tropical Livestock Unit)	10.7	(1.05)	4.1	(0.22)	8.4	(0.70)	9.2	(0.70)
Share of ruminants (%TLU)	20.8	(3.22)	41.3	(2.11)	36.7	(3.24)	40.8	(3.24)
Number of livestock species (no.)	4.4	(0.22)	3.9	(0.11)	4.6	(0.13)	5.1	(0.19)
Livestock diversity (SID)	2.7	(0.14)	2.5	(0.07)	2.7	(0.08)	2.8	(0.12)
Production value of chicken (M VND/yr)	18.1	(3.56)	4.5	(0.86)	10.7	(1.52)	9.2	(1.79)
Production value of pig (M VND/yr)	43.4	(12.09)	3.6	(0.66)	13.5	(2.24)	8.1	(2.07)
Livestock productivity (M VND/TLU)	9.53	(1.58)	4.39	(0.53)	5.43	(0.86)	3.38	(0.47)
Marketing and utilization								
Share of rice sold (%)	36.4	(7.91)	9.3	(1.76)	14.7	(3.25)	16.7	(4.96)
Share of maize sold (%)	15.3	(5.54)	28.5	(2.41)	16.4	(2.63)	60.1	(4.00)
Share of chicken sold (%)	34.3	(6.60)	11.1	(1.62)	27.1	(3.28)	12.5	(3.26)
Share of pig sold (%)	73.3	(11.32)	20.2	(3.02)	53.0	(7.17)	29.5	(6.27)
Innovation								
Use of innovation for crops (% crop area)	61.0	(3.68)	47.8	(1.44)	64.8	(2.16)	53.1	(1.69)
Use of innovation for livestock (% herd)	39.9	(3.97)	10.6	(1.07)	52.7	(2.21)	21.3	(2.38)
Period of innovation use (yrs)	5.9	(24.10)	3.3	(0.15)	8.7	(0.34)	5.3	(0.33)
Contacts for agricultural information (no./yr)	24.1	(2.13)	6.5	(3.02)	32.9	(1.51)	12.8	(1.26)
Nutrition								
IDDS main respondent	5.6	(0.20)	3.9	(0.10)	5.3	(0.15)	4.9	(0.20)
IDDS child	5.0 (n=2)	(1.00)	3.0 (n=28)	(0.34)	5.0 (n=7)	(0.69)	4.2 (n=4)	(0.63)
Food supply sufficiency	1.4	(0.08)	1.2	(0.04)	1.0	(0.04)	1.2	(0.07)
Food self-sufficiency	5.7	(1.08)	6.8	(0.43)	7.7	(0.67)	24.4	(1.86)
	High		Low					

Source: Humidtropics household baseline survey in Northwest Viet Nam (2015).

Seemingly unrelated regression analysis

The results from the four diversity equations estimated together as a system are presented below (Table 2.2). All the models are significant at the one percent level, except crop diversity, which is significant at five percent. There was a significant cross-equation correlation (p=0.06).

Table 2.2 Factors influencing various diversity indices

	RMSE	R-sq	chi²	P-value
Crop diversity	3.714	0.080	29.55	0.013
Livestock diversity	0.751	0.272	127.44	0.000
Income diversity	0.595	0.129	50.50	0.000
Dietary diversity	1.411	0.170	69.82	0.000

	Crop diversity		Livestock diversity		Income diversity		Dietary diversity	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Gender, hh head (1=male, 2=female)	-0.394	0.743	0.191	0.152	0.046	0.120	0.124	0.285
Education level, hh head (yrs)	0.170***	0.061	0.010	0.012	0.018*	0.010	0.073***	0.023
Farming experience (yrs)	0.044**	0.020	0.007*	0.004	-0.001	0.003	0.009	0.008
Cultivated area (m²)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Annual off-farm income ('000VND)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Plots cultivated (no)	-0.024	0.067	0.015	0.014	-0.008	0.011	0.021	0.026
TLU	0.002	0.045	0.023**	0.009	-0.009	0.007	0.025	0.018
Share of ruminants (% TLU)	-0.008	0.008	0.014***	0.002	-0.004**	0.001	-0.006*	0.003
Gender asset disparity	-0.043	0.093	-0.010	0.019	-0.014	0.015	0.038	0.035
Domestic asset index	0.004	0.003	0.001*	0.001	0.000	0.000	0.003**	0.001
Distance to market (km)	-0.002**	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Market integration crops (%)	-0.008	0.008	-0.003	0.002	-0.002	0.001	0.003	0.003
Market integration livestock (%)	-0.003	0.008	0.002**	0.002	0.004***	0.001	0.003	0.003
Use of crop innovations (% crop area)	0.013	0.012	-0.002	0.002	0.001	0.002	-	-
Use of livestock innovations (% herd)	-0.007	0.009	0.000	0.002	0.001	0.001	-	-
Household members (no.)	-	-	0.028	0.029	0.041*	0.023	-0.047	0.055
Livestock species (no.)	-	-	-	-	-	-	0.145**	0.071
Constant	1.796***	1.402	1.365***	0.314	1.865	0.249	2.854***	0.590

***, ** and * denote statistical significance at 1%, 5% and 10% levels respectively

Breusch-Pagan test of independence: chi²(6) = 12.031, Pr = 0.0613

Source: Humidtropics household baseline survey Viet Nam (2015)

It appeared that crop diversity was positively associated with the education level of the household head and years of farming experience. Similarly, crop diversity increased when the distance to markets was reduced. Livestock diversity was also positively and significantly influenced by years of farming experience, though much less than crop diversity. The domestic asset index, Tropical Livestock Units (TLU), the share of ruminant livestock and the share of livestock products sold were also linked to higher livestock diversity.

All other factors held constant, income diversity was positively and significantly influenced by the household head's education level, the number of household members and the share of livestock and livestock products sold. However, income diversity was negatively influenced by the share of ruminant TLU. It appeared that households keeping more ruminants had less diverse income sources. Finally, dietary diversity was positively and significantly influenced by the household head's education level, by the domestic asset index and by the number of livestock species kept. As with income diversity, the share of ruminant TLU negatively influenced dietary diversity.

3.4 Concluding remarks

The classification of farm households in Northwest Viet Nam was based on factors related to wealth, production, marketing, innovations and nutrition. The multivariate analysis approach, combining factor analysis and cluster analysis, allowed us to identify four typical farm household classes and the socio-economic characteristics associated with their farming and market choices.

It is hoped that these results will serve as a reference for future economic analysis in Northwest Viet Nam. While agricultural technological advances contribute to increasing yields and incomes, the results indicate that this link is not straightforward in this diverse environment. The diversity in the study region is measured by crop, livestock and income diversity while quality of nutrition is measured by diet diversity. The classification results indicated that although the poorest households showed low diversity in all indicators, the economically successful households tended to specialize in market-oriented farming activities, while diversifying their income sources. Households with high production diversity were those endowed with comparatively extensive land and livestock resources.

Results of the econometric analysis highlight the important role of farmer education in association with higher production and income diversity scores. While these results are indications, they are in line with literature showing that educated farmers are good at organizing complex farming operations, accessing multiple income sources, and ensuring diverse diets. We also see that while farming experience has a positive impact on crop and livestock diversity, it is not directly linked to increased income and diet diversity. This suggests that the knowledge farmers are provided with could be made more relevant for improving their livelihoods overall, particularly targeting improvements in their nutritional status. Although the share of ruminants had a positive effect on livestock diversity, this had a negative effect on both income and diet diversity. This may be attributed to the fact that the main meats Vietnamese consume are pork (56 percent) and poultry (27 percent) (OECD 2016). Accordingly, pork and poultry also generate the most livestock income. While livestock market integration had a positive effect on both livestock diversity and income diversity, this did not significantly affect diet diversity.

These analyses indicate that promising strategies for poor rural households with limited production resources would be to diversify income sources, with an emphasis on non-farm opportunities, while also modernizing their agricultural production and focusing on market orientation. Diversifying crop and livestock production appeared to be attractive mainly for farmers with above average resources. However, further analysis would be required to better assess the complex relationships between diversity and livelihood indicators.

4. Farm strategies and farm performance: How are they related?

4.1 Introduction

In the previous sections (2 and 3), we reviewed situational analyses to characterize study sites and then examined food security levels that arise from specific farm household strategies and performance, how the two are related, and the implications for potential farm interventions. In this section, we apply a new analysis framework to quantify a simple food security indicator, specifically developed to analyse the livelihoods of smallholder farmers (Frelat et al 2016), and to assess the potential impacts proposed intervention options might have in the Central Highlands of Viet Nam.

4.2 Approach

The analysis uses data obtained with the ImpactLITE farm household survey undertaken in 2014 (see https://ccafs.cgiar.org/impactlite-tool#.V7djrfkrLIU for a detailed description). Members of 400 households in the Central Highlands of Viet Nam were interviewed. Information on household composition, farm practices, production, sales and consumption of agricultural produce and off-farm income was collected for each household.

This information was used to quantify a simple indicator of food security, called 'potential food availability'. Detailed information about this indicator can be found in Frelat et al (2016) and Hammond et al (2016), but in short, the indicator quantifies the potential of a farm household to generate enough food (expressed in kcal) to feed the family through its on- and off-farm activities (see Figure 2.1).

Information on yearly crop production, consumption and sales, livestock production and off-farm income is combined with family size and composition, to quantify an estimate of whether the family can potentially be fed, based on these activities. The indicator is easily quantifiable using the information collected in many farm household cross-sectional surveys. This food security indicator does not cover all the complexity contained in the concept of food (in)security, but is simply a potential supply indicator. The indicator provides

a continuous 'food availability scale' that allows us to quantify the contribution of key determinants of food availability for individual households within and across sites. It functions well for sites in which food insecurity is major problem, and where agricultural productivity is low and where total production is low due to small farm sizes. More detailed survey analyses have shown that food availability relates well to other indicators of food security such as diet diversity and hunger, and food insecurity access scales up to values of roughly 5000 kcal per male adult equivalent per day (Hammond et al 2016, Frelat et al 2016).

Beyond this value the results diverge, and the food availability indicator is not very useful as an indicator of food security because agricultural production is no longer the main constraint for achieving food security and a diverse diet.

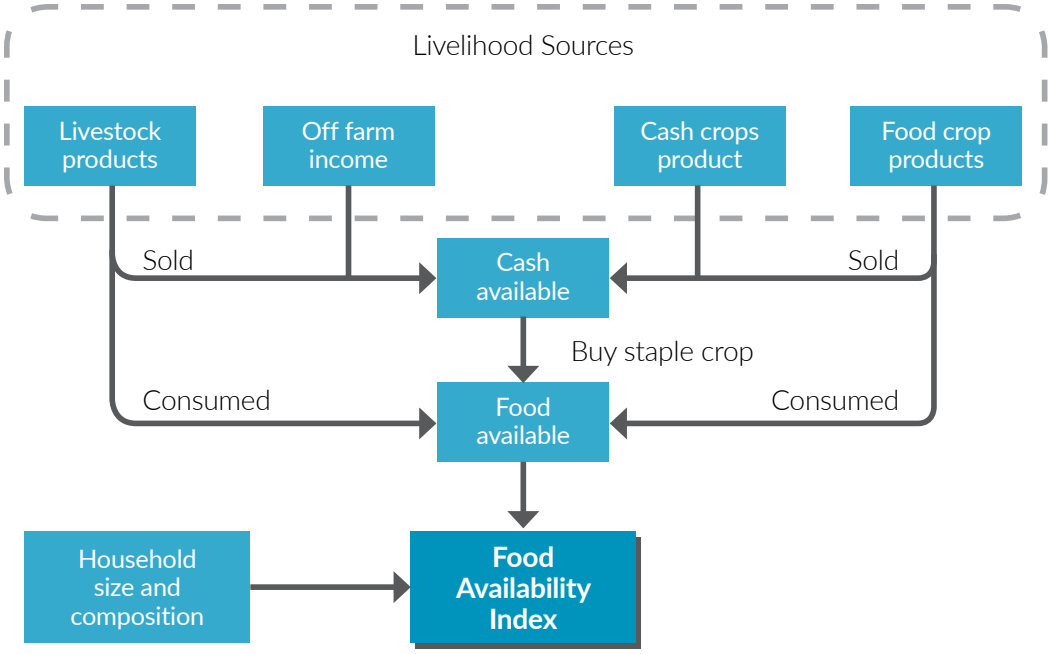

Figure 2.1 Scheme explaining the calculation of the Food Availability indicator (following Ritzema et al nd)

The analysis in this chapter follows the steps used in Ritzema et al (nd) and Paul et al (nd) in which i) a core set of interventions was identified; ii) an intervention's likely effect was defined if the intervention is adopted for productivity, market prices and land allocation; and, iii) the consequences of the changes on the simple food security indicator were quantified for each individual farm household.

The interventions studied in the Action Sites in the Central Highlands of Viet Nam and evaluated in this section were identified based on a literature overview of existing agricultural interventions and a collation of ongoing experimental work within the Humidtropics and related projects, mainly in the Northwest Viet Nam Action Area. The interventions are

presented in Table 2.3 together with assumed effect changes. The interventions listed range from introducing Son Tra (*Docynia Indica*) or the 'Hmong apple', a relatively new fruit tree species, to integrated pest management, to improved market access.

Table 2.3 Interventions evaluated in this impact assessment study together with their estimated effect changes if they were to be adopted

Intervention	Yield estimates	Price estimates	Literature
Expansion and improvement of Son Tra fruit production	2 tons/ha average	Farm gate price ranges between: 3000-15 000 VND/kg	Hoang et al (2013)
Coffee nutrient management	Yield improvement of 29-44%	No effect	Long et al (2015)
Integrated pest management	Yield of French bean improved by 5.7%	Cost saving of ~50% from reduced fertilizer use	Long et al (2015)
Improved agroproduct market linkages through value chain development	No effect	Price increases up to 40%	Long et al (2015)
Expansion and further intensification of agroforestry systems	Overall yield increases up to 10%	No effect	World Agroforestry Centre (2015)

4.3 Results

The baseline results of the food availability analyses showed that 26 percent of the farm households were food insecure, i.e. had a food availability ratio[1] of less than 1.5, the value related to saturation of other food security indicators such as the Hunger and Food Insecurity Access Scale and Household Level Diet Diversity (e.g. Hammond et al 2016). The five interventions had only a little effect on changing this 26 percent value: improved market access (23 percent), agroforestry (24 percent) and integrated pest management (IPM) (25 percent) had small positive effects, while improved coffee management (26 percent) and introduction of Son Tra (28 percent) had no or even negative effects on this value.

Figure 2.2 presents more detailed results on the intervention analyses, where we have divided the farm household population into four groups: severely food insecure, food insecure, roughly food secure, and food secure. These results show that the interventions had differential effects across these four farm household groups. Introduction of Son Tra had a positive effect on the income of most food-insecure households, but a negative effect on the other households because its introduction on the farm meant the farmer had to replace other crops with Son Tra. In this scenario, all existing crop areas were reduced equally to make room for an allocation of 10 percent of the total arable land area to Son Tra. This worked out positively for the most food-insecure households, because they could replace part of their low-yielding and low-market price food crops, but for the more food-

[1] The ratio between potential annual energy supply of food divided by the annual energy need of the family.

secure households with higher crop yields and more intensive market-oriented systems, Son Tra production did not improve the performance of the existing crops. Improved coffee management only improved the food security status of the already more food-secure households, because they were the ones currently growing coffee. Improved market access and intensified agroforestry systems increased food security across all households, with improved market access especially having large positive effects.

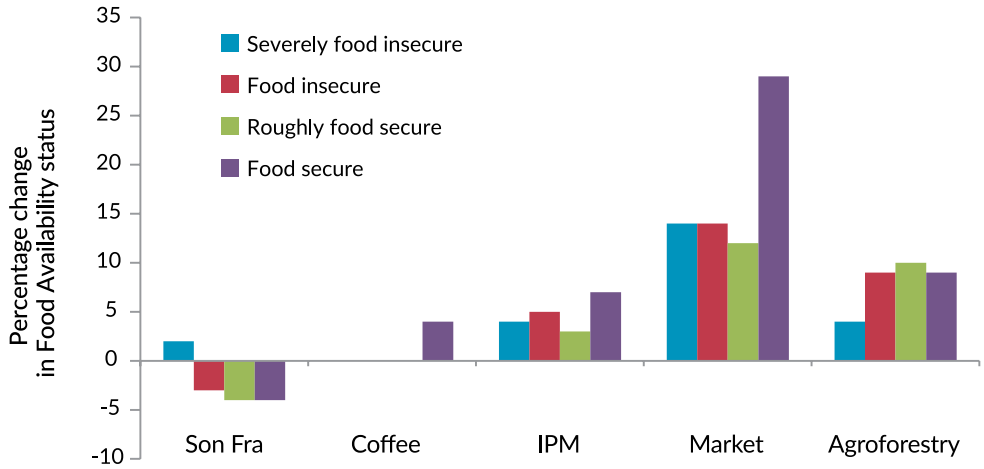

Figure 2.2 Percentage change in food availability status due to the interventions as compared to the baseline. Different colours are the different food availability classes

4.4 Concluding remarks

The simple analyses presented here shows a clear differentiation between the interventions, with the introduction of Son Tra, with the current production levels and market prices, targeting the poorest households (15 percent of the sampled population); the coffee management intervention, on the other hand, targeted the relatively food-secure households that form about 55 percent of the total population. In this way, the analysis gives a first indication of the outreach potential of different interventions, the effect they might have on food security, and how they might affect different farm groups within the overall population. This information can be used to better target interventions and better assess the efficiency of investment in supporting different interventions.

5. Conclusion

The cases presented in this chapter demonstrate examples of different levels and types of systems analysis, each with different objectives and tools, beginning with broad low-resolution analysis to increasingly focused higher-resolution analysis with narrower boundaries.

The first set of situational analyses (cf. section 1) addressed broad regional-level systems consisting of districts or provinces in a specific country. The system components were major sectors and institutions in the landscape, not individual actors. A mix of participatory, qualitative and quantitative tools was used to assess conditions and trends in general rural development, agriculture, markets and environment. The types of learning gained informed public investment in extension and agricultural development, opportunities for private public partnerships, and priorities for research.

In contrast, the next two examples of systems analysis (cf. section 2 and 3) addressed a more narrowly focused system, at the level of a group of farmers in selected communities, which could be described as a landscape. Further, the analyses only directly addressed a single component of the system, which was the individual farm household. This single component was characterized as a bounded farm household system, which included agricultural and other land-use practices, and also intrahousehold decisions, resources and capacities. Some interactions with elements outside the system were also captured indirectly, such as the degree of market orientation. The only information-gathering tool used was a quantitative survey of individual farm households. The analytical tools used in the two cases differed somewhat, however, since they asked different questions. Of key importance to both analyses was the level and type of variation between individual farm households within the landscape level system. The types of learning gained guided research and development priorities for that landscape, including what types of agricultural practices, and mixes of strategies, were most likely to lead to positive welfare outcomes for the households, and also characterized what those outcomes were likely to be, in this case livelihood and nutrition indicators.

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A bio-trap for home-based production of vegetables in Son La, Viet Nam. Photo credit: ICRAF/Pham Duc Thieng

Integrated tree, crop and livestock technologies to conserve soil and water, and sustain smallholder farmers' livelihoods in Southeast Asian uplands

Chapter 3

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Summary

After reviewing the main causes and effects of land degradation and erosion in the uplands of mainland Southeast Asia, this chapter presents several case studies of recent land-use changes governed by economic, political and institutional transitions, the expansion of teak and rubber tree plantations in northern Laos and southwest China, respectively, and of monocropping coffee in the Central Highlands of Viet Nam. We explain how these environmental disturbances are altering water and soil resources across different geographic scales, from the agricultural plot to the headwater catchment. Examples of coping strategies combining field trials and participatory approaches are illustrated with several case studies taken from research for development activities conducted in Cambodia, Laos, Viet Nam and the Yunnan Province of China. These activities were part of the CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics) in the Central Mekong Action Area. We propose solutions for sustainable agricultural intensification to diversify income, improve dietary diversity and improve natural resource management. The accomplishment of these objectives requires long-term involvement with ethnic minority communities that have been the particular focus in the target areas. The three-and-a-half-year lifespan of Humidtropics in the Mekong region was a short period. It would require extension to maintain the carefully built and nurtured relationships with local implementation partners and local farming communities, and reach its full promise.

1. Introduction

Over the past two decades, the agricultural sector in the Mekong region (Cambodia, Laos, Viet Nam and the Yunnan Province of China) has experienced profound changes, especially in smallholder farms. Market and population pressure, expanding infrastructure into formerly remote but fragile upland regions, government policies and incentives aimed at modernizing and commercializing the smallholder sector (MPI 2011), have induced a drive towards specialization and commercialization (Baudran 2000, Ducourtieux 2006). Enticed by booming markets for certain commodities and associated foreign direct investments (LIWG 2012), more smallholders have converted part or all of their farms into commercial plantations of rubber, coffee, teak, cashews or cassava (Neef et al 2013, Schönweger et al 2012). While such specialization has the potential to transform subsistence livelihoods into much more lucrative agricultural enterprises, it too often also leads to a weakening of ecological processes typical of more diversified traditional farm systems that integrate trees, annual crops and livestock; the result is land degradation (Cramb et al 2009), compromising ecosystem and livelihood sustainability (Rerkasem et al 2009). The absence of intercropping/crop rotation, animal manure cycling and appropriate plant understoreys to cover and protect soils may lead to increased dependency on inorganic and often potentially toxic inputs to control pests and diseases or maintain soil fertility, while simultaneously exacerbating soil erosion and water runoff problems (Guardiola-Claramonte et al 2010, Ratanawilailak 2013, Valentin et al 2008, Ziegler et al 2009a). Consequently, the future productivity and long-term sustainability of agricultural landscapes in the region may be jeopardised. With specific references to activities conducted as part of the CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics) in the Central Mekong Action Area, this chapter has three objectives:

1. To analyse the magnitude of the problems, specifically to explain how recent land-use changes are modifying erosion rates and runoff processes and the consequences over multiple scales (section 2).
2. To review the methodological approaches and tools applied to analyse the environmental and livelihood footprints and trade-offs in the contexts of i) the northern uplands of Laos where teak tree plantations are gradually replacing cash crops, and ii) rubber tree plantations in southwest China, and iii) on-farm integration, diversification, specialization, intensification and commercialization of integrated tree-crop-livestock smallholder farms in the Central Highlands of Viet Nam (section 3).
3. To provide examples of coping strategies (with enabling factors and constraints) through the case studies introduced in section 3 and with an additional case study focusing on rainwater harvesting for home-based vegetable production in Northwest Viet Nam (section 4).

2. Land use and water-soil interactions across geographic scales

Soil erosion is a major issue for sustainable agriculture in sloping land areas. It can cause severe negative environmental, economic and social impacts both on- and off-site. On-site, soil erosion leads to a loss of topsoil (Valentin et al 2008), the most nutrient and organic matter-rich part of the soil, in some cases even exposing the acid subsoil. Landslides and sediment transfer to down sites (Downing et al 2008, Thothong et al 2011) result in widespread land degradation (Sidle et al 2006) which, in turn, results in a decline in land productivity associated with decreasing soil organic matter levels (Kendawang et al 2005). The off-site effects of erosion on the quality and availability of water can have serious consequences for rural population health and natural ecosystems, and cause accelerated siltation of downstream reservoirs.

Researchers from the International Water Management Institute (IWMI), the French Institut de Recherche pour le Développement (IRD) and their national partners in Laos – the Department of Agricultural Land Management (DALAM) – and Viet Nam – the Soil and Fertilizer Research Institute (SFRI) – have demonstrated that afforestation through teak tree planting or by natural forest regeneration can induce divergent hydrological changes (Lacombe et al 2016). An observatory including long-term field measurements of fine-scale land-use mosaics and of hydrometeorological variables (Valentin et al 2008) has been operating in several headwater catchments in tropical Southeast Asia since 2000 (Photo 3.1). This monitoring network, named 'Multi-Scale Environmental Change' (MSEC, http://msec.obs-mip.fr/) has been funded by the French watershed network SOERE-RBV (réseau des bassins versants), the French Observatory for Sciences of Universe (Observatoire des Sciences de l'Univers), IRD and IWMI. Humidtropics enabled the data collected over the last 14 years to be compiled to produce the analysis reported here. A water balance model, repeatedly calibrated over successive one-year periods and used in simulation mode with the same year of rainfall input, allowed the hydrological effect of land-use change to be isolated from that of rainfall variability in two of these catchments, in Laos (Houay Pano catchment in Luang Prabang Province) and Viet Nam (Dong Cao catchment in Hoa Binh Province). Visual inspection of hydrographs, correlation analyses and trend detection tests allowed causality between land-use changes and changes in seasonal streamflow to be ascertained. In Laos, the combination of shifting cultivation (alternation of rice and fallow) and teak tree plantations gradually expanding and replacing fallow land led to intricate streamflow patterns: pluri-annual streamflow cycles induced by the shifting system on top of a gradual streamflow increase over years caused by the plantations' spread. In Viet Nam, the abandonment of continuously-cropped areas combined with patches of mixed-tree plantations led to the natural regrowth of forest communities followed by a gradual drop in streamflow.

These contrasting hydrological behaviours may appear counter-intuitive but proved to be closely linked to the way the land was managed. In Viet Nam, the natural groundcover including deep litter and soil naturally enriched with humus allowed rainwater to infiltrate

the soil, which allowed plants to develop deeper and thicker root systems as well as a denser tree canopy. Rainwater was better absorbed by the soil and then evapotranspirated by the growing trees, resulting in less water leaching into the streams during both the wet and dry seasons, and an overall reduction in erosion. In Laos, farmers moved from a shifting rainfed rice-based system to teak plantations. Teak trees usually develop a thick canopy and deep and dense root systems, which theoretically should reduce streamflow by increasing evapotranspiration. However, the hydrological effects of the teak plantations studied in Laos were very different. The area beneath young teak trees was cultivated with annual crops, inducing a high rate of soil surface crusting; the large leaves of mature teak trees concentrate rainfall into big drops that hit the soil with increased kinetic energy, forming surface crusts. In addition, most farmers intentionally kept the soil bare under mature teak trees by recurrent burning of the understorey[1]. These three actions created a soil crust in the plantations that was four times less porous than fallow land, producing higher runoff and streamflow, and – crucially – intense erosion.

Photo 3.1 The research site in Laos: Houay Pano catchment, part of the 'Multi-Scale Environmental Change' (MSEC) network. A: Stream water level measured within a V-notch weir by a water level recorder equipped with a data logger. B: Teak plantation in the rain. Root exposure illustrates ongoing erosion. C: Small fairy chimneys on steep soil in a teak plantation, revealing intense erosion rates. D: Tipping bucket rain-gauge used to monitor rainfall. Photo credits: IWMI/Guillaume Lacombe

[1] We assumed that this practice resulted from a mix of beliefs and practical considerations. i) Farmers generally considered that understorey vegetation competed with teak trees in accessing soil water and nutrients. Thus, they believed that burning this understorey vegetation improved teak trees' access to resources even though teak trees were known to explore and exploit deep soil layers much more thoroughly than understorey species. ii) When clearing plots to grow annual crops farmers usually poorly controlled the spread of fire into adjacent teak tree plantations; since adult teak trees are fire-resistant, this represented a convenient and effortless way of suppressing understorey vegetation in teak tree plantations. iii) The absence of understorey vegetation in teak tree plantations also improved access to and circulation within plantations, which was a desirable feature for many farmers for maintenance and exploitation purposes (NTFP harvesting, pruning, thinning, etc).

Soil permeability controlled by surface crusting was the predominant process explaining why two modes of afforestation (natural regeneration versus planting) led to opposite changes in streamflow regime in the two studied countries (Lacombe et al 2016).

One of this research's distinguishing features was its geographic scale. Previous research into this topic looked at 1 m^2 micro plots (Ziegler et al 2004, Podwojewski et al 2008, Valentin et al 2008, Patin et al 2012). By contrast, Lacombe et al (2016) confirmed previous findings at a scale about 1 million times larger (i.e. 1 km^2), which is more appropriate for water resource managers. The authors mapped land-use changes over a 13-year period by conducting detailed field surveys, recording daily water data and using modelling and statistical tools to match water flow differences against land-use changes while isolating the compounding effect of climate variability.

In the reforestation area in Viet Nam, both wet and dry season streamflow dropped by more than 50 percent. In the teak plantations in Laos, streamflow increased by more than 100 percent in both the wet and dry seasons with tremendous implications for natural resource management policy, especially in Laos (Lacombe et al 2016). The Government of Laos has set a goal to increase forest cover to 70 percent by 2020 (MAF 2005). A key driver is the commitment to hydropower development (http://www.poweringprogress.org/) and increasing forest cover will theoretically increase the available water for hydropower in the long term. CGIAR's research demonstrated that these ideas about the relationships between forest cover and hydropower development were not necessarily true. On the Vietnamese side, natural regrowth actually decreased the amount of water released into the catchment. On the Lao side, while streamflows did increase significantly, the high erosion rates associated with teak plantations led to excessively sedimented water unsuitable for hydropower development and detrimental to aquatic ecosystems.

These results were not necessarily typical of afforestation and should be extrapolated with caution. For instance, in Viet Nam, the reduced streamflow observed during the dry season was not necessarily characteristic of all reforested areas (Andréassian 2004, Bruijnzeel 2004, Calder 2007). In other situations, forest growth significantly improved the soil capacity to absorb and store water while the increased evapotranspiration caused by the growing vegetation remained moderate. These two concurrent changes resulted in a net gain in groundwater recharge followed by an increase of streamflow during the dry season, while at the same time total annual flow decreased. As such, it is important to consider the site-specific effects of the vegetation on the soil during both wet and dry seasons when attempting to link water resource management to land use.

Although important for the sustainable management of headwater catchments, the full understanding of hydrological processes altered by land-use changes remains limited in the tropics. While in most cases, afforestation will reduce annual streamflow, the opposite effect may also happen. Put simply, land use has more effect than land cover, sometimes leading to extreme yet opposite hydrological behaviours. Given that commercial tree plantations will continue to expand in the humid tropics, careful consideration is needed before attributing to them positive effects on water and soil conservation.

3. Understanding the drivers of soil and farming land degradation and water availability

3.1 Land-use management and impacts on water and soil in northern Laos

In 2015, the Humidtropics research team in Laos (IWMI, IRD and DALAM) decided to expand current knowledge on the effects of several land-use types on erosion and runoff to a wider range of farming practices typical of the northern Laos uplands. This work constituted the first exploratory phase of a project that aimed to, together with farmers and local stakeholders, test and develop innovative on-farm land management practices that allowed stream water quality to be improved while sustaining the fertility and productivity of erosion-prone soils in the mountainous environment. The overarching objective was to contribute to improving soil and saving water through collaborative field work between targeted farmers, researchers, government extension agents, community pillars, local knowledge gatekeepers and relevant authorities (Photo 3.2).

A combination of erosion and runoff monitoring in the field, focus group discussions and participatory rural appraisals, field visits and individual in-depth exchanges with farmers and other local knowledge gatekeepers was conducted in the small Houay Dou catchment in Xieng-Ngeung District of Luang Prabang Province, about 20 km south of the Houay Pano catchment. Ten typical land-use types were identified for the monitoring as representing usual farming practices, including annual crops (maize, *Musa spp*; Job's tears, *Coix lacryma-jobi*), tree plantations (banana; vernicia, *Vernicia montana*; rubber, *Hevea bresiliensis*; teak, *Tectona grandis*), with or without understorey, and broom grass (*Thysanolaena latifolia*). For each of the 10 land-use types, three microplots of 1 m^2 each were installed and equipped with a metal frame inserted into the soil at a depth of approximately 10 cm (Photo 3.2). Runoff water was collected in a tapped and buried bucket and the runoff amount was measured after each main rainfall event. Rainfall was recorded by an automatic meteorological station located in the watershed. Hydrometeorological data were collected during the 2015 monsoon season between May and October, and analysed in 2016. Preliminary results (to be published in a peer-reviewed journal article) indicated that farmers did not invest effort in maintaining the two studied annual crops, Job's tears or maize. The reasons appeared to be that a drastic drought in 2015 resulted in a very low crop coverage with significantly reduced crop yields. For these two annual crops, the runoff coefficient was much above the average of the 10 monitored land-use types. In contrast, broom grass was found to be the most efficient crop for erosion control because it efficiently protected the soil with a high interception rate. Broom grass, known in Laos as 'dok khem', is a naturally growing, semi-domesticated non-timber forest product (NTFP) naturally present in upland fallows, degraded forests and degraded land along roads and in villages. It mainly requires labour for harvesting, drying and threshing the inflorescences, which are the plant parts eventually used to make brooms. When cultivated, it is less time consuming than other field crops. Weeds need to be pulled out and then cut back once annually. Yield is estimated to be 1 ton/ha of dried and threshed inflorescences. A family

with all members working full-time on broom grass can generate an income up to USD 1200 per year. After harvesting, the broom grass flowers are sun-dried for three to five days. The seeds are removed by manual threshing and the grass stems are bundled for storage until it is time to sell them to traders or for broom making (Khamhoung and Gansberghe 2016).

Although trees usually exhibit a high percentage of canopy cover, teak and vernicia trees were found to be relatively inefficient in protecting soil from runoff and erosion because a rather limited amount of vegetation residues were found to cover the soil. In contrast, because fire was strictly controlled in rubber tree plantations, the percentage of residues on the soil surface was higher than in the teak and vernicia plantations. This coverage protected the soil from the direct impact of raindrops. In management terms, it was paramount to control fire in all types of tree plantations.

Photo 3.2 Land use, erosion and capacity building in the Houay Dou catchment. A: focus group discussion on erosion issues in teak plantations. B: Microplot under fallow. C: Cross-village visit. D: Training with agricultural extension services and district representatives from the Ministry of Agriculture and Forestry. Photo credits: IWMI/Guillaume Lacombe

In partnership with the policy research centre of the National Agriculture and Forestry Research Institute (NAFRI), IWMI conducted surveys among minorities in five villages around Houay Dou Basin to understand the villagers' preferences for cropped species, with a focus on the 10 land-use types monitored during the 2015 wet season. Some differences were observed between the villages, but overall there were good agreements as detailed thereafter (Pers. Comm. Sonali Senaratna Sellamuttu and Anousith Keophoxay). Overall, farmers indicated that they used to grow more upland rice, but because of low yields they switched to several different cash crops. Broom grass, banana and fallow lands were usually the preferred land-use types because broom grass was easy to plant and grew easily with minor inputs. It required minor maintenance due to limited spread of weeds. Field work

was simple and could be performed by the household without hired labour. In addition, the market demand was high and relatively stable, although prices exhibited some fluctuations. Broom grass production was stable all through the year. The only major problem was the possible competition for grazing land, which was not a significant concern in this area. Bananas were also a favourite crop. They were easy to grow and local traders usually came on-site to buy. If not sold, villagers were happy to eat the fruit. Fallow lands were appreciated especially by women because this was where they collected NTFP. Job's tears was often preferred, compared to the traditional upland rainfed rice, because it could be planted on previously fallow land with no age requirement (while rainfed rice should be cropped following a fallow plot aged at least five to seven years). In addition, Job's tears could be grown for three consecutive years at the same location. Among all annual crops, maize was a low priority for farmers, who grew this crop to feed livestock only and not for selling. Among the three main tree species planted in the region (vernicia, rubber and teak), teak was the favourite because it was considered a long-term investment that would benefit the farmers' children. Rubber and vernicia were not prioritized currently because of dropping prices on regional markets. Farmers in Houay Dou were considering pulling vernicia trees out to replace with another crop.

3.2 Rubber plantations in Yunnan

Although rubber was first introduced to Asia from the Amazon rainforest in the late 19th Century, there has been a recent massive expansion of rubber plantations across the Greater Mekong region driven largely by increasing demand for natural latex from China. Huge swaths of formerly multiuse landscapes and natural forests have been replaced by monoculture rubber (Ziegler et al 2009b, Fox et al 2014). Between 2003 and 2010, about 15 000 km^2 of land was converted to rubber plantations in Cambodia, southern China, Thailand and Viet Nam (ANRPC 2010). This massive land conversion had predictable consequences for ecosystem services (Wu et al 2001, Mann 2009, Qiu 2009, Ziegler et al 2009b, De Blécourt et al 2013; Yi et al 2014; Fox et al 2014), including water services, carbon sequestration and biodiversity conservation. About one-quarter of the Xishuangbanna prefecture in Yunnan Province was converted to monoculture rubber, mostly in the species-rich lowlands, including 23 616 ha within protected areas (Chen et al 2016). This land conversion dramatically reduced biodiversity in a prefecture that only covers 0.2 percent of China but used to include 23 percent of the vascular plant species found in the whole country (Liu and Slik 2014, Sreekar et al 2014). Sreekar et al (2016) observed only eight bird species in a monoculture rubber plantation located more than 500 m away from a large forest fragment where 160 bird species were usually found. Moreover, although rubber has been a path-out-of-poverty for many smallholders, there have been severe social consequences with widespread reports of land grabbing and coercion. Reduced access to NTFP and economic dependence on a single commodity has also left many farmers vulnerable to fluctuating rubber prices. Through a bilateral project funded by the German Government (GiZ Green Rubber project), the Humidtropics research team investigated links between land cover change and ecosystem functioning in Xishuangbanna. In this brief case study, we focus on the soil and water.

Several studies have demonstrated that rubber is a relatively deep-rooted plant that can modify local and regional water balances (Guardiola-Claramonte et al 2008, 2010, Tan et al 2011, Liu et al 2011, Carr 2012). Due to their large xylem vessels (Ayutthaya et al 2011), rubber trees consume more water than most native forest species in Southeast Asia. Earlier studies have shown that rubber trees have an extended root system allowing a wide part of the soil to be explored for water uptake. Depending on the season and zoning of soil moisture, the tree is able to shift from shallow to deep soil layers to extract water where water is the most abundant at a certain point in time, indicating significant plasticity in sources of water uptake (Liu et al 2013). As a result, rubber extracts more water throughout the dry season than natural vegetation and extracts water from deeper soil as the dry season progresses (Guardiola-Claramonte et al 2008). This feature enables the tree to thrive through periods of greatest water demand. Studies comparing rubber plantations with natural secondary forests found that soil under rubber had significantly reduced water infiltration capacity (Liu et al 2000).

We investigated the effects of understorey management on soil erosion using surface-flow interception traps. In treatment areas farmers were paid not to spray the understorey with herbicides, which they normally did twice a year, to allow the understorey to regenerate naturally. During the first wet season, six to 10 months after establishment, soil erosion in the current practice (control) areas was six-eightfold higher than in treatment areas, and overland flow was 9-19 percent higher. This experiment was still in its first year and understorey vegetation growth was limited when these measurements were made, hence we expect this effect to increase as the understorey's natural regeneration progresses. Other recently published studies have shown that splash erosion is much higher in monoculture rubber than in rubber agroforestry treatments (Liu et al 2016). Together these results support popular reports of increased wet season flooding and siltation of rivers, and reduced dry season flows following conversion of secondary forests to monoculture rubber plantations. In rubber-dominated watersheds, many formerly perennial streams now regularly run dry during the dry season, often affecting household water supplies. Local communities have also reported deteriorating water quality with increased turbidity and algal growth.

At a larger scale, watershed studies generally confirmed these results although the low density of hydrological stations and complex patterns of land cover change have made it more difficult to interpret patterns. In one 9432 ha watershed in Xishuangbanna, from 1992 to 2010, while rubber cover increased from 9 percent to 44 percent, the natural buffering capacity of the watershed declined by 9 percent, indicating accelerated runoff and deteriorating watershed function.

Following the sharp drop in rubber price in 2012, many farmers replaced rubber with alternatives, especially bananas. However, these options were more available to wealthier farmers, who could afford to write off losses. Farmers in more marginal areas were more inclined to wait out the low rubber prices.

3.3 Monocropping coffee in the Central Highlands of Viet Nam

The Central Highlands of Viet Nam comprise a series of undulating plateaus straddling the border of eastern Cambodia and southern Laos. Elevation generally ranges between 300 m and 900 m. Although fertile basaltic soils exist at the tail end of the Annamite mountain range in the northern and eastern parts of the Central Highlands, soils over much of the rest of the area are commonly acidic, light-textured and of low fertility (Tri 1997, Tran 1998, Thai and Nguyen 2002).

Historically, the agricultural sector was dominated by ethnic minority groups (mainly Ê Đê, Mnong and Tay) practising mixed low input and low output smallholder farming. In these systems, they relied heavily on shifting cultivation to maintain soil fertility. After the end of the 'American' War in the mid-1970s however, the Vietnamese Government encouraged ethnic majority Vietnamese (Kinh) people to migrate from the more densely populated areas of Viet Nam into the sparsely populated Central Highlands (Dang et al 2001, Cramb et al 2004). The Kinh brought more intensified and market-orientated forms of smallholder agriculture. Coffee production in particular was strongly promoted as a livelihood strategy by the national government, becoming the region's agricultural mainstay, especially in the lower lying areas of the southern and southeastern parts of the Central Highlands (i.e. Dak Lak and Dak Nong provinces) (Bui 2003). The coffee boom in the 1980s and 1990s in turn drew more immigrants from other areas of Viet Nam to the Central Highlands, and more smallholder farms became specialized in coffee (Long 2007).

However, this specialization in coffee, while allowing farmers to reap better returns to labour in good times, also made them more vulnerable to market or price shocks. Falling coffee prices in the late 1990s meant that smallholders growing coffee on less fertile land, where coffee yields were lower, had problems breaking even. On the other hand, as Tran and Kajisa (2006) argue, the (over)reliance on inorganic fertilizers in more specialized and commercially orientated monocropping farming across Viet Nam has led to declines in soil organic matter and soil productivity. In such cases, the use of inorganic fertilizers has often replaced traditional practices. These traditional practices typically consisted of i) use of animal manure and plant biomass on-farm for composting and adding to various of crops; ii) use of leguminous rotations to boost nitrogen input into the soils and control pest and disease cycles; and, iii) long fallow periods to allow soils to regain a measure of fertility. As a consequence, the normal ecological processes typical of the more diversified traditional farm systems that integrate trees, annual crops and livestock were weakened, and this resulted in declines in soil fertility. To some extent, Long (2007) corroborated similar perceptions among smallholder farmers in two communes in Ea Kar District in Dak Lak Province in the Central Highlands. Interviewing 42 coffee monocropping smallholders and 49 smallholder farmers practising diversified/mixed integrated farming, she found that while prices fluctuated, soil degradation and poor soil fertility were the two main concerns of the coffee monocropping farmers.

The challenge to sustainably intensify agricultural production in the Central Highlands, therefore, is to develop and diffuse practices and systems that appropriately balance specialization and commercialization as a means of generating increased farm income on the

one hand, with appropriate on-farm diversification and natural resource management on the other hand to ensure continued future ecological productivity of smallholder farms.

4. Solutions and interventions to sustainably recover lands while ensuring short-term economic returns

4.1 Improving understorey management of teak tree plantations in Laos

The effects of land-use management on water and soil in the northern Laos uplands (presented in section 3.1) were discussed with the farmers in the study villages and with the Ministry of Agriculture and Forestry (DAFO) district representatives. Two priority actions were identified during the focus group discussions: 1) to raise the awareness of farmers regarding the environmental and agro-ecological consequences of their current practices, such as the frequent teak understorey clearing; and, 2) to identify and implement sustainable solutions for water and soil conservation. Action 1 was achieved through village-level group discussions and learning activities (e.g. cross-learning field visits) with the provision of relevant, farmer-focused, local-language information materials (cf. Photos 3.2). Action 2 required more time and was only partially achieved under Humidtropics. While the identification phase was completed, the implementation phase was only partly initiated.

We found that DAFO usually did not focus on erosion issues but rather advised farmers on how to maximize benefits from teak plantations through seed handling, nursery techniques, transplanting, pruning and thinning. One solution to control erosion, identified during the discussions, consisted of introducing understorey cash crops to the tree plantations. Interspersing teak trees with understorey crops promoted rainwater infiltration into the soil, which reduced soil surface erosion. At the same time, the soil enrichment with organic material improved its water holding capacity, thus enabling plant development during the dry season. Since erosion did not seem to be seen as a major issue for teak tree growers, a realistic incentive to encourage farmers to grow understorey crops was to emphasize the possible additional income they could earn from selling the economically profitable understorey crops and their derived products.

Depending on local soil and climate conditions, several species could be cropped under teak trees with potential economic returns: galangal, ginger (although the market demand was still limited), broom grass (farmers usually preferred this crop because of its high market demand, cf. section 3.1), cardamom (with a potentially high income, although yields are uncertain: cf. Khamhoung and Gansberghe 2016), natural grass (easy to grow, good for erosion control, but no immediate economic benefit although it may have some biodiversity-based ecosystem service benefits like pest control), mountain peanuts (high market demand) and the small fast-growing mimosoid tree *Leucaena leucocephala*, originating from Latin America, for livestock fodder. According to field surveys conducted among DAFO officers, the timing for planting

understorey crops was critical as it influenced the plants' successful development. The best time was usually one year after teak trees were planted, except for broom grass which was more invasive. In that case, it was preferable to wait until teak trees were two years old.

Several constraints impeding the introduction of understorey crops were also identified during the discussions and possible solutions were proposed. In Luang Prabang Province, teak trees were usually planted at two-metre intervals. With this relatively high density, the canopy closed only a few years after the trees were planted, which did not allow sufficient light to reach the ground for understorey development. To allow understorey crops to develop, a minimum of three metres between trees was necessary, in addition to pruning and thinning at regular intervals (about three years). These activities were beneficial for both the harmonious and productive growth of teak trees, and also for the development of the understorey crops. Another important constraint to understorey development was fire spreading from adjacent plots cleared to grow annual crops. Some villages have defined rules to avoid fire associated with rice-based shifting cultivation practices from spreading into teak plantations. These rules, which are not legal, are more or less rigorously enforced by village heads. Finally, in some areas around the Houay Pano catchment, erosion under teak plantations was already at an advanced stage. Opportunities for reversal with crop or natural vegetation development were limited because the most fertile topsoil had been washed away already. In this situation, an alternative and mechanistic control of erosion could involve recycling branches from pruning used as natural barriers along contour lines and maintained by the trees.

A few farmers who were already growing broom grass and cardamom under teak trees were identified in the surveyed villages. Trained by DAFO, they started this intercropping only one year ago and were still waiting to see if the technique was profitable. Due to the very limited number of training courses DAFO has been able to provide with limited funding, only a few landholders have adopted such innovative techniques.

4.2 From monoculture rubber to green rubber in China

Many environmental problems commonly associated with rubber and other plantation crops, including teak, Acacia, Eucalyptus and oil palm, derive from managing plantations as monocultures rather than crops per se. For example, rubber has been managed by smallholders in Indonesia, Malaysia and southern Thailand as a component of secondary forest regeneration for more than 100 years and studies of these 'jungle rubber' systems have found that they approximate advanced secondary forests in terms of ecosystem service delivery (Warren-Thomas et al 2015). For example, in Sumatra it was found that jungle rubber supported 50-80 percent of the bird species found in nearby primary forests (Gouyon et al 1993). Meanwhile, carbon sequestration rates were typically as high, or higher, than for natural regeneration. Hence, improved plantation management holds substantial promise for restoring ecosystem functioning across the enormous swaths of land under monoculture management globally.

Photo 3.3 Rubber plantations in southern Thailand. A: Young (three years) rubber timber system. B: Mature (10 years) rubber timber system. C: Rubber intercropped with Salak. Photo credits: ICRAF/Rhett D Harrison

Experiments conducted by the World Agroforestry Centre (ICRAF) and partners in Indonesia demonstrated that modern high yielding rubber clones could be intercropped with many other species (Penot et al 1999). In selecting suitable intercrop species, the only critical limitation was that rubber performs poorly when shaded, so intercrop species should be selected to grow under the rubber canopy (Photo 3.3). Typically, smallholder farmers preferred to manage the crop in two phases. In the first three years, the rubber was intercropped with annual crops as this negated the need to control competition and fertilizers benefited both intercrop and rubber. This also provided a short-term return that offset the cost of establishing the rubber trees. In Xishuangbanna, smallholders often contracted migrant farmers to establish rubber plantations; the migrant farmers were unpaid but got a free lease on the land to grow pineapples for two to three years. After about three years the rubber canopy started to close and it was no longer profitable to manage annual crops. The long-term intercrop could either be established with the rubber or after harvesting the annual crop in the third year. Shade crops such as tea, coffee, cacao, salak and Gnetum were often recommended, although some farmers liked to grow fruit trees like mangosteen, mangos and durian because of the ready market even though productivity in the shade was low (~50 percent). Intercrops could also include timber species and species yielding non-timber forest products. In the latter systems, high-value, slow-growing timber species were allowed to grow up under the rubber. Then after the rubber was harvested at 25-30 years the timber was left to grow for another 10-20 years. These systems were potentially very profitable, but farmers in Xishuangbanna appeared very reluctant to make such long-term investments. This

may reflect the recent history of displacements and changing land regulations in China. Over time, timber-based systems could become highly diverse and are analogous to advanced secondary forests.

Photo 3.4 Participatory approaches to prioritize agroforestry techniques as part of GiZ Green Rubber Project. Man'e village, Menglun County, Xishuangbanna, China. A: Farmers proposing agroforestry trials. B: Discussion of different options including rubber monoculture and rubber agroforestry. Photo credits: ICRAF/ECA

Through Humidtropics, the research team worked with government officials and farmers in Xishuangbanna to diversify and improve rubber management (Photo 3.4). The principal outcome was an on-farm trial to be established in Man'Dian village near Menglun in 2017. The trial will test the performance of four systems: i) monoculture rubber; ii) rubber intercropped with fruit trees; iii) rubber intercropped with timber and non-timber forest products; and, iv) natural regeneration enriched with species from iii). The species were selected together with the farmers who are also providing their land and labour. This trial is now being extended to northern Thailand, northwest Laos and Sumatra.

4.3 Integrated crop-tree-livestock farming in the Central Highlands of Viet Nam

Aimed specifically at addressing suitable entry points for building on the potential of sustainable intensification and diversification of agriculture in the Central Highlands of Viet Nam (cf. section 2.3), the International Centre for Tropical Agriculture (CIAT), together with Tay Nguyen University (TNU) and the Western Highlands Agriculture and Forestry Science Institute (WASI), convened a multistakeholder platform in Buon Ma Thuot, Dak Lak, Central Highlands of Viet Nam, in September 2014. The platform comprised representatives from the local Department of Agriculture and Rural Development (DARD), the National Agricultural Research Systems (NARS), non-governmental organisations, local authorities, a coffee consultancy firm, three CGIAR centres, TNU and WASI. Discussing research avenues to appropriately balance specialization and commercialization with on-farm diversification, the platform reached consensus that there was an urgent need to facilitate the development and diffusion of smallholder farming systems that integrated livestock and crop activities in

a manner that allowed both the risk of crop failure and the needs of labour on- and off-farm to be better spread. At the same time, they had to ensure environmental resources were not exhausted and that dependency on external inputs was not exacerbated at the cost of short-term production boosts. In particular, the platform highlighted the need for research on improved soil conservation and more effective nutrient cycling.

Small funds by Humidtropics to support multistakeholder platform research projects afforded the platform the opportunity to take action and address the expressed needs through a specifically designed project. Due to its research expertise on integrated crop-tree-livestock smallholder farming systems, WASI was designated to lead the project. The platform further selected two pilot sites for project interventions: Ea Tyh Commune of Ea Kar District in Dak Lak Province, and Dak Dro Commune of Krong No District in Dak Nong Province (Photo 3.5A). These two study communes differed to some extent in population densities and predominant crops and farm types (Table 3.1). Both have predominantly poor soils (mostly sandy and Gley soil). This allowed for testing interventions that accentuated soil fertility maintenance or improvement.

Table 3.1 Characteristics of two targeted communes

Commune	Population densities*	Average farm size	Percentages of HH engaged in different productions					
			Perennial tree crops			Annual crops		
			Coffee	Pepper	Cashew	Rice	Cassava	Sugarcane
Ea Tyh	>220 person/km^2	2.1 ha	40	15	15	45	35	24
Dak Dro	<150 person/km^2	1.4 ha	80	20	30	50	15	1

Note: Values rounded to the nearest 5 are based on a survey of randomly-selected households (HH) undertaken in each commune in early 2016 (See Chapter 2; Ea Tyh: 153 households in 6 villages; Dak Dro: 157 households in 5 villages).

* Annual Reports of the People's Committees of each commune (2014).

Within each commune, two target villages were selected in consultation with local authorities and based on criteria including relatively high numbers of ethnic minority smallholders and the possibility of finding specialized coffee monocropping farms close to integrated and more diversified farms. Meetings were held in each village to introduce the project aims, and a suite of participatory rural appraisal approaches were applied to gain a better understanding of the village setting and the farmers' major aspirations, priorities and main challenges (Photo 3.5B). Subsequently, in participation with the whole village, five smallholder farms in each village were selected as pilot sites for participatory research and visible demonstrations or village learning activities. Special attention was paid to ensure the selected farms represented a broad spectrum of diversification and integration, potential challenges and opportunities, and ethnicity and gender. Both Kinh and Ê Đê or Mnong smallholder farms were explicitly included, as well as female- and male-led households among the pilot farms. The final farm selection included about 50 percent female-headed households in all villages, and about 75 percent and 16 percent ethnic minority farmers in the villages of Ea Tyh and Dak Dro Commune respectively.

Photo 3.5 Coffee dominance in the Central Highlands of Viet Nam. A: Typical smallholder coffee farm landscape in Dak Dro Commune, Krong No District, Dak Nong Province, Central Highlands. B: A group of ethnic minority Ê Đê smallholder farmers undertaking an exercise to rank different farm activities in terms of importance to household income, labour, subsistence, future sustainability of the farm, etc. The exercise here was led by a commune extension worker sitting at the table (second from right). Photo credits: WASI/CTM Long

WASI project staff then started regularly contacting the local district and commune DARD extension offices in the target areas, and together with specially designated government extension agents from these DARD offices, visiting the target villages and pilot farmers. Experience from previous projects led by CIAT, TNU and WASI in the same Central Highlands areas highlighted that project staff needed to take sufficient time on the ground in study sites to build relationships with farmers, field advisors and other local actors, as local extension can be the difference between success and failure (CIAT-IFAD 2016). This is crucial, especially with ethnic minority smallholders, not just to understand the priorities, aspirations and challenges of smallholders and the extension agent closest to the farmers, but also to effectively work with them on a mutual trust basis. In discussions during the regular visits over the first few weeks with the pilot farms and the larger community, several potential technologies for further investigation were elucidated. These included planting small parcels of land (approximately 1-2000 m^2) on the farm with forages or intercropping forages within coffee gardens, and fattening or finishing cattle for market using these forages in a cut-and-carry system. Planting highly productive, nutritious forages on-farm may allow smallholders to increase livestock productivity without relying on increasingly scarce natural resources (Peters et al 2001). Importantly, if forages were planted close to the homestead and animals kept close by, this had the potential to decrease the labour required to collect feed, or tether or herd animals far away from the farm (Stür et al 2006, Dimang et al 2009, Ba et al 2013). By cut-and-carrying the forages to stalled animals, this in turn allowed manure to be collected in the stalls. Other technologies highlighted for further study and development by both the platform and smallholders in the target villages during community meetings included intercropping fruit trees such as durian and avocados within the coffee trees, as well as technologies focused on improving coffee yields such as grafting new plant material to older trees.

WASI staff sampled and analysed soils from various plots on all 20 pilot farms for pH, organic matter, total and available potassium, total and available phosphorus, calcium and magnesium to create a baseline on soil fertility. Subsequently, trials involving the various proposed

potential technologies were initiated on the pilot farms in the second half of 2015. Initially, experienced WASI researchers trained local commune and district extension staff on the relevant technologies in a series of training-of-trainer events. The WASI staff, supported by the freshly-trained extension agents, subsequently trained trial farmers and their neighbours over several days on each technology, using the trial farms as training venues and thereby initiating the on-farm trials. WASI and district DARD extension agents continued to follow up and monitor the trials, while convening and facilitating several village learning activities, field days and farmer cross-visits where the other farmers in the village or from neighbouring villages and communes were invited to examine and assess the proposed technologies. Additional training on issues such as composting or local pig husbandry and manure management was provided at regular intervals and included both local extension agents and more than 200 farmers from the study communes. While disseminating knowledge on these methodologies, these regular training events also provided a forum for regular interaction and relationship building between farmers, extension agents and WASI project implementers. The biophysical and economic outcomes of the trials were to be evaluated at the end of 2016.

4.4 Harvesting rainwater to improve home-based vegetable production in Northwest Viet Nam

In the Greater Mekong region uplands, rainfall is often the only water resource available for agriculture. River streams in headwater catchments are ephemeral and often too far away from farming lands, while groundwater is often too deep and saline with high extraction costs. In the absence of water for irrigation, the monsoon climate in Southeast Asia forces farmers to limit cultivation to the rainy season, mainly between June and October. To sustain vegetable production year-round and improve the nutritional value of food for smallholder farmers, rainwater harvesting and storage is seen as a way to secure water resources outside of the rainy season and during drought spells.

The World Vegetable Center (WorldVeg), IWMI and the Fruit and Vegetable Research Institute (FAVRI) have explored possible options to store rainwater for dry season vegetable production using rooftop rainwater harvesting, ponds and demonstration sites for further development at a scale larger than villages. The aims were to improve water access for vegetable gardening in the Northwest Viet Nam uplands. If managed well, home gardens can produce enough vegetables and the micronutrients (vitamins and minerals) contained therein, to nourish a family all year-round (Chadha and Oluoch 2007, Chadha et al 2011). However, the productivity of most household gardens was low because of poor soil quality, limited water availability, low quality seed, crop pests and diseases, poor crop management and the destruction of crops by livestock (World Vegetable Center 2016). The location and size of the household garden was largely determined by access to water during the dry season. Household wastewater could be reused in the garden if it did not contain sewage water or excessive amounts of detergents. Mulching could make water use more efficient by reducing soil evaporation.

Thong village in Mai Son District, Son La Province, was isolated from the commune centre by a 3.7 km rough road that complicated market access during the wet season and water access all year-round (Photo 3.6). It was inhabited by Hmong ethnic people who cultivated a

mono-maize crop on sloping lands. They had limited experience cultivating vegetables. Since 2014, Humidtropics has supported several families to set up field trials of vegetable gardens with the support of WorldVeg and FAVRI. Villagers wanted to extend vegetable production during the dry season but were constrained by lack of water. WorldVeg, IWMI and FAVRI implemented a rainwater harvesting system using rooftop rainwater stored in a tank. In a rainwater harvesting system, the water tank's storage capacity was the most expensive element, directly influencing water availability and construction costs. IWMI developed a water balance model to evaluate the optimal storage volume to maximize the storage capacity (i.e. minimize the risk of water shortage) while minimizing investment costs. A simple spreadsheet daily water balance model was developed in MS Excel to simulate the daily volume variations of the water stored in a tank collecting rooftop rainwater. The model used daily time series of rainfall, referenced evapotranspiration and associated crop water demand to compute the tank water inflow (originating from the roof), and outflow (for crop irrigation). A failure function evaluated the frequency of water-stressed days (i.e. when the amount of water stored in the tank was lower than the crop water demand) over each multi-year simulation period accounting for interannual climate variability. This model included several parameters that determined the size and type of the roof, size of the vegetable garden, cultivated crop species and associated water demand. The model simulations indicated that a storage capacity of about 20 m^3 was sufficient to secure vegetable production all through the dry season with a garden of about 50 m^2 and a roof (to collect rainfall) of about 100 m^2.

Based on these results, a rainwater harvesting system was set up in the village. Two main water storage options were considered to collect rainwater from the roof of a shed nearby the WorldVeg experimental site: i) a cement tank partially buried in the soil with a total storage capacity of 10-15 m^3, and ii) four inox tanks each with a 5 m^3 storage capacity. The second option was selected for its greater flexibility (tanks can be moved as necessary) and because it was easier to install using materials readily available in the region (Photo 3.6). The roof, already equipped with gutters, had a total area of 169 m^2 and the vegetable garden was 42 m^2, making the total storage capacity of 20 m^3 appropriate for this system. The total system cost was reasonable compared with the concrete tank. Moreover, it could last for at least 10 years. The rainwater harvesting system was set up on October 2015. The field trial included two treatments, one with irrigation (Photo 3.6C) and one without. Vegetables were selected and cultivated during the dry and the wet seasons from October 2015 to June 2016. Twenty-one and 17 vegetable crops were selected to grow in the irrigated and strictly rainfed garden respectively, based on the climate pattern and their water requirements.

Yield corresponding to each species was found to be greatly improved with the use of the rainwater harvesting system. Without irrigation, crops with limited root penetration (e.g. leafy vegetables) or high water content (e.g. cucumber) were the most affected by water shortages. Solanaceous and root vegetables, and legumes with a smaller leaf area were less affected. This study demonstrated that water is one of the most important biophysical factors that affect crop growth and yield. Maintaining gardens during the dry season was possible when using drought-tolerant crops such as legumes, solanaceous and root vegetables. In addition, these vegetables provided diversified nutrients for villagers who often suffer from malnutrition.

Photo 3.6 Harvesting rain to produce vegetables in Northwest Viet Nam. A: typical Hmong house in Thong village. B: the four tank units installed by WorldVeg/IWMI/FAVRI to store rainwater from the roof of a shed. C: vegetable garden irrigated with a rainwater harvesting system. D: traditional gutter made from bamboo sticks in Thong village. Photo credits: IWMI/Guillaume Lacombe

5. Conclusion

The Mekong region (Cambodia, Laos, Viet Nam and the Yunnan Province of China) has experienced profound transformations over the past decades: the 'modernization' of agriculture, in particular, is occurring at an unprecedented pace. Traditional, highly diversified, low external input/low output subsistence and semi-subsistence smallholder farming systems are being replaced by more specialized, commercially orientated farms and plantations of teak, rubber or coffee. In these new sloping land systems where trees are commonly monocropped, the soil between trees is often left bare and exposed to erosion from rain and overland flow. Additionally, farmers practising more specialized forms of agriculture often rely increasingly on inorganic fertilizers and agrochemicals to sustain soil productivity rather than the traditional practices of long fallow periods to allow the soil to regenerate its fertility. While the larger income generated from these plantations may benefit the household in the short run, if not done properly such monocropping systems have the potential to gradually erode the land's fertility, leading farmers to use ever-increasing amounts of inputs to sustain yields and ultimately even jeopardising the land's future productivity. It also makes farmers much more vulnerable to price fluctuations for the single commodities they are producing.

However, it does not have to be one extreme of unsustainable production for short-term income gains pitted against another extreme of poorly remunerative but environmentally sustainable subsistence or semi-subsistence farming that perpetuates poverty. To ensure

productive agriculture and food production for future generations, the challenge is really centred on how to best harmonise income generation from commercially-oriented, specialized tree and monocropping systems with the benefits of more diversified farming systems that allow soil and water to be better conserved. Such an integrated approach also enables the production of multiple other ecosystem services including carbon sequestration and biodiversity conservation.

To achieve this, Humidtropics brought researchers from a variety of disciplines together with local farmers and government extension workers, as well as other important stakeholders of agricultural development processes in northern Laos, southern Yunnan and the Northwest and Central Highlands of Viet Nam. Indeed, in this context, the very core of the Humidtropics effort lay in marrying holistic scientific ideas on improving on-farm soil and water conservation with bottom-up participatory approaches to ensure that the local stakeholders' priorities, concerns, perspective and analyses were addressed and placed in the centre.

Humidtropics initially facilitated and funded the establishment of local and thematically orientated multistakeholder platforms to kickstart the process and bring together a range of broader systems thinking to complex problems. Specially developed on-farm and on-station trials, a variety of hands-on training sessions for local extension agents and farmers, various village learning activities and inspirational cross-visits and on-farm demonstrations followed. These allowed new methodologies to be tested and displayed, while at the same time ensuring that the local farmers remained owners and co-drivers of any innovation. Additionally, it also allowed the local DARD or DAFO extension agents, crucial to the future link between research and farm practice and perhaps also for future up- and out-scaling, to have sufficient buy-in to the processes. Importantly, such on-farm trials also enabled increased interaction between researchers, project staff, local extension and farmers.

When working with ethnic minorities and disadvantaged households making up a considerable part of the sociocultural fabric of the study areas, it was of paramount importance that scientists, project staff and extension agents spent sufficient time in the study areas. This allowed them to create dynamic exchanges and to build and foster relationships and mutual trust with the local actors. This in turn could greatly assist the development and diffusion of suitable soil and water conserving technologies and systems, both in and beyond study sites. But this also takes time, often many years. Humidtropics is set to close, even while now showing some initially promising results in developing suitable intercropping, or water harvesting activities, or on-farm diversification that can enhance whole-farm income generation and nutrition cycling from animal manure. Many activities and trials are still ongoing. Some of the first cycles of comprehensive biophysical and sociocultural evaluations are planned for later in 2016 or in 2017. Therefore, as both a postscript to the Humidtropics soil and water conservation efforts in the Central Mekong Action Area and as a recommendation for future initiatives, we propose that funding, even small amounts, over much longer timelines be explored; funding that allows partnerships with co-implementers or relationships with ethnic minority communities that, in our case, have just started to develop, to mature and be deepened so that future research for development becomes more effective.

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Grass sharing in Son La, Viet Nam. Photo credit: ICRAF/Pham Duc Thieng

A review of efforts to integrate nutrition in systems research

Chapter 4

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1. Introduction

Some of the grand challenges facing the world today include unsustainable food systems, the double burden of malnutrition (undernutrition and obesity) and environmental degradation. In addition, population growth, climate change and changing consumer preferences add pressure to our current food production systems. Current agricultural practices are moving toward intensified monocultures, which increase yields in the short term, but can limit agrobiodiversity. The result is that diets are often dominated by a single staple crop (most notably rice, maize or wheat) and lack diversity in other nutrient-rich foods such as vegetables, legumes, fruit or animal-source foods (fish, milk, eggs and meat).

These grand challenges and the drivers that influence them are interconnected and require integrated system approaches to understand how people interact with their environment to achieve food and nutrition security. The CGIAR Research Program on Integrated Systems for the Humid Tropics (Humidtropics) sought to address nutrition and dietary issues within a broader integrated research for development (R4D) approach. It is, however, recognized that a systems project is more complex than projects focusing on specific commodities, and requires more time for partnerships and common goals, methods and analyses to evolve. This is particularly true for nutrition which is a relatively new concept to many. Benefits, including

health, from improved nutrition are influenced by several factors beyond agricultural interventions and thus require collaborations with partners beyond the agricultural sector including in education, health and anthropology.

This chapter will review research projects and evaluate tools and approaches used to address nutrition in Humidtropics in the Central Mekong Action Area between 2013 and 2016. A more detailed look into four of these projects that analyse diet or nutrition data will be presented from four case studies. The chapter will then review the efforts of multistakeholder platforms in the Central Mekong Action Area to include nutrition and will conclude with recommendations based on lessons learned to better integrate nutrition into systems research to enable positive outcomes in diets and nutrition.

1.1 Review of Humidtropics Central Mekong project portfolio and scope on nutrition

A review of Humidtropics partner research protocols, tools, activities, reports and other documents from the Central Mekong Action Area was performed with the focus on nutrition. Follow-up interviews clarified whether nutrition methods, approaches and indicators were used, and if not, to identify why. Results were circulated to researchers for review (see table online here [http://tinyurl.com/o2lj3k2]). It is important to note that some gaps remain, as collated information depended on the researchers' responses and any associated documentation.

The review identified seven main projects implemented in the Central Mekong 2013 to 2016 (Table 4.1). Of these seven projects, three were in Viet Nam (two in the Northwest and the other in the Central Highlands), one was in Thailand, two were in China (one in Xishuangbanna and the other in Honghe, both in Yunnan Province) and one was conducted across two countries (Viet Nam and Laos). Although each project had its own objectives, they had one commonality: to improve the livelihoods of poor rural populations.

Table 4.1 Seven main work projects conducted under Humidtropics in the Central Mekong Action Area and their respective research centres

Main work projects in the Central Mekong Action Area	Institutions involved
1. Research for development of appropriate technical innovations in integrated farming systems for scaling up in Northwest Viet Nam	• Soils and Fertilizers Research Institute (SFRI), • Viet Nam Academy of Agricultural Science (VAAS) • Fruit and Vegetable Research Institute (FAVRI), VAAS • Northern Mountainous Agriculture and Forestry Institute (NOMAFSI), VAAS • Centre for Agrarian Systems Research and Development (CASRAD) • The World Agroforestry Centre (ICRAF) • International Livestock Research Institute (ILRI) • International Water Management Institute (IWMI) • The World Vegetable Center (WorldVeg)
2. Improving dietary diversity and diet quality through systems innovation: A pilot study in Viet Nam	• Bioversity International • Center for Agricultural Research and Ecological Studies (CARES) • HealthBridge Foundation Canada • National Institute of Nutrition (NIN), Viet Nam • Wageningen University and Research (WUR)
3. Assessment of different opportunities for agricultural diversification in Nan Province, Thailand	• Chiang Mai University • Mae Fah Luang University • WorldVeg
4. Enhanced livelihoods and better natural resource management through appropriate integration and diversification on smallholder farms in the Central Highlands of Viet Nam	• Western Highlands Agriculture & Forestry Science Institute (WASI) • International Center for Tropical Agriculture (CIAT) • ILRI • IWMI
5. Attraction in action: Using pheromones and other safe and sustainable management strategies to reduce losses from insect pests and plant diseases on vegetable legumes and leafy brassicas in Southeast Asia	• WorldVeg • FAVRI
6. Appraisal and innovations on diversified and sustainable rubber ('green rubber') in Xishuangbanna, China	• ICRAF • WUR
7. Activities for Humidtropics in Honghe	• Bioversity International • International Potato Center (CIP)

To assess the extent to which nutrition research was implemented in the Central Mekong, we examined both overarching work projects and separate individual activities conducted by the research institutions to see whether nutrition was included as an outcome indicator. Only three projects directly stated a primary or secondary project objective of improving nutrition (1, 2 and 4). Nutrition matters because it provides a foundation for human development, and without adequate nutrition individuals are unable to achieve their full potential (Frankenberger and McCaston 1998). The 'Sustainable Livelihoods Approach' acknowledges the integral role of nutrition, particularly through building human capital (Slater and Yeudall 2015), and is one of three CGIAR strategic goals (CGIAR 2015); however, it was not integrated into all projects.

Each project could be broken down into multiple work packages of activities that often would be running in parallel. The seven projects were further divided into 14 separate activities, of which five explicitly included improved nutrition in their objectives (these activities were in projects 1, 2 and 3). These activities often included a pathway leading to increased availability of nutritious foods, often combined with nutrition education. Education components focused on improving nutrition knowledge and attitudes to encourage behaviour change toward diversification of diets and home garden production, and urged that income generated from improved yields be used to buy nutritious foods. One activity also included participatory nutrition cooking classes, using improved recipes to motivate the production and consumption of crops or foods targeted by the project. Only one activity's research protocol included a clear description of a specific nutrition impact pathway.

Although most activities did not include improvements in nutrition as an outcome, two activities included the assessment of nutrition indicators in literature reviews or baseline assessments. One activity included a nutrition education training session without including a specific nutrition outcome objective in project or activity plans. Project 4 included nutrition in the objectives, however did not integrate nutrition-sensitive activities into its operation.

Nine out of the 14 activities listed in Table 4.2 included neither nutrition outcomes in research protocols or objectives, nor collected data on nutrition indicators. These activities' objectives focused on other agricultural technical innovations such as soil, water and pest management, and integrated farming systems to improve yields and improve market linkages. Possible nutrition impact pathways were always identifiable by the review team even when not made explicit in the original work plan or proposals. Primarily, the identified pathway to improve nutrition was through improved productivity of key crops which could then be consumed directly or sold. If sold, the projects could have included nutrition education components to encourage farmers to use income to purchase nutritious foods.

It is not realistic or always feasible that all projects or activities will have the technical or financial resources to include nutrition outcomes. However, it is important that at a minimum, a 'do-no-harm' approach is applied to ensure research activities or interventions do not negatively impact nutrition. Such an approach includes basic nutrition indicators in base- and endline assessments, helping to build an evidence base for further research.

Table 4.2 Summary of activities in the Central Mekong Action Area and their scope on nutrition

Note: A table with the full detail can be viewed online here [http://tinyurl.com/o2lj3k2].

Project and title	Activities	Possible nutrition impact pathways[1]	Nutrition objective or scope of project	Nutrition method or approach
1. Research for development of appropriate technical innovations in integrated farming systems for scaling up (Viet Nam)	• Re-establish upland farming systems • Assess techniques for nutrient management and safe vegetable production with integrating farmland systems • Evaluate soil erosion to improve quality • Establish fodder grass for livestock development (CASRAD, SFRI)	• Improved diet via increased availability of nutritious foods, or by improved quality/ nutrient composition of foods produced • Encouragement to use increased income from sale of crops to buy nutritious foods, if combined with nutrition education sessions • Improved food safety	No	Not included
	• Improve water access for vegetable gardening (IWMI)	• Improved diet if improved water management techniques improved yields	No	Not included
	• Re-establish upland farming systems • Monitor impacts of intercropping and grass strips on soil erosion • Understand the social processes of agricultural innovation to improve the livelihoods of ethnic minority groups, especially women (ICRAF, NOMAFSI)	• Improved diet via improved yield of specific foods, or by improved quality/ nutrient composition of foods produced • Encouragement to use increased income from sale of crops to buy nutritious foods, if combined with nutrition education sessions	No	Not included
	• Complete consultation on livestock, households and value chains, baseline survey, situational analysis (ILRI)	• Results used to identify priority areas where nutrition needed to be addressed to guide project planning from CGIAR centres/Humidtropics partners	• Increasing food security • Improving nutrition and health	• Literature review • Qualitative 24-hour diet recall

[1] Not all projects identified nutrition impact pathways or achieved impacts on nutrition. This column provides examples of possible impact pathways that could have brought about positive changes in nutrition within the project scope.

Project and title	Activities	Possible nutrition impact pathways[1]	Nutrition objective or scope of project	Nutrition method or approach
	• Analyse value chain and establish market linkages for vegetable products • Promote safe vegetable production through integrated crop management trials • Identify suitable technologies for increasing commercial vegetable productivity in Son La • Develop home garden packages and increase nutrient supplies to the soil and availability from home garden produce (WorldVeg, FAVRI, NIN)	• Increased availability of nutritious foods for direct consumption to improve diet quality • Encouragement to use increased income from sale of crops to buy nutritious foods, if combined with nutrition education sessions • Improved food safety	• Nutrition not an objective but was included in the project scope	• Literature review • Anthropometric measurements • Knowledge attitude and practice survey • Quantitative 24-hour diet recall
	• Assess how interventions and species promoted in the home gardens (part of a multistakeholder platform collaborative research project in the first phase) can be adapted or improved to better increase dietary diversity • Provide input to improve home garden production be more relevant to identified dietary needs • Use results to outline some enabling/inhibiting factors along impact pathway from production to household consumption of selected key species (WUR, Bioversity International) Note: This was planned but never funded	• Home garden interventions designed to target local community dietary gaps increased the availability of nutritious foods for direct consumption • Production barriers overcome to increase availability of nutritious foods for consumption	• Improvement in dietary quality and diversity • Increased consumption of particular species for diet optimization	• Farm DESIGN • Identify barriers and opportunities for improved consumption of nutritious food

Project and title	Activities	Possible nutrition impact pathways[1]	Nutrition objective or scope of project	Nutrition method or approach
2. Improving dietary diversity and diet quality through systems innovation: A pilot study (Viet Nam)	• Test 'best-bet' interventions and provide capacity building support options to improve dietary diversity and answer the following questions: • How does locally available biodiversity correspond to dietary diversity and nutrition? • How does a household's production diversity and availability and access to market and wild diversity influence dietary diversity and nutrition? • What nutrition knowledge, attitudes and practices exist and how do they affect dietary and production diversity? • What key household and landscape system elements can be leveraged to improve dietary diversity and quality? (Bioversity International, CARES, HealthBridge, NIN, WUR)	• Increased availability of nutritious foods for direct consumption that target local dietary gaps to improve diet quality • Nutrition education sessions to encourage production and purchasing of nutritious foods	• Improvement in dietary diversity • Improvement of consumption of particular species for diet optimization	• Quantitative 24-hour dietary recalls • Nutrition Knowledge, Attitudes and Practices (KAP) survey • Key informant interviews • Focus group discussions • Anthropometric measurements • Gender (decision making power)
3. Assessment of different opportunities for agricultural diversification in Nan (Thailand)	• Conduct workshops on improved management of home gardens, including seedling preparation and integrated pest management • Conduct experiments on mushroom production • Complete research on fruit tree orchard established • Complete comparative study on different intercrops (Chiang Mai University, Mae Fah Luang University, WorldVeg)	• Home garden interventions could have made more nutritious foods available for direct consumption • Encouragement to use increased income from improved yield to buy nutritious foods, combined with nutrition education sessions. • Improved food safety	• Nutrition not an objective but was included in the project scope	• Literature review

Project and title	Activities	Possible nutrition impact pathways[1]	Nutrition objective or scope of project	Nutrition method or approach
4. Enhanced livelihoods and better natural resource management through appropriate integration and diversification on smallholder farms (Viet Nam)	• Provide scientific backstopping and research on soils • Assess household vulnerability • Provide extension for forages • Conduct whole-farming modelling climate scenarios (CIAT, WASI, IWMI)		No	Not included
	• Conduct a value chain assessment • Assess the viability of beef cattle (ILRI)	• A component on nutrition in the value chains assessment could have been included to identify commercial opportunities to improve nutrition (for example via improved processing to increase nutrient content or food safety)	No	Not included
	• Implement home garden trials (WorldVeg)	• Improved nutrition through training courses, which included nutrition education • Increased yield and production diversity could improve diet quality	Yes	• Quantitative 24-hour dietary recalls • KAP survey • Key informant interviews • Focus group discussions

Project and title	Activities	Possible nutrition impact pathways[1]	Nutrition objective or scope of project	Nutrition method or approach
5. Using pheromones and other safe and sustainable management strategies to reduce losses from insect pests and plant diseases on vegetable legumes and leafy brassicas (Cambodia, Laos and Viet Nam)	• Quantify baseline indicators for evaluating project outcomes in 35 years including: • Pesticide use, crop yield losses from pests, and gross margin (as an indicator of the economic reward for farmers to follow integrated pest management) • Farmers' knowledge, attitudes, and practices in integrated pest management (WorldVeg)	• Increased availability of nutritious foods for direct consumption to improve diet • Increased availability of nutritious foods for sale, combined with nutrition education sessions, to encourage income generated to be used to buy nutritious foods • Improvements in food safety	No	Not included
6. Appraisal and innovations on diversified and sustainable rubber ('green rubber') in Xishuangbanna (China)	• Scale up green rubber (ICRAF, WUR)	• Nutrition education sessions could have been used to encourage income generated from improved yields to be used to buy nutritious foods	No	Not included
7. Activities for Humidtropics in Honghe (China)	• Conduct a situational analysis • Assess the status of biodiversity • Assess the status of nutrition, dietary diversity and food systems • Assess and identify the potential innovation platform on integrated systems (Bioversity International, CIP)	• Results identified areas where nutrition needed to be addressed to guide project planning from CGIAR centres/Humidtropics partners	• Assessing dietary diversity norms	• 4-cell focus group method • Focus group discussions

2. Approaches and indicators

The projects and activities that did include nutrition within their scope used a wide variety of approaches and indicators (projects 1, 2, 3 and 4), including diet quality and food security indicators, that were operationalised across different scales (community, household, individual) and different target groups (women, young children, older children, households) (Table 4.3). Only a few internationally validated nutrition indicators were used, including anthropometric measurements (wasting, stunting, underweight, BMI), dietary diversity, food consumption score and breastfeeding (De Onis and Habicht 1996, WHO 2007, WFP 2015, FAO 2016). Other indicators have not been validated for their sensitivity to nutrition and diet quality outcomes, and it is not understood to what extent they accurately measure nutrition elements. In many cases it was found that indicators of household food security (access) such as a Household Dietary Diversity Score (HDDS) have inappropriately been used as a proxy for diet quality or nutrition. It was also evident that some indicators were applied at a different scale than what has been validated (for example, application of the Food Consumption Score at the individual level, rather than the validated household level). This is a common error often evident in agriculture research projects that attempt to include nutrition, however it is important to note that validating these indicators is within the scope of household food security (access) (Vellema et al 2016). Each activity tended to use unique indicators, and thus indicator data could not be easily compared across Central Mekong Action Area activities. Only a few indicators (anthropometric and dietary diversity) were used by two or three activities in the Humidtropics research portfolio. Furthermore, only one activity, intending to capture gender empowerment variables related to nutrition, included nutrition-sensitive gender indicators.

2.1 Data collection methods

Different data collection methods were used to collect an array of nutrition indicators including surveys, anthropometric measurements, focus group discussions and other rapid appraisal methods, key informant discussions and literature reviews. The surveys included household or individually administered surveys to capture qualitative or quantitative diet recalls over different time frames (24 hours or seven days), annual household consumption of produced foods, nutrition knowledge, attitudes and practices and household food production. Anthropometric measurements were collected either directly by the research teams or from community health records. Two activities used quantitative diet recalls with similar methodologies, and one used a qualitative 24-hour recall. Only one project used a representative sample sufficient to capture dietary changes.

Only three of the 14 activities documented across the Central Mekong project portfolio included testing innovations that specifically targeted improving nutrition. These focused on innovations around home gardens and nutrition education. Unfortunately, at the time of writing, these activities had not completed endline surveys or innovation testing, and no data was available to assess the impact or effectiveness of these innovations.

Table 4.3 Summary of nutrition indicators used in Central Mekong Action Area research activities

Indicator level	Indicators to capture nutrition in Central Mekong projects*
Children aged 12-24 months	• Inadequate micronutrient intake • Proportion of children meeting minimal dietary diversity requirements • Ratio of animal protein consumption • Anthropometrics (wasting, underweight, stunting)
Children aged above 24 months	• Caloric consumption per day • Ratio of animal protein to total protein consumption, iron and vitamin A needs • Anthropometric measurements (wasting, underweight, stunting) • Ratio of animal protein consumption
Children aged 6-14 years	• Anthropometrics (underweight and stunting)
Women of reproductive age (15-49 years)	• Early initiation of breast feeding • Continued breastfeeding at two years • Breastfeeding or complementary feeding practices • Nutrition knowledge and attitudes • Daily estimated energy requirements reached • Chronic energy deficiency (BMI) • Minimum dietary diversity • Individual dietary diversity score • Food consumption score • Relative frequency of foods consumed • Proportion of energy from proteins, carbohydrates and lipids • Inadequate micronutrient intakes • Mean daily intake of key macro- and micronutrients • Average number of meals and snacks • Mean quantity of key species from key food groups consumed
Individual	• Trees used for food • Supply sufficiency • Self-sufficiency of calories and protein production • Monthly average per capita consumption of key commodities • Consumption of vegetables (in grams) per day
Household	• Caloric consumption per day • Diet diversity score • Agricultural products used for household consumption • Household food insecurity access scale • Gender (decision-making power) • Food consumption score
Community	• Number of households and frequency of foods consumed • Taste preferences of men, women and young children for local food

***** Not all indicators applied are validated for nutrition or diet quality outcomes. Often household food security indicators were inappropriately used (e.g. household food insecurity access scale, Household Diet Diversity Score)

3. Case studies

Four case studies are presented to illustrate how projects and activities used different methods to approach nutrition in systems research.

3.1 Case study 1: Piloting a systems approach to improving nutrition with Thai minority communities in Mai Son district, Son La Province, Viet Nam, using a local food system approach to bridge dietary gaps

This case study is derived from project 2 (table 4.2): Improving dietary diversity and diet quality through systems innovation: A pilot study in Viet Nam.

Background

The study was designed to identify the current status of dietary diversity and nutrient intake among women of reproductive age (15-49 years) and children aged between 12-23 months, and to determine if there is a link to locally available biodiversity in selected Thai villages in Mai Son District in Northwest Viet Nam. In Mai Son, five ethnic groups represent approximately 80 percent of the ethnic population. The study's pilot phase focused on one minority group, as each minority ethnic group has unique farming and food cultures. The research was intended to demonstrate that engaging households in a full community-based participatory research cycle to diversify production through a systems perspective and improve nutritional knowledge can improve dietary diversity and quality for women of reproductive age and young children. Children in the 12-23 months age bracket were selected as they are within the critical 1000-day period (WHO 2013), able to eat whole foods and in many cases the same foods as adults. The cycle of participatory research ensures that the results obtained during the research project are derived through the community and the benefits are returned directly to the community for direct application to achieve the desired outcomes.

The original study design centred on a repeated cross-sectional study, with the baseline conducted in 2014 and an endline planned in 2017 to assess the impact of a nutrition systems intervention during the study period. Unfortunately, due to the announcement that Humidtropics as an independent CGIAR Research Program would finish at the end of 2016, the research had to be redesigned, limiting the intervention to one year with an endline assessment to be conducted in November 2016. At the time of writing, the endline assessment had not yet been done and as such, the results presented are from the baseline study, together with an explanation of how these results were used to design a systems intervention to improve nutrition.

The case study objective is to provide examples of participatory approaches available to identify local dietary gaps, and identify food systems solutions designed to improve multiple systems dimensions.

Methods

The null hypothesis to be tested was: dietary diversity (as measured by the diet diversity score) of women of reproductive age and young children (12-23 months) is not improved by improving availability and access to more diverse products and nutritional knowledge.

The sample communes were randomly selected using criteria that included population size (at least 50 percent of households were from a Thai ethnic group), and rural livelihoods (agriculture was the main household income source). Four communes (Co Noi, Muong Chanh, Chieng Chan and Chieng Luong) were selected from 15 eligible communes in Mai Son District, Son La. The key target population was women of reproductive age and children aged 12-23 months.

A total of 400 households were sampled for a baseline. The sample size was estimated based on the prevalence of children aged 6-23 months who consumed foodstuffs from four or more food groups in the 24 hours before surveying in Son La Province in 2012 (Gibson and Ferguson 2008, Gorstein et al 2007, NIN 2012).

Surveys collected dietary data from women using quantitative 24-hour dietary recalls (with a repeat on a non-consecutive day for a subsample of 25 percent of selected households), nutrition knowledge, attitudes and practices, and household food insecurity. To capture seasonal variation in the diet and in household food security, dietary intake assessments and household food security assessments were conducted in both the wet and dry seasons in 2014 (August/September and November/December, respectively). Anthropometric measurements were taken for women and children in the dry season only.

In addition to the dietary data, a comprehensive household production survey was conducted with the household head. Inventories of all species produced on-farm or hunted or collected in the wild were taken, per-plot type (home garden, sloped, paddy, forest) and per growing season, to develop an in-depth view of the availability of locally produced foods. In addition, a market diversity survey was conducted in the main market of each commune.

Results

Nutrition knowledge

Women responded that the causes of malnutrition were insufficient quantity and quality of food; complementary food[2] with a consistency that was too thick (making it difficult to swallow) and that did not contain sufficient nutrients; illness; and, poor childcare (64 percent, 17 percent, 11 percent and five percent respectively; three percent of responses were categorized as 'other'). More than 18 percent of women stated that they did not know why malnutrition occurred. When asked to state different methods to prevent child malnutrition, just under 75 percent of women were able to provide a correct suggestion including giving the child more food, increasing feeding frequency, and providing more diverse foods (59 percent, 23 percent and 18 percent respectively). A quarter of the women responded that they did not know how to prevent malnutrition.

[2] A complementary food is food or drink introduced to a child from a recommended six months old to supplement breastfeeding. At this age, breastfeeding is no longer sufficient on its own to provide all the nutrients required.

Knowledge of dietary diversity in feeding infants and young children

Knowledge about dietary diversity was limited. A full 58 percent of women had never seen the food pyramid, only 33 percent had heard of 'colouring the porridge plate'[3], and only 1.4 percent (six households) could name the four food groups associated with a 'balanced meal' (starches, protein, fat and vegetables). While 85 percent of women believed a diversified diet was important, 36 percent reported it was difficult to provide one for their children. The main barriers were reported as a lack of locally available foods (51 percent), lack of money to buy different foods (37 percent), lack of time to prepare the foods (28 percent) and lack of capacity or skill on how to prepare some foods (11 percent). While 95 percent of women believed providing several meals to children each day was important, 19 percent said it was difficult to do so.

Nutrition status

The rates of stunting and underweight children in the Thai community were high at 20 percent and 14 percent, respectively. Child wasting was one percent. The rates of underweight, overweight and obesity in mothers were eight percent, 16 percent and seven percent, respectively, using BMI as the indicator (≤18.5, 23-25 and ≥25).

Women and children's dietary intake and gaps

In terms of individual dietary diversity, children consumed 3.7 out of seven food groups, compared to the minimum of at least four food groups as recommended by WHO (2013). Women consumed 4.8 out of 10 recommended food groups. The percentage of women and children reaching minimum dietary diversity (MDD) (FAO 2016) was 59 percent and 58 percent, respectively. The percentage of women who reached MDD (consumed a food from five or more food groups) during the wet and dry seasons was almost the same at 58 percent and 59 percent, respectively. For children, 57 percent and 58 percent reached MDD (consumed four food groups or more) in the wet and dry seasons, respectively. The least consumed food groups over both seasons were legumes, nuts and seeds, dark green leafy vegetables and vitamin A-rich fruits (Table 4.4).

[3] 'Colouring the porridge plate' is a concept promoted by the Viet Nam National Institute of Nutrition (NIN 2013).

Table 4.4 Percent of young children and women by food group consumed, separated by season

Indicators	Wet season (August-September)		Dry season (November-December)	
	% consumed food groups		% consumed food groups	
	Children (N=350)	Women (N=350)	Children (N=411)	Women (N=411)
Starch staples	99	100	100	100
Legumes*	16	17	16	17
Nuts and seeds	2	3	2	3
Dairy product	11	0	6	1
Flesh foods	81	89	83	88
Egg	37	25	43	28
Dark green leafy vegetables	12	26	11	31
Vitamin A rich vegetables	37	74	31	70
Fruits rich in vitamin A	5	3	3	3
Other vegetables	41	85	42	85
Other fruits	30	35	32	28
Fats & oil	14	30	15	32
Sweets	81	12	75	10

*High-nutrition target food groups in red

Baseline results to identify system solutions to nutrition

A participatory consultation process with farmers was conducted to identify a set of underutilized, locally available crops from the under-consumed food groups (vitamin A-rich vegetables and fruit; dark green leafy vegetables; and, legumes, nuts and seeds) to act as the cornerstone of the interventions designed to improve diversity in the diets and landscape. The results from the baseline product survey produced a shortlist of locally available foods per food group that could be used complementarily at different times of the year to ensure stable supplies of that food group. The shortlist included foods favoured by both men and women, as results suggested that men's food preferences influenced what women grew in the home garden.

The farmers were asked to list the positive and negative aspects associated with each of these species (per food group) in terms of production (availability and access of inputs, knowledge of management best practices, seasonal availability, and pests and diseases) and consumption (taste, ease of preparation). Foods from each food group were then ranked comparatively using the pairwise ranking method to identify the top foods from each group. Village nutrition clubs were used to connect both the nutrition education and agricultural capacity components of the intervention. These clubs, facilitated by village health workers, met once every two months. They consisted of women with young children from each village who volunteered to learn more about how to diversify their home garden and their diets. Nutrition education material was developed in consultation with the National Institute of Nutrition and other national partners to ensure that fundamental nutrition messaging was in line with national priorities, and to encourage a link to nutrition-sensitive agriculture that was relevant to the dietary gaps and local biodiversity in the landscape.

Discussion and conclusion

Measuring food intake from quantitative 24-hour food recalls can be challenging. To obtain the best quality data, several techniques were applied, including developing simple guidelines for a multipass 24-hour recall adapted from several authors (Gibson and Ferguson 2008, Arimond et al 2010, FAO 2011) and repeating the data collection from a subsample of households on a non-consecutive day. Trained enumerators asked open-ended questions, and gathered quantitative data using a combination of digital scales, graduated measuring jars, modelling clay and shredded paper as measuring tools to estimate food intake amounts. Surveys took an average of 60 minutes (combined, including the time for the women to report on both their own and their child's diet).

To address language barriers that can affect data quality, Thai enumerators were recruited from a local health school in Son La. In some cases, the name of a species or a variety of food reported during the diet intake survey was not known, beyond the common name used in a village (names could change from village to village). Where possible, samples were provided to the local agriculture partners to identify, combined with cross-checks with local agriculture or health staff to identify the common name, sometimes based on their description or using pictures for confirmation if a sample was not available. Some foods from the wild were too difficult to identify and could not be included in the analysis.

Data analysis required a database and an updated food composition table. The software for data analysis developed by the National Institute of Nutrition based on Microsoft Access was not user-friendly; however, this software has been adapted to fit the quantitative recall method described above. Further efforts should include making the database more user-friendly, so it can be used by a broader audience.

In Son La, the commune-level government health centres are responsible for monitoring the nutrition status of children under five years old using periodic anthropometric measurement. No system currently exists to monitor dietary diversity. The local food system approach will be evaluated at the end of the intervention trial for lessons learned, so that they can be used with other minority groups in Son La Province (more than 50 groups), each having a different context and dietary diversity status than the Thai group.

The participatory approach tested in Mai Son was able to successfully identify local dietary gaps, and work with communities to design and operationalise local solutions to bridge these gaps with innovative approaches using locally available agrobiodiversity. The innovations are expected to diversify local home garden production and improve the diet quality and diversity of women and children who participated in the diversity club sessions. Local nutrition and healthy diet capacity and knowledge was also developed by female and male farmers who participated in the diversity clubs, but also of the health and agriculture extension workers who helped to implement and facilitate the clubs.

3.2 Case study 2: Links between dietary diversity and other farm household characteristics in the Central Highlands of Viet Nam

This case study is derived from project 4 (table 4.2): Enhanced livelihoods and better natural resource management through appropriate integration and diversification on smallholder farms in the Central Highlands of Viet Nam.

Background

The Central Highlands of Viet Nam are home to some of the poorest and most marginalized people in the country, including a significant population of ethnic minorities. As such, it was one of the focus areas for the Humidtropics activities in the Central Mekong.

Humidtropics (in cooperation with the German Federal Ministry for Economic Cooperation and Development (BMZ) and the CGIAR Research Program on Livestock and Fish), conducted household-level research in the Central Highlands to begin to understand various aspects of household welfare status and related drivers, and to inform subsequent interventions and development strategies. This research focused on the use of a suite of household indicators that are comprehensive in scope and supported by data that can be easily and rapidly collected.

Within this context, the case study objective is specifically to develop some initial understanding of correlations between dietary diversity and other household indicators, based on primary household survey data. Such understanding is useful in discerning the drivers of household dietary diversity, as well as the direct and indirect effects of farm level interventions on household dietary diversity.

Methods

A survey of 310 households was conducted in December 2015 in two locations in the Central Highlands of Viet Nam: 1) Ea Tyh Commune, Ea Kar District, Dak Lak Province; and, 2) Dak Dro Commune, Krong No District, Dak Nong Province. Survey respondents were randomly selected, and were comprised of a mixture of Kinh, the majority ethnic group in Viet Nam, and other ethnic minorities.

The survey was implemented using the Rural Household Multi-Indicator Survey (RHoMIS) tool, a digital survey and analysis platform designed to rapidly characterize farm households using a suite of 16 standardized indicators. These indicators range from poverty, food security and market orientation, to agricultural intensification, gender equity in the control of household resources and greenhouse gas (GHG) emissions. RHoMIS is implemented using an Android device (tablet or smartphone), and data is uploaded automatically to a cloud server. RHoMIS survey results are used to calculate values for each indicator on a per household basis. A full description of each indicator is not given here, but can be found in Hammond et al (2016). Of special interest is the Household Dietary Diversity Score (HDDS), which has been adapted to capture the frequency and seasonal differences of household access to diverse foods, and can be used as a proxy indicator for dietary diversity (Hammond et al 2016). Respondents were asked how often food from each of 12 food groups had

been consumed within the previous four weeks. Possible respondent choices were 'daily', 'weekly', 'monthly', or 'never'. HDDS results are on a scale of 0 to 12, where 12 equates to consumption of food from 12 food groups on at least a weekly basis.

Simple statistical analysis on household indicators is used to discern household welfare status, and links between household dietary diversity and other household characteristics. In addition, a regression analysis of HDDS as a function of the other indicators employed a stepwise simplification procedure to exclude non-significant parameters, producing a parsimonious first order linear regression model for HDDS.

Results

Results presented in Table 4.5 provide both an initial assessment of farm household welfare status and suggest links between dietary diversity and farm household characteristics. Indicators with the strongest correlation to HDDS across the full set of households (as suggested by both the Spearman Correlation Coefficient and regression parameters) are the negatively correlated Household Food Insecurity Access Scale (regression p=3.8e10) and the positively correlated Value of Farm Produce (regression p=6.19e6). Intensification and Food Availability also have high correlations to HDDS, though they were excluded from the linear regression model. Parameters with the weakest correlation to HDDS were Off-farm Income, Family Size, and Gender Equity. While most indicators trended monotonically across HDDS groupings, a few did not, e.g. Off-farm Income.

The RHoMIS tool, implemented by enumerators from the Western Highlands Agriculture and Forestry Institute (WASI), performed well in terms of rapidity of data collection and in the quality of data produced. Equally successful surveys using RHoMIS were subsequently conducted in Cambodia and Laos, also in the Development Triangle of the Humidtropics Central Mekong Action Area, enabling an opportunity to conduct a three-site analysis following this case study.

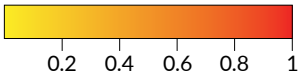
Discussion and conclusions

Dietary diversity in the Central Highlands is most strongly correlated to food security. As perceived food insecurity drops, dietary diversity predictably increases. High correlation with the Intensification indicator may suggest that sustainable intensification options may lead to improved dietary diversity. Surprisingly, Off-farm Income is not correlated with dietary diversity. Further exploration of the link between the Value of Farm Produce indicator and dietary diversity is needed, as this finding is not accompanied by a parallel and equally strong correlation with Market Orientation. Together, these results may indicate that dietary diversity is more closely tied to on-farm production than off-farm income in the Central Highlands.

These results suggest areas for further in-depth research that will be reported in subsequent peer-reviewed journal articles. One such area is to assess whether indicator values differentiate substantially by ethnicity, and if so, what the implications may be related to the degree of marginalization that these minorities may be experiencing.

Table 4.5 Farm household indicator values and correlations to Household Dietary Diversity Score (HDDS) from two locations in the Central Highlands region of Viet Nam (n = 310)

			Medians		
Indicator	Median Value	Corr Coeff to HDDS	Low-HDDS group	Mid-HDDS groups	High-HDDS group
Farm siza (ha)	1.5	0.26***	1.0	1.2	1.9
Livestock ownership (Total Livestock Units [TLU])	0.7	0.24***	0.2	0.6	1.2
Family size (Adult Male Equivalent [MAE])	3.1	0.043	3.6	2.8	2.8
Crop diversity (number of crops grown)	2	0.16***	2	2	2
Intensification (kg N_{fert}–ha^{-1})	1500	0.36***	1000	1100	2000
Market orientation (0–1)	0.76	0.12***	0.59	0.75	0.79
Food availability (kcal–MAE^{-1}–day^{-1})	4.07e4	0.34***	2.01e4	3.60e4	5.84e4
Livestock contribution to food availability (kcal–MAE^{-1}–day^{-1})	0.014	0.11*	0.00014	0.014	0.017
Farm productivity (Mcal–ha^{-1}–yr^{-1})	2.56e7	0.20**	1.72e7	2.60e7	2.80e7
Household Food Insecurity Access Scale (HFIAS [0-27])	5	0.41***	9	7	3
Progress out of Poverty Index (PPI [0–100])	66	0.25***	45	66	70.5
Off-farm income (USD–yr^{-1})	327	0.048	318	371	254
Value of farm produce (USD–yr^{-1})	2570	0.36***	1410	2180	4320
Gender equity (0–1)	0.5	0.016	0.5	0.5	0.5
GHG emissions (kg CO_2 eq–$household^{-1}yr^{-1}$)	8300	0.30***	5010	6340	14100
GHG emissions intensity (kg CO_2 eq–$kcal^{-1}$	0.26	0.054	0.36	0.23	0.27



Mean indicator values are presented for the full data set, and Spearman Correlation Coefficient values indicate the degree of correlation between each indicator and HDDS. Median indicator values are also reported for households falling within three groupings: those with HDDS values greater than 7, those with HDDS values from 5 to 7, and those with HDDS values less than 5. Heat map colouration, as indicated by the legend, reflects the relative value of those medians to the 90 percent quantile value for each indicator: dark red shading suggests that a median value is at or near the 90 percent quantile for that indicator, while yellow shading shows the value is among the minimum calculated indicator values. Indicator labels highlighted in yellow indicate highly-significant parameters in the HDDS regression model. Significance levels are denoted by *p < 0.05 **p < 0.01 ***p < 0.001.

3.3 Case study 3: Application of theory of change to identify potential interventions contributing to improved diets and nutrition in Northwest Viet Nam

This case study is derived from project 1 (table 4.2): Research for development of appropriate technical innovations in integrated farming systems for scaling up.

Background

Northwest Viet Nam, one of Humidtropics' Action Sites in the Central Mekong, is an agrarian, mountainous region rich in ethnic diversity and natural resources. However, poverty and malnutrition remain prevalent due to geographical challenges and poor infrastructure limiting access to markets, resources and healthcare. Sustainable interventions in the agrifood system can directly improve local agricultural development, rural livelihoods and nutritional well-being. The complexity of the issues in Northwest Viet Nam's food system requires stakeholders from agriculture, marketing, nutrition and health, private and public sectors and local leaders to work together in finding feasible solutions.

Nutrition is incorporated in food systems research at the onset of project planning. A multistakeholder meeting was held to develop a food systems theory of change to achieve nutritional outcomes in Northwest Viet Nam. From the list of proposed priority interventions, a home garden pilot study was selected and designed to improve household food production and consumption. Results showed the home garden model can improve household nutrition through increased vegetable supply and consumption.

The case study objective was to demonstrate the sequence of incorporating nutrition in food systems research from planning to achieve tangible results.

Approaches

Multistakeholder meeting

Humidtropics' cross-cutting nutrition component, jointly led by Bioversity International, the World Vegetable Center (WorldVeg), and Wageningen University and Research (WUR), facilitated a multistakeholder platform to address nutrition outcomes of food systems research in Northwest Viet Nam. The first meeting, held in December 2014, introduced the theory of change as a tool for stakeholders to develop solutions in the current food system that incorporate and maximize nutritional benefits for consumers. The objectives of the meeting were to:

- Visualize potential nutrition pathways of change for Humidtropics in Northwest Viet Nam.
- Identify assumptions leading to successful results of the proposed theory of change.
- Identify possible interventions resulting in improved nutrition outcomes.
- Facilitate a networking and communication platform among stakeholders to improve diets and nutrition in Northwest Viet Nam through systems research.

Twenty-eight regional, national and international agriculture, nutrition, marketing and economics experts from the public and private sector, NGOs and government institutions participated in the stakeholder meeting.

Developing a theory of change and identifying nutrition interventions for food systems research

Nutrition objectives were clearly defined in the stakeholder meeting. The stakeholders agreed on the long-term outcomes as improving rural livelihoods and overall household nutrition. To address different food system components, the stakeholders were divided into three groups: Production, Market, and Consumption. Backward mapping was applied to create a pathway of change by determining preconditions for achieving long-term outcomes. Underlying assumptions for each group's pathway of change were discussed to test the feasibility of the theory. Lastly, each group proposed two to three priority interventions. Throughout the meeting, ideas were exchanged and discussions provided feedback to the theory of change.

The proposed interventions were:

Production: 1) enhance crop productivity; 2) implement integrated pest management; and, 3) diversify production systems.

Market: 1) establish information sharing systems for producers, market actors and consumers; 2) create local markets; and, 3) establish wholesale selling points.

Consumer: 1) nutrition education and information dissemination; 2) training on income generating skills; and, 3) create off-farm income opportunities.

Based on a priority setting exercise, home gardens were selected as the intervention deemed most appropriate.

Selected intervention: home garden

A multi-approach home garden intervention package was designed as a pilot study following the discussions and proposed interventions of the stakeholder meeting. The home garden package consisted of three main interventions: nutrition-focused home garden training, seed distribution, and monitoring and evaluation. Ten intervention and 10 control households (n=20) participated in the study, with households equally shared among two ethnic villages (Rung Thong in Muong Bon and Xum 1 in Chieng Mung) consisting of Hmong and Thai minorities in Son La Province, Northwest Viet Nam. Intervention households received the home garden package while control households only had monitoring and evaluation. Both groups participated in data self-reporting on their home garden production and situation. At the end of the study, control households were offered home garden training and received vegetable seed kits.

The main intervention was the nutrition-integrated home garden training. Training materials were developed by WorldVeg in partnership with the Fruit and Vegetable Research Institute (FAVRI) and the National Institute of Nutrition (NIN) in Viet Nam. Nutrition education was incorporated in home garden practices and materials were produced and taught in the local language. Training was done at two levels: training of home garden trainers, and training of home garden participants. The training modules were designed to include both theory and

hands-on interactive activities to enhance the learning experience, knowledge retention, and practical application. Topics included nutrition principles; feeding the family; planning and growing a nutritious garden; and, post-harvest food preservation and utilization. An important aspect of the home garden training was designing a nutritious garden that includes fruits and vegetables that maximize diet diversity and nutritional benefits, is suited to family preferences, and ensures a year-round food supply. Participants consulted training experts to create a suitable layout for their household. In the training, they also engaged in gardening and nutrition activities from preparing the soil and drainage to sowing, recording growth, seed conservation, food preservation and cooking nutritious meals. At the end of the training, participants completed a training evaluation form to ensure concepts were understood, and that participants were ready to apply the learning and receive feedback on the quality of the training.

Home garden seed kits were given to participants to help kickstart their gardens. The kits were customized for each household according to the vegetables chosen for their garden layout. WorldVeg partnered with FAVRI to prepare locally adapted seed kits from high yielding and nutritious varieties. Participants requested seeds for at least 20 different vegetables for their home gardens, and introduced new vegetables to their home gardens for the first time.

Participating households were monitored throughout the study. Surveys, interviews and participant self-reporting was used to collect data on crop varieties, planting and harvesting dates, weight of weekly harvest by crop, use of harvested produce, role of women and men in various home garden activities, and home garden constraints.

Results

The total vegetable harvest (in kg) from the home gardens was recorded during the 49-week study period from July 2014 to June 2015. The intervention households produced 5.8 times more vegetable supply than the control households ($P<0.01$). When adjusted for area, the intervention group produced 1.7 times more vegetables per square metre than the non-intervention households ($P<0.01$; Table 4.6).

On average, intervention households produced 226 kg of vegetables compared to 39 kg in control households during the study period. The daily vegetable and vitamin A supply per person was also significantly higher in the intervention group (122 g and 391 mcg RE, retinol equivalent of vitamin A supply) compared to the control group (22 g and 94 mcg RE; $P < 0.01$). In fact, intervention households had a daily supply of 5.5 times more vegetables and 4.2 times more vitamin A per person than control households. Among ethnic groups, the differences were apparent and significant for total vegetable supply per household and daily vegetable supply per person for Hmong and Thai households, and vitamin A supply for Thai households only. The home garden package improved the supply of vegetables and plant-based micronutrients in both ethnic groups. The most prominent improvement in home vegetable production was seen in the Hmong households who initially participated minimally in home gardening.

A high percentage of the vegetables grown in the home gardens were consumed by household members: 49 percent and 84 percent in intervention and control households, respectively. Figure 4.1 shows continuous harvests from July 2014 to June 2015 from the intervention group's gardens. On average, about 4.6 kg of vegetables were harvested per household per week which was equivalent to 164 g/person*day for a family with four members. For the control group, the traditional garden provided 28 g/person*day for a family with four members.

Intervention households also gave more produce as gifts compared to the control households. Increased gift-giving in the intervention group may be due to their abundant harvests. During the harvest period, vegetable supply was more than sufficient for the family's consumption and any additional vegetables were shared with neighbours. Gift-giving is a cultural universal and is known to increase social interactions with neighbours and mental well-being for the gift giver (Saad and Gill 2000, Joy 2001).

The intervention group showed higher plant diversity and grew 42 different vegetables compared to the control group of 24 vegetables. Increased home vegetable production has also contributed to increased supplies of many types of nutrients, including vitamin A, multiple types of vitamin B, vitamin C, iron, calcium, magnesium potassium, manganese, phosphorus and selenium, and other health promoting phytochemicals. The nutrient content of vegetables was retrieved from the Vietnamese Food Composition Table (FCT). For those vegetables not present in the Vietnamese FCT, values were instead derived from WorldVeg's Nutrient Database.

Discussion

The proposed interventions resulting from the theory of change approach successfully incorporated nutrition in food systems research at the program planning stage. Women and smallholder farmers could benefit from the interventions through improved household nutrition and reduced local poverty. Interventions encompassed diversification of production and potentially livelihoods through income-generating skills for women, improved natural resource management, increased production of nutrient-dense locally adapted food varieties, creation of retail and wholesale markets, and nutrition education for local households. Theory of change was a relatively new approach for the stakeholders. Multiple meetings were required to refine the pathway of change, ensure assumptions were feasible and define indicators to measure program achievements. The first meeting's priority was to introduce theory of change thinking into effective program planning and to facilitate communication between stakeholders of diverse disciplines and backgrounds. Multistakeholder program planning requires regular brainstorming and discussion sessions before taking practical steps to design relevant and suitable interventions for implementation. This is time-consuming and requires a considerable shift in the way people think about program and project planning.

The home garden model in this study shows promise for improving household food production, nutrient supply and diet diversification. The model is worth scaling up and could be modified for other malnourished rural regions to improve household nutrition. Sustainability of home gardens can be achieved with the support of agricultural, rural development and nutrition policies and programs. Research and development of high-yielding vegetable seed kits for different regions and subsidized seed prices would encourage the adoption of home gardens. Government and non-governmental initiatives to facilitate scaling should focus on providing financial assistance; building infrastructure to improve access to roads and water supply; training and technical assistance; and, sufficient monitoring, evaluation and adaptation of home garden programs. Stakeholders mentioned these challenges when discussing assumptions, yet they were not addressed in the priority interventions. Advocacy for food system and nutrition policies and a country action plan would further enable interventions to be adopted.

Table 4.6 Total vegetable supply for home garden intervention for Thai and Hmong communities compared to control groups from July 2014 to June 2015 in Northwest Viet Nam (n=20)^

Households (N=20)		Total vegetable supply per household (kg)			Daily vegetable supply per person (g)			Daily vitamin A supply per person (mcg RE)		
		I[a]	C[b]	P value[c]	I	C	P value	I	C	P value
All[d]	mean	226	39	<0.001***	122	22	0.002**	391	94	0.003**
	SD	102	26		72	12		230	73	
Hmong	mean	179	29	0.004**	114	17	0.042*	408	110	0.052 ns
	SD	62	22		73	11		245	93	
Thai	mean	245	49	0.045*	97	26	0.011*	290	79	0.024*
	SD	115	28		30	12		110	51	
P value[e]		0.36 ns	0.23 ns		0.64 ns	0.24 ns		0.37 ns	0.54 ns	

*** Significant at < 0.001. ** Significant at < 0.01. * Significant at <0.05 c ^ Results are from project reports and do not necessarily reflect analysis conducted.

Four Thai households and five Hmong households were in the intervention group. Five Thai and five Hmong households were in the control group. I[a] = intervention group, C[b] = control group. All[d] includes one additional Kinh household for the intervention group. P values[c] from t-tests comparing the means between intervention and control groups. P values[e] in this row are from t-tests comparing the means between Hmong and Thai households within a treatment group.

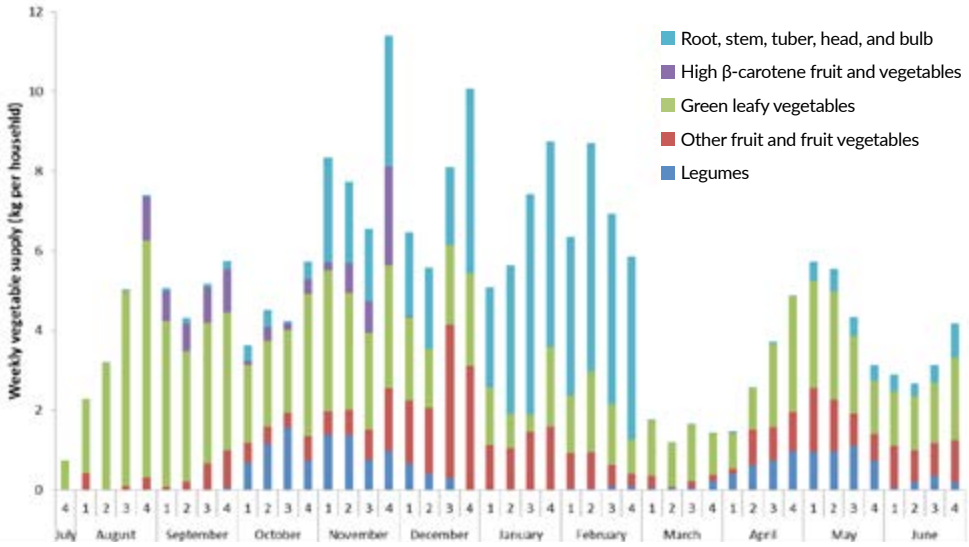


Figure 4.1 Average weekly harvest (kg) per household for home garden intervention for Thai and Hmong communities compared to control groups from July 2014 to June 2015 in Northwest Viet Nam (n=20)

3.4 Case study 4: Exploring the potential of agrobiodiversity to improve human nutrition, resource management, and farm productivity and profitability

This case study is derived from project 2 (table 4.2): Improving dietary diversity and diet quality through systems innovation: A pilot study in Viet Nam.

Background

The study aim was to evaluate alternative foods and crops identified as entry points based on their beneficial contribution to nutrition and health, and their impact at farm and landscape level. This analysis established the effect of adopting alternative foods and crops at the system level. Based on diagnosing the farm and household's current situation, it examined the potential joint effects on nutrition, environmental indicators, labour-leisure time, profitability and household budget. This provided insights into the desired foods that could be grown on the farm, collected from the landscape or purchased from the market. Such adoption and adaptation decisions could be informed by an ex-ante assessment of the impacts on the farm and household dynamics; the impact on the costs and revenues of cultivation versus purchasing costs; demands for labour for cultivation or collection; quantification of required inputs; cycles and losses of nutrients and the resulting soil fertility; and, other environmental indicators.

The study implemented the participatory DEED approach (Giller et al 2011) as an overarching methodological framework guiding integration of project components for the landscape assessment (Groot et al 2007, 2010). DEED employs four consecutive steps for the analysis and design of existing and future landscapes:

1. Describe: description and characterization of the current farm or landscape configuration in land use, farming practices, household activities and socioeconomics, and nutrition.
2. Explain: determination of landscape performance through productive, socioeconomic and environmental indicators.
3. Explore: exploration of the trade-offs and synergies at the farm, household and landscape levels. At this step the suitability of new options or entry points within the given livelihood objectives and constraints can be explored.
4. Design: fine-tuning of selected alternatives in the farm or landscape after combining the collected information from the previous steps.

Here we present an overview of the case study analysis in two villages in Son La Province in Northwest Viet Nam. We characterize the households and farming systems, identify shortages in nutrition, and explore the potential for improving nutritional performance, while analysing the effects of implementing new crops, technologies or practices on productive, socioeconomic and environmental farm performance.

Method

A landscape and farm analysis was performed in two communities that differed in landscape and crop diversity. Doan Ket village is characterized by a flat topography and cultivation of maize and vegetables for the market. Na Phuong village is situated in a hillier environment with maize cultivation in the uplands (sold as animal feed) and rice in the lowlands. In this village, the cropping pattern is less diversified and households rely on home gardens for nutrition. In Na Phuong village, the possibilities for off-farm income generation are less than in Doan Ket.

Landscape mapping was done to position the fields. Resource flow mapping was used to identify sources of water, firewood, foods and feeds harvested from open and common areas in the surrounding landscape and to make an inventory of interactions with markets.

Focus group discussions were held to characterize the cropping patterns and sequences and the associated labour allocation throughout the year. Crop productivity was assessed. Moreover, the desirability of potentially promising alternative crops was discussed in the focus groups. The criteria for crop evaluations were productivity, nutritional values and resource demands (water, fertilizer, labour, etc.).

Ten farms in each village (n=20) were characterized using the Impact LITE survey instrument (https://ccafs.cgiar.org/impactlite-tool). This provides an overview of farming activities (crops, animals, gardens). Additionally, a food frequency survey was conducted in each household.

The FarmDESIGN model (Groot et al 2012) was used to calculate biophysical and socioeconomic farm and household indicators. The model was extended with modules to quantify nutrition indicators (dietary diversity scores, nutritional functional diversity, food group consumption patterns), household labour allocation and household budget. The model employs a Pareto-based evolutionary algorithm to perform multiple objective optimization that is used to generate and select alternative farm configurations to improve the performance of selected indicators.

Data

With the ImpactLITE survey we made an inventory of crops, trees and animals that were kept and cultivated and extracted from the farm as well as collected from the landscape, or purchased from the market. Within the ImpactLITE survey, 24-hour recall surveys were also performed; these were followed up with food frequency surveys in the focus group discussions. The frequency at which households consumed products was measured and this data was used to calculate the functional dietary diversity of the households in the two villages.

Results

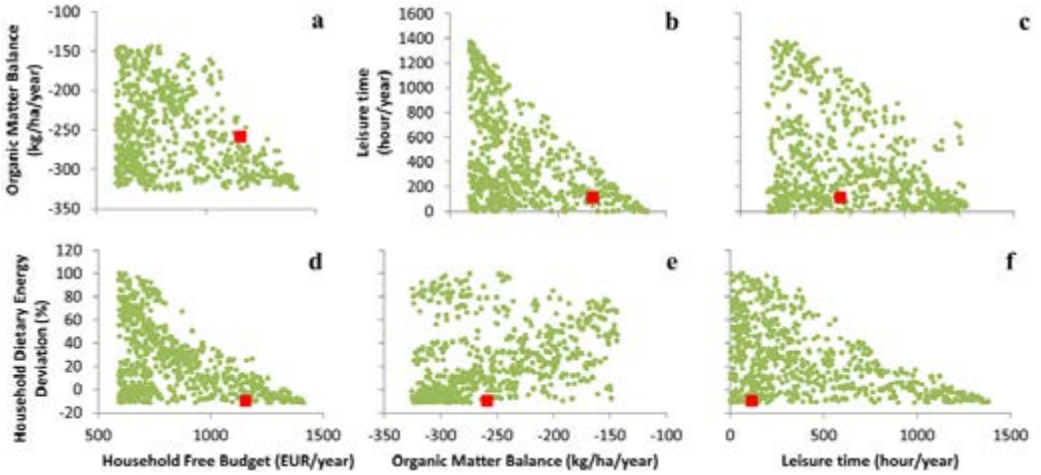
Households in Doan Ket were smaller than in Na Phuong (on average 4.5 and 5.1 household members, respectively), but cultivated larger farms (1.95 ha versus 1.20 ha) and used more labour on the farm (5556 h/year versus 4964 h/year). The average household income was not different between the two villages, but varied considerably within the communities and was mostly derived from farming. A large proportion (50–90 percent) of the household budget was spent on food purchases. The functional dietary diversity did not differ between the households in the two villages.

The main crops cultivated in Doan Ket were maize, French beans and onions, but only a few households had a home garden. In Na Phuong, all households cultivated a home garden. These were diverse and contained as main crops and fruit trees: onions, cabbage, pak choy, papaya, guava, mango, pomelo and banana. In both villages organic matter inputs into the soil did not compensate for losses, leading to a negative organic matter balance, while fertilizer inputs were relatively high (exceeding the crop demand and uptake), thus leading to considerable accumulation in the soil with a risk for nutrient losses.

In exploring possible nutritional outcomes, we evaluated the effects of incorporating various new crops into the home gardens: mustard greens, pumpkin, yellow-flesh sweet potato and water spinach. Even though home garden areas were small, reconfiguration of the cropping areas could contribute to alleviating shortages of micronutrients and vitamins. Our explorations suggest that gains in some nutrients, like magnesium and iron, were more easily attained than gains for vitamins A and C. For instance, reconfiguration that replaced eggplant and papaya areas with sweet potatoes resulted in an almost tenfold increase in iron yield, while vitamin A only doubled. Some trade-offs were also observed. For instance, by increasing the area for growing sweet potatoes at the expense of vegetables such as tomatoes and eggplants, the model predicted gains in vitamin A and iron production, but with a reduced household budget and small decreases in soil organic matter.

Explorations focusing on interactions between labour use, household budget and food consumption highlighted trade-offs in household budget against household leisure time and food consumption. The key factors are hired labour hours, field size of food crops and the amount of food consumed. With more labour hired, the household leisure time (household labour balance) would increase but the household budget would decrease; with more food consumed by the household, the nutrition indicator would increase but the household budget would decrease. Nutrition and household leisure time were linked when the farm household cultivated its own food crops. For instance, in our case, the farm household

produced rice only for home consumption and a trade-off existed between household leisure time and household dietary energy deviation because rice cultivation is labour intensive (Figure 4.2). If the labour requirement of the food crop is less than other crops grown on the farm, a synergy may exist between nutrition and household leisure time.



Note: Red squares indicate current performance; green dots are alternative farm configurations.

Figure 4.2 Windows of opportunity and trade-offs between four objectives for maximization of organic matter balance, labour balance, dietary energy availability and free budget for a representative farm household in Na Phuong

Discussion

The analysis provided detailed insights into farm and household configurations in contrasting villages. Both villages were characterized by large variations, but in general the income levels were low and dependence on farming was high. There were large nutrition deficiencies, but the proposed interventions in home gardens by adding new crops had the potential to alleviate these constraints, although in some cases trade-offs with household budget or soil fertility were found. In general, the model-based exploration demonstrated large windows of opportunity for further improving farm performance and the income and nutritional status of the households in the case study villages.

The detailed analysis was demanding in terms of data collection, and depended strongly on secondary data to establish nutrient composition of foods. Future research efforts will use only selected modules to reduce the data requirements and the duration of the analysis.

4. Multistakeholder platforms and nutrition

A key component of systems agricultural research for development (R4D) in Humidtropics was the use of platforms to engage multistakeholders in the design, implementation, monitoring and recommendations resulting from activities. Multistakeholder platforms enable local problems to be analysed along with the identification of feasible interventions

to address the issues. Stakeholders (researchers, the private sector, farmers and other local and national actors) met regularly to discuss and agree on collaborative actions, which were followed up outside the multistakeholder platform meetings. This multistakeholder and local approach facilitated links between stakeholders and encouraged innovative approaches, transferred information and technology, and empowered communities by applying participatory and locally appropriate solutions. The Humidtropics Central Mekong Action Area had launched multistakeholder platforms in four Action Sites: in Northwest Viet Nam; Central Highlands, Viet Nam; Nan in northern Thailand; and Xishuangbanna in Yunnan Province, southwest China.

At the outset, a meeting with stakeholders and research centres was conducted to identify the geographical areas where interventions were needed. A situational analysis (see Chapter 2) was conducted with platform members and was presented at platform meetings. These meetings established a better understanding of the priority problems related to rural livelihoods and identified entry points for interventions. This enabled areas where the platform should focus its efforts to be recommended. After the local problems and possible solution entry points had been identified, the platform members collectively decided how to assign the different roles and responsibilities for implementing, testing and evaluating the impact of innovative solutions generated by the platforms.

Northwest Viet Nam

The multistakeholder platform in Northwest Viet Nam was launched initially in August 2013. The platform, led by partnering centres ICRAF and the Department of Agriculture and Rural Development (DARD), facilitated further partnerships and collaboration between national and international research institutions, NGOs, extension centres, actors in the private sector, and local farmers. At the initial meeting were participants from Humidtropics core partners namely ICRAF, ILRI, CIAT, IWMI and WorldVeg, and national research institutions and universities such as FAVRI, NOMAFSI, Institute of Policy and Strategy for Agriculture and Rural Development (IPSARD), CASRAD, AFRI, NIN, Viet Nam National University of Agriculture (VNUA) and the Forest Science Centre for Northwestern Viet Nam (FSCN). The focus was on productivity and environmental stability. An NGO that focused its work in Viet Nam was also at the initial meeting (HealthBridge Foundation Canada). The event was also attended by national agencies from Europe (Centro Europeo di Ricerca e Promozione dell'Accessibilità ITALIA (CERPA) and CIRAD) and provincial government departments, agencies and associations (Son La Plant Protection Division, Son La Crop Production Division, DARD, local farmer associations and women's unions). These representatives raised the issues and challenges that the platform needed to address with future projects and research. Partners including NIN, Healthbridge Canada, FAVRI, Bioversity International and WorldVeg brought a nutritional perspective to the platform and encouraged the inclusion of nutrition and diet in each stage of the platform's activities.

A situational analysis (see Chapter 2) was then conducted by platform members (SFRI, Centre for Sustainable Rural Development (SRD), FAVRI, CASRAD, ILRI - leading, Bioversity International and ICRAF) and included a review on nutrition using secondary data collection from the NIN. These data showed trends in malnutrition (stunting, underweight and wasting), iron deficiency, vitamin A deficiency, prevalence of women of reproductive age (15-49 years)

with chronic energy deficiency (BMI <18.5kg/m^2), rate of individuals being overweight or obese, proportion of children meeting minimal dietary diversity requirements (at least four of seven food groups consumed), and breastfeeding practices (NIN 2010, 2012). The situational analysis recommended that improving dietary diversity should be a priority research area in the Northwest, and recommended diversifying production systems and establishing nutrient-rich niche market value chains as key entry points.

Two initiatives were formulated through this multistakeholder platform: 1) A multistakeholder platform research project; and, 2) a local-level multistakeholder platform for commercial vegetables in the area. Since the platform was revitalized in March 2015, two meetings have taken place: one in March 2015 and another in October 2015. The final meeting for Humidtropics was planned for October 2016. One outcome the platform research project set out to achieve was an improvement in dietary diversity and basic nutritional status. Data collection was conducted by four partners, and WorldVeg included pathways for how and where nutrition could be affected, such as two one-day nutrition education training sessions for 10 households.

Central Highlands, Viet Nam

The multistakeholder platform established in the Central Highlands of Viet Nam was launched in September 2014 by WASI and supported by CIAT. The platform fostered further partnerships and collaboration between international research organizations or organizations that work internationally (Australian Centre for International Agriculture Research (ACIAR), BMT, CIAT, CIRAD, Commonwealth Scientific and Industrial Research Organisation (CSIRO), ILRI, ICRAF, Wageningen University and Research (WUR), WorldVeg); and local and national research organizations and universities (WASI, DARD, Tay Nguyen University (TNU), Hue University, Department of Science and Technology (DoST) and the National Institute of Animal Sciences (NIAS)). The only centre with a nutrition/diet framework was WorldVeg, though no national or local nutrition institutions were in the partnership.

The multistakeholder platform addressed nutrition during the situational analysis conducted by a select number of platform members: TNU, WASI and CIAT, funded by ILRI. The situational analysis report included a review of the existing regional and national nutrition data for the Central Highlands published by the NIN. This information came from a General Statistics Office survey from 2009, 2010 and 2011. The data included the proportion of children less than five years old who were underweight, severely undernourished, or who exhibited severe signs of stunting, or had clinical vitamin A deficiency; the proportion of individuals who suffered from anaemia; dietary energy (kcals); protein and fat intakes. The situational analysis concluded that the nutrition status of children should be improved and suggested that this could be achieved by focusing on underdeveloped livestock and fish sectors as entry points.

Two projects were operationalised through this platform: a farmers' group on cattle development, and a multistakeholder platform research project titled 'Enhanced livelihoods and better natural resource management through appropriate integration and diversification on smallholder farms in the Central Highlands of Viet Nam'. Only the platform research project included improving diets as an objective through WorldVeg's implementation of improving home gardens.

Nan, Thailand

The multistakeholder platform located in Nan, Thailand was launched in May 2014. The team was led by WorldVeg and Chiang Mai University, with the participation of Chulalongkorn University. The launch meeting was attended by 41 people representing 21 stakeholders, including: CGIAR centres (ICRAF and ILRI); representatives from educational institutions (Chiang Mai University, Chulalongkorn University, Mae Fa Luang University, Mae Jo University, Nan Community College, and Tanchum High School); international organizations (WorldVeg), national organizations and governmental departments (the Department of Agricultural Extension and the Land Development Department); provincial government organizations and departments (Muang Jung Subdistrict Administrative Organization, Nan Agricultural Extension and Development Center, and Nan Provincial Administrative Organization); funding agencies for agricultural development and productivity (Royal Initiative Discovering Institute, Thai Research Fund, Hag Muang Nan Foundation, Pong Kum Temple Learning Community Encourage Foundation, Bank for Agriculture and Agricultural Cooperatives) and a private sector representative from Hongsa Power. The only platform member who participated at the initial meeting and had a background in diet and nutrition was WorldVeg; no national nutrition stakeholders were present.

The situational analysis conducted by WorldVeg, Chiang Mai University, and ICRAF put together data collected through key informant interviews as well as a literature review (see Chapter 2). The results were presented at the multistakeholder platform meeting. Diet and nutrition information relevant to the population was in the executive summary and included the proportion of children underweight, stunted, and with deficient folate and iron intake. Although data were presented on nutrition, improvements in nutrition or diet were not included as recommendations. Despite this, the activities developed and carried out by various platform members did include some scope on nutrition, including WorldVeg's work in introducing and improving home garden management.

Xishuangbanna, China

The final multistakeholder platform, in Xishuangbanna, China, was launched in September 2014 and led by ICRAF. Fifty-three participants from various government, research, business and non-government organisations attended the initial meeting. Stakeholders included international and national (ICRF and Syntao); provincial and prefectural (Xishuangbanna Bioindustrial Office, Yunnan Green Foundation, Xishuangbanna Tropical Crops Institute, Yunnan Institute of Insect Resources, Xishuangbanna Tianyun Linzhong Herbal Medicine Growers Ltd, Meteorological Bureau of Xishuangbanna, Yunnan University, Xishuangbanna Development and Reform Office, Yunnan Forestry Investment Company, Yunnan Tea Institute, Yunnan Forestry Bureau, Xishuangbanna Tropical Botanical Garden, Yunnan Business Institute, Yunnan Environmental Science Institute); and, other public and private sector stakeholders (Nabanhe National Nature Reserve, Xuandali Cropping Company Ltd, and Sunbird Ecotourism). No stakeholders with expertise in nutrition participated.

At this meeting, the platform collectively decided that a baseline survey would not be conducted. Instead, key stakeholders had the task of impressing the regional issues on the meeting's members. Nutrition was not considered an entry theme or priority issue to be

tackled by the platform at that time. Later, the platform conducted a situational analysis, but no information on diets or food was included in that report (see Chapter 2). The report does however acknowledge that the review had blind spots and that further investigation regarding livelihoods should be conducted. The activity that came out of the platform, titled 'Appraisal and Innovations in Xishuangbanna, China', did not include any recommendations on nutrition or diet improvement, nor did it capture such data.

4.1 Cross-site comparison

This chapter analyses seven main initiatives in the Central Mekong in Viet Nam, China, and Thailand undertaken by the Humidtropics core partners and their national and local partners. These initiatives all had one centralized objective: to improve farmers' livelihoods. Although the partners shared a common objective, they approached the objective differently and focused on different aspects. The work was initiated in similar fashion in all projects with situational analysis and meetings with key stakeholders to identify the areas where research was needed. These meetings were conducted through the multistakeholder platforms established in each Action Site, with key stakeholders identified and invited to join. After the main livelihood issues were described and entry points for interventions identified, separate projects and activities were developed to best address the issues and potential of each region.

The three projects and activities that included aspects of nutrition or diet in work plans employed various approaches and indicators with little harmonization across projects, making it difficult to collate data or conduct cross-site analysis. Often, indicators more specific to food security (access) were used (e.g. Household Dietary Diversity Score (HDDS) and household food production) indicating a lack of knowledge and experience on how to select appropriate indicators specific to nutrition and diet quality-related outcomes. From the numerous indicators implemented, only seven are internationally validated for nutrition and diet-related outcomes (see section 2 for more detail).

Tools and methods used to collect nutrition and diet-related data also varied across projects and activities. This included household or individual surveys, anthropometric measurements, focus group discussions and other rapid appraisal methods, key informant discussions and literature reviews. The surveys included qualitative or quantitative diet recalls over different time frames (24 hours, seven days) and at different scales (individual or household), annual household consumption of produced foods and different versions of the FAO Nutrition Knowledge, Attitudes and Practices questionnaire (FAO 2014). Anthropometric measurements were collected either directly by the research teams, or through review of community health records. However, the consistency between approaches necessary to compare data between activities was lacking. This can be explained by different stakeholder interests and levels of nutrition understanding in the multistakeholder platforms. It takes time to evolve a common goal and working methods and this is based upon trust built around activities. Because the Humidtropics project was truncated due to funding constraints and the CGIAR Consortium's decision to end the project early, this was not achieved.

Most projects and activities in the Central Mekong were initiated through multistakeholder platforms, or by building on existing bilateral projects carried out by the core partners. This highlighted how critical it was to have a diverse stakeholder representation including representatives from provincial or local entities and organizations with diet and nutrition experience, at the initial meetings where strategy was formulated. The purpose of the multistakeholder approach was to ensure each area of development and livelihoods was represented, and to ensure priorities were well evaluated and representative of a wide range of rural development dimensions.

The lack of multistakeholder platform partners with experience in diet and nutrition was a weakness, particularly in representation from provincial or local entities and organizations. In almost all platforms, no local nutrition representation was present at meetings.

In Northwest Viet Nam, four of the 21 stakeholders had a background in nutrition and diet (NIN, Healthbridge, WorldVeg and Bioversity International); 12 focused directly on improving agricultural productivity; four focused on other types of community and environmental development. In the Central Highlands of Viet Nam, of the 16 stakeholders represented at the initial meeting, one had a background in nutrition and diet (WorldVeg), 11 focused directly on improving agricultural productivity and one focused on other types of community and environmental development.

In Thailand, of the 21 stakeholders represented at the initial platform meeting, two had a background in nutrition and diet (WorldVeg and ICRAF), 10 focused directly on agricultural productivity, and three focused on other types of community and environmental development.

In China, of the 20 stakeholders represented at the initial meeting, none had a background in nutrition and diet, three focused on agricultural productivity, and 12 focused on other types of community and environmental development.

Diversity across stakeholders represented in multistakeholder platforms, particularly in relation to nutrition, is a major area for improvement for future applications of systems research. Reaching out to the different levels in each sector is also imperative to understand what the issues are locally as well as nationally, and to facilitate the sharing of examples of innovations and solutions that have had success in different regions to overcome local problems.

5. Recommendations for future systems research for nutrition based on lessons learnt in the Central Mekong Action Area

Of the seven projects analysed in this chapter, three included nutrition in their objectives. Of the 14 activities summarized, five included nutrition as an outcome while two included nutrition and food security indicators and seven activities did not include nutrition. The main reason nutrition was not included in the scope of projects was that the lead researcher

felt that they (or their institute) did not possess the capacity to work on nutrition and the topic was beyond the scope of their mandate or expertise. Additionally, nutrition was not prioritized by the multistakeholder platforms or during situational analyses. Of key importance is the infrequent participation of local nutrition stakeholders in multistakeholder platforms; this is likely the main reason why nutrition was not raised as a priority area for intervention more frequently. Nutrition was also less familiar to many stakeholders than other indicators. Having platforms that did not prioritize nutrition resulted in projects and activities that did not work directly to improve nutrition.

Within the nutrition inclusive research efforts that did occur, the wide range of nutrition indicators and data collection highlights the need for more coordinated guidance at the CGIAR Research Program level regarding which indicators and methods to implement. Having a wide array of different indicators and data from different sites makes it extremely difficult to conduct cross-site comparisons and analysis. As a minimum, anthropometric measurements and qualitative dietary recall information could be used to better understand how diets and nutrition are affected by production increases or other agriculture-related outcomes that the different research centres wanted to address.

For systems research to have a positive impact on nutrition, it is critical that future multistakeholder platforms have active local nutrition partners, such as members from the National Institute of Nutrition (NIN) or the Department of Nutrition and Health, or non-government organizations with experience, understanding and expertise on local nutrition issues. Such coordinated efforts will help to ensure that activities include the minimum nutrition indicators needed to evaluate impacts on nutrition and diet that are critical to the well-being of poor rural households.

The recommendations proposed could have been addressed if Humidtropics had continued and if fully functional multistakeholder platforms had been sustained and further evolved around tangible sets of activities.

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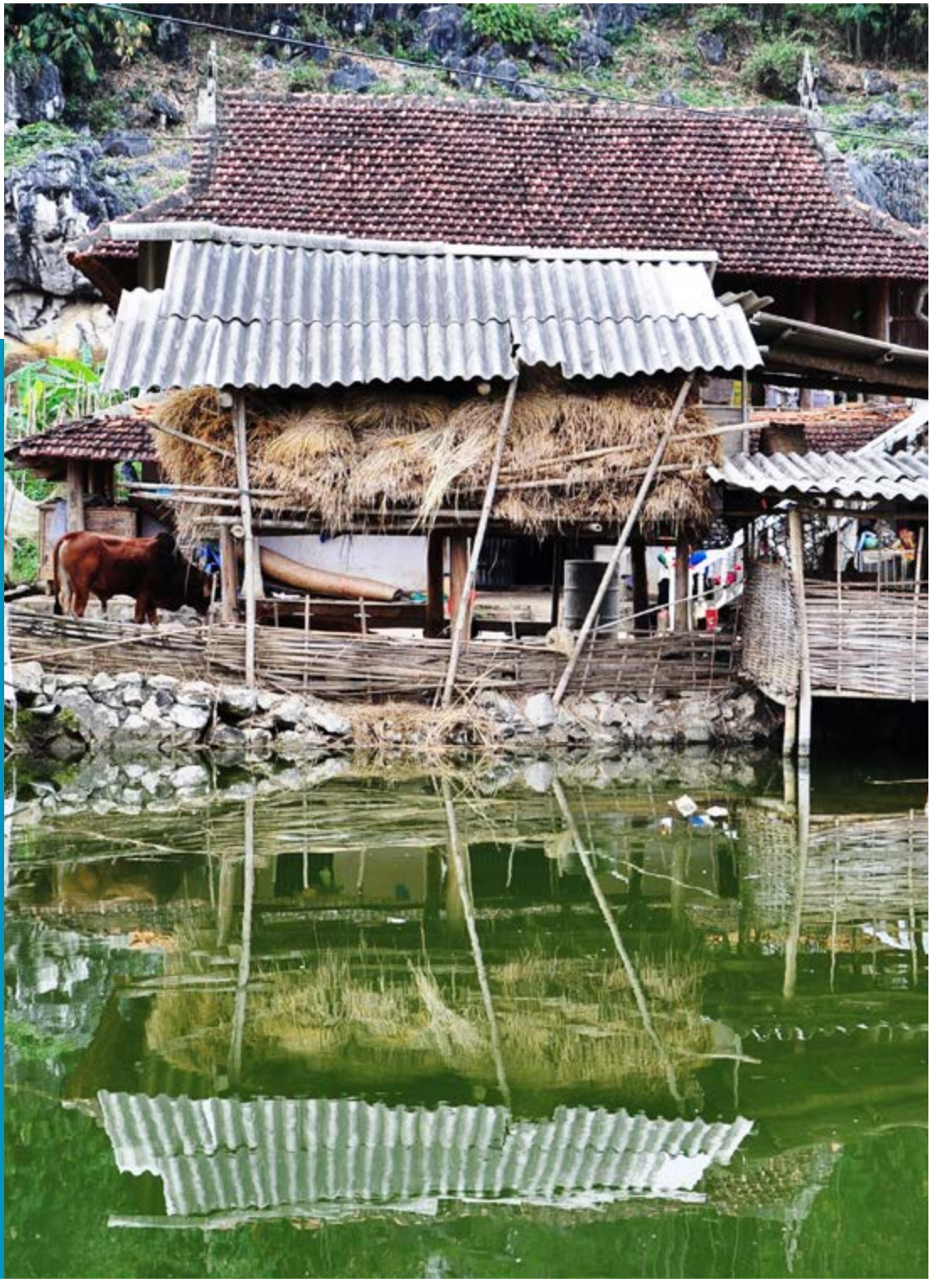

A Thai household with cattle and fish pond in Northwest Viet Nam. Photo credit: ICRAF/Pham Duc Thieng

Integrated systems research for sustainable smallholder agriculture in the uplands of mainland Southeast Asia: Achievements and lessons learned

Chapter 5

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Summary

Photo 5.1 Participants of Humidtropics Central Mekong Action Area 2015 planning meeting in Xishuangbanna, China. Photo credit: ICRAF/Thanh Tu Mai

After introducing the objectives and outcomes of Humidtropics, and some institutional constraints the research program faced, this chapter offers a synthesis of achievements, gaps and challenges of agricultural research for development activities implemented in the Humidtropics Central Mekong Action Area, as well as a discussion of the challenges faced. This chapter provides lessons learned from implementing agricultural research for development in this region, and offers insights and recommendations that could support integrated agricultural systems research in the Mekong region and elsewhere.

1. Introduction

1.1 Humidtropics strategic objectives and development outcomes

Humidtropics, a CGIAR Research Program on Integrated Systems for the Humid Tropics, was one of three systems research programs among the 15 CGIAR Research Programs (CRPs) of the CGIAR consortium. Officially launched globally in mid-2012, the program aimed to help poor farm families in tropical Africa, Asia and the Americas boost their income and livelihoods through partnership-based research on integrated agricultural systems for agricultural development. In 2013, Humidtropics research was restructured into a new programmatic framework, as seen in Figure 1.1 (Chapter 1). Humidtropics' Intermediate Development Outcomes (IDOs) were derived directly from its four Strategic Objectives (SOs) of 1) Livelihoods Improvement; 2) Sustainable Intensification; 3) Women and Youth Empowerment; and, 4) Systems Innovation. Each Strategic Objective related directly to one or two IDOs. For each IDO, indicators were defined with targets to be reached by 2023 (Humidtropics 2014).

Strategic Objective 1 addressed the goal of improved livelihoods in terms of income and nutrition for rural farm families, and was further defined by IDO 1 on income and IDO 2 on nutrition. The aim of IDO 1 on income was to increase the income earned by smallholders, and obtain more equitable sharing of profits in the value chain as a result of Humidtropics system interventions. IDO 2 on nutrition aimed to increase consumption of diversified and quality foods by the poor, especially among nutritionally vulnerable women and children (Humidtropics 2014).

Strategic Objective 2 on sustainable intensification focused on increasing total farm productivity while respecting integrity of natural resources. It was further detailed in IDOs 3 and 4 on productivity and environment. However, sustainable intensification is an overarching theme also addressed through contributions from the other Humidtropics IDOs. IDO 3 on productivity concerned the total farm-level productivity through sustainable intensification and diversification. IDO 4 on environment was about reversing land degradation and other negative environmental effects brought about by agricultural intensification through monocropping; it explicitly aimed to restore more natural ecosystem functions and services. Together, the overall aim was to optimize returns from the farm, sustainably manage biodiversity, soil fertility and ecosystem services, and enable the land to remain productive (Humidtropics 2014).

Strategic Objective 3 concerned empowering women and youth through better control over and benefit from integrated production and marketing systems. It was directly linked with IDO 5 on gender. This IDO focused on transforming women's status and position through Humidtropics system interventions. This IDO also addressed youth and marginalized groups' empowerment as an essential component to ensure their improved access to and control over the benefits from integrated systems interventions (Humidtropics 2014).

Strategic Objective 4 addressed enhanced capacity for systems innovation and corresponded to IDO 6 on capacity to innovate. This IDO supported systems interventions to achieve impact at scale. It involved building capacity among actors to innovate within the livelihood system, and creating a more enabling policy, business or development environment for scaling innovations (Humidtropics 2014).

1.2 Constraints of implementing Humidtropics in the Central Mekong Action Area

As described above, Humidtropics as an integrated systems research program had ambitious goals based on a 15-year timeframe, with indicators and targets to be reached by 2023. At the beginning of the CRP, four Action Areas were defined globally as 'tier 1', to be further expanded into 'tier 2' countries at a later stage. Unfortunately, the CGIAR consortium decided to close all three systems CRPs by the end of 2016, and thus the research for development (R4D) activities did not move beyond 'tier 1' areas. Below, we provide an overview of some constraints the CRP faced globally, as well as in the Central Mekong Action Area.

The first constraint was related to budget. The Humidtropics budget was repeatedly cut, with a smaller budget allocated each year. Although all 15 CRPs suffered budget cuts, these cuts affected some CRPs more than others. Such uncertainties in core funding made many Humidtropics international partners shift their priorities, which inevitably left Humidtropics and other systems research CRPs with even less resources to achieve their ambitious goals.

Photo 5.2 Focus group discussion with male farmers in Son La, Viet Nam. Photo credit: ICRAF/Lisa Hiwasaki

A second constraint was structural and related to how Humidtropics R4D activities were managed. According to the CRP program structure (Figure 5.1), it would have been logical for systems analysis (described in Chapter 2) to be implemented before testing innovations related to integrated systems improvement on natural resource management, productivity, institutions and R4D on scaling (described in Chapters 3 and 4) at Action Sites and Action Areas. However, when activities commenced, funding for all activities was provided to each core partner simultaneously. In practice, this often meant that integrated systems improvement, scaling, and institutional innovation activities had to begin before entry themes and entry points were identified through situational analyses, and before priorities were set through multistakeholder platforms. Although this was an inevitable result of launching a CRP with multiple international research organizations involved, each with their own research agenda and local partners, these preconceived agendas, short timeframes and pre-existing local partner landscapes hindered the promotion of truly bottom-up, demand-driven and integrated research.

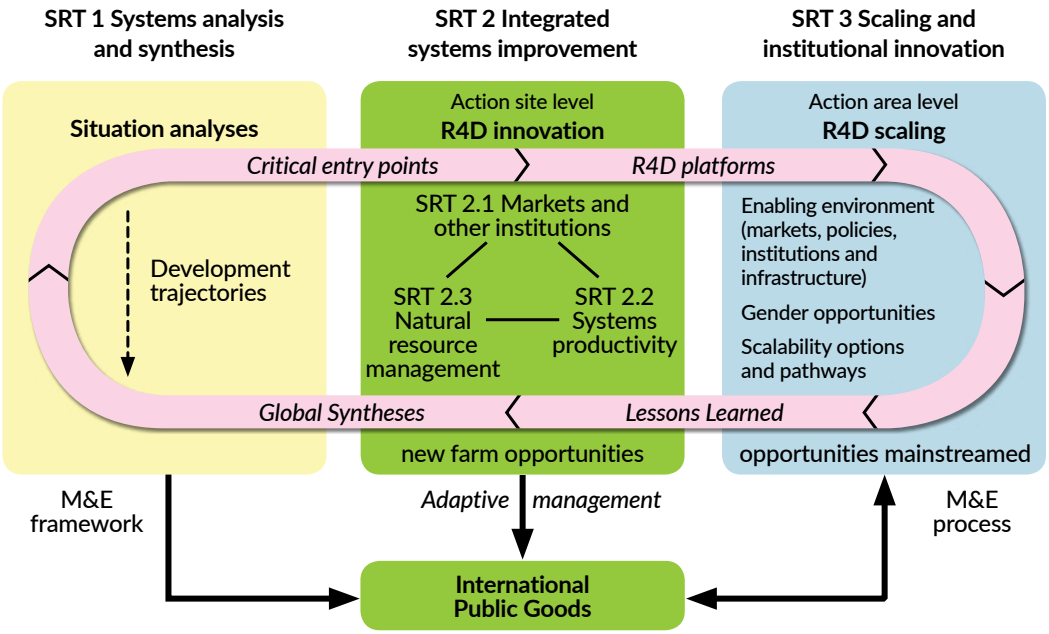

Figure 5.1 Humidtropics program structure

Third, although eight Humidtropics core partners were involved in R4D activities in the Central Mekong Action Area, not all core partners had offices and staff based in the region. The establishment of a Core Team with a representative from each core partner was crucial to provide a management structure that enabled a joint decision-making process to prioritize, plan and implement R4D activities in line with Humidtropics objectives. Because Humidtropics funds were allocated to each Humidtropics core partner directly from the lead institute based in Africa (International Institute of Tropical Agriculture (IITA)) — including accompanying reporting obligations to IITA and not to the Action Area coordination team

— such a management structure was indispensable to enable coordination of activities at the Action Area level. However, the physical absence of some core partners in the region resulted in less than optimal coordination and at times fragmented approaches to implementing some thematic activities that required close collaboration among the local and international partners involved. This may also have played a role in why nutrition was not raised as a priority intervention area more frequently in the Central Mekong, as discussed in Chapter 4.

2. Implementing agricultural systems research for development in the Central Mekong: Synthesis of achievements, gaps, and challenges

We begin this section by outlining overall accomplishments of Humidtropics in the Central Mekong, followed by key achievements organised by the Humidtropics' Strategic Objectives.[1]

First, we obtained a much better understanding of the biophysical and social contexts in which rural and agricultural development is taking place. The situational analysis results clearly illustrate the diversity of agricultural and rural development settings across Humidtropics sites in the region. Contrasting features include: i) differentiated development levels, including both infrastructure and agricultural technology; these somewhat reflected national development differences; and, ii) in some cases (Thailand, China) population levels have stabilized while elsewhere, such as in Viet Nam, population growth continues (see Chapter 2 for more information on each Action Site, and Annex I for reports and other publications produced in each country).

However, strong commonalities were also apparent, reflecting some of the shared cultural history as well as similar physical terrain and agricultural traditions. Among the commonalities are: i) mountainous terrain characterized by some relatively remote and thinly settled locations in elevated areas, but also settled valley locations with better market access; ii) linked to this, strong disparity in income between urban and rural populations; iii) a significant presence of ethnic minority communities, many of which are socially, politically, economically and geographically marginalized, particularly in the case of women; iv) a mix of agricultural market types, including both strong local demand but also longer distance and cross-border markets for specific products, some of which are high value; and, v) the relatively strong role of the State. In all sites, most of the population is rural and agriculture still plays the dominant role in livelihoods.

[1] Due to the shorter than expected timeframe of Humidtropics activities in the Central Mekong Action Area, insufficient quantitative data was collected to track achievements against IDO targets. We thus rely primarily on qualitative evidence, but provide quantitative evidence where possible.

It proved extremely useful to characterize the agro-ecological and social systems of our field sites through situational analyses, characterizing the farm households through baseline surveys, and using various tools to identify and prioritize entry points in each Action Site. Although the process was lengthy, costly and at times cumbersome, obtaining a comprehensive image of the field sites before starting agricultural R4D activities played a key role in bringing the project closer to the farmers. The different innovations trialled at each field site were direct outcomes of this process. Furthermore, the information and data obtained will remain an important resource for others working on agricultural development and R4D in the region, as they will be openly available through the community of practice (http://community.humidtropics.org/).

Second, modest funds allocated to local partners through the Multistakeholder Platform Research Project Funds were successful in generating locally relevant, integrated agricultural R4D activities. Three such projects were implemented in the Central Mekong: one in Northwest Viet Nam, another in the Central Highlands of Viet Nam, and a third in Thailand. Although small in scale, the integrated approach and close attention paid to these projects had concrete impacts on the ground. Qualitative impact assessment not only demonstrated that impacts were reported by farmers, but also showed that unanticipated project outcomes were observed. Smallholder farmers, most notably ethnic minority women farmers in the Central Highlands of Viet Nam, perceived as meaningful that they now had more time and opportunities to interact with neighbours and other farmers to talk about the project and share experiences due to the time- and labour-saving interventions introduced, which are described below in section 2.1.[2] Furthermore, these projects were critical to energizing the multistakeholder platforms. As the platform research projects were led by local organizations, they played a major role in generating broad partnership engagement in R4D activities (Hiwasaki et al 2017). Moreover, these projects were effective in filling gaps in existing agricultural activities implemented through CGIAR's research projects (Schut et al 2016).

Third, collaboration among international agricultural research organizations working in the region was substantially improved. Organizations that had not previously worked together were brought together as part of multistakeholder platforms established in various Action Sites and the resulting platform research projects, and also through joint implementation of R4D activities in the different field sites that would not have been possible otherwise. An example is the joint International Water Management Institute (IWMI)–World Vegetable Center (WorldVeg) field testing of crop and water management practices for home-based vegetable production in Northwest Viet Nam. This partnership resulted in establishing a demonstration site for home-based vegetable production during the dry season using roof-top harvested rain as the primary water resource. Based on field surveys and water balance modelling, a rainwater harvesting system was designed with an optimized storage volume that minimizes both costs (mostly due to the dimension of the storage tank) and risks of water shortage. Other farmers in the village have since scaled out home-based vegetable production without any support from the project.

[2] During qualitative impact assessment undertaken by ICRAF Viet Nam, 20-24 June 2016.

Furthermore, partnerships were strengthened between international agricultural research organizations and local partners, especially through the platform research projects. Local institutions worked jointly to implement these integrated agricultural R4D activities, enabling joint learning not just from the international research organizations but also from each other.

2.1 Strategic Objective 1: Livelihoods improvement

Mainland Southeast Asia is undergoing intense social and economic changes, such as expanding infrastructure and markets, and government policies and programs that promote rural and agricultural development. These offer many economic opportunities to improve farmers' livelihoods (King 2008, Kelly 2011). Monoculture cash crop plantations such as rubber, coffee, maize and cassava grown for regional and global markets have increased household incomes for farmers. However, this has been at the expense of local food production and thus has not necessarily led to positive livelihood outcomes with improved food and nutrition security. This development has also been at the expense of sustainable natural resources management and has led to severe land degradation and issues with access to and quality of fresh water.

The commercialization of 'safe' vegetables[3] or off-season vegetables in home gardens in Northwest Viet Nam, implemented by WorldVeg and the Fruits and Vegetables Research Institute (FAVRI), aimed to enhance local food production while promoting improved dietary diversity and diet quality. Another relevant intervention was the introduction of forage grass and home gardens in the Central Highlands of Viet Nam, with evidence that livelihoods improved after just one year of activities. Farmers we interviewed[4] said that before the grass VA06 was introduced, they would spend up to four hours a day cutting grass for their cattle. They had to go far from their homes to find feed for their cattle, incurring fuel costs at approximately 1 USD per day. With forage grasses grown in small land parcels around their house and close to where their animals were kept, they would only spend one hour per day to maintain and cut the grass, with no fuel costs. Home gardens were also popular, and farmers commented that instead of going to the market to buy vegetables, they now grew a wide range of vegetables for their daily meals such as cabbage, tomato, lettuce, cucumber, green bean, squash, pumpkin and eggplant, sometimes enough to share with their neighbours. Thus, instead of buying vegetables from the market every day, only money to buy seeds every 3-4 months was necessary. What became evident from our conversations with farmers was they felt the Humidtropics R4D activities had positive impacts on their lives. Even if their incomes did not increase, they were saving money and time by growing grass for their livestock and vegetables for their own consumption.

[3] In Viet Nam, the term 'safe' is used to signify vegetables produced under a process that ensures safety for consumers. The details of such processes tend to differ among the producers, but the standards set by VietGAP (Vietnamese Good Agricultural Practices, a national certification for agricultural products), is what farmers generally strive to follow.

[4] During qualitative impact assessment undertaken by ICRAF Viet Nam, 20-24 June 2016.

Despite these achievements, a notable gap in Humidtropics activities in the region was the lack of private sector involvement, both in the multistakeholder platforms but also in the R4D activities implemented. Local and national research partners were reluctant to involve the private sector in multistakeholder platforms that were still in the early phase of conducting situational analyses, baseline studies and identifying entry points for innovation. As a result, links with the private sector remained weak, even when concrete agricultural R4D activities were implemented, and very few activities focused on creating market linkages for farmers. This was unfortunate, especially because it was identified as a gap from the beginning through situational analysis (ILRI 2014) and stated in IDO 1.

2.2 Strategic Objective 2: Sustainable intensification

The unprecedented speed at which agriculture has been transformed in mainland Southeast Asia has compromised longer-term land productivity and ecosystem integrity. Government policies have enforced rapid conversion to accommodate specialized and intensified forms of agriculture, in particular monoculture cash crop plantations, as well as increased use of inputs for intensified agricultural production. This has resulted in environmental degradation, including rapid deforestation and erosion of farm land; loss of biodiversity; inequitable access to natural resources, including water; and, degrading ecosystem services, with particularly negative impacts on the poor (Drahmoune 2013). Such changes in northern Laos and southwestern China are described and analysed in Chapter 3. Not only do conversions to teak plantations (in northern Laos) and rubber (in southwestern China) replace traditional subsistence farming systems, the loss of natural resources (e.g. soils through erosion) jeopardizes land productivity over the long term, especially if tree plantations are to be converted back to food production (Ahrends et al 2015). Food-producing crops have lower rooting depth than trees, and consequently are less productive on the over-depleted soils that usually result from years of tree plantations.

Considering that conversions to commercial monocropping of maize or cassava from traditional subsistence farming are wide-spread in Northwest Viet Nam, the multistakeholder platform research project there introduced forage grasses, organic composting, and safe vegetables to smallholder farmers. Multistakeholder platform meeting discussions indicated a parallel interest and demand for small-scale diversification for subsistence and income. During interviews with farmers[5], one of the most common observations was they felt the environment had become “cleaner” and the project had helped them “protect the land”. They felt that planting grass strips on the hills had reduced soil erosion and was protecting the land, especially when intercropped with coffee, maize or cassava. Furthermore, using less fertilizer as a result of organic composting and growing safe vegetables also presumably contributed to lessening water pollution, thus the farmers’ perception of a “cleaner” environment.

[5] During qualitative impact assessment undertaken by ICRAF Viet Nam, 26-29 September 2016.

The relatively rapid changes in land use, and unsustainable agricultural intensification in a region characterized by steep terrain, require innovations to improve soil conservation within evolving production systems. Such innovations can be both technological (e.g. new cropping practices including planting hedges) and institutional in nature (e.g. alternative land tenure arrangements). The case studies in Chapter 3 demonstrate how processes to facilitate identifying, designing and testing innovations – either technological or institutional – are context-specific, leading to divergent trajectories towards achieving the different IDOs. For example, in northern Lao PDR, we showed that the ongoing expansion of teak tree plantations, often mentioned as part of the efforts to enhance soil and water conservation through so-called reforestation, is actually increasing erosion and compromising long-term sustainability of cropping lands. Through discussions with farmers and local authorities, recommendations were formulated. Several agroforestry cash crops used as understorey in teak plantations were suggested to reduce soil erosion and some were tested. Similarly, in the Central Highlands of Viet Nam, smallholder coffee farmers faced with a double burden of low coffee productivity from aging trees grown on marginal soils and volatile coffee prices, sought ways to diversify production and restore or improve soil fertility. This was addressed, for example, by working with farmers and local government extension agents to develop cut-and-carry forage grass systems that could enhance the productivity of ruminant livestock on the farms, while decreasing the time and fuel cost involved in collecting feed for the animals. Such systems allowed animal manure to be collected more effectively, composted and applied to vegetable home gardens, or to coffee, pepper or cashew plantations. By actively involving commune extension workers in the process, they became facilitators for interaction between farmers and helped spread forage innovations to other villages and hamlets. Thus, integrated agricultural systems research based on multistakeholder processes and partnerships is one way to realize a region's potential. However, implementing multistakeholder processes has its challenges in this region, as will be discussed in section 3.

2.3 Strategic Objective 3: Women and youth empowerment

The Mekong region is characterized by considerable ethnic diversity. Ethnic groups, particularly those living in upland areas, are usually disadvantaged. They tend to have less material wealth, lower school attendance rates, lower literacy levels, and fewer job opportunities and market access (ILRI 2014, Hammond et al 2015). Their interactions with their natural surroundings, including traditional farming practices, differ from the lowland population, which forms the political core of the countries that comprise the region. Until recently, socialist States classified minority groups according to their perceived development level and justified the central government's expansion to exert control over remote regions (Fiskesjö 2006, Harrell 1995).

Situational analysis in Northwest Viet Nam (ILRI 2014; also see Chapter 2) demonstrated that ethnic minorities also have relatively poor access to extension services and markets. It was concluded that interventions targeting ethnic minorities and women can have greater impacts to alleviate poverty and inequalities. Focusing on women would be relevant especially for dietary diversity and nutrition, as women are the main decision-makers on food served at the table (ILRI 2014).

Photo 5.3 Researchers sharing results of discussions at Humidtropics Central Mekong Action Area 2016 planning meeting in Hanoi, Viet Nam, November 2015. Photo credit: ICRAF/Lisa Hiwasaki.

Despite the tremendous ethnic diversity and inequitable development in the region, agricultural R4D activities implemented and interventions proposed under the framework of Humidtropics in the Central Mekong Action Area did not specifically address marginalized groups, most notably ethnic minorities. For example, out of more than 30 R4D activities implemented in the region in 2015, only two directly contributed to the IDO on Gender. Moreover, only one activity specifically mentioned 'ethnic minority'. This meant that within existing activities, ethnic minorities were either left out, not recognized, or subsumed by the ethnic majority. Thus, the benefits of Humidtropics research and interventions may not have reached the poorest smallholder farmers in the region, and if they did, may have been inappropriately designed and potentially led to exacerbated negative impacts on cultures and livelihoods by introducing new technologies that go against social norms, rules and ways of engaging in agriculture (Kawarazuka 2016).

To address this gap, a research component focusing on marginalized groups — most notably ethnic minorities — began in the region in 2015. It resulted in a gender norms study, two literature reviews, two policy briefs, draft journal articles, and 'Guidelines to Engage with Marginalized Groups in Agricultural Research for Development in the Greater Mekong'. The Guidelines were piloted in Lao PDR and Viet Nam, and further revised with contributions from various scientists and practitioners. Thus, a unique product was developed that will be useful for scientists implementing agricultural R4D in the Mekong region; it is included in Annex II of this book.

2.4 Strategic Objective 4: Systems innovation

Through multistakeholder processes, Humidtropics strived to implement bottom-up research in which farmers and other stakeholders guided the agricultural R4D agenda. Such participatory research would support collaboration between researchers, extension workers and farmers to jointly develop solutions towards sustainable agricultural development (Klerkx et al 2012). To realize the aim of using participatory approaches and multistakeholder platforms to build capacity to innovate among all platform members, capacity for platform facilitation had to be established first. Two three-day capacity development workshops were organized, targeting facilitators and those supporting them. A document intended to guide establishment and improve the functioning of multistakeholder platforms was also developed. Despite such efforts, managing and facilitating multistakeholder processes was difficult, and ensuring that such processes functioned well was challenging, especially considering the region's cultural and institutional contexts, as described and analysed in detail in section 3.

During the qualitative impact assessment of the multistakeholder platform research projects in both Northwest and Central Highlands of Viet Nam, we found that while some actors commented on how these Humidtropics projects were "closer to the farmers" than other projects they had experienced, these projects continued with the technology transfer model, in which researchers develop technologies that are then transferred in a top-down manner by project staff or extension staff to farmers. Development actors played no role in these projects, and the farmers continued to be in 'receiving mode', expecting to be 'taught' technological innovations. These projects did not have an element of building farmers' capacities to innovate on their own, nor was there room for non-technological innovation. This was perhaps inevitable after years of top-down imposition of technology, as well as the sociopolitical context in Viet Nam. However, it is evident that in the timeframe of Humidtropics in the Central Mekong Action Area, adoption of multistakeholder platforms did not lead to widespread changes in the enabling environment that determines how agricultural R4D is conducted.

Furthermore, these platforms did not lead to scaling of innovations. Although we found pockets of success in the design and testing of innovative technologies (as described in Chapter 3) and tools (as described in Chapter 4), development impact through scaling out or up was not yet achieved in the Central Mekong Action Area. This reflected the limited timespan during which the platforms were effectively operating, but may relate to wider questions about the extent to which such local platforms can benefit the livelihoods of many thousands of farmers in developing countries (Dror et al 2016). Only if local platforms are closely linked with existing public and private extension mechanisms and networks can the technologies and other types of innovations scale out or up beyond the original scope, geographical focus or intended audience of the platform.

3. Multistakeholder processes and partnerships: Key lessons learned

Humidtropics adopted a multistakeholder approach that focused on bringing research, government, development and business partners together to i) identify and analyse key constraints, and ii) to prioritise, design and implement innovations to overcome these constraints. To facilitate this, Humidtropics facilitated the launch of multistakeholder platforms in China, Viet Nam and Thailand. These multistakeholder processes had different degrees of success. In Northwest Viet Nam, for example, stakeholders identified entry themes which were further jointly narrowed to entry points, which in turn formed the basis for a platform research project. This project focused on agricultural diversification through intercropping coffee–fruit trees–grass strips, and fruit trees–vegetables, in a predominantly maize monocropping system. The R4D activities proved effective in bringing together numerous research institutes working in the region to implement research and share the results (Hiwasaki et al 2017). Unfortunately, although four other multistakeholder platforms were launched in 2014, two did not continue beyond 2015 so did not lead to joint activities or outcomes. Below, we offer five reasons why this may have happened.

The first reason is the limited understanding by Humidtropics partners of how multistakeholder processes can be effectively implemented and facilitated. It was evident from how funding, support, and other resources were allocated by the core partners that establishing these platforms in and of itself became an important objective. Limited attention was given to questions of what functions platforms actually needed to perform in linking different stakeholder groups, working across scales, and whether this required new platforms to be established as opposed to building on existing partnerships in the region.[6] Thus, even though platforms were established, financial and human resources did not follow to enable their continued implementation and facilitation. This is unfortunate, as a training needs assessment preceding a capacity development workshop for multistakeholder process facilitators in November 2014 showed that approximately 70 percent of the Humidtropics partners in the Central Mekong Action Area had very limited experience facilitating multistakeholder processes.

Second, all platforms were supported through or facilitated by (inter)national research organisations, which may have contributed to deterring truly demand-driven agricultural R4D agenda setting and implementation. As Humidtropics functioned as an umbrella, it relied on bringing together different existing projects under the integrated systems approach, with limited resources to initiate new activities. Many existing projects had not necessarily been designed as systems research projects. Nor did their predetermined foci and activities always match the demands of specific stakeholders. Furthermore, institutional mandates and geographical focus as well as personal expertise and preferences sometimes created obstacles to responding adequately to demands of farmers and other stakeholders (see also Schut et al 2016).

[6] It should be noted that it was not only the Central Mekong Action Area that was facing such challenges, as similar patterns were observed in the Humidtropics Action Areas in Africa (Schut et al 2016).

Third, although the platform research projects were critical to energize the multistakeholder platforms and forge collaboration, they were not entirely effective in filling gaps where multistakeholder platform members did not have expertise, mandates or resources. Modest funds were provided by Humidtropics management as seed funding to fill agricultural R4D gaps and to respond to the difficulties of meeting stakeholder demands.

Fourth, sociopolitical contexts in the Central Mekong made it difficult to adapt the multistakeholder process and platform approach in the region. The multistakeholder platform approach was piloted by the Forum for Agricultural Research in Africa (FARA), under the Sub-Saharan Africa Challenge Programme (SSA-CP) (Adekunle and Fatunbi 2012) and the Dissemination of New Agricultural Technologies for Africa (DONATA) project. These pilot platforms may have influenced the design of Humidtropics platforms to be more suitable for the socio-economic and institutional contexts where they were first tested, and may help explain why the platforms took off more smoothly in the African Action Areas. These programs had already shown some tangible impacts and thus secured stakeholder buy-in, as well as identified gaps on which Humidtropics tried to build. This experience was largely absent in the Central Mekong Action Area.

Also, many of the resource materials such as facilitation guides were published in English and French, and case studies mainly originated from the African continent, which may have caused poor resonation and limited understanding for facilitators from the Mekong. To overcome such barriers, Innovation Platform Practice Briefs developed under Humidtropics were translated into Mandarin, Thai and Vietnamese and used in the capacity development workshops for platform facilitators (see Annex I for information on where to download them).

Fifth, and closely related to the above point, is that the Mekong sociopolitical context is very different to that in the African platform locations. In the Mekong region, the strong role of the State, especially in countries such as China and Viet Nam, means the role and mandate of civil society organisations are commonly less clear. There is typically less enthusiasm for grassroots action, and what is regarded as 'participatory'. In these environments, multistakeholder processes functioned in a top-down manner, driven by government and national research institutions, with little or no participation by civil society or the private sector. As such, it is difficult to address, let alone challenge, existing power dynamics and to enable multistakeholder processes to present different perspectives, debate issues, evaluate options and incite collective action (Hiwasaki et al 2017).

For multistakeholder platforms to be effective in generating innovative and sustainable solutions to complex agricultural challenges, resources need to be allocated to facilitate and implement these platforms outside of meetings, with attention given to what functions such platforms actually need to fulfil. It is challenging to realize demand-driven agricultural R4D agenda-setting and implementation when multistakeholder platforms are supported by agricultural research organizations whose agendas are already set. An important lesson here is the need for guidance on how to operationalize multistakeholder processes in a global research program across different sociocultural and political contexts. Overall, not enough attention was paid to adapting the multistakeholder process approach to specific

sociocultural and political contexts in the Mekong, nor was there enough discussion about whether multistakeholder platforms would be the best approach to implement R4D activities and achieve development outcomes in the Central Mekong Action Area (Hiwasaki et al 2017).

4. Reflections on challenges

In this chapter we have synthesized the achievements, gaps, and challenges from the Humidtropics research in Central Mekong Action Area. Here, we offer some reflections.

First, it was unfortunate that our activities were constrained by general trends within the agricultural R4D system. Agricultural R4D is increasingly funded to achieve development objectives, with increasingly short-term outcomes expected from donors. Implementing integrated agricultural research, which entails longer timelines, was greatly hampered by short project cycles of donor-funded bilateral projects.

Second, fostering innovation in the agricultural system is a complicated process that requires long-term commitments and partnerships. Unfortunately this was not to be realized under Humidtropics, due to the program's premature closure at the end of 2016.

Furthermore, there are challenges in implementing integrated systems agricultural R4D as part of a global research program. Although Humidtropics was a global research program, it initially lacked clear guidelines on research methods and tools, which resulted in different international research organizations using diverse tools and methods. This complicated cross-site comparison, analysis and learning. Moreover, a much smaller budget and lower priority was placed on the Central Mekong, and Central America and Caribbean Action Areas, compared with the two African Action Areas. The research program was originally designed with a larger budget (including bilateral projects), making it difficult for Action Areas without the critical mass to implement activities in a similar manner.

5. Conclusions and recommendations

Through this book we have demonstrated that significant research and development achievements resulted from our four years of integrated agricultural R4D activities in the Central Mekong Action Area, despite the constraints under which the activities were implemented and the challenges discussed above. The partnerships and collaborative relationships established through our work, particularly the collaborative work with local partners to identify and test innovations, will continue beyond Humidtropics, and may be scaled up in other CRPs in the second phase. We believe the lessons learned through the Humidtropics experience will contribute to strengthening the collective effort towards improving the livelihoods of poor farmers through sustainable agricultural development. Based on these achievements, gaps and challenges, we put forward recommendations for implementing future agricultural R4D in the Central Mekong region.

Photo 5.4 Farmer cross visit in Son La, Viet Nam. Photo credit: ICRAF/Pham Duc Thieng

We claim that agricultural R4D to **improve livelihoods** of smallholder farmers would have more impact if it goes beyond simply focusing on agricultural production and includes agricultural R4D activities that strengthen farmers' roles in the value chain. This might take the form of connecting smallholder farmers to markets, supporting the development of entrepreneurship and agribusiness, building social networks for agribusiness, or by improving farmers' capacities to improve product quality and processing. As discussed in Chapter 2, local traditional products, crops and livestock exhibit untapped potential for high-value markets beyond the region, due to their unique characteristics and the value placed by consumers on their origin. It was evident from agricultural R4D on safe vegetables in Northwest Viet Nam that producers have the potential to earn much higher incomes, as long as they are connected to the market. Taking a public-private partnership approach to develop market-driven branding and certification systems could significantly contribute to improving livelihoods, especially of smallholder farmers in upland areas.

Based on the agricultural R4D activities implemented in the Mekong region, we recommend that future R4D activities for **sustainable intensification** prioritize techniques that concurrently meet several criteria: i) the generation of short-term additional incomes; ii) limited initial investment needs; and, iii) long-term conservation of natural resources (e.g. water and soils). One example is the conversion of monoculture plantations to agroforestry

polycultures that both generate short-term incomes (e.g. cardamom or broom grass as understorey crops in teak plantations) and long-term incomes (timber and latex from the teak and rubber trees, respectively), and that also protect the soil against erosion: the understorey both reduces the erosive power of raindrops hitting the soil and improves runoff infiltration. Another example is integrated coffee and livestock farming systems, where farmers diversify their coffee production by planting forage grasses and legume species (which can help with intensification of animal production, reduce soil erosion and build soil fertility). The animal manure can be used to increase the productivity and quality of coffee.

To ensure agricultural R4D in the Central Mekong **empowers women, youth and other marginalized groups,** we recommend that inequity be addressed, not just in agricultural development but also in how agricultural R4D is conducted. Special attention should be devoted to increasing the capacity of women and ethnic minorities to adopt appropriate agricultural innovations, while understanding how policies and biophysical constraints positively or negatively affect their development. Increasing their limited and inequitable market access and rectifying disadvantaged roles in the value chain are also important. Agricultural R4D that fully and meaningfully engages marginalized groups and reflects their interests and needs can transform the social inequality of these groups and result in social and technical systems interventions that can contribute to all the IDOs.

As for promoting **institutional innovation**, while bottom-up participatory approaches are often perceived as the most promising for innovation and scaling of innovation, they may not be sufficient. In some situations, it is conceivable that people only have a partial view of the range of technical and institutional options that could contribute to improving their livelihoods. For this reason, as argued in Chapter 3, R4D should account for both local knowledge and state-of-the-art innovations (scientific knowledge). This combination may contribute to raising the innovation capacity of the targeted populations over the long term.

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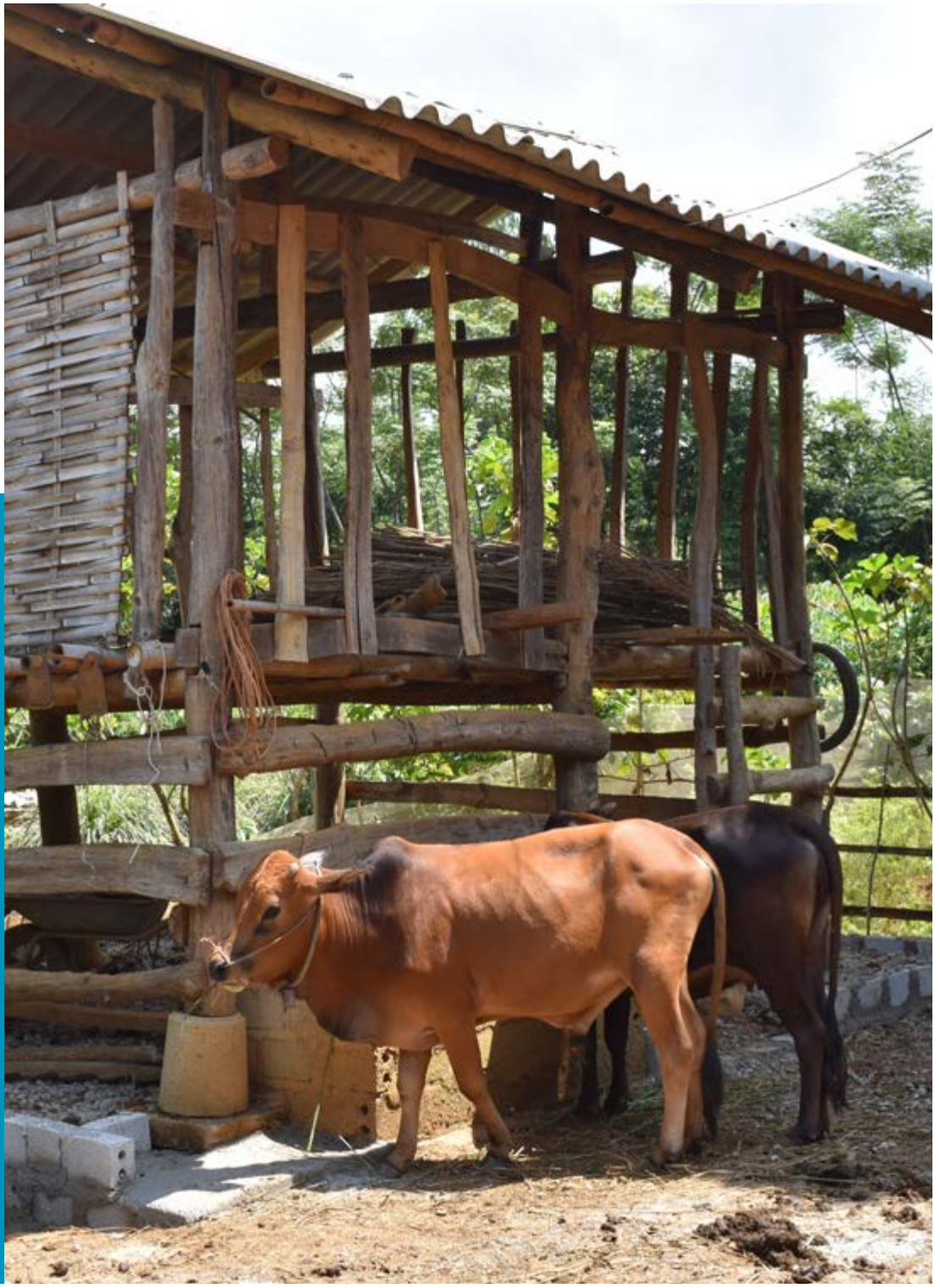

Cattle in a *Thai* ethnic minority house in Viet Nam. Photo credit: ICRAF/Lisa Hiwasaki

Annex I: List of Humidtropics Central Mekong Action Area outputs 2014-2016

I.1 Peer-reviewed journal articles and book chapters

Ha TTT, Schreinemachers P, Beed F, Wang JF, Loc NTT, Thuy LT, Van DT, Srinivasan R, Hanson P, Afari-Sefa V. 2017. Sustainable intensification of smallholder agriculture in Northwest Vietnam: Exploring the potential of integrating vegetables. In: I Öborn, B Vanlauwe, M Phillips, R Thomas, W Brooijmans, K Atta-Krah, eds. *Sustainable intensification in smallholder agriculture: An integrated systems research approach*. Oxon, UK: Earthscan from Routledge. https://www.routledge.com/Sustainable-Intensification-in-Smallholder-Agriculture-An-integrated-systems/Oborn-Vanlauwe-Phillips-Thomas-Brooijmans-Atta-Krah/p/book/9781138668089

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I.2.2. Briefs

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Hiwasaki L, Culas C, Minh TT, Senaratna Sellamuttu S, Douthwaite B, Elias M, Kawarazuka N, McDougall C, Pannier E. 2016. *Guidelines to engage with marginalized ethnic minorities in agricultural research for development in the Greater Mekong.* Hanoi: ICRAF Vietnam. Open access: http://humidtropics.iita.org/share/s/A8ScIS-CSJqgGDH50AU-TA

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I.5. Translations of publications into Central Mekong languages

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Mother and son in Son La, Viet Nam. Photo credit: ICRAF/Lisa Hiwasaki

Annex II: Guidelines to engage with marginalized ethnic minorities in agricultural research for development in the Greater Mekong

1. Introduction and background: What is this document and why is it needed

The Greater Mekong region (Cambodia, Laos, southern China, Myanmar, Thailand, and Viet Nam) is characterized by considerable ethnic diversity [1]. Many ethnic minority groups live in remote rural uplands and mountains where the soil is less fertile and the terrain uneven and steeply. Ethnic minorities' social and cultural norms, farming practices, and traditional bodies of agricultural knowledge differ from the lowland ethnic majority peoples who form the political core of Mekong countries [2, 3]. State and private sector programs and policies to promote rural development in the agricultural sector focus on intensifying agricultural production using hybrids and chemical fertilizers and pesticides, which replace traditional farming techniques. Monoculture plantations of cash crops grown for regional and global value chains such as rubber, coffee, maize, and cassava replace subsistence oriented, diversified agricultural production. Furthermore, swidden cultivation—often practised by upland ethnic minorities—has generally been considered archaic and environmentally destructive by those with political power [4, 5]; therefore, development policies widely promoted cultural integration, economic standardization, and agricultural modernization [6, 7].

Aim and Target Audience of these Guidelines:

- The ***target audience*** of the Guidelines is researchers working on agricultural research for development (R4D) in the Mekong region, most particularly those working in (or interested in working in) transdisciplinary research teams for agricultural R4D in the Mekong region. This includes national & international researchers, **and** social & bio-physical scientists. Local practitioners and development workers who implement research-oriented development projects may also find the Guidelines useful.
- The ***aim*** is to promote, to researchers working on agricultural R4D in the Mekong region, meaningful engagement of groups who are typically marginalized in agricultural R4D, i.e., ethnic minority groups, the poor, and disadvantaged women. Considering the significance of this issue in the Mekong region, the focus is on ethnic minorities. We propose principles, methods and tools that can move agricultural R4D towards transdisciplinary action research that increases the engagement of marginalized groups. Most of these principles, methods and tools are relevant for agricultural R4D in general, but using these is particularly important to help prevent further marginalization of certain groups.

The intense social, economic, and political changes the Greater Mekong region is currently undergoing—such as rapidly expanding infrastructure and markets, government policies and programs that promote rural and agricultural development—present many opportunities for improved livelihoods [5, 12, 13]. At the same time, some of these changes pose threats to sustainable livelihoods of upland smallholder farmers [3, 4]. As a result of such developments and in addition to infrastructure and market links, there have been significant changes in the cultures and livelihood strategies of ethnic minorities. These have too often led to loss of decision-making power, resulting in increased marginalization [14]. These changes make ethnic minority farmers more vulnerable to external risks such as changes in market prices, climate change, extreme climatic events, and environmental degradation, and food insecurity [15].

Agricultural research or rural development projects in this region further marginalizes ethnic minorities because they focus on promoting or enforcing lowland techniques and innovations for agricultural modernization and commercialization. Most agricultural research for development (R4D) projects work only with majority ethnic groups or ethnic minority groups who are accessible in terms of location and language, and are thus better-off than others.[1] This further reinforces the marginalization of certain ethnic groups, especially those who live in remote areas. Even when ethnic minorities are brought into agricultural R4D projects, innovations are often introduced in a top-down manner, and worse, often do not meet their needs.

This creates a vicious cycle whereby marginalized ethnic groups continue to be marginalized, and prejudices against them are reinforced [8]. This is an issue because ethnic minority groups in the region tend to constitute the poorest of the poor, with less material wealth, lower school attendance rates, and fewer job opportunities and market access [9, 10, 11].

> This document is designed to help researchers who want to engage with ethnic groups to ensure agricultural R4D stops contributing to their further marginalization. It can be used by those wanting to design new projects that engage with ethnic minorities from the start or those already implementing projects and wanting to improve their current practice.

The overall approach that these Guidelines recommend is transdisciplinary action research. A transdisciplinary action research project that meaningfully engages marginalized ethnic groups must deal with not only technological and institutional challenges and innovations, but must also take into account the various systems embedded in the specific contexts where R4D takes place:

- ***Socio-cultural, economic and political systems*** (culture, traditions, norms, financial tools, economic, consumption patterns, politics, policies, and development history),
- ***Agro-ecological systems*** (water, soils, crop/animal varieties, fertilizers, agricultural techniques, land use systems, farm management knowledge & practices, livelihoods, and markets), and the

[1] For example, out of more than 30 R4D activities implemented in Central Mekong Action Area of Humidtropics CGIAR Research Program in 2015, only two directly contributed to Humidtropics' Intermediate Development Objective (IDO) related to "women and other marginalized groups"; moreover, only one activity specifically mentions "ethnic minority".

- ***Agricultural R4D system*** (operationalization of agricultural R4D, constraints inherent in conventional approaches and methods).

Transdisciplinary research is uniquely suited to analyze where these various systems interact and overlap and can enable a more holistic approach to agricultural R4D in marginalized communities [16, 17]. See Annex I for a more extensive list of transdisciplinary research resources.

What do we mean by transdisciplinary research?

Multidisciplinary research involves several disciplines but there is no interaction between them.

Interdisciplinary research involves several disciplines, with interaction between them. "Unidirectional interdisciplinarity" refers to research where coordination of the disciplines is imposed by a single discipline, whereas "goal-oriented interdisciplinarity" refers to research where interactions and coordination of disciplines are determined by the nature of the problem to be solved.

Transdisciplinary research involves researchers from a range of scientific and technological disciplines, but also other stakeholders, such as local people and government entities [18].

In transdisciplinary action research, the disciplinary "silos" are torn down, as are the barriers between researchers and research subjects. Researchers from multiple scientific disciplines—social, economic, political, and bio-physical scientists, for example—work together with communities who hold local and indigenous knowledge. Scientific knowledge and local and indigenous knowledge are given equal value in order to understand and address the livelihood contexts of marginalized groups in an integrated manner. Such research engages with ethnic minorities in a way that gives them choices about if, when, and how they participate in, shape, and benefit from research. This is based on the understanding that local people may have different trajectories of development, and through their local knowledge and agency, new or alternative pathways could be developed.

Implementing transdisciplinary action research calls for a learning paradigm and "new professionalism" that brings together different sciences and worldviews, which enables the understanding of the diverse and complex local realities in a participatory manner. This often requires a change in worldview of those implementing agricultural R4D. Transdisciplinary action research uses participatory action research as a core methodology to engage, reflect and learn with farmers, and act as catalysts for innovations and facilitators of farmer-to-farmer learning [19].

This document identifies different challenges that maybe faced at different stages in the project cycle. Not all projects will necessarily face all challenges, and not all challenges come at the same time. While there may appear to be many things to get right when reading the guide from cover to cover, doing good transdisciplinary action research is not as complex as it might first appear.

The guide is built on the collective experience of 22 researchers and practitioners with experience engaging with ethnic minorities or other marginalized groups in Southeast Asia. This experience, captured during three workshops, was complemented by literature reviews in China and Viet Nam , and in-depth field work four villages (in Northwest Viet Nam and Northern Lao PDR).

The Guidelines are built on an analysis of the factors that lead to marginalization that agricultural research can affect. These factors bring about three sets of challenges: the agricultural R4D system as a whole; for research teams; and for agricultural R4D projects. The Guidelines are organized around these three sets of challenges, identifying for each challenge strategies that can help prevent further marginalization according to different stages in the project cycle (Figure 2).

2. Challenges to operationalizing Transdisciplinary Action Research and strategies to prevent further marginalization of ethnic minority groups

The marginalization of ethnic minorities in and through agricultural R4D is influenced by two groups of factors (Figure 1): (i) ***internal factors***, which reflect livelihood assets and access to them; and (ii) ***external factors***, which reflect constraints of agricultural R4D projects that are usually conceived and designed externally. These factors interact with each other and can result in marginalization at different scales, in different contexts, and over different time frames. Consequently, benefits of agricultural research and interventions do not reach marginalized ethnic groups, and may negatively impact their cultures and livelihoods.

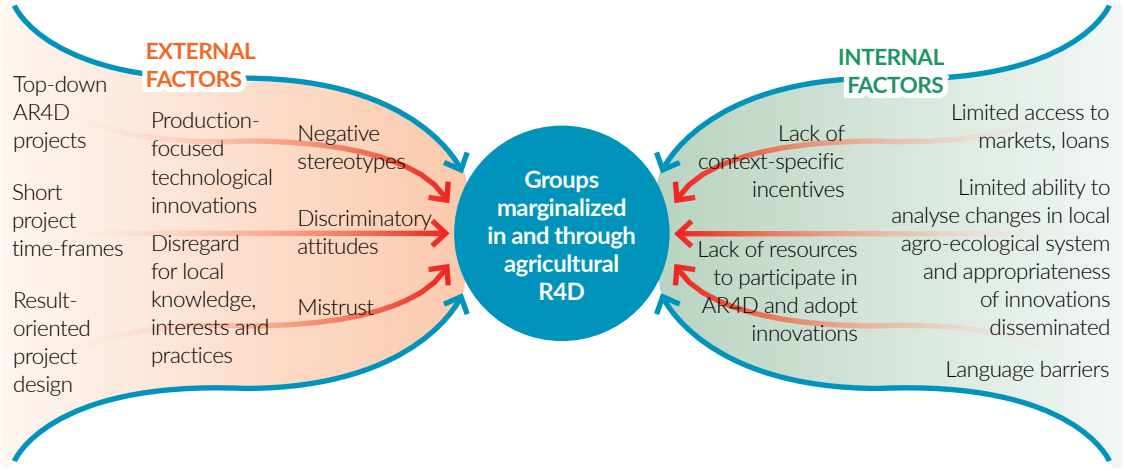

Figure 1. Factors contributing to marginalization of ethnic minorities in and through agricultural R4D

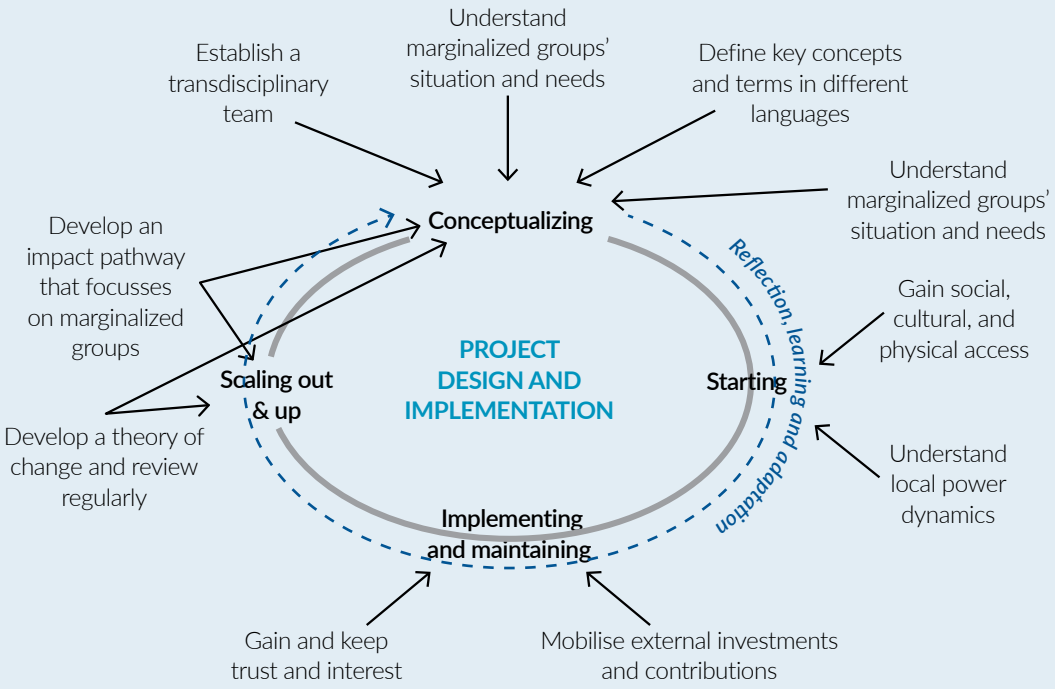

Figure 2. Transdisciplinary action R4D that engages with marginalized groups

Table 1 below outlines the strategies that can help agricultural R4D researchers to carry out transdisciplinary action research that engages more effectively with marginalized ethnic minority groups in order to achieve more inclusive and equitable rural development from agriculture. The table serves as an index to the Guidelines, and also includes examples of actions and that can be used to address each challenge. These examples give an indication of resource implications entailed in order to facilitate participation and engagement of marginalized groups, which is further discussed in section 3. below.

Table 1 Index to the Guidelines: Challenges and strategies

Type of challenge	Challenge (Challenge number)	What to do about the challenge	Activities and methods
System challenges	Improved understanding of research context **a.1**	Establish an effective transdisciplinary team	See challenges c.1 to c.5 and b.1 below for the range of activities and tools to implement these strategies
	Meeting needs and interests of diverse stakeholders **a.2**	Obtain holistic and broader perspectives of the various stakeholders	
	Insufficient time to meaningfully engage marginalized groups **a.3**	From the project conceptualization: • Engage marginalized groups • Use existing knowledge on ethnic groups • Incorporate "scaling out & up"	
		Build trust	
Team challenges	Establishing and sustaining an effective research team **b.1**	Establish an effective transdisciplinary team	Stakeholder workshops
	Fostering positive interactions within research team **b.2**	Tear down the "silos" that result in different scientific disciplines and knowledge systems	Training on participatory and qualitative research tools Joint fieldtrips and other activities
	Combatting negative stereotypes and discriminatory attitudes **b.3**	Break down negative stereotypes about ethnic minorities and combat prejudice	Joint fieldtrips and other activities
Project challenges	At project conceptualization		
	Integrating ethnic minorities in project conceptualisation **c.1**	Identify the ethnic minorities that are present at a given site, characterize the field sites, and ensure that such information is incorporated into project design	Reconnaissance field visit with gender-sensitive rapid assessment
		Define key concepts and terms in different languages, particularly those used by the ethnic minorities	Create a multilingual glossary of key project terms and concepts
		Design demand-driven and socially inclusive research	Participatory planning and vision-setting

Type of challenge	Challenge (Challenge number)	What to do about the challenge	Activities and methods
	Project start		
	Reaching ethnic minorities **c.2**	Gain social, cultural, and physical access	Project kick-off meeting
	Project implementation		
	Engaging ethnic minorities without negatively impacting local systems **c.3**	Understand local systems and power dynamics	Stakeholder mapping and analysis
	Sustaining ethnic minorities' interest and engagement **c.4**	Gain and keep trust	Workshops and training with ethnic minority groups and regular visits Multi-stakeholder processes
	Maintaining project activities under budget constraints **c.5**	Mobilize investment and contributions	- Workshop to define project finance priorities and identify resources.
	Scaling out and up		
	Ensuring widespread development impacts **c.6**	Develop an impact pathway that focusses on marginalized groups	Workshop to identify development challenge and capacities to build
	Linking development outcomes for ethnic minorities **c.7**	Develop a theory of change and regularly review	Outcome sourcing

a. **Systemic Challenges:** Ensuring that ethnic minorities benefit from agricultural R4D requires a deep understanding of both the research context itself and the needs of diverse stakeholders. Achieving such an understanding requires significant amounts of time, money, and human resources. These resources can be difficult to secure under current financial constraints, which often require researchers to "cut corners." Thus, we recognize that it will be difficult to implement transdisciplinary action agricultural R4D that truly engages with and results in benefits for marginalized ethnic groups unless the agricultural R4D system as a whole changes, or your institution or funding source(s) support the investments and long-term commitment required for such research to bear fruit.

*** Challenge a.1:** How can we improve our understanding of the socio-cultural, economic, and political dimensions of the research context?

Implementing agricultural R4D that does not further marginalize ethnic minorities requires the use of social scientific approaches, methods and tools to analyse the socio-cultural, economic, and political dimensions of the research context. However, this is often not sufficiently recognized by agricultural R4D researchers, who tend to focus on agro-ecological dimensions.

What to do a.1: establish a transdisciplinary team, led by a scientist from a relevant discipline with an interdisciplinary background and clear understanding of transdisciplinary approaches.
→ See Challenge b.1 for more on establishing a transdisciplinary team.

*** Challenge a.2:** How can we address the different needs and interests of diverse stakeholders?

The political, socio-cultural, and economic realities in the Mekong context are complex: there is a diverse range of stakeholders with diverse (and sometimes conflicting) needs and interests.

What to do a.2:

- Obtain broader, holistic perspectives of the local reality of the various stakeholders in your field sites, i.e., differences in needs and power relations within the community at multiple scales.

  → See Challenge c.3 on who the different stakeholders are, how to understand the stakeholders and their local power dynamics.

- Recognize that not all stakeholders' needs can be met with one agricultural R4D project. You can be explicit about which stakeholders' needs the project is targeting, while ensuring that the most disadvantaged groups are not marginalized. One way this can be addressed is by establishing multi-stakeholder platforms whereby the various stakeholders get together to jointly identify problems, discuss and prioritize challenges, develop and test possible solutions, and build their respective capacities. An acute sensitivity to power structures and dynamics among the stakeholders is necessary to ensure that the process of prioritization does not contribute to further marginalization of disadvantaged groups; e.g., a civil society representative or a scientist can provide support for ethnic minority farmers who may not be able to speak out in multi-stakeholder platforms.

  → See Challenge c.4 below for information on multi-stakeholder processes.

*** Challenge a.3:** How can we address the fact that the typical R4D project cycle does not allow us have sufficient time and resources to engage with marginalized ethnic groups in a meaningful way?

Donors often have requirements about the project cycle and output delivery within a set amount of funding and a constrained timeline. This can make it difficult to meaningfully engage local farmers, especially marginalized ethnic minorities with different worldviews and socio-cultural, economic, and political realities from the ethnic majority group. Local partners—often from the ethnic majority—can also steer the project away from working in sites where ethnic minorities live, or away from working with marginalized ethnic groups who live in the research site. Furthermore, the project timeline is not necessarily aligned with the "timeline" of villagers.

What to do a.3:

- Invest time and money to engage marginalized groups, especially ethnic minority women, from the project conceptualization stage.
- In addition to agro-ecological knowledge, use existing knowledge (e.g., local & indigenous knowledge from literature review or projects undertaken in the site in the past) on ethnic groups in project conceptualization.
  → see Challenge c.1 on how marginalized groups can be engaged and integrated in the conceptualization of a project, and how existing knowledge can be used for project conceptualization.
- Incorporate "scaling out & up" stage in the project conceptualization and implementation;
  → see Challenge c.6 and c.7 for how scaling out and up can be done.
- Recognize that a key component when working with marginalized groups is building trust, which takes time. Consider your research project as part of a long-term commitment that goes through a long process of engagement with marginalized groups.
  → see Challenges c.2 and c.4 for building and maintaining trust.
- Engage with donors and research institutions so that the evaluation and assessment of research are not just on numbers of people impacted. Rather, to value qualitative impacts, particularly evidence that R4D activities are strengthening the capacity of ethnic minorities to drive their own development trajectories. Without this, research on marginalized ethnic groups will not be prioritized or funded.

b. **Team Challenges:** By definition, transdisciplinary research entails working with a diverse team of researchers and local collaborators: in order to conduct productive transdisciplinary research, such a team must be strengthened (rather than weakened) by its diversity. Fostering a dynamic that allows for this presents several considerable challenges.

*** Challenge b.1:** How can we establish and sustain a project team that will enable us to engage effectively with ethnic minorities and meet their research needs?

What to do b.1: Establish a transdisciplinary team which consists of scientists representing all disciplines necessary to solve the agro-ecological research problem and development problem. Avoid expanding the team unnecessarily, as this can render the research expensive and cumbersome to manage.

How b.1:

- At the beginning of a project, organize stakeholder workshops to identify potential collaborators.
  → see Challenge c.2 below for more information on how such workshops can be organized to identify potential co-learners and project participants, and Challenge c.3

for how to implement stakeholder mapping and analysis to identify potential research team members.

- Include in the team:
  - a team leader: a scientist from a relevant discipline with an interdisciplinary or development background with a clear understanding of transdisciplinary approaches, and the ability to communicate with all team members;
  - researchers who have experience with, or who are already working with, ethnic minorities, including:
    - social scientists with participatory and qualitative research expertise, and with experience working with the particular marginalized groups to be engaged. Social scientists can also work with local or traditional knowledge holders and ensure such knowledge and practices are incorporated in the agricultural R4D;
    - bio-physical scientists from disciplines that can help solve the agro-ecological challenges of the site, with the ability to listen to the real needs of ethnic minorities, instead of imposing on these groups what researchers think is the best "solution";
  - development workers or organizations with experience working in the region, who can engage with the marginalized ethnic groups, and play key roles in scaling out and up agricultural R4D results;
  - local farmers from the field site(s), especially ethnic minorities who are holders of local and indigenous knowledge, or others who can gain social and cultural, as well as physical, access to such knowledge;
  - policy-makers and government partners, who are important for scaling out and up. As much as possible, look for people from the relevant ethnic minority group(s).
- Carefully select potential team members before finalizing the team by taking the time to check their references; facilitate quality interactions, e.g., by doing activities such as field trips. It is important to keep in mind that "soft skills" such as interpersonal skills are extremely important for project success.
- Ensure that women are adequately represented in the research team, especially to enable interviews, focus group discussions and other interactions with women to be implemented by women.
- As much as possible, look for qualified researchers with the same ethnic background as those in the field site you intend to study. If you have difficulties finding such researchers, considering training ethnic minority researchers.
- Within the timeframe available, allow adequate time for discussions and reflections on transdisciplinary action research approaches among all team members, and provide training as necessary on participatory and qualitative research tools and methods.

* **Challenge b.2:** How can we foster positive interactions among transdisciplinary team members?

What to do b.2: tear down the "silos" that result in different scientific disciplines and knowledge systems that typically work separately and do not interact with each other by fostering regular and meaningful interactions among team members. Make sure all members of the team speak a "common language", especially when it comes to working with marginalized ethnic groups.

How b.2:

- Conduct field visits together and reflect while in the field on key issues, which can bring the different perspectives together.
- Organize events for sharing knowledge, experiences, progress, and challenges working with ethnic minorities.
- Develop and implement joint-action activities for addressing common challenges that create safe spaces that hold participants together for long enough to understand and appreciate each other's perspective, which is necessary for reaching a durable solution.

* **Challenge b.3:** How can we address the negative stereotypes and discriminatory attitudes, including paternalistic attitudes, that may be held by some project team members?

What to do b.3: Break down negative stereotypes about ethnic minorities that might make some team members reluctant to engage with them, and combat prejudice by influencing the mindset of researchers through discussions and the dissemination of correct information.

How b.3:

- Organize a learning session for all team members to obtain an understanding of how the political and economic system has historically marginalized some ethnic groups.
- Showcase some "good examples", e.g., success stories of how some ethnic groups have successfully engaged with agricultural R4D projects, and demonstrate how ethnicity or gender can be an asset, not an obstacle, to effective implementation of project.
- Organize field activities to learn about local or traditional knowledge and practices—agro-ecological or otherwise—and assist the research team in learning directly from ethnic minorities.
- Create opportunities to increase "positive" interactions between non-marginalized groups and marginalized ethnic groups, e.g., by engaging graduate students from marginalized groups in the region or working with particularly innovative role models.

- Carefully deconstruct who typically participates in the research and who does not, paying particular attention to the reasons why certain groups may have been excluded from, or want to participate in, the research process in the past. This should serve to explain that if project benefits are kept in the hands of leaders and local elites, projects could reinforce the marginalization of certain groups.
- Facilitate creation of safe spaces, as mentioned in Challenge b.2 above.

c. **Project Challenges:** Different actions and methods are categorized according to different phases of a research project: (i) project conceptualization, (ii) project start, (iii) project implementation and maintenance, and (iv) scaling out and up. In this section, the approaches, actions, and methodologies that can be adopted are categorized according to challenges or constraints that commonly occur at each stage.

i. Project Conceptualization Stage

*** Challenge c.1:** How do we integrate marginalized ethnic groups in the conceptualization of a project?

What to do c.1-1: Identify the ethnic minorities that are present at a given site, characterize the field sites, and ensure that such information is incorporated into project design.

If the planned research will take place in upland areas, it's very likely that the farmers will be predominantly from one or more ethnic minorities. To ensure ethnic minorities and their needs are not ignored or subsumed in the proposed research, key social, demographic, historical, cultural and economic information—as well as information about previous projects implemented in the area—should be obtained before field site selection takes place and the research focus is set. However, even after the site has been selected and the research focus has been set, collecting such information is still relevant.

In addition, characterization of the field site(s) is important to provide the overall context, including key agricultural, ecological, political, and geographic information. Information gathered can be incorporated into the project design and help conceptualize the overall project with a more in-depth understanding of the key issues.

How c.1-1:

Collect secondary data on key social, geographic, demographic, historical, cultural, political, and economic information; combine these data with information about previous projects implemented in the area. Ideally, this should be complemented by a reconnaissance field visit to conduct a rapid yet gender-sensitive assessment which

includes transect walks, key informant interviews and focus group discussions (FGDs) with key local stakeholders, including women. Stakeholder categories to engage with at the site include farmers (including both female and male ethnic minority farmers), local NGOs, local government agencies, in addition to other formal and informal groups, e.g., village youth groups, women's unions, farmers' groups, and traditional village committees.

Key information is listed below that will help identify more disadvantaged ethnic minority groups that should be targeted by the research and/or intervention—or at least not excluded from it—and help understand their specific contexts. Ensure that the below information is obtained from both men and women:

- ***Demographic and socio-economic information***: Information should be collected on different ethnic groups living in the area, each ethnic group's characterization (income levels, land use patterns, livelihood strategies, ownership/access to land, and natural resources, and the historical background as to why and how long they have lived in that area. Be mindful of how these characterizations differ according to gender and income levels). Pay attention to the considerable diversity that usually exist**s** between and within ethnic minority groups and also how those groups may differ along gender lines: demographic and socio-economic information should be disaggregated per ethnic group and by gender.
- ***Relationships among different ethnic groups***: Compile an overview of the historical relationship between the State, which is usually composed of one or more majority ethnic groups, and minority ethnic groups, as well as the relationship between and within different ethnic minority groups. This includes institutional settings that could have led to or reinforced marginalization of some ethnic groups over others: e.g., through laws and policies concerning land tenure, rural development, market incentives, gender, and the environment—including delineation of protected areas. Note also that some ethnic groups may intentionally marginalize themselves in the national system.
- ***Local/traditional agro-ecological knowledge of marginalized ethnic groups***: This information should include farming practices, conservation practices, customary laws on use and protection of land and natural resources. Be mindful of possible conflicts between: agricultural innovations and local/ traditional agro-ecological knowledge; and official laws and policies and customary laws.
- ***Livelihood strategies of ethnic minority farmers, in particular, traditional livelihoods and the cultural and social norms, worldviews, beliefs, and values that underpin those livelihoods***: Are they in line with or do they clash with new State-endorsed trends in agriculture, e.g., introduction of monocultures, introduction of new cash crops, hybrids, and chemical fertilizers, etc.?
- ***Past or current development or agricultural R4D projects, or other innovations introduced to the site, and whether or not they involved all ethnic groups:*** It is important to gain an understanding of these initiatives, their outcomes, and lessons learned, as part of setting the background to the agricultural R4D project.

Case study: Gender and Ethnic Dynamics of Household Decision Making in Hydro-power related Resettlement in Bolikhamxay Province, Lao PDR by Sonali Senaratna Sellamuttu

This study explored the underlying gender values, norms, and practices that influence the decision making patterns of households in the wake of resettlement. The study took place in an ethnic minority resettlement village in Bolikhamxay Province, Lao PDR, and focused particularly on decisions related to livelihood strategies. The village's main ethnic groups are the *Tai Maen* (55%) and *Tai Yor* (37%), with small numbers of *Tai Meuy* and mixed ethnic households. The qualitative methods used in the study included separate male and female focus group discussions (FGDs) and individual open-ended interviews with men and women from different ethnic minority groups that centered on livelihood trajectories and social network mapping.

We found the design of resettlement, compensation, and livelihood packages provided by hydropower companies tend to target a household as a unitary entity: in general, these measures tend to overlook which decisions are made jointly and which are gendered. Ethnicity also influences household decision-making in general, and the extent of male and female influence in particular. Different ethnic groups may show a preference for different livelihood activities, and vary in the degree to which household decisions are made jointly.

Hydropower companies typically focus on the material aspects of wellbeing within their livelihood packages—for example, by ensuring joint asset ownership and material equity in capabilities (such as education and health). However, in the context of hydropower resettlement—which often requires resettled groups to change their livelihood or replace it with a new one—it is necessary to disaggregate the costs and benefits in terms of gender and ethnicity. These costs and benefits need to be assessed in relational and subjective terms in addition to the material terms more typically addressed by hydropower companies. For example, our findings revealed that women's control over decisions on riverbank gardening and gathering of non-timber forest products had decreased: resettlement led to newly enforced land use patterns, with resultant material costs for both women and men. At the same time, women's weaving has increased, with material benefits for both women and men and relational and subjective benefits for women. Overall, the study helped provide insights into why some household members may accept (while others reject) livelihood options offered by hydropower development.

For more information:

Weeratunge N, Joffre O, Senaratna Sellamuttu S, Bouahom B, Keophoxay. 2016. Gender and household decision-making in a Lao Village: implications for livelihoods in hydropower development. *Gender, Place & Culture* 23(11): 1599-1614. doi: 10.1080/0966369X.2016.1219319.

What to do c.1-2: Define key concepts and terms in the different languages in the research, particularly those used by the ethnic minorities, but also by all team members.

Working with ethnic minorities in the Greater Mekong region entails working with at least three languages: the language used by the ethnic minority(s), the language of local/national partners (who are usually from the ethnic majority group), and the language of the international researchers (English is usually chosen as the common language, but for many researchers English will not be their first language).

How c.1-2: Spend time among key research team members to ensure that the key terms and concepts are agreed upon and are meaningful in all languages involved in the R4D project. This is particularly important when some concepts or terms are based in one (usually foreign) language but are difficult to translate into other languages. If no direct translations exist, then make sure that all research team members are using the same definitions of key concepts and terms when talking about the project, not just among themselves but also in conversations with outside the team members. Making a glossary of key terms and concepts in different languages with the involvement of qualified translators, and referring to this glossary often (especially when hiring interpreters), would be useful.

What to do c.1-3: Design research that is focused on marginalized groups and driven by demands of marginalized groups. When possible, have ethnic minority groups represented directly in project conceptualization and increase their capacities to be meaningfully involved in the conceptualization of the project and in R4D activities as part of the transdisciplinary team.

> Once secondary and primary information is collected to get a better understanding of who the marginalized ethnic groups are, it is necessary to engage them in the design of the proposed research project through a consultative process. This entails listening to what local farmers want, what they don't want, and why; it also entails listening to what they need and prioritize, instead of imposing research ideas and interventions on them. Through such an inclusive participatory planning process, you—as outsiders— can understand the visions and plans of villagers; in turn, the villagers will be empowered to participate meaningfully in research and interventions as part of the transdisciplinary team. Demand-driven research that focuses on the needs of marginalized ethnic minorities is the only way to ensure that the most marginalized people in the targeted community benefits from the agricultural R4D innovations. One of the primary reasons why many agricultural innovations are not adopted, or only adopted by better-off ethnic group(s), is because projects do not meet the needs of marginalized groups. At the same time, expectations—both the participants' and research team members'—of how the marginalized ethnic groups may benefit from the project should be kept realistic from the onset.

How c.1-3: Organize a local-level project design workshop that includes the identified marginalized ethnic groups and other local stakeholders. Areas of mutual interest to both the marginalized ethnic groups and the project team need to be clearly mapped out, as well as areas beyond the scope of the project and that therefore cannot be tackled by the project. When selecting the workshop participants, be particularly mindful of internal marginalization e.g., the head of an ethnic minority village is less marginalized than poorer villagers, and their wives are likely to be even more marginalized. A village head cannot represent or speak for those more marginalized, and a man cannot speak for women, even if they are from the same ethnic group. Keep in mind that **the more marginalized someone is, the less likely s/he would be the ones proposed as participants of meetings by village heads and local agricultural extension workers.**

Inclusive participatory planning and vision-setting at the village scale will enable joint identification of needs and priorities specific to marginalized ethnic groups; in addition, it is crucial for short, medium and long term objectives of the agricultural R4D to be made jointly with all farmers. During such workshops, do not assume that ethnic minorities have high cohesion, avoid viewing a single ethnic minority group as a homogeneous / monolithic entity, and be sensitive to the power relations among and within the different ethnic groups. Through the use of facilitators and interpreters, create an environment that makes it possible for less powerful and marginalized groups to speak out.

ii. Project Start Stage

* **Challenge** c.2: How do we reach ethnic minority groups when implementing a project?

***What to do** c.2:* *Acknowledge that there are two types of access—physical access, and cultural and social access—and take steps to obtain both through the right project team and participants.*

Concerning *physical access*, it is necessary to get official permits, which can be difficult to obtain in some countries in this region whose governments are often politically sensitive, especially when working with ethnic minorities in border areas. It is necessary to identify appropriate local "gate keepers" who can act as an intermediary between the project, the State, and ethnic minorities, and permits need to be requested through them.

Concerning *cultural and social access*, the project team needs to include researchers with knowledge, experience and good contacts with ethnic minorities. Having researchers who are members of ethnic minority groups and/or some researchers who speak ethnic minority languages will help build trust between the project team and ethnic minorities. Having a glossary of key terms and concepts (see Challenge c.1-2) would also be helpful. Social scientists familiar with qualitative research methods can help with the collection of social and cultural information necessary to work with minority groups. Challenge c.1 includes some information on the kind of information which would be useful.

Identify the relevant project participants and stakeholders—the targeted population of the project—and understand the various social relations and power dynamics at work. These will be between different stakeholder groups; between different ethnic groups within a village or a commune or a district; within ethnic groups, including gender groups and the poor; and with outside actors. It is important to understand that there is usually considerable diversity within marginalized groups. Avoid "token representation" of ethnic minorities in the research project, and make sure that the people targeted by the project are fully participating throughout the process.

Text box: 'Red stamps and gold stars': Implementing fieldwork in socialist Southeast Asia

In addition to the practicalities of obtaining the authorization to enter the field, in a compilation of work by social scientists who have done fieldwork in China, Laos and Viet Nam , Turner (2013) raises several key issues in the preparation stage for field research: (1) positionality of the researcher and critical reflexivity, which affects the relationship between researchers and informants; (2) power relationships, in particular the roles of "gate keepers" (who enable researchers to access resources, knowledge and field research sites) and "minders" (people designated to accompany foreign researchers) in the research process; and (3) ethical dilemmas, especially when data and documents published could be considered offensive and thus have negative consequences on the lives and livelihoods of local informants or research assistants.

For more information:

Turner S, ed. 2013. *Red Stamps and Gold Stars: Fieldwork Dilemmas in Upland Socialist Asia*. Vancouver and Toronto: UBC Press.

How c.2: Design and plan research in the following ways:

- ***Leave room for adaptability and flexibility about project activities in the project plan.*** This will allow research to be adaptive and change direction depending on the needs of ethnic minority farmers, research progress, etc.
- ***Schedule some open and unstructured time in the project plan.*** "Transect walks" (a purposeful walk through a village with locals for the purpose of seeing the village through the eyes of a local), "participant observation" (accompanying locals on specific parts of their daily routine to develop a firsthand understanding of how local livelihoods fit into daily activities), and "informal conversational interviews" are methods that can be used to get acquainted with local people and environments, and are necessary to secure such time in the project plan and be included when submitting requests for research permits.
- ***Secure time and process to obtain the right authorizations and logistical support to work in certain areas, and with ethnic minorities.*** This necessarily entails collaborating productively with both ethnic minorities and government entities. Plan ahead, as the process can take a long time (minimum a few weeks), especially if the research involves foreign researchers and is in sensitive areas such as national borders or recently-relocated villages.
- ***Engage local organizations and/or social scientists who already have a relationship with the ethnic groups in your research site.*** They can be identified through stakeholder analysis, described below in Challenge c.3. They can connect you and your team members with ethnic minorities and facilitate their participation, in ways that respect cultural and religious norms and practices. They can also advise you on ways to interact with ethnic minorities in appropriate ways.

- ***Organize a stakeholder workshop to identify project participants.*** Participants in such a meeting must be carefully chosen, and the project team needs to ensure that marginalized ethnic groups are included in this meeting by local authorities who are in charge of inviting participants. At the kick-off meeting, present the project objectives and activities, and choose farmers to be involved in the project according to some criteria. The usual way of choosing participants—to ask local government or village heads to designate "volunteers"—often results in further marginalization of some ethnic groups, women, and the poor. Discuss with the village heads and/or local authorities to see how the project can reach out to the poorest and the most marginalized members of the community. If possible, seek volunteer project participants directly from the villagers. Above all, ensure that the selection process does not create tensions, or create new local inequalities;
- ***Throughout the project, make sure that local collaborators don't get into uncomfortable or conflictual situations by being involved with the project.*** The project team must be conscious of all kinds of problems or disorders that can be created by the project, as it injects sought-after resources into resource-poor areas, both directly and indirectly. See also Challenge c.3 below.

Case study: Engaging resettled ethnic minority groups in piloting new livelihood opportunities in Kon Tum Province, Viet Nam by Sonali Senaratna Sellamuttu

In the development of hydropower schemes, displaced local people may be financially compensated for their losses. Despite that compensation, adapting to a new place and finding viable livelihood activities can present significant challenges. This project focused on optimizing reservoir management for local livelihoods by explored cultivation of a short-duration cassava variety. The project took place in the drawdown area of the Yali reservoir in Kon Tum province, Viet Nam , which is populated by both the Kinh (Viet Nam 's majority ethnic group) and the Jarai, an ethnic minority group.

During the selection of farmers for this particular project, it was apparent that prevailing local circumstances had an effect on the household selection process: local beliefs and norms and the limited availability of seedlings of the new cassava variety both had an impact. Local leaders tended to choose farmers who appeared 'open to innovation and to taking risks,' and could afford to invest in the necessary inputs. This resulted in a situation where the initial project beneficiaries tended to be farmers who were already at an economic advantage. None of participants were from the Jarai, who were included only in the second year of the trial, following successful results in the first year.

Similarly, participants in the training programs conducted in association with the livelihood pilot were mostly Kinh, though some Jarai farmers were included as well. Project representatives strongly felt that the group should have been more representative of the population's ethnic composition, and that the participation of marginalized groups should be encouraged rather than

Case study: Engaging resettled ethnic (cont.)

discouraged; however, the local leaders who drove the selection process felt that representatives of ethnic minority households lacked adequate language skills and were not sufficiently open to innovation or inclined to follow technical recommendations. Based on the local administrative and political context, it was difficult for the project to change the selection criteria in a way that prioritized marginalized communities.

Several approaches were adopted by the project to overcome some of these constraints and ensure that the Jarai ethnic minority group could also benefit from the cassava livelihood pilot. For example, a staff member of the Department of Agriculture and Rural Development (DARD) of the Jarai ethnicity group was appointed to supervise activities under the project, including training and communication between district and provincial levels. During the training program, visual aids were used, which proved to be especially helpful in overcoming language barriers or limited technical knowledge and found particularly useful when engaging with the Jarai. Furthermore, in the case of the Jarai farmers engaged in both the pilot and training sessions, it was found more effective when the younger generations with a better understanding of Vietnamese (spoken by Kinh but not by all Jarai) were involved. This was important to note for future training and for up-scaling of the project.

For more information:

Senaratna Sellamuttu S, Joffre O, Nguyen Duy P, Pant J, Bouahom B, Keophoxay A. 2014. Hydropower development and livelihoods: a quest for a balanced approach through research and partnerships. From the proceedings of the Fifth International Conference on Water Resources and Hydropower Development in Asia, Colombo, Sri Lanka. March 2014.

Nguyen Duy Phuong, Nguyen Dinh Thong, Nguyen Thi Van, Luong Thi Loan, Din y, Senaratna Sellamuttu S, Chu Thai Hoanh. 2016. Assessment of benefits to the different gender and ethnic groups from MK1 project pilots in Yaly HP area for scaling-up livelihood enhancement in the Mekong Region. CGIAR Research Program on Water Land and Ecosystems (WLE), Mekong Focal Region report.

*** Challenge c.3:** How do we engage marginalized ethnic groups in a way that transforms the political, economic, and social systems, at the same time minimizes detrimental impacts on the marginalized at the local level?

What to do c.3: Pay special attention to the changes created outside the activities of the project, and take efforts to understand local systems.

Because the project is a new element introduced to the local political, economic, and social system, the project team must be aware of and pay attention to the changes that take place in a site that are not related to the project. For that, it is necessary to understand local power dynamics and the role played by local interest groups, whether formal or informal.

How c.3: Clearly map the stakeholders and the relationships between them. Implement stakeholder analysis, including gender analysis, to understand the local political system, power dynamics (including who has control over resources), and existing conflicts at different scales (within households, within villages, and village-outside). This should be complemented by assessments of the different needs and capacities of specific marginalized groups.

Stakeholder analysis—which consists of identifying stakeholders, differentiating between and categorizing stakeholders, and investigating relationships between stakeholders—can be done through mixed methods, consisting of questionnaires complemented by in-depth qualitative research [20, 21]. Understanding local beliefs and the customary institutions that govern local social relationships will provide key knowledge that allows the project team to know the best ways to deal with each stakeholder. Research using ethnographic methods to produce first hand in-depth knowledge, and—when it is available—reading ethnographic literature on the ethnic group(s) in question can help the research team to understand and deal with the local social, political and cultural system. Only after this is done, can the project start to define its place and its position in the social, political and economic local system.

People to be identified for the project are:

- ***Key stakeholders***: Stakeholder categories include farmers (particularly the more marginalized ethnic minority farmers, women, and the poor), researchers (local & international), NGOs (local & international; especially NGOs which focus their work on ethnic minorities), government, policy makers, and formal and informal groups (village youth groups, women's union, farmer groups, traditional village committee). As you determine which stakeholders can be effectively engaged, be aware that many people "wear multiple hats": ethnic minorities could be government employees, farmers might be members of NGOs, and so on.
- ***Potential "co-learner experimenters" and people ready to test new innovations***: This should include both male and female ethnic minority farmers. Identify those who are more open to new ideas and innovations, but make sure they are not too different for everyone to learn from. "Innovative farmers" can become key persons to implement the project and to transfer knowledge to both men and women.
- ***Potential participants of research***: Look beyond farmers and other stakeholders who always participate in projects (such as the village head's extended family members) as they are usually from the ethnic majority group **or** from a selected group of ethnic minorities, and not marginalized groups.
- ***People who are typically excluded/ marginalized***: Pay special attention to those who are typically excluded, such as ethnic minority groups who live in more remote areas, women, the poor, etc.
- ***Potential research collaborators***: Local partners and/or social scientists who have worked with ethnic minority groups and who have already established long-term engagement with ethnic minority farmers.

iii. Project Implementation and Maintenance Stage

*** Challenge c.4:** How do we effectively maintain marginalized groups' interests and engagement in project activities, including monitoring and evaluation (M&E)?

What to do c.4: Make concerted and consistent efforts to gain and keep the trust and interest of marginalized groups throughout the entire duration of the project by ensuring they have ownership of the project and the research topics and problems are of interest and relevance to them.

It is often the case that researchers and donors do not go beyond just looking at numbers of ethnic minorities in the list of participants when monitoring participation of ethnic minorities in projects. However, to go beyond token representation and ensure ethnic minorities benefit fully from agricultural R4D activities and interventions, it is important to ensure that they are meaningfully engaged.

How c.4:

- For trials and surveys:
  - Instead of only working with ethnic minority farmers who speak the official language of the country, secure interpreters who can facilitate communication between researchers and ethnic minority farmers. See also Challenge c.1-2 above.
  - Provide context-specific incentives: these should not be limited to money, but should also include activities like communal meals—which can double as a means to building relationships with the community. Incentives should help to ensure that ethnic minorities and women are voluntarily participating, rather than being coerced—e.g., that they are not merely being asked to participate by a village headperson.
- For focus group discussions (FGDs), workshops, and training sessions:
  - In group settings, create an environment which enables ethnic minorities—and especially women in ethnic minority groups—to speak out without fear of repercussions, to ensure that their voices are heard and incorporated. Choosing skilled facilitators (men for FGDs with men, and women or FGDs with women) from the targeted ethnic group(s) and strengthening their capacities is thus very important.
  - Have a facilitator who speaks the language of each ethnic minority present, or hire interpreters who are well familiar with the key terms and concepts in the languages involved. See also Challenge c.1-2.
  - Ensure the training meets the needs of ethnic minority farmers, in particular women, by conducting training needs assessments and obtaining basic information (see Challenge c.1 above) beforehand, to understand separate and joint needs of different farmers, e.g., the specific needs of women and men, and the specific needs of different ethnic minority groups. This differentiation is important for project implementation: if women are not involved with land

Case study: Understanding socially constructed challenges in agriculture of an ethnic minority group in Yen Bai Province, Northern Viet Nam by Nozomi Kawarazuka

Over the past two decades, Dao ethnic minority farmers in Northern Viet Nam have adopted some new technologies such as high yielding industrial cassava varieties and tree crops. To investigate how this worked along gender lines, this study asked: how do gendered social values and practices influence the ways Dao men and women engage in modern agriculture? To explore this question, we conducted in-depth interviews with 15 women and 13 men at different life stages and of different economic statuses in a single-ethnic village of "White-Trousers Dao" in Yen Bai.

Dao men and women continue to use their own knowledge-sharing systems, even after modernization of their agricultural practices. They tend to trust information from their family and relatives and to adopt new practices only after confirming positive outcomes with their own eyes: new technologies are slow to spread across the entire village. On top of this, there are strong social stigmas attached to debt, so Dao farmers—men in particular—tend to be reluctant to borrow money. In the case of cassava, however, Dao men are willing to go into a small amount of debt related to cassava production since they have seen how cassava is a viable crop in this particular context.

Current farming practices require intensive male labour work, making it difficult for poor families with a shortage of male labour to invest in new crops and technologies. This is because Dao women access resources through the family as a collective institution and must depend heavily on manual labour. Family relations are very important in the extent to which they can invest in agricultural resources. Hence, without considering such social contexts, mainstream agricultural development may contribute to internal marginalization within the marginalized community.

This case study thus shows that exploring social dimensions of agriculture helps develop context-specific approaches to facilitating uptake of new technologies in ways that fit well with the social context of the ethnic minorities.

For more information:

Kawarazuka N, Thuy CTL. 2016. *Understanding socially constructed challenges of cassava farming for ethnic minorities: a case study of a Dao ethnic group in Northern Vietnam*. Research Program on Integrated Systems for the Humid Tropics. CGIAR. Open access: http://humidtropics.iita.org/share/s/J0yQyX5vRTCWqR4I-Tjgvg

preparation, it may not be useful to ask women to come to a training session on that topic. However, in some cases, it can be useful to involve spouses if the intervention targets women, as this can help enhance the husbands' understanding and facilitate women's participation.

- Consider how to make use of ethnic minorities' traditional ways of learning and their unique paths to innovation. Typical classroom-type training sessions are generally a very different way of learning for them. Whenever appropriate, use visual aids, which can help overcome language barriers and limited literacy or technical knowledge.

Case study: Towards soil erosion mitigation and sustainable agriculture in Northern Lao PDR: Participatory on-farm research using a gender equity lens in the Houay Dou catchment by Sonali Senaratna Sellamuttu, Bounthanom Bouhom and Anousith Keophoxay

Soil erosion is one of the major issues impacting sustainable agriculture in the sloping lands of Northern Laos. This problem is currently magnified by the spread of commercial tree plantations—e.g., teak trees—replacing traditional rice-based shifting cultivation systems. Soil erosion has led to negative impacts both on and off the research site.

In collaboration with farmers and agricultural extension services, research conducted under the Humidtropics CGIAR Research Program was implemented to test and develop innovative on-farm land management practices that improve stream water quality while sustaining the fertility and productivity of erosion-prone soils in the mountains of Northern Lao PDR. Ten different types of land use in the Houay Dou catchment have been monitored for runoff and soil erosion rates.

Farmers working in the Houay Dou catchment belong to Lao-Tai ethnic majority group and Hmong and Khmu ethnic minority groups. Using qualitative, participatory approaches, we investigated the different perceptions and preferences the farmers have in terms of the different land uses and agricultural practices adopted in the catchment. The findings were disaggregated based on gender, ethnicity and wealth rank. Data was collected from three villages (Park Thor, Houy Khong and Na Kha).

It appears that men and women had different views on the importance of different land use practices and their preference rankings therefore differed. For example, in Pak Thor village, men ranked the most important land use as banana cultivation (as there was a good market to sell their product and this contributed to their household income and they could also use the produce they did not sell for home consumption), whereas women ranked fallow land as their priority because it was the main area used to collect non-timber forest products (NTFPs) as part of their livelihoods and this was considered particularly important by women as they are the primary collectors of NTFPs. There were also differences in preference ranking of land use practices depending on the village and the key land uses available to local people. In Na Kha village for example where approximately 85% of the 47 households were found to be engaged in teak plantations, as expected this land use type was ranked high by both men and women. It was ranked the first preference by men (because of the current high demand for teak and the villagers can earn high income from teak plantation as a good source for household saving) and second by the women (one reason given is that it takes time to obtain benefits as one needs to wait until the teak trees mature).

Furthermore, it appeared that better-off households have preference for teak plantation with larger areas and are not interested in upland rice, while poor households who have limited land prefer upland rice cultivation and NTFPs for home consumption. In the case of the middle wealth category they appeared to give preference to banana, broom grass, and NTFPs as sources of income. In relation to ethnicity, the Hmong gave preference to land use practices involved in the cultivation of maize, broom grass, rubber and banana, Khamu appeared to prefer upland rice cultivation, while Lao-Tai appeared more interested in teak plantations.

It was noted that soil erosion was not an issue that was specifically brought up by the farmers. However it was encouraging to note that the production of broom grass was ranked relatively high by both men and women since this land use practice has been demonstrated to have the lowest erosion rates from the biophysical studies. In Na Kha village, for example, broom grass was ranked second by men and first by women while in Pak Thor village, broom grass was ranked second by men and third by women in the focus group discussions.

This case study demonstrates that gender, wealth and ethnic grouping influences agricultural decision-making. Overall, it is clear that a nuanced approach will be required when informing farmers how to select land use types that can limit erosion and preserve soil fertility.

- Hold separate meetings and develop interventions separately for different ethnic groups, to ensure interventions and training meet the needs of each group, and can be done in ways that promote their learning, e.g., in the ethnic group's own language and own way of learning). Similarly, consider holding separate meetings and developing separate interventions for men and women.
- As mentioned above under trials and surveys, provide context-specific incentives.

- When developing or introducing interventions:
  - Jointly develop locally-generated technological and institutional innovations derived from a combination of scientific and local knowledge systems. This can be done by obtaining information on local and indigenous agricultural and ecological knowledge, and seeing how this can be integrated with agro-ecologically appropriate technological innovations. These innovations can be built on information collected at the project conceptualization stage (see Challenge c.1).
  - Scale out innovations (technological or institutional) tested elsewhere only after:
    - giving farmers full information of pros and cons;
    - obtaining the willingness of local people to accept and then adopt innovations, and if necessary, building their capacities to adopt them;
    - ensuring that the innovation is based on local culture, knowledge, aspirations, capacities;
    - carefully considering what kind of impacts the new innovation may have on the local culture and social relations within the village;
    - considering the existence and/or distribution of assets (e.g., economic, natural (water, access to farming land, etc.), social and political (power, prestige, networks), etc.) that enable adoption of the innovation;
    - assessing the relevance of the new innovation in the local economic, socio-cultural and ecological contexts; and
    - considering the role of researcher as facilitator of technological and/or social innovations that can help them meet their needs.
- Throughout the project cycle:
  - Establish multi-stakeholder processes—e.g through multi-stakeholder innovation platforms—through which systemic problems and opportunities supported by systems analysis are prioritized; project entry points that require social and technical innovations should be jointly identified. Regular platform meetings should be held to share agricultural R4D research results and build members' capacities. Engage a facilitator who can ensure marginalized groups are represented and are able to participate meaningfully in these processes.
  - Work closely with ethnic minority farmers so issues and changes they want in the future can be jointly identified, from the minority's perspective.
  - Include tangible results that can be achieved in the short term at the same time as a more in-depth research is being undertaken.

Case study: Understanding gendered concepts and processes of agricultural innovation in Dien Bien Province, Northern Viet Nam by Nozomi Kawarazuka

Agricultural interventions in ethnic minority communities in Viet Nam have often shown that the introduction of new technologies can partially close the agricultural "technology gap." However, men tend to accept the use of new technologies more readily than women, as purchasing seeds and other agricultural inputs are often closely associated with men's existing gender roles. If agricultural interventions are to support women and men in equal measure, it is important to understand gendered social mechanisms of innovation instead of looking solely at overall production levels.

This study asked how gender relations shape agricultural innovation, and how subsequent changes in production reconfigure gender roles and relations within the family and the village. To address this question, fieldwork was conducted in a black Thai ethnic minority village in Dien Bien Province. We carried out in-depth-interviews with 12 men and 17 women from 29 households.

Most black Thai women perceive themselves to be in a lower position of power than their husbands and in-laws. They believe this arrangement was desirable for Thai families. Social expectations of wives have been increasingly associated with earning incomes through innovation in livestock, from which women eventually gain their status in the family. To achieve this, women start new activities on a very small scale to ensure that potential failures do not have any serious repercussions for their livelihoods. This is to avoid risk: success or failure in agriculture can influence their position in the family, and affects their family's reputation. Women also depend on their own family networks and support instead of their husbands', so that success can be more clearly attributed to women's capacities and efforts, thereby improving their social and familial position.

Agricultural interventions for supporting women need to take account of the underlying power relations that shape women's strategies and opportunities. Agricultural research and interventions conducted without a gender lens run the risk of continuing to support wealthy men whose concepts of innovation fit well with scientists' notions of and interests in innovation instead of equitably supporting all parts of a village. This case study shows that taking a gender lens is also important when engaging with ethnic minorities.

For more information:

Kawarazuka N. 2016. *Gendered processes of agricultural innovation.* Research Program on Integrated Systems for the Humid Tropics. CGIAR. Open access: http://humidtropics.iita.org/share/s/QmshLQRbQaew1YrGamUiKA

- Build trust with ethnic minorities, by making regular visits to field sites, and participating in local social activities.
- If the project has not been jointly developed with the ethnic minority groups, clearly communicate the project's outcomes (i.e., do not create false expectations) and keep them updated on research progress.
- Negotiate with donors if possible to allow research to be adaptive and change direction depending on farmers' needs, the progress of the research, etc.

Case study: Mixing Methods for Holistic Project Evaluations: Revisiting Nepal's Home Garden Project through a Qualitative Lens in Nepal's mid-hills and terai (plains), Gulmi and Rupandehi Districts by Marlène Elias and Miranda Morgan

The project entitled 'Enhancing the contribution of home gardens to on-farm management of plant genetic resources and to improve the livelihoods of Nepalese farmers' was led by Bioversity International and implemented by Nepalese NGO LI-BIRD between 2002 and 2013. An evaluation using primarily quantitative methods concluded that the project had made a substantial contribution to biodiversity conservation and livelihoods. A subsequent qualitative study deepened understanding of how and why the project also improved gender equality and social inclusion; illuminating the value of combining qualitative and quantitative methods in project evaluations based on four considerations.

First, the qualitative analysis helped contextualize the project within the larger system in which it was embedded, pointing to a confluence of factors external to the project (e.g., the acquisition of electricity, water pumps and mills) that facilitated the livelihood changes that had been attributed to the project. Second, while quantitative data excels at identifying trends, qualitative research is crucial for identifying those trends. Qualitative data revealed the non-linear process of change, including the fact that transformations in gender and social relations often occur when the various parties involved in research—e.g., women and men, members of different ethno-religious or socio-economic groups—are encouraged to interact with one another. Third, the qualitative analysis illuminated unanticipated project outcomes, which participants themselves perceived as meaningful. For instance, both male and female Dalits (considered a low caste) expressed that some of the biggest changes they experienced were associated with relations across castes, which had not been anticipated and hence not measured using pre-defined indicators. Using open-ended qualitative methods helped capture the importance of the project in participants' own terms. In this light, the project's intellectual and emotional benefits emerged as even more significant to female and male participants than the material outcomes of the project. Finally, qualitative research allowed local interests to be identified and built upon when planning future initiatives. Hence, if the purpose of impact assessments is not only accountability but also learning, combining quantitative and qualitative methods is needed to enable the breadth and depth of analysis required in the learning process.

For more information:

Elias M, Morgan M. 2016. Mixing methods for holistic project evaluations: revisiting Nepal's 'Home Garden Project' through a qualitative lens. *Bioversity International series of Impact Assessment Briefs no. 18*. Rome: Bioversity International.

Elias M, Morgan M. 2014. Evolution of gender relations among Nepalese farmers. Available online: http://www.bioversityinternational.org/news/detail/evolution-of-gender-relations-among-nepalese-farmers/

Gotor E, Martin W. 2013. Home gardens in Nepal. *Bioversity International series of Impact Assessment Briefs, no. 10*. Rome: Bioversity International. Available online: http://www.bioversityinternational.org/e-library/publications/detail/home-gardens-in-nepal/

Carter J, Byrne S, Schrader K, Kabir H, Uraguchi ZB, Pijls N, Fendrich P. 2014. Learning about women's empowerment in the context of development projects: Do the figures tell us enough? *Gender and Development* 22:327–349.

- During M&E, include locally-defined indicators that are jointly defined by local stakeholders, including marginalized groups. In addition to quantitative indicators, include qualitative indicators which may be difficult to measure but can be captured through observational techniques. These include indicators that can monitor gender and other social relations, and qualitative milestones specific to marginalized groups.
- Incorporate reflexive and iterative M&E, which involves marginalized groups, and enables both researchers and research participants to learn from feedback and from mistakes made in the field.
- Be mindful of the fact that impacts of the project can go beyond the anticipated impacts, e.g., to other projects or activities taking place in the research site, and make sure that these impacts do not contribute to internal marginalization of certain groups within the ethnic minority group, or further marginalization of other groups.

Case study: Building trust in the field, by Christian Culas

An anthropological study conducted for three years between 2010 and 2013 in a Tay ethnic minority commune in Lao Cai Province, Viet Nam , explored different ways of the local perception and understanding of 20 development projects. The commune's main ethnic groups are the Tay (95% of the population); other groups, the Dao, Kinh, and Nung, comprise 5%. The qualitative methods used in the study included participant observation, individual open-ended interviews with stakeholders of different projects, and social network mapping related to project participation.

Our findings showed that in majority of the projects, project team members only visited the target village once or twice during the project period. This can be changed for the benefit of all stakeholders if external staff modify their schedules to spend more time around the project site. We noted that the most popular projects by the villagers are always those in which project members spend "non-project" time with villagers. For example, when villagers remember the names of project staff, it is a strong indication that the project is integrated into the local social world.

A successful project is one which has been incorporated into local social life; if possible, project staff should attend social events (weddings, local banquets and parties). We found that when the project is able to integrate some elements of the local social life, the relationships between the project and local people become stronger and more flexible. In line with the local way of holding meetings, at the same time organizing official meetings with the 'correct' team members – including people from the local party members, local government officials, etc., it would be useful for a project to have informal meetings (outside the official meeting place, in a private home) to learn about issues that do not come up in formal settings and to meet people who do not come to these formal meetings.

For more information:

Culas C, Pannier E. 2014. *Final research Report (2010-2013): socio-anthropological study of development project and social change in an ethnic commune in Northern Vietnam*. Paris: French Development Agency.

- Ensure sustainability of the project and its outcomes by linking farmers with relevant stakeholders and building investment in the project's purpose.

*** Challenge c.5:** How do we implement and maintain project activities that engage ethnic minorities under budget constraints?

What to do c.5: Mobilize investment and contributions from project participants, including ethnic minorities, counterparts, and partners (i.e., NGOs, enterprises).

It is often the case that a project may not have the full budget in the actual implementation phase, due to budget cuts from donors or other external circumstances. To compensate for the reduced budget, it is worthwhile to look for additional investments and contributions from the project participants by mobilizing their available resources and funding.

How c.5: Organize a workshop with project participants, in order to:

- identify and prioritize activities of most interest and relevance to participants;
- redesign the project according to prioritization by participants, and as necessary, redesign (downsize) proposed activities; and
- identify participants' resources and willingness to contribute resources (including in-kind contribution of their time and equipment/inputs necessary) to the implementation of redesigned activities. Such contributions can also improve participant commitment and project sustainability.

iv. *Scaling out and up*

*** Challenge c.6:** How can we ensure that the agricultural R4D project has positive development impacts on ethnic minorities, and the impacts are widespread?

What to do c.6: Establish a commonly-agreed and compelling development challenge with the marginalized ethnic groups(s) and other key stakeholders (including the relevant authorities) at the outset, as well as the strengths they can bring to tackle it, and the opportunities that exist to make progress. Develop a theory of change for the project on this basis, that also takes into account that agricultural R4D achieves impact through three interlocking impact pathways, through: the development and adoption of technology; developing capacity to innovate; and, influencing policy.

The capacity development pathway is likely to deliver most results in combatting marginalization because its causes are more to do with a lack of capacity than lack of technology. Research builds capacity to innovate through the collaborative research process. The capacities it builds includes:

- new technical skills, e.g. how to carry out experiments and analyze the results;
- self- and collective- efficacy;
- ability to assess options and identify key system challenges;

- ability to go through iterative visioning, planning and reflective learning cycles;
- capacity to link to other actors and to use linkages strategically in support of own plans;
- enhanced capacity for effective collective action; and,
- enhanced leadership skills [22].

Building capacity to innovate will increase the likelihood of unexpected outcomes as well as expected ones. Experience shows that it is often the unexpected and opportunistic outcomes that lead to real impact. The project should monitor for these and retain sufficient flexibility to support beneficial ones.

With respect to the technology development and adoption pathway, development partners and relevant government and extension services who are part of the transdisciplinary research team would take the lead role in ensuring that the research findings are widely understood and adopted by the marginalized group(s). They also play a key role in ensuring that these technologies/activities/interventions are scaled out in a suitable manner to other ethnic groups.

With respect to the policy influence pathway, it is important to present to decision makers and policy makers evidence-based research findings and methods to demonstrate the importance of engaging with ethnic minorities: project evidence should provide policy makers with information for scaling and institutionalization of innovations.

***How** c.6:*

- Carry out a stakeholder workshop, including minority groups, to agree the overall development challenge, identify stakeholders' strengths and opportunities to tackle it.
- Involve development practitioners and other relevant local stakeholders such as government extension services in the transdisciplinary team, and get their inputs from the beginning regarding strategies and mechanisms that are already in place or can be adapted to potentially scale out the proposed technologies/interventions/activities, particularly among marginalized ethnic groups. Describe this explicitly as part of the project's communication and uptake strategy.
- Use this input to develop a theory of change for the project that makes its causal assumptions explicit.
- Carry out a mid-term review to identify emerging outcomes and positive feedback loops, both expected and unexpected. Use these findings to revisit and provide detail to the original theory of change. Make appropriate course corrections including providing support to emerging feedback loops and outcomes and making the project's outreach and communication strategy more specific. In some cases, generic stakeholder groups can be replaced with specific organizations, or better, the names of specific people.

- Develop an understanding of the extent of the need and demand for the technologies, interventions, or other project activities amongst ethnic minority groups in the neighbouring communes, districts, and provinces; assess whether or not an enabling environment exists for scaling out. Consultations with relevant partners and simple GIS-based decision support tools can be used in this context.
- Take steps to understand the best way of ensuring farmer-to-farmer learning, taking into account that how information flows and how effectively it is exchanged may be shaped by pre-existing social networks and relations. As much as possible, make use of ethnic minorities' traditional ways of learning and innovations.
- Identify potential "champions" at appropriate levels at the beginning of the research, who can help with scaling out among ethnic minorities and also with scaling up.

Text box: Effectively communicating research findings by Marlène Elias and Ewa Hermanowicz

According to Elias and Hermanowicz (2016), it is important to consider four factors when preparing to communicate research findings:

- *Understand your audience* by identifying groups who will be using your findings from the very start of the research process. Consult both women and men from these groups to hone in on stakeholder information needs and perceptions. Also, share your findings with different types of actors, including groups that can take up, but also further share the research results.
- *Showcase relevant findings*, e.g., by gender and/or by ethnic group, by unpacking, analyzing, and representing data according to relevant variables of analysis—these could be ethnicity, gender, or age, for example. Images and videos used to illustrate research findings should include both women and men and include members from all relevant ethnic groups.
- *Share research findings* with differentiated stakeholders through relevant channels: by considering where different target audiences obtain their information, and use those channels for outreach. Use appropriate language that is matched to the level of technical understanding of the target audience. Adopt diverse and mixed methods of communication to reach different ethnic groups and both women and men—e.g., visual materials such as illustrated pamphlets, photographs and videos, and verbal methods of transmitting information.
- *Monitor and evaluate outreach strategy:* whatever communication activities are chosen, they should be monitored and evaluated for effectiveness in reaching the different target audiences to strive for continuous improvement and fine-tune the communication strategy.

All these must be adequately planned and budgeted for early on in the research process. By ensuring that local women, men, and marginalized groups are able to equitably access research findings, it is possible to support their empowerment—an essential part of the R4D process.

For more information:

Elias M, Hermanowicz E. 2016. *Practical tips for communicating findings in a gender-responsive way*. Rome: Bioversity International.

This can be a high-level politician with a research background, policy-makers, local authorities or local elites, or members of Indigenous People's / ethnic minorities' groups.

- Organize policy dialogues and field visits for key local, regional, and national policy makers to project sites.
- Identify and participate in existing national processes such as sector working groups, national forums, and donor and development meetings: participation in these processes will help inform decision-makers of research findings and the importance of engaging with marginalized ethnic groups.
- Include a budget for a communications and uptake coordinator, who could promote project interests and generate knowledge both proactively and reactively during the course of the project. The uptake coordinator should invest adequate time to promote project uptake to the degree needed: this requires additional time and effort, as well as a specific skill set.

*** Challenge c.7:** How do we ensure that our project is directly linked to the outcomes that marginalized ethnic groups need?

What to do c.7: The identification of a common development challenge with marginalized groups, as described above in Challenge c.6, ensures that the project goals match their needs. The subsequently-developed theory of change shows how project activity and outputs are expected to contribute to these goals. The project will need to establish a monitoring and evaluation system to track these assumptions and intentions as implementation unfolds, and adjust accordingly.

How c.7:

- Develop a theory of change in a participatory manner with project staff, partners, and key stakeholders. The process helps identify key actors to target: who needs to be influenced, how they ought to be influenced—e.g., bringing about changes in their knowledge, attitude, or skills—and strategies to do this. Participatory identification of a theory of change helps build ownership of the project by implementing partners.
- Further refinements can be made to the theory of change mid-term, after a more in-depth understanding is gained at the research site, after specific relationships and partnerships are initiated and early outcomes have been identified.
- In addition to a mid-term review, plan for annual after action reviews for the project to critically reflect on its progress over the year in terms of what is working well, not so well and what to change in the coming year. It may not be practical to carry out these reviews with the entire team; it is thus important to plan how and when reflections and iterative project modifications will occur.
- Outcome evidencing is a suitable method for carrying out a mid-term revisiting of project theory of change. The method identifies outcomes to which the project is contributing and how it is doing so.

Text box : Outcome evidencing: a method for enabling and evaluating program interventions in complex systems by Rodrigo Paz-Ybarnegaray and Boru Douthwaite.

Outcome evidencing is a rapid and participatory evaluation approach built on a complexity-aware understanding of how change happens. The approach assumes that programs achieve impact when the resources they provide find resonance with key stakeholders engaged in on-going or emerging areas of change. The approach is designed to (a) identify areas of change to which the program is contributing; (b) within them, identify clusters of outcomes, both expected and unexpected; (c) develop causal chains that link the program activity and outputs to emerging outcomes; and (d) compare those links with the program's original theory of change. The information is then used to show accountability to stakeholders as well as to derive lessons and propose actions to strengthen the capacities of the implementing teams and the implementing organizations as a whole.

For more information:

Paz-Ybarnegaray R, Douthwaite B, (in press). Outcome evidencing: a method for enabling and evaluating program interventions in complex systems. *American Journal of Evaluation.*

3. Resource implications

Transdisciplinary action research has different resourcing and timing requirements to normal agricultural R4D. Start-up takes longer to gain access, engage, build trust and connections and to identify research issues that motivate participation from a range of actors, in particular ethnic minorities and other marginalized groups. Team composition will be different, involving a broader range of disciplines and more "soft" skills, in particular facilitation.

Given the importance of engagement and creating safe spaces to work on issues of mutual interest, the number and type of events will be greater, and they will last longer. See above index (table 3) for the kind of activities, methods, and tools that can be used to facilitate participation and engagement.

While front end costs maybe higher, and research outputs slower to come, return on investment can be expected as a result of the motivation, trust, linkages, platforms built, etc. that evidence shows [23] can last many years after the project finishes. The additional time and costs required to work with marginalized groups may not fit with the donor's current orientation toward "efficiency" and short time frames of projects. Discuss and negotiate with donors and host institutions about this different dynamic that such an agricultural R4D entails. If there is no institutional or donor support, transdisciplinary action research that engages ethnic minorities would not be worth starting.

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5. About this document

This document is an output of Humidtropics, a CGIAR Research Program on Integrated Systems for the Humid Tropics. This document is a result of literature reviews on ethnic minorities and agriculture in China and Viet Nam , a gender norms study in a village in Northwest Viet Nam , three experts' workshops, and in-depth qualitative research in two villages in Northwest Viet Nam and one district in Northern Lao PDR. All aforementioned research was implemented between 2015 and 2016. Results of gender norms studies in five Northwest Viet Nam villages undertaken between 2014 and 2016 also contributed to the composition of this document.

The preparation for this document has been led by Lisa Hiwasaki (ICRAF), with significant contributions from participants of a write-shop in July 2016: Christian Culas (CNRS), Thai Thi Minh (University of Copenhagen), and Sonali Senaratna Sellamuttu (IWMI). Text and other inputs were also provided by Marlène Elias (Bioversity International), Nozomi Kawarazuka (CIP/CIAT), Cynthia McDougall (World Fish), and Emmanuel Pannier (EFEO), who also participated in at least one of the two expert workshops held in September and November 2015, and Boru Douthwaite. The other participants of these workshops are also acknowledged: Ann Degrande (ICRAF), Luu Thi Thu Giang (CARE), Pham Van Hoi (CARES VNUA), Pham Huong (CIAT), Farhat Naz (ICRAF), Gaetan Reuse, Elisabeth Simelton (ICRAF), Lương Thị Trường (CSDM), and Chusak Wittayapak (CMU). The document benefitted substantially from the following reviewers: Steve Déry (Université Laval), Kyoko Kusakabe (AIT), Ruth Meinzen-Dick (IFPRI), and March Schut (IITA/WUR). The authors are grateful for their time and expertise which has improved the Guidelines.

We would like to acknowledge Humidtropics, RTB, and the CGIAR Fund Donors for their provision of core and project-specific funding without which this research could not deliver results that eventually positively impact the lives of millions of smallholder farmers in tropical Americas, Asia and Africa.

Further reading (links provided for all documents available on-line)

Publications on working with ethnic minorities in the Mekong region

- Culas C, Razafindrakoto M, Roubau F. 2015. Ownership and Participatory Processes: From Global motto to Local challenges. The case of a Key Poverty reduction program in ethnic minority areas of Vietnam. *Local politics, global impacts: steps to a multi-disciplinary analysis of scales.* Surrey, UK and Burlington, US: Ashgate.
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Integrated Systems Research for Sustainable Smallholder Agriculture in the Central Mekong

Achievements and lessons learned from working with upland smallholder farmers

Edited by L. Hiwasaki, A. Bolliger, G. Lacombe, J. Raneri, M. Schut and S. Staal

Integrated Systems Research for Sustainable Smallholder Agriculture in the Central Mekong is the result of research for development activities implemented from 2013 to 2016 in Central Mekong Action Area of Humidtropics, the CGIAR Research Program on Integrated Systems for the Humid Tropics.

The objective of this book is to demonstrate achievements made, as well as challenges faced, while implementing integrated systems research to promote sustainable development of smallholder farming in the uplands of the Mekong region.

We hope this book will be of interest to CGIAR and other agricultural research for development organizations and researchers, as well as international (donors, other research organizations etc.), national and local partners.

The book is organized around three research themes: a) Systems analysis and synthesis, establishing baselines and conducting situation analysis to identify interventions; b) Integrated systems improvement in practice, the various interventions undertaken to promote environmentally sustainable smallholder agriculture; and c) Nutrition dimensions, the challenges of ensuring incorporation of nutrition within the production and livelihood systems.

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