AgResults Evaluation Design:
Vietnam Emissions Reduction Challenge Project

Submitted to:
Department for International Development
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The AgResults initiative is a partnership between the Australian Government, the Bill & Melinda Gates Foundation, the Government of Canada, the United Kingdom's Department for International Development, the United States Agency for International Development, and the World Bank.

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Acronyms

AGS	Applied GeoSolutions
AWD	Alternate Wetting and Drying
DFID	Department for International Development
DNDC	Denitrification Decomposition
ERT	Emissions-reducing technology
GHG	Greenhouse gas
GoV	Government of Vietnam
IRB	Internal Review Board
JSC	Joint Stock Company
MARD	Ministry of Agriculture and Rural Development
MT	Metric tonne
PfR	Pay-for-results
SCP	Structure, Conduct, Performance
USAID	U.S. Agency for International Development

Preface

AgResults is a US$152 million multilateral learning initiative. It promotes the development and dissemination of high-impact agricultural innovations for food security, health, and nutrition through the design and implementation of prize competitions that are a class of 'pay-for-results' (PfR) project. AgResults also evaluates the effectiveness and efficiency of these prize competitions and incorporates evidence-based learning to refine the PfR approach. By using PfR, AgResults goes beyond traditional aid measures to promote the adoption of innovative technologies with high-yield development impact. AgResults calls upon the ingenuity and drive of the private sector to identify and execute the most effective and efficient strategies to achieve development outcomes. It does so by providing incentives to private sector actors to develop and facilitate the uptake of innovative technologies, and overcome market failures impeding the establishment of sustainable commercial markets for these technologies or goods they produce. It thereby aims to achieve substantial and sustained development impacts, including improved food security and food safety, increased farmer incomes, and better health and nutrition.

AgResults is funded by the governments of Australia, Canada, the United Kingdom, and the United States, and by the Bill & Melinda Gates Foundation. The funds are managed through a Financial Intermediary Fund operated by the World Bank as Trustee. The AgResults team comprises the Steering Committee, Secretariat, Trustee, country-specific Project Managers, and the External Evaluator. The Steering Committee oversees the implementation of AgResults and is composed of the five donors and the Trustee. The Steering Committee is responsible for strategic oversight of the initiative, including endorsement of key management decisions, approval of concepts and business plans for proposed projects, and monitoring of projects and the initiative as a whole. The Secretariat is responsible for implementing the initiative and reports to the Steering Committee. The Trustee provides financial intermediary services.

The Steering Committee appointed Abt Associates to serve as External Evaluator for the first six AgResults challenge projects. The evaluator's role is to use rigorous scientific tools to determine to what extent the prize competitions achieve their objectives to produce private sector behaviours and social outcomes different from, and better than, what would have happened in the absence of the AgResults initiative. The evaluator defines the overall evaluation framework for the AgResults initiative and an impact analysis strategy for answering common evaluation questions for each competition. The evaluator implements and analyses field surveys, conducts qualitative market analyses, and communicates evaluation findings to the Steering Committee and wider audiences. The evaluator's role is vital to the AgResults learning agenda of understanding how donors may leverage the private sector to develop and spread agricultural innovation. As funding permits, the evaluator also assesses the sustainability of each competition's benefits once the PfR incentives are removed.

This report presents our evaluation design for the Vietnam Emissions Reduction Challenge Project. The authors are Tulika Narayan, PhD; Judy Geyer, PhD; Denise Mainville, PhD; Adi Greif, PhD; and Cris Price, ScM.

Executive summary

This report describes the AgResults External Evaluator's plans to study the impact of Phase 2 of the Vietnam Emissions Reduction Challenge Project on the market for emissions-reducing technologies (ERTs) for cultivating rice. This report also describes plans to study the resulting impacts on greenhouse gases (GHGs) from rice cultivation in the Thai Binh province as well as net farmer income from rice. The evaluation design draws from the research and field work conducted as part of the in-country Initial Qualitative Assessment in August 2017 and the Phase 2 Baseline Assessment in October 2019 (Abt Associates, 2017; Abt Associates, 2019a).

The technology packages promoted to farmers in Phase 2 qualified for inclusion on the basis of their GHG emissions reduction and yield performance during testing in Phase 1, which concluded in 2018. In Phase 2, four Vietnamese private sector firms are competing for AgResults prizes in 2019 and 2020 (covering four rice seasons consisting of the spring and summer crops of each year). The competitors win prizes based on their results in promoting technology adoption among Thai Binh rice growers, reducing GHG emissions, and increasing rice yields. Competitors that surpass specific GHG emissions reduction and yield targets will share an interim prize pool of US$500,000 at the end of each crop cycle based on their performance. The top three performers will get end-of-phase prizes of US$750,000, US$400,000, and US$200,000, respectively. The AgResults Vietnam External Verifier, Applied GeoSolutions, independently assesses technology uptake, GHG emissions, and yield increases in order to help the Secretariat determine prize winners.

The AgResults Steering Committee tasked External Evaluator Abt Associates with answering the seven evaluation questions listed in Exhibit ES-1. The questions span a range of topics and require various research methods. The team will assess the impact of the project on private sector involvement in the market for ERTs, farmer uptake of ERTs, and GHG emissions. It will also assess the sustainability of farmers' technology uptake, the cost effectiveness of the pilot, and lessons learnt regarding the use of PfR to spur the adoption of ERTs. For this assessment, the team will use qualitative assessments, a randomised incentive design, and a quasi-experimental design.

Exhibit ES-1. Evaluation questions and analytic methods

#	Evaluation question	Analytic method
1	**Market for GHG ERTs:** What is the project's impact on private sector involvement in the development of a market for ERTs?	Qualitative approach: Structure, Conduct, Performance (SCP) conceptual framework guiding key informant interviews and document reviews, integrating findings from questions 2 and 3 on this list.
2	**Technology uptake:** What is the project's impact on farmers' uptake of ERTs, and on GHG emissions?	Randomised incentive design: Multivariate regression comparing rice cultivation practices and GHG emissions in rice plots of randomly assigned treatment and control communes
3	**Farmer impact:** What is the impact of ERTs on farmers' incomes?	Quasi-experimental design: Multivariate regression comparing farmers that adopt ERTs to matched comparison farmers
4	**Consumer demand:** What is the project's impact on poor consumers' demand for ERTs and derivative products?	The Vietnam challenge project is intended to achieve supply-side objectives, and effects on poor consumer demand for rice produced using ERTs are neither intended nor anticipated. Thus, we do not anticipate addressing this question for the Vietnam challenge project.
5	**Sustainability:** What evidence exists that the effects of the project will be sustainable in the medium to long term?	Qualitative approach: SCP and qualitative farmer interviews.

#	Evaluation question	Analytic method
6	**Cost-effectiveness and scale:** What is the evidence on the scale of any effect on private sector investment and uptake, and on the cost-effectiveness of the project as an approach?	Qualitative approach: SCP and a per-unit cost-effectiveness analysis of GHG emissions reductions and changes in farmers' net rice revenue.
7	**Lessons learnt:** What lessons can be learnt about best practices in the design and implementation of pay-for-results initiatives?	Synthesis of results from Evaluation Questions 1–6.

Data collection and analysis will continue through January 2021. There are three major data collection efforts: the GHG emissions data collection (farmer diaries), the household income survey, and qualitative data collection. These are described below:

- The GHG emissions data collection makes use of household diaries. The data collection team will recruit 300 from treatment and control commune farmers in February 2020 to maintain diaries for both their spring and summer crops in 2020.
- The household-level income survey will be fielded to 2,000 households in treatment and control communes a few weeks after harvest in both the spring and summer crops of 2020. This timing allows the survey to collect information on sales revenue because farmers will have sold their harvest.
- The qualitative data collection will take place in January 2021. This timing will inform both what happened in the last two crops of the project, and also the likelihood that any of the project's impacts are sustainable.

Throughout data collection, the evaluation team will closely monitor the incidence of COVID-19 in Vietnam and follow local health guidelines to protect researcher and respondent safety. In March 2021 the evaluation team will present findings at the biannual Steering Committee meeting. Following the meeting, the team will submit a final report for DFID approval.

1. Setting for the AgResults Vietnam Challenge Project

To inform this evaluation design, we interviewed key stakeholders—including competitors, Advisory Council members, project management personnel, government officials, and rice value chain actors such as farmers, traders, cooperatives, and processors (see Annex A for the list of interviewees). We also visited two supermarkets selling high-value rice products. The assessment further drew on a review of the competitors' applications, project design documents, other reports on ERT options in Vietnam, and our report on the baseline assessment of Phase 1, which provides context about the technology developed before the project began (Abt Associates, 2017).

1.1 Motivation and implementation plan for the project

According to recent estimates, the agriculture sector is the second largest contributor to GHG emissions in Vietnam (World Resources Institute, 2016). Within the agriculture sector, rice cultivation is the largest contributor to growth in agricultural emissions, contributing to 28% of the total change in the sector from 1991 to 2012. According to FAOSTAT, 2012 rice cultivation contributed 48% of CO_2-equivalent emissions from the country's agriculture (FAOSTAT, 2017).

In response, the Government of Vietnam (GoV) developed a strategy to reduce these emissions in 2012. In its Action Plan, Vietnam's Ministry of Agriculture and Rural Development (MARD) set a goal to reduce GHG emissions by 20% along with 20% poverty reduction and 20% economic growth by 2020. Specifically, the GoV is committed to an 8–10% reduction in its GHG emissions between 2010 and 2020 (Prime Minister of Vietnam, 2012).

The Vietnam Emissions Reduction Challenge Project aims to support the GoV in its goal to reduce GHG emissions. The project is designed to incentivise the use of rice-farming technologies and farming practices (referred to collectively as 'technologies' hereafter) that reduce GHG emissions and increase yields, and to promote large-scale adoption of these technologies in Thai Binh province. This province is located in the Red River Delta region of northern Vietnam.

Thai Binh has eight district-level sub-divisions consisting of seven districts, the provincial capital, and 267 communes. There are approximately 77,000 hectares dedicated to rice and 481,760 farmers in Thai Binh province.[1] The commune is the lowest level of civic administration in each district. The AgResults Secretariat's initial forecast was to engage 75,000 rice farmers. However, more recently it expects that 16,000 farmers will participate in the AgResults Vietnam Challenge Project (Deloitte, 2015, 2019).

The project has two phases. In the first phase, 12 competitors—seed companies, fertiliser companies—tested and tailored ERTs during two rice-growing seasons: Summer 2017 and Spring 2018 (see left side of Exhibit 1-1). The six technologies that performed best in terms of percentage increase in yield and percentage reduction in GHG emissions qualified to move to the second phase (see Abt Associates (2019b) for an assessment of Phase 1). Of these six, four competitors elected to participate in Phase 2.

[1] Data source: Baseline data from commune-level survey of spring 2018 rice cultivation.

Exhibit 1-1. Implementation timeline for the AgResults rice emissions project

Phase 1, Crop 1	Phase 1, Crop 2	Summer 2018 - Gap	Phase 2, Crop 1	Phase 2, Crop 2	Phase 2, Crop 3	Phase 2, Crop 4
Summer 2017 (planting beginning July 2017)	Spring 2018 (planting beginning January 2018)		Spring 2019 (planting beginning January 2019)	Summer 2019 (planting beginning July 2019)	Spring 2020 (planting beginning January 2020)	Summer 2020 (planting beginning July 2020)

In the second phase, the project has awarded and will continue to award prizes to competitors based on the yield increase, GHG reduction, and the number of farmers who successfully adopt the ERTs. The second phase continues for four rice-growing seasons (see centre and right side of Exhibit 1-1): Spring 2019, Summer 2019, Spring 2020, and Summer 2020, with awards at the end of each rice-growing season and a final award at the end of the four growing seasons. The objective of this phase is to reward competitors for promoting sustained uptake of their technologies among farmers, and the GHG reductions and yield increases that result from this uptake.

In addition to benefitting from the AgResults incentive, private sector competitors may also benefit by strengthening their procurement of high-quality rice, and by developing a demand base for their ERTs (e.g., short-duration rice variety). Thus, private sector competitors are expected to promote farmer adoption of their technologies as a strategy to increase profit and improve their market positions, rather than simply to qualify for the AgResults prize incentive.

Exhibit 1-2 presents details of the incentive structure for the project, including Phase 1 and Phase 2 prizes based on actual reduction in emissions and increase in yields, and adoption of ERTs that each competitor is able to achieve.

Exhibit 1-2. AgResults Vietnam Challenge Project incentive structure

TEST			SCALE		
Phase 1 (1.5 years): Competitors test solutions on control plots			**Phase 2 (2.5 years): Successful solutions that win Phase 1 are scaled up**		
Interim Prize: Competitors who surpass their competitor-specific baselines for GHG emissions reductions (60% weight) and yield increase (40% weight) **share an interim prize of US$35,000–75,000 proportional to their results**			**Interim Prize per Crop Cycle (3):** Competitors who surpass their competitor-specific baselines for GHG emissions reduction (20% weight), yield increase (20% weight), number of farmers reached (40% weight), and repeat use of tool/product (20% weight) **share a prize of US$500,000 proportional to their results**		
Milestone Prize: Competitors with the highest combined GHG emissions reductions (60% weight), and yield increases (40% weight) receive prizes:			**Grand prize**: The three competitors with the highest number of farmers reached (40% weight), repeated use of solutions (20% weight), total GHG emissions reduction (20% weight), and percentage increase in average yield (20% weight) receive added prizes:		
1st Place US$50,000	**2nd Place US$30,000**	**3rd Place US$20,000**	**1st Place US$750,000**	**2nd Place US$400,000**	**3rd Place US$200,000**

Source: Deloitte (2017).

In Phase 1, the Project Manager directly measured yield by assessing the quantity of rice harvested, and directly measured emissions using chambers situated in both control and treatment plots. In Phase 2, emissions measurement is based on a combination of remote sensing data and direct measurement of cropping practices, with Phase 1 data contributing to refining this model for estimating GHG emissions. Yield measurement, on the other hand, is based on direct measurement of sampled fields by the project management staff. Overall, the project's approach to measure and verify the indicators on which the prizes are based is not subject to manipulation, as it is very hard for the competitors and farmers to know which activities would increase emissions. That said, the measurements are often uncertain (see Abt Associates, 2019b for more details).

Although the project business plan does not present an explicit theory of change, an implicit theory of change is predicated on the understanding that Vietnamese rice farmers will adopt and sustain use of emissions-reducing technologies (ERTs) if such technologies also improve the farmers' well-being. In the project design, these improvements are indicated by rice yields. The project's theory of change is represented graphically in Exhibit 1-3. It shows that the AgResults intervention—prizes to competitors for the development and dissemination of yield-increasing and emissions-reducing technologies—is expected to lead competitors to tailor these technologies in Phase 1 (which they did). The intervention is then expected to lead the same competitors to disseminate these technologies to farmers in Phase 2 of the project (which is ongoing). The outcomes of the Phase 2 dissemination include farmer uptake of these technologies, and their resulting increased yields (and returns). These outcomes support the project's ultimate intended impact: sustained use of ERTs by farmers.

A notable feature of this theory of change is the assumed connection between yield increases and sustained uptake by farmers, in which yield increases are assumed to be the channel by which farmers increase their incomes, thus motivating sustained uptake. We have challenged this assumption at least two fronts in our past assessments (see Abt Associates, 2019a, 2019b). First, yield increases can be associated with either positive or negative impacts on income, depending on the cost incurred in achieving those increases. Second, higher incomes can result not only from yield increases, but also from increases in prices received for rice, reductions in costs of production, and even from revenue accrued from products or services ancillary to rice. For example, rice bran or husks can be a source of revenue. Thus, in our evaluation we will account for the broader financial aspects of rice production in an evaluation of farmer uptake and income effects. Suri (2011) also notes these aspects and explains that once benefits and costs of technology uptake are accounted for, they can explain low adoption of technology.

The project's theory of change presumes that the competitor will consider these financial aspects when developing technologies in Phase 1, given that prizes in Phase 2 are based on farmers' uptake of these technologies. Technologies' profitability—which includes the concept of reduced complexity of technology, better prices, and lower costs—is expected to have a significant role in the technologies' success in Phase 2.

Exhibit 1-3. AgResults Vietnam Challenge Project theory of change

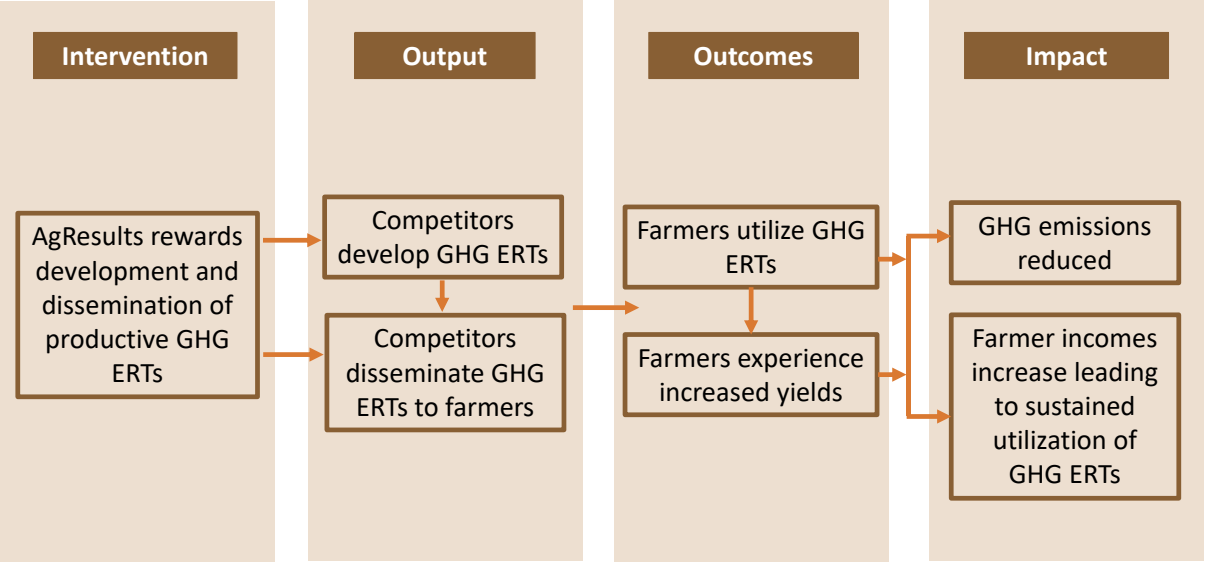


Exhibit 1-4 summarises the four competitors and the technology packages that they are implementing in Phase 2.

Exhibit 1-4. Competitors and their technology packages

Competitor	Technology package	Co-applicants	Key defining feature
#4 An Dinh Technology Development and Investment Company Limited	Japonica rice variety combined with low seed density, synthetic fertiliser applied six times, Alternate Wetting and Drying (AWD) with no deep drain event, Fito-biomix RR used as decomposer fungi for stubble and rice straw.	Dong Hai Cooperative, Qunnh Phu district; Bio Technology Joint Stock Company (JSC)	Use of Japonica rice variety by a competitor who has experience trading in it, along with bioproduct to decompose stubble and rice straw.
#5 Thai Binh Seed Corporation	High-yield medium-quality rice along with low seed density, organic fertiliser, AWD, and stubble and rice straw management using composter fungi.	Vietnam Seed Breeding Association; Vu Hoa Agricultural service production & trading cooperative, Kien Xuong district	Established company with strong foundation in Thai Binh along with existing relationships with the farmers.
#18 Food plant and rations plant institute plant seed joint stock company (FARI –SEED JSC)	Short-duration rice variety with potentially higher yield, low density, fertiliser application, AWD with 2 drain events, and stubble and rice management with bio fungi.	Than Ne agricultural service cooperative, Kien Xuong district	Advanced variety of rice with shorter duration along with low inputs.
#23 Binh Dien Fertiliser JSC	Low-density seed, synthetic fertiliser, AWD with three drain events, and stubble and rice straw treatment with compost maker.	Soils and fertiliser research institute; Nguyen Xa Agricultural Service Cooperative, farmers	Fertiliser.

Source: Abt Associates (2017).

1.2 Rice value chain

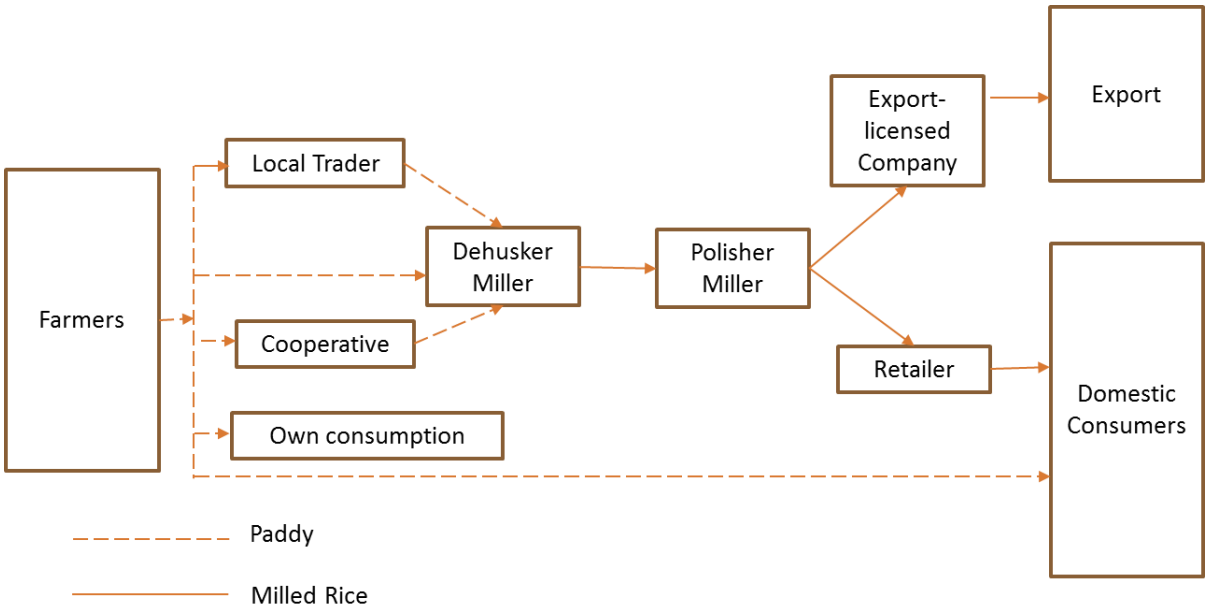
Since the project aims to transform rice production in Thai Binh, it is useful to consider it within the context of the current rice value chain in Vietnam and Thai Binh. Exhibit 1-5

graphically depicts the traditional rice value chain for Vietnam. Farmers produce rice using inputs—seeds, fertilisers, and pesticides—acquired from local agro-input dealers or their cooperatives (farmers may also save seeds from previous harvests or obtain them from neighbours or the rice market). They sell their produce to local traders and cooperatives and set aside some production for consumption. The traders and cooperatives get the rice dehusked and polished for sale to either the export market or domestic market through retailers.

Production activities—including land preparation, seeding/sowing/transplanting, water management, and harvest—are largely performed manually using family labour. Weed and pest control are typically chemical rather than manual. Following harvest, rice (which is referred to as 'paddy' at this stage, prior to husking) is transported to the family compound, where it is dried, threshed, and cleaned. Families typically retain a portion of their rice harvest for their own consumption and sell their surplus to other households (who will consume it) or local small-scale traders. Traders then transport the rice to local millers where it is husked; then they sell and transport it to large-scale factories where it is milled and packaged for export or retail sale.

The government is heavily engaged in Vietnam's rice sector, with the national ministry (MARD), provincial departments, and district-level departments all engaged in providing extension services to support rice production. At the lower level, communes and cooperatives are directly engaged in rice production. Communes are the lowest administrative unit in Vietnam below a district, and farmers come together under cooperatives within the communes. Most communes have only one cooperative, but there can be more. In Thai Binh, nearly all farmers are members of cooperatives.

Exhibit 1-5. Vietnam's traditional rice value chain



About 70% of Vietnam's rice production is sold for domestic consumption or consumed on-farm (Nghiep, 2017). Vietnam exports about 30% of the rice it produces, with about 60% of those exports going to other Asian countries (of which 55% go to China); nearly 30% to Africa; just under 7% to the United States; and the remainder to Europe, the Middle East, and Oceania (Nghiep, 2017). On average, prices paid for Vietnamese rice on the global market are lower than the global price norm due to its relatively low quality (Nghiep, 2017). In addition to producing relatively low-grade rice, Vietnam's rice exports have suffered disruptions due to the presence of excess pesticide residues. In the first eight months of 2016, for example, the U.S. Department of Agriculture rejected 94 containers of rice and rice

products imported from Vietnam due to illegal pesticide residues (Vietnambreakingnews.com, 2016). This led MARD to put a voluntary temporary hold on further exports of rice to the United States to avoid a U.S. ban on its rice (Customs News, 2016). Likewise, Japan stopped importing rice from Vietnam in 2008 due to pesticide residues, though it subsequently allowed imports from two companies that demonstrated capacity to comply with quality standards. This suggests that there is market potential for rice with reduced pesticide residues and reduced chemical use. Interviews with several stakeholders found some companies are already working to capitalise on the market for safe rice—not just internationally but domestically after a food poisoning scare raised awareness of the issues among consumers in Vietnam.

1.3 Socio-economic factors considerations in rice production and marketing

The socio-economic dimensions of rice production and marketing are likely to influence multiple dimensions of the project; including the development of a market for ERTs, patterns of ERT uptake among farmers, and the benefits that accrue to farmers who do utilize ERTs. Important socio-economic dimensions that we will factor into our evaluation include patterns of industrialisation and economic out-migration, gender roles and patterns, land reform, and collective action. We introduce these themes briefly here.

Thai Binh is a fairly industrialised area, and its residents have access to economic activities that are significantly more lucrative than rice production. Between 1999 and 2011, agriculture's contribution to Gross Domestic Product in the Red River Delta region decreased from 42% to 21%, while industry's contribution grew from 23% to 47% (GSO, 2011, in Khue et al., 2016). Nonetheless, rice production remains an important part of the Thai Binh economy and household livelihoods, and is perceived to contribute in particular household food security and provide some protection against economic shocks (Ellis, 2000, in Khue et al., 2016).

Thai Binh has also been affected by significant outmigration from rural areas by residents seeking greater economic opportunity. Gender patterns of economic outmigration from the countryside to cities vary, but in general, younger and better-educated people leave farming communities to pursue economic opportunity, and older and less-educated people remain. Vietnam has a mandatory retirement age, and rice farming is seen largely as the domain of older people who have little other economic opportunity or people who otherwise have limited mobility (e.g., because they must stay close to home to care for elderly relatives). The population is skewed towards women as age progresses—there are 117 women for every 100 men between the ages of 35 and 64 (United Nations Food and Agriculture Organization [FAO], n.d.; Gallina and Farnworth, 2016). Women also play a primary role as caregivers to elderly family. For these reasons, women are heavily represented among Thai Binh's rice farmers. In general, outmigration has led to shifts in gender roles in agriculture with women taking on the tasks that men had (Lovell, 2016; Gallina and Farnworth, 2016). In rice, men are traditionally responsible for 'heavier' tasks such as ploughing and the application of crop chemicals; women are responsible for seeding/transplanting and crop management; and both men and women participate in harvest and post-harvest activities such as drying (Agrifood Consulting International, 2002). These traditional roles have shifted to accommodate changes in labour availability, and labour-short households have also compensated by hiring labour and participating in community labour-sharing arrangements (Khue et al., 2016).

In addition to their work in rice production, women contribute to their households' livelihoods by earning cash from processing, producing, and selling food, and from small-scale trade activities (many small-scale local rice traders are women) (Agrifood Consulting International, 2002). In general, women have less access than men to farm technology, knowledge about technology, extension advice, savings, and operating capital. Research has shown that the failure to incorporate women in training about sustainable agricultural practices (such as

those relating to ERTs) reduces uptake of those technologies. This is likely at least in part because women are responsible for implementation of some portion of those technologies during rice production. Furthermore, statistics on gender differentials in rural Vietnam reveal that in general, women-headed households have a smaller household size with fewer members of the household at working age. Fewer female-headed households have access to land, and on average those with land have 25% less land than male-headed households, and within that land, less irrigation coverage. Female-headed households also have much lower access than males to all types of agricultural machinery—for example 10.7% of male-headed households have a water pump for agriculture compared to only 1.7% of female-headed households. Female-headed households have lower access to communication and media—for example televisions and phones; and lower access to all sources of agricultural information about all aspects of production and markets. Female-headed households are less likely to obtain loans from nearly all loan sources, and are also less likely to sell rice that they produce. Finally, it is notable that female-headed commercial farmers only account for 4.3% of all commercial farms in Red River Delta, with males heading the remainder.

Land reform has also affected rice production. Prior to a 2010 land reform program, households typically had multiple, very small plots, reducing the efficiency of their agricultural activities. The land consolidation program, based on Decision 72/2010/NQ-HĐND of the Thai Binh People's Committee (Thai Binh People's Committee, 2010), allowed households to consolidate land by facilitating land transactions among neighbours, and further consolidation occurred in 2018. This reduced the number of plots and increased the area cultivated in each consolidated plot, which should have a positive influence on adoption of ERTs.

Another factor important in understanding uptake is the role of collective action. The commune is the lowest level of civic administration in each district. Within each commune in Thai Binh, collective action, in the form of cooperatives and interest groups, is very important: nearly all Thai Binh rice farming households are cooperative members.

Cooperative membership is household-based, and men often represent households in cooperative deliberations, although women may fill in for them depending on availability. The 2012 Cooperative Law led to the establishment of three types of cooperatives in agriculture: Agricultural Services Cooperatives, which provide services related to production and account for 70% of agricultural cooperatives in the country; Agricultural Service and Integrated Business Cooperatives, which include marketing of agricultural products in their service portfolio; and Specialised Cooperatives. A total of 67% of cooperatives distribute inputs, and 60% provide land cultivation services (Loc and Hang, 2015). In general, people tend to speak of 'old' and 'new' cooperative models and perceive the new cooperative model to be more progressive, while the old model is characterised as not very efficient or active. The 2012 Cooperative Law also recognised farmer associations as businesses, enabling them to access credit from banks (Loc and Hang, 2015).

2. Evaluation Question 1: Impact of the project on the market for GHG ERTs

This section describes how we will utilize the Structure, Conduct, Performance (SCP) framework to assess the project's impact on private sector involvement in the promotion of ERTs, and developing a market for these ERTs. Section 2.1 describes the SCP conceptual framework. To apply that method, the team will collect data along the value chain from diverse market actors, including competitors, input and service providers, rice traders and processors, farmers, and sector experts in government and the development community. Section 2.2 describes the data sources and sampling plan. Section 2.3 describes the data analysis.

2.1 Qualitative design

SCP is a theory-based, primarily qualitative approach to value chain or market systems analysis. It links the underlying characteristics of a market to the strategic decisions that market players—including firms, farmers, and consumers—make about whether and how to engage in the market, given their perspectives on the underlying market conditions. The strategic decisions of numerous firms give rise to the market structure, which includes the numbers and characteristics of market participants, the predominant marketing channels, and modes of product transformation and value addition. Together, these factors affect the performance of the market, including such considerations as whether demand for ERTs expands and if performance drivers derive from demand for rice or the demand for inputs associated with rice technologies. While we refer to the overall paradigm as SCP, the specific analytical model that we will use in this evaluation reflects a causal flow from Situation to Strategy to Structure to Performance.

- **Situation:** The underlying, or 'basic' conditions of a market (also referred to as its 'situation') are fixed in the short- to medium-term and include characteristics of supply and demand of a product and its market and the institutional environment. Supply and demand conditions include cost structures, seasonality of demand and supply, income distribution, and buyers' and suppliers' responses to changes in prices and income. Other salient characteristics of a market include the prevalence of information costs and asymmetry and asset specificity, which increase transaction costs and risk. The institutional environment includes both formal (legal) and informal (cultural) controls on behaviour, and is critical to establishing behavioural norms that reduce transaction costs and the risks to which potential buyers and suppliers in the market are exposed. Together, these conditions define the incentives and create interdependencies that shape individuals' and firms' decisions regarding whether and how to engage in the market (North, 1990).
- **Strategy:** Individuals' and firms' strategic behaviours reflect their attempts to pursue profit and utility objectives given the constraints imposed by markets' underlying conditions (or 'situation'). Strategic behaviour includes such decisions as whether to invest in production facilities or a new venture; pricing and service delivery choices; whether to register a company rather than continue as an informal entrepreneur; and the choice of institutional arrangements between market actors, such as the type of contract structure.
- **Structure:** A market's structure is shaped by the aggregate decisions of many individual firms. Structural elements include the numbers of buyers and sellers in the market, the characteristics of production and value creation (such as the technological packages that dominate), the degree and types of product differentiation, and barriers to entry and exit. Such structural features tend to evolve over the medium- to long-term and as such are among the basic conditions that influence firms' strategic behaviour.

- **Performance:** The performance of a market can be understood in innumerable ways, but the main elements of interest for the low-emissions rice project include whether a sustainable market for low-emissions rice production technology emerges and whether that market is accessible and appropriate (in terms of physical access, product form, pricing, and quality assurance) to the needs of its buyers.

We will apply the SCP framework to develop and test qualitative hypotheses regarding the effects of the project incentive on private firms' perceptions of, participation, and outcomes in the aforementioned markets.[2] The framework, above, give rises to small, specific questions the team will seek to answer during data collection in order to describe the overall impact AgResults had on private sector involvement in the development of markets for low-emissions rice technologies. Exhibit 2-1 lists these smaller, specific questions and the outcome measures sought to answer those questions. These outcome measures will be used to qualitatively assess the hypotheses.

We will aggregate the data in order to draw conclusions about the market as a whole, but we will also analyse how the development of markets for low-emissions rice and low-emissions rice production technology differ by the major characteristics of the production technologies, the differentiated output characteristics of the rice being marketed, and by the characteristics of the competitors themselves.

Exhibit 2-1. Sub-questions and relevant outcomes for Evaluation Question 1

Evaluation Question 1: What has been the project's impact on private sector involvement in the development and uptake of markets for ERTs and their product?	
Sub-question	**Relevant outcomes**
Basic Conditions What are firms' perceptions of market conditions, and how do those perceptions influence their decisions around engaging in the market for low-emissions rice and its production technologies? How do different value chain actors—particularly farmers, input suppliers, competitors, traders, processors, and buyers—perceive low-emissions rice and low-emissions production technology in terms of its relevance to them and their business models? How does the institutional environment affect development of the low-emissions rice production technology market? What other factors—such as end-market demand, production conditions, and key socio-economic trends—	• Market situation for low-emissions rice production technology and market actors' perceptions of these conditions - Supply and demand conditions for low-emissions production technologies - Transaction costs and risk in low-emissions production technology markets - Perceptions of price and volume parameters underlying entry and sustained participation in markets - Existence of enabling legislation for development of low-emissions rice production technology and output markets

[2] The SCP paradigm is a product of the Industrial Organisation school of economics (Caves, 1972; Scherer and Ross, 1990). The use of SCP as an evaluation tool was pioneered by John Holtzman of Abt Associates (Holtzman, 2003). The seminal SCP framework delineates how underlying conditions in a market influence its structure, which in turn influences individual firms' conduct in the market (such as decisions to invest in new market segments and technological and organisational decisions). Individual firms' decisions, at an aggregate level, lead to market performance outcomes of interest such as the adequacy of a product's supply in terms of volume and quality, prices, returns to investors, and responsiveness to consumer demand. Building on the basic SCP framework, Sutton (1992) introduced the practice of examining how endogenous and exogenous sunk cost investments influence industry structure. This approach, which we will apply in the current analysis, recognises that firms' strategic conduct is a direct response to market conditions and that aggregation of the outcomes of firms' strategic behaviour gives rise to market structure. The paradigm thus follows the logical progression from situation (basic or underlying market conditions) to strategy to structure to performance.

Evaluation Question 1: What has been the project's impact on private sector involvement in the development and uptake of markets for ERTs and their product?	
Sub-question	**Relevant outcomes**
indirectly influence demand for and supply of low-emissions rice and its production technologies?	- Activity of institutional buyers (including government) in low-emissions rice production activities, technology, and rice markets - End-market demand and other exogenous factors as relevant
Strategy • What drives the decision of different market actors to buy or supply improved low-emissions rice and/or its production technologies? • What are procurement, value-addition, merchandising, and distribution strategies for low-emissions rice and its production technologies (as relevant to different market actors)?	• Market strategy for low-emissions rice production technology by market actors - Drivers for decisions to buy or supply low-emissions rice production technology - Procurement, value-addition, merchandising, and distribution strategies for low-emissions rice and its production technologies
Structure • How are low-emissions rice production technologies and the low-emissions rice value chain structured in terms of product movement through the market? • How many private sector actors of different types participate in the market? • What volumes are transacted by different types of market actors? • What technologies, organisational arrangements, and logistical arrangements predominate? • What is the pattern of women's participation in the value chain?	• Low-emissions rice production technology market structure - Flow and types of low-emissions rice production technology through the value chain - Number and types of private actors who participate in the market - Volume and share of volume transacted by different value chain actors - Technologies and logistical arrangements predominant in the market - Difference in how women participate in the low-emissions rice production technology value chain, particularly at the production level
Performance • Does a sustainable, private sector-driven market for low-emissions rice production technology and low-emissions rice exist? • Is low-emissions rice production technology accessible (in terms of availability and price) to diverse producers? • Do farmers perceive benefits from use of low-emissions rice technology? • What are farmers' experiences with different distribution modalities (e.g., ag-input suppliers versus organisational or institutional suppliers) of low-emissions rice production technologies? • Does the market disadvantage or otherwise affect specific stakeholders, such as women or other vulnerable groups?	• Market performance - Existence of market volume and quality to support sustained low-emissions rice production technology trade - Returns and perception of benefits of engagement in the market - Ability of vulnerable groups such as farmers and women to participate in and benefit from the market

2.2 Qualitative data collection

To analyse the market for low-emissions rice technologies both before and after implementation, we will conduct interviews with project competitors, input suppliers, farmers, cooperative and commune representatives; downstream rice value chain players, including traders, processors, exporters, and retailers; and other sector experts in government, non-governmental organisations, or the donor community. We collected baseline data beginning in June 2018 and will collect endline data in January 2021. Within each community, we will speak to farmers, capturing diversity in terms of gender, scale of production, and exposure to low-emissions rice production systems. We will also interview commune and cooperative leaders. We will identify candidates for data collection in consultation with competitors and local extension officers, and through referrals solicited within the community. We will also incorporate results from analysis under Evaluation Questions 2 and 3, particularly to help enrich our documentation of the market's structure and performance.

To enable qualitative comparison with a push initiative, we will complement our data collection in Thai Binh with corresponding data collection in Nam Dinh, where a USAID-funded 'push intervention' has been implemented by Winrock since 2012. This initiative under the USAID-funded Vietnam Forests and Deltas program works through Nam Dinh's local Agricultural Extension Centres to refine and disseminate improved rice production practices; in particular, the One Must, Five Reductions system. While emissions reductions are among the benefits of the Vietnam Forests and Deltas program, but are not its primary focus, the two programs have many concrete benefits in common. As we discovered from interviews with farmers, community leaders, and project staff during our Initial Qualitative Assessment, these benefits are the dissemination of these technologies leading to improved farmer yields and livelihoods, as well as associated emissions reductions. The commonality suggests that careful qualitative comparison of the programs can still offer substantial insight. From this comparison, we will learn about the relative strengths and weaknesses of push versus PfR approaches in increasing farmer uptake of low-emissions rice technologies.

Exhibit 2-2 provides the sample sizes for each type of respondent for the endline survey. The sampling plan is designed to ensure representation of the different competitors, and includes two communes per competitor, for a total of 8 communes in the treatment group. We selected four and two communes, respectively, in the Thai Binh control area and in Nam Dinh.

Exhibit 2-2. Sampling plan for Evaluation Question 1

Respondent group					Sample size
National-level sample					
Phase 2 competitors					4
Advisory Council members and verifier					All members
Other sector experts					5-7
Traders, processors & exporters					7-10
Commune-level sample					
	Thai Binh Treatment		Thai Binh Control	Nam Dinh Control	**Total**
Communes	8		4	2	**14**
Within commune sample					**Total**
Commune leadership	1		1	1	**14**
Cooperative leadership	1		1	1	**14**
Farmers	4		4	4	**56**

Note: The farmer sample is also replicated in Section 3.2 Exhibit 3-1.

We will employ ‘best practices’ in qualitative research to ensure the robustness of our qualitative methods. These include ‘naïve’ questioning approaches (rather than ‘leading’ questions which introduce bias), triangulation of data sources (for example, seeking information from multiple levels of the marketing chain to obtain diverse explanations of phenomena), and careful documentation of the evidence supporting results (Yin, 2003). To track the development of the market throughout the life of the project, we will monitor implementation through regular communication with the Project Manager and the Secretariat. We will review data on competitors’ activities from the project’s monitoring system.

Much like quantitative research, the validity of qualitative research is also bolstered by leading with theory-based models (such as the SCP framework), as well as actively seeking out disconfirming rather than confirming evidence. These best practices will allow for nuanced exploration of diverse factors, such as those identified above, which might also affect the project’s outcomes of interest.

2.3 Qualitative data analysis

We will record most data using audio recordings (with respondent permission and following best practices to ensure integrity of the data) or, where necessary, verbatim notes. We will clean, code, and analyse data using Microsoft Excel and SPSS. Analysis of qualitative data begins with coding, i.e., flagging pieces of data that relate to a theme or concept of interest (thematic codes) or to a specific evaluation question, sub-question, or objective (structural codes). The codes will be informed by *a priori* concepts that the project theory of change, SCP framework, desk research, and the Initial Qualitative Assessment suggest will factor into the success of the project but adapted to incorporate additional themes that emerge during review of the data. We will apply this deductively developed codebook to enable content analysis, a form of text analysis that enables hypothesis testing (Bernard, 2006).

We will analyse data on market structure using descriptive statistical methods. For example, for sales and production data gathered from the project’s monitoring system, we will present descriptive statistics and comment on the implications of any observed trends over time.

We will analyse data from key informant interviews using pattern analysis, in which we will evaluate preliminary hypotheses on the basis of field results to ascertain patterns and divergences among similar market actors. The analytic process and interactions with the team’s in-country staff will facilitate an active search for disconfirming evidence and alternative explanations for observed outcomes, and we will further investigate results that do not align with the hypotheses.

3. Evaluation Question 2: Impact of the project on ERT uptake and GHG emissions

This section describes how the evaluation team will use a random assignment design to estimate the impact of the project on ERTs for rice cultivation and the impact on GHG emissions. Section 3.1 describes the random assignment design. The team will use qualitative research to understand the 'how' and 'why' of low-emissions rice technology uptake among farmers by assessing their knowledge and practice around the new technologies. Section 3.2 describes the qualitative approach, data sources, and sampling plan. Section 3.3 describes gender considerations in both the random assignment design and the qualitative approach.

3.1 Random assignment design to estimate impact on ERT uptake and GHG emissions

In July 2018 the evaluation team randomised all non-urban communes in Thai Binh that had not already participated in Phase 1 to the following two study arms:

- PfR treatment communes (205)
- Control communes (50)

In the PfR treatment communes, AgResults competitors are eligible to earn prizes based on their actions to increase farmers' uptake of Phase 1 technologies, increase yield, and reduce emissions. In contrast, competitors cannot earn any prizes for their actions in the 50 control communes until the end of Phase 2. Competitors are not restricted, however, from conducting any business in any of the Thai Binh communes.

The randomised prize restriction is feasible given the verification protocol, which uses geo-referencing to gather yield and cultivation practice data on individual farmers with whom competitors engage. This approach cannot ensure that prize-induced promotion of ERTs will *not* take place in the control areas, because competitors are free to engage farmers (and vice versa) according to what is lawful and in each party's business interest. However, the absence of AgResults prize money for technology promotion in the control communes should minimize influence of the AgResults Vietnam Challenge Project in those areas. In other words, it is a randomised incentive design.

This design creates contrasting 'treatment' and 'control' conditions in different parts of the province, allowing us to evaluate the impact of the PfR activity compared to outcomes absent AgResults. An important feature of this design is that *communes* rather than farmers are randomized. Farmers in the same communes share drainage systems. As a result of randomizing at the commune level, competitors can promote Alternate Wetting and Drying technologies without generating impacts in the treatment group that 'spill over' to control group farmers. AWD technologies must be applied by groups of farmers who share an irrigation system. Because most AWD systems would operate among farmers in a single cooperative (usually one per commune), randomising clusters of farmers at the commune level minimises spill-over issues for the impact analysis.

Data collection for random assignment study

Applied GeoSolutions (AGS), the External Verifier for the AgResults Vietnam Challenge Project, will provide emissions estimates for rice plots in the randomised treatment and control communes. We propose to estimate emissions throughout both the spring and summer crops of 2020 from 200 rice plots from 200 distinct irrigation drains in the treatment communes and 100 rice plots from 100 distinct irrigation drains in the control communes. Analysing emissions data from the first Phase 2 rice crop provided by AGS, the evaluation team found that the correlation of emissions (per hectare) of rice plots sharing the same irrigation drain is roughly 0.9. For this reason, the team concludes that there is little value in

collecting data from multiple plots served by the same drain. Rather, it is more advantageous to collect data from plots in many cooperatives, i.e. many drains. We do not yet have complete knowledge of the number of big drains per district, per commune, or per cooperative.[3] However, we know that there can be multiple large drains per commune, and multiple farmers are serviced by the same drain.

To increase the chance that treated areas are in the sample, the team will stratify the sample in both the treatment and control communes based on the commune characteristic most associated with being treated in Crops 1 or 2, and being 'scouted' for Crop 3.[4] In the 50 communes in the control group, we plan to sample 100 drains, and one randomly selected plot within each drain. We plan to sample 200 drains and one randomly selected plot in the treatment group. This design has an 80% chance of detecting an impact if the true impact is equal to or greater than 582 kg of CO_2 equivalent per hectare (a 10 percentage point reduction). Phase 1 demonstrated that correct use of the technologies reduces carbon emissions by average of 4,260 kg of CO_2 equivalent per hectare.

The team acknowledges that this sampling may not necessarily select known, AgResults-treated fields. The AgResults Verifier, AGS, will announce the number of farmers who participated in the project and the assessment of the total emissions reductions from farmers who participated. As Evaluators, we will provide an assessment of the overall impact of AgResults on GHG emissions in Thai Binh rice cultivation, and can also capture positive 'spill-over' effects of treated fields sharing the same drains, and thus ERT-related draining schedule, with fields not specifically adopting the complete ERT package.

For each sampled plot, the team needs to provide details on rice cultivation practices to AGS who will estimate GHG emissions. The particular emissions measure that AGS will generate and which the evaluation team will analyse is *metric tonnes of $C0_2$–equivalent per hectare.* AGS does not measure emissions directly. Instead, AGS uses a scientifically rigorous, tested, and validated simulation model—the Denitrification Decomposition model (DNDC)—that *estimates* emissions based on information about agronomic practices used in rice cultivation along with data on soil type, temperature, and rainfall from global data systems. As input, the model requires several pieces of information about how rice was cultivated on a particular plot of land. As output, the DNDC model provides an estimate of the total amount of $C0_2$-equivalent emitted from that plot during the process of rice cultivation, and also the amount of $C0_2$-equivalent per hectare.

Annex C lists the specific data elements describing rice cultivation practices that AGS requires in order to estimate emissions. These data will also allow the team to determine if any of the four technology packages was used on each of the rice plots it observes.

For each sampled plot, the team needs to obtain details on rice cultivation practices to input into the DNDC model. Obtaining accurate records of rice cultivation at the level of detail required is challenging (e.g., seed type, planting density, percentage of last season's crop still in the field when planting, level of water when planting, type/amount/date of each

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[3] There are two different types of drains in each commune. There are 'big' ('under the dike' drains) as well as small ('inland') drains. From informal discussions with district staff, we know, for example, that Quynh Phu district has 27 communes, 51 big drains, and 299 smaller drains. A typical cooperative in the Kien Xuong district has 3 big drains and 20 smaller ones, although handfuls of communes only have one big drain. We understand the correlation of emissions to be related to the 'big' drain.

[4] This analysis is ongoing. The baseline report found that communes being 'scouted' for crop 1 had a lower percentage of farmers who belonged to a cooperative, had a higher percentage of farmers with large plots of land, had higher average rice yields, and were less likely to have experienced rice leaf-folder caterpillars in the spring of 2018.

fertiliser application, date of each drain/flood event). For reasons related to expense, we have ruled out field observers. For accuracy, we have also ruled out the possibility of asking the farmer after harvest time what his/her cultivation practices were during that season. Moreover, in-field pretesting revealed that many farmers are uncertain about their cultivation schedule because they did not independently manage it or make decisions about it: a large portion rely on real-time guidance from cooperative leaders to provide step-by-step instruction throughout the season. (The team hypothesizes that this practice is rooted in cultural/political history rather than a general lack of knowledge or capability.)

To avoid these challenges, the in-country evaluation lead, Diep Phan, will coordinate a cooperative-level data collection activity similar to the baseline commune survey. To comply with local customs and to obtain local drain information, we will recruit farmers using the following procedure:

1. U.S.-based staff will randomly select which communes to sample from the treatment and control groups.
2. Vietnam-based staff will reach out to the associated cooperative leaders and obtain information about drain locations and farmers serviced by each drain.
3. Vietnam-based staff will randomly select up to two drains in each commune, and from those, randomly select farmers to recruit to the survey.
4. For each field selected, the farmer will fill out a diary in both the spring and the summer crops about his/her rice cultivation practice, receiving incentive payments upon diary completion.
5. For each drain selected, the cooperative leader will fill out a diary describing drain events at that drain, and any rice cultivation directions or instructions issued to farmers in his/her cooperative that season.

The team will ask the cooperative leaders and farmers to fill out pre-annotated diaries, maintaining them throughout the season.[5] The team will send periodic reminders to keep the diaries current. Completed diaries will be rewarded with a small monetary incentive. Annex C displays the English version of the pre-annotated diary. The earliest planting date of which the team is aware is January 28, 2020, and we anticipate recruiting farmers to the sample in the second week of February.

Data analysis for random assignment study

To assess the project's impact on technology uptake, the team will estimate a multivariate regression to test for differences in the proportion of farmers who used any of the four Phase 2 ERTs in the treatment communes to the proportion in the control communes. The sample size described above (100 drains in the control communes, 200 in the treatment) provides an 80 percent chance of detecting a difference if the true difference in uptake is at least 5 percentage points.

To study the project's impact on uptake, the team will estimate a multivariate regression testing whether the cooperative leaders in the treatment group communes were more likely to implement any one of the four technology packages than the control group communes. To estimate the project's impact on GHG emissions, the team will estimate a multivariate regression model. Using this model, we will test for differences in average total emissions per hectare (summed over the spring and summer crops of 2020) between the control group rice plots and treatment group rice plots, controlling for baseline commune covariates.

[5] The diaries are 'pre-annotated' in that they indicate the specific type of details that the farmer should record. Annex C presents the pre-annotated diary.

Secondary analyses will focus on technology spread (explained in adjacent box) and whether impacts on uptake vary by season. To analyse differential impacts, we will estimate a multivariate regression and test for differential impacts on uptake. For example, one commonly held assumption is that uptake is more likely to improve yields in the summer crop, so uptake may be higher in the summer than in the spring.

Technology Spread

Adjacent or neighbouring farmers may be influenced by AgResults farmers to change their rice cultivation projects, and/or they may be affected by the AgResults water management practices. For each commune that a competitor is working, we will have two farmer diaries that provide estimates of those farmers' GHG emissions from rice. So if a competitor is working in 10 communes, we will have 20 farmer diaries corresponding to those communes. We will report what proportion of those farmers seem to have the same technology as that competitor, and also look at their emissions (20 samples is larger than the samples used in Phase 1 to judge effectiveness). We will then compare those 20 farmers' emissions to the emissions the Verifier associates with the competitor's technologies.

3.2 Qualitative study of farmer knowledge, attitudes, and practices around ERTs

To supplement the quantitative impact evidence, the team will use qualitative research to understand the 'how' and 'why' of ERT uptake, production, and sales decisions among farmers. We can evaluate the decision to adopt these technologies from a behaviour-change perspective in which farmers' decisions to utilize ERTs are outcomes of their knowledge and attitudes about it. Knowledge of and positive attitude toward ERTs are necessary pre-conditions for adopting them. Historically, adoption has been sluggish because of the associated behaviour change costs, such as with water management, a key aspect of all the technology packages. Thus, we will interview farmers regarding their awareness of ERTs and their experience using them. We will also explore the factors influencing their awareness and use of ERTs, in conjunction with other important factors such as their practices and preferences around input use, technology uptake, and disposition of the rice they produce, such as retaining it for household consumption versus sale. The 'knowledge' component (also assessed quantitatively) will evaluate whether farmers are aware of key elements of the ERTs; and if they are aware, we will explore the extent of their knowledge about these technologies, particularly their nature and potential agronomic benefits of their use. The 'attitude' component of our inquiry will assess farmers' perceptions of the attractiveness of the ERTs to them and perceived constraints to using them such as ease of access and application, and economic impacts of their use, for example labour implications or market benefits. The 'practice' component will focus on farmers' actual decisions around use of ERTs, and the disposition of rice produced using them such as consumption or sale to different types of buyers that may value ERT-produced rice specifically.

Data collection for qualitative study

The qualitative inquiry will gather data through open-ended questions about farmers' self-reported knowledge, attitudes, and decision-making surrounding ERT uptake and income (these farmers may not be the sub-sample of farmers we interview for the quantitative inquiry). We will use these data to develop our understanding of the 'how' and 'why' of changes detected in the quantitative household survey. Uptake of improved technology packages is far from binary; these technologies are complex, and adhering to their prescribed application can be tedious. Farmers may apply aspects they perceive are most important for achieving higher yields and not others (these are 'imperfect' adopters). To enable the comparative analysis, the team will aim to sample non-adopters, imperfect adopters, and perfect adopters to understand the dynamics behind each group's adoption decisions and the constraints they face. While the qualitative outcomes at endline will not be

directly attributable to the project, the evaluation will nonetheless be able to draw useful insights about how different factors may have influenced uptake and household income, including household socio-economic characteristics, the market for rice, the market for inputs applied as part of the technology packages, farmers' knowledge and perception of technology packages, and household decision-making, among others.

Finally, the team will draw similar data from farmers in Nam Dinh province who were part of USAID's low-emissions rice 'push' program to understand the type of ERTs that the program promoted, the level of uptake of these technologies, and the knowledge and attitudes around them, including constraints and opportunities in adoption. These findings will be contrasted to the corresponding Thai Binh information to compare relative performance of push and PfR initiatives in encouraging farmers to adopt ERTs.

The team will use non-probabilistic, multi-stage sampling to select research participants for the qualitative analysis. We will sample farmers from two communes per competitor, selecting respondents who represent a range of important sub-populations along lines of gender, scale of production, and level of adoption. Exhibit 3-1 displays the total sample size for the treatment group, control group, and push-incentive group. Annex B provides the preliminary semi-structured interview guide.

Exhibit 3-1. Farmer sampling plan for qualitative endline data collection

Type of Household	Number of Households
Treatment (Thai Binh), 4 households per commune, 2 communes per competitor	32
Control (Thai Binh), 4 households per commune, 4 communes	16
Push (Nam Dinh province), 4 households per commune, 2 communes	8
Total	***56***

Notes: These are the same farmers described in Section 2.2 Exhibit 2-2.

Data analysis for qualitative study

The team will use Microsoft Excel and SPSS to organise, code, and analyse the qualitative data.[6] Analysis of qualitative data begins with coding, i.e., flagging pieces of data that relate to a theme or concept of interest (thematic codes) or to a specific evaluation question, sub-question, or objective (structural codes). The codes will be informed by *a priori* concepts that the project theory of change, SCP framework, desk research, and the Initial Qualitative Assessment suggest will factor into the success of the project. We will apply this deductively developed codebook to enable content analysis, a form of text analysis that enables hypothesis testing (Bernard, 2006).

During initial, exploratory data analysis, the team will broadly analyse thematic coded data for common patterns, cultural categories, themes, and outliers related to the topics of interest. After initially exploring the data, we will test hypotheses developed based on the project theory of change to determine if farmers' uptake of ERTs and subsequent outcomes fit the expected pattern and which factors impact ERT uptake and outcomes (e.g., gender, farm scale, type of technology).

3.3 Gender considerations

Our assessment of potential gender-differentiated effects of AgResults' impact will focus on inter-household—particularly patterns of uptake of GHG ERTs and how these, and the costs and benefits associated with them, differ on the basis of "gendered household structure" (the

[6] Due to resource constraints, the evaluation team will primarily code notes taken during data collection, audio recordings of interviews, photographs, and short videos rather than coding transcripts.

composition of a household with respect to age and gender, with reference to socio-economic and cultural context) within and among communities. We will also look at intra-household distribution of roles, responsibilities, and control over productive resources—including labour—and their output (such as rice or revenue from agricultural sales) as these relate to the uptake of GHG ERTs.

Given the considerations outlined in Section 1.3, the team does not have *a priori* hypotheses about how uptake of ERTs may be differentiated by gender. We will explore gender-based differences in these critical outcomes using both quantitative and qualitative methods, collecting data on gendered household structure and on intra-household roles and responsibilities in production, marketing, and decision-making regarding rice production and sales. We will use our qualitative inquiries to enrich our understanding of these issues and to identify any other unanticipated, gender-differentiated outcomes at the farmer level.

4. Evaluation Question 3: Impact of ERT uptake on farmer incomes

One of the objectives of the project is for the new technologies to increase yield while reducing GHG emissions. In fact, competitor farmers' yield increases are weighted as importantly as GHG emissions reductions in calculating Phase 2 prizes (see Section 1.1 for more detail). Project competitors consistently claimed that their technology packages would increase profitability of rice production by reducing farmer expenditures on chemical inputs without concomitant sacrifices to yields (Abt Associates, 2019b). In many cases, these competitors also reported that their technology packages would increase farmer yields, and in a few cases, competitors planned to provide farmers with better prices for the rice. The degree to which these expectations are borne out will greatly affect the technology packages' attractiveness to farmers.

However, the increases in yield are not necessarily linked to expected increases in income (Deloitte 2019), even taking into consideration the drainage costs subsidies and heavily discounted fertilizer prices competitors offer to participating AgResults farmers. Moreover, yield increases can be associated with either positive or negative impacts on income, depending on production costs and market demand for additional harvest. Economic theory posits that has supply increases, per unit prices generally decrease.

Section 4.1 describes how the team will use a quasi-experimental design with a matched comparison group to estimate the impact of ERT uptake on farmer income. Section 4.2 describes the qualitative methods the team will use to interpret the impact estimates on farmer income, and Section 4.3 describes gender considerations.

4.1 Matched comparison method

The evaluation team will use a quasi-experimental design to focus on the impact of adoption of farmer income, rather than using the available experimental design to estimate the impact of the project at large on farmer income. Notably, the evaluation will not estimate the impact of *the program* on average farmer income. The reason for this choice is we fully expect that changes in average farmer income would not be detectable in a random sample of farmers in the treatment and control communes, owing to low uptake rates. In 2019, 7,970 farmers had participated in the project although many of those farmers co-farm, i.e. work on the same field(s). The project requires that competitors each reach 4,000 farmers in order to be eligible for the grand prizes at the end of Phase 2. Even if competitors triple the number of engaged farmers in 2020, less than 7% of farmers in the treated communes will have participated.The baseline survey data found that there are 361,972 farmers in the treatment group.

The evaluation team will compare net income from rice for AgResults farmers in the treatment communes to net income from rice of a matched comparison group of farmers. For the same groups of farmers, we will also compare rice yield. We will select comparison farmers from the 44 cooperatives located in the 50 communes randomly assigned to the control group.[7] Instead of selecting comparison farmers randomly from the control group communes, we will mimic the selection criteria that each of the four competitors used to select farmers in treatment group communes. Farmers selected by aggregators will naturally differ from non-selected farmers on a range of factors that the evaluators cannot observe and that may independently influence outcomes. The impact evaluation must account for these unobservable factors that affect which farmers competitors select to receive the

[7] The RCT Adherence Report, written after this report, explains the selection of the 44 cooperatives, which were selected because they are similar to the cooperatives in which AgResults competitors worked in Crop 3.

project ‘treatment’, so the influence of those factors on outcomes is not mistakenly interpreted as the impact of the project, thus creating ‘selection bias’ in the findings.

To address selection bias, we will select comparison communes from the control group that are similar on baseline characteristics to communes selected by the competitors. Within the sampled comparison communes, we will select farmers using the criteria applied by each individual competitor to select farmers. Three competitors first selected the land area that was flat, contiguous, and irrigable. They later convinced farmers associated with that land to join the program. One competitor focused on finding the most serious rice farmer or farmers that grow for sale and farmers who have larger than a 300-meter area under rice. Using field research conducted in May 2020, our *RCT Adherence Report* will outline the details of the comparison commune and farmer selection.

After the farmer survey is conducted, we may refine the matched sample using statistical methods to enhance the equivalence of the treatment and comparison group with respect to soil type, elevation, GIS information on historic temperature, rainfall, and data on commune-level and farmer-level baseline characteristics that we have for all farmers in Thai Binh. We will prioritize the matching on variables that we know as the most influential confounding factors of income– rainfall, elevation and baseline rice production.

The impact of the intervention is expected to vary by competitor because they differ in the technologies they promote and the way in which they share information about the technology with the farmers. They differ particularly in how much training they provide to farmers and how much of the project’s monetary prizes they share with the farmers—both of which can lead to very different impacts. The overall focus of the quantitative evaluation is on the impact on the ‘average’ farmer in Thai Binh who adopts any of the technologies, rather than estimating the impact of adopting a particular technology. The sample of farmers will be stratified by competitor, and in proportion to the percent of AgResults farmers working with that competitor in Crop 3.[8] Our qualitative research will draw out the differences between competitors and their technologies to draw contrasts in their engagement and incentives offered to farmers.

Data collection for matched comparison study

We will conduct two large-scale farmer surveys, one at the end of each rice crop season in 2020. Using farmer recall, the survey will gather information on rice sales, associated costs of production including labour, and input costs. This will help us measure the net income from rice. We will not measure total farmer income, as that endeavour would greatly lengthen the survey, but we will ask questions about the extent to which they agree with the statement that “income from rice farming is a significant proportion of my household’s annual income” (or something similar, as tested in the pre-test).

The survey will also collect data on intermediate outcomes that would affect income, including knowledge of the technology, technology uptake, and rice yields.[9] Annex D provides a draft farmer survey instrument.

Our proposed sample size—shown in the shaded row of Exhibit 4-1—provides an 80% chance of detecting a significantly positive impact on income if the true impact is a 7.8% increase in income, and a greater than 80% chance of detection for a larger actual impact. It offers an 80% chance of detecting an average impact of 0.7 MT/hectare on yield (a 10.6%

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[8] Our *RCT Adherence Report* will describe this stratified sampling plan using detail gleaned from May 2020 field work.

[9] The survey will measure rice yields based on farmer recall and area of the field. The evaluation will measure the area of the field using GPS.

increase over control group mean), and a greater chance for a larger actual impact.[10] This proposed sample size provides the right balance between the cost and the ability to detect impacts. Doubling the number of farmers in each commune, for example, does not provide sufficient additional statistical power to warrant the expense (a reduction of 1 percentage point in the minimum detectable impact on net revenue). The increase in statistical power by doubling the number of farmers does not provide as much additional value as the exercise of conducting the data collection for each of the two crop seasons in 2020, which allows two possible chances to detect meaningful impact. The other rows in Exhibit 4-1 illustrate the trade-off between the ability to detect impact with varying sample sizes.

Exhibit 4-1 shows the sample size needed to detect statistically significant differences between treatment and control groups. These are the same sample sizes we would need to detect statistically significant differences between competitors. We would need a sample of 2000 farmers (1000 in each competitor) to give us an 80 percent chance of detecting a statistically significant difference in average net income between two competitors if the true relative difference is 7.9%. It is not feasible to sample 1,000 AgResults farmers for each competitor. Studying subsets of farmers in the sample of 1,000 AgResults farmers *in total*, a hypothesis test to examine whether differences between competitors are significant will not have sufficient power. That said, we can report the average net revenues by competitor and conduct descriptive comparisons between the competitors.

The power analysis assumes we will use linear regression to study outcomes. Additionally, the analysis relies on several assumptions about underlying variation in the data, for which we turn to a survey of rice farmers Abt conducted under contract with USAID to study uptake of low-emissions rice technology in Thai Binh (Belova et al., 2013). This survey provides data on uptake of low-emissions rice technologies, yields, revenue, and income for rice farmers in the same geographic region as the 2014 AgResults Vietnam Challenge Project. The data suggest that we should assume an average yield of 6.6 MT per hectare in the control group and average net revenue from rice of 4,406,000 VND ($190 USD).[11]

The samples sizes in Exhibit 4-1. Minimum detectable impacts for various sample sizes correspond to the analysis sample at each of two time points. At each of these time points, we will be selecting matched samples of treatment and comparison farmers from the pool of treatment and comparison farmers that have valid outcome measurements. There will not be any missing baseline data, as there are no farmer-level baseline data for this study. We expect that the two matched samples (from July 2020 and November 2020) will mostly or entirely overlap. Where households from the first round are unreachable or uninterested in second round, we will recruit additional households.

For quantitative data, Abt will contract with a firm to collect data electronically using tablets or smartphones and a to-be-determined survey software package (likely SurveyCTO, SurveyBe, or SurveyToGo). The firm will script not only the survey questions and response options but also data quality control mechanisms—such as range checks and skip patterns—to reduce data entry error. Additionally, field supervisors will perform back checks for a minimum of 10% of households interviewed as well as sit-ins to observe at least 10% of interviews. The Abt team and field supervisors will review data daily during the survey period for accuracy, consistency, and adherence to the sampling plan. The data collection firm and the Abt team will then upload data to secure servers and prepare it for analysis by

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10 For each case, we tolerate a 10% chance of a Type I error (a false positive).

11 The data used as input to the power analysis provides different means from those found for treatment farmers in Crop 1 of Phase 2. In Crop 1 of Phase 2, the average yield was 5 MT per hectare. The expected average net income from rice is $171, $638, $301, and $36 for each of the four ERTs, respectively (AgResults Secretariat, 2019).

generating outcome measures of interest (e.g., net income, yield given the farmers' responses.

Exhibit 4-1. Minimum detectable impacts for various sample sizes

Minimum detectable impact		Sample size, by experimental arm				
Detectable percent increase in yield	Detectable percent increase in net revenue from rice	Number of farmers per cooperative	Number of treatment group cooperatives	Number of control group cooperatives	Total number of cooperatives	Total number of farmers
8.7%	6.4%	106-107	50	44	94	10,000
9.2%	6.9%	53-54	50	44	94	5,000
9.5%	7.1%	42-43	50	44	94	4,000
10.0%	7.4%	32	50	44	94	3,000
10.7%	7.9%	21-22	50	44	94	2,000
12.8%	9.5%	10-11	50	44	94	1,000

Note: Assumes a .10 significance level in a two-tailed test with 80% power, a mean and standard deviation of yield of 6,605 kg/hectare and 4,705 kg/hectare (analysis of data from the Belova et al., 2015 study), a mean and standard deviation of 4,406 K VND and 2,328 K VND (analysis of data from the Belova et al., 2015, study), and an ICC across communes of 0.12, a cluster-level R squared of 0.6 and a farmer-level R squared of 0.1. Originally, we planned to sample an even number of cooperatives in the treatment and comparison groups. We found that to protect against commune selection bias, we should not sample from all 50 control communes as originally planned. Please see the *RCT Adherence Report* for a detailed explanation.

Farmer survey data analysis

To compare the mean outcomes for farmers in the treatment group to the mean outcomes of the farmers in the matched comparison group, we will use a regression model that includes baseline characteristics as covariates and, if appropriate, fixed effects associated with the coarsened exact matching model. As covariates, we will use baseline information about the communes: their population density, soil type, road connections, irrigation systems, and perhaps other geographic descriptors, as well as a limited set of farmer baseline characteristics provided as recall data in the endline survey.

We will conduct a statistical test to determine whether any regression-adjusted mean difference in outcomes between treatment and control farmers is statistically significant, i.e. where there is a 10% likelihood of a false finding. To conduct valid inference on the estimated impact, we will need to take into account that geographically proximate groups of farmers might have correlated outcomes. In particular, we view farmers in the same cooperative as likely to have correlated outcomes because they share a knowledge network, common soil quality, similar rice management systems, and possibly other common unobservable factors. We will account for this correlation by estimating cluster-robust standard errors.

To summarise, the regression model will have the form suggested in Equation [1], where the treatment indicator T_j is equal to one if the farmer participated in AgResults, and zero otherwise. The estimate of β measures the average impact uptake on outcome *Y*. Each farmer *i* obtains outcome Y_{ij}. *Z* represents the commune-level covariates, such as the temperature or soil composition, for cooperative *j;* X represents the farmer-level covariates; S represents fixed effects for the matching strata; and *γ (gamma)* and δ $(delta)$ represent the average impact of covariates on the outcome. There is also an individual idiosyncratic error term, ε_i.

$$Y_{ij} = \alpha + \beta T_j + \gamma Z_j + \delta X_i + \varphi_s S_i + \epsilon_i \quad [1]$$

We will estimate a linear model where the dependent variable is a continuous variable measuring the net revenue from rice. In addition we will also estimate a model with yield, awareness as the exploratory outcomes. The coefficient on the treatment dummy, β, above will give the estimated impact on uptake of low-emissions rice technology or other outcome.

To evaluate the internal validity of the model, we will report the mean and standard deviation of commune-level baseline characteristics in the treatment and control groups for all regression models that we analyse (i.e., pooled across all competitors). This "baseline equivalence" analysis will indicate which baseline characteristics differ between the treatment and control groups at a statistically significant level; we will discuss the implications of any that do. We will also include in the impact regression model any baseline variable that differs significantly between the treatment and control group for a given sample, in addition to including the baseline variables we expect to be important determinants of the outcome of interest in their own rights.

In addition to reporting the overall average treatment effects, the team will estimate treatment effects for female-headed households. Female-headed households may experience different intervention impacts. We have not built the outcome survey sample at a scale providing for confident analysis of subgroup-specific effects, given that we can use only a portion of the data for each examined subgroup. Therefore this analysis will be exploratory. If the sample size allows, we will also consider impacts by competitors and therefore technology types. An additional exploratory analysis we will conduct is to assess the program's impact on female household labour hours used for producing rice. There are indications that some of the labour will be reduced, but other activities might increase female labour. We will estimate the overall impact of the new technology on female labour burden.

4.2 Qualitative study of farmer income

To obtain a nuanced understanding of farmers' costs and revenues from rice, and their associated drivers and uncertainties, we will supplement the presentation of the results of the matched comparison design with insights from the qualitative interviews with a small sample of farmers. Section 3.2 of this report describes the sample size, and Annex B provides the preliminary semi-structured interview guide. The guide includes questions about farmer production and sales decisions, and the analysis will help us understand how farmers' decisions to grow, sell, or consume a crop are outcomes of their knowledge and attitudes about rice cultivation. We will study how farmer knowledge and attitudes motivate and constrain those decisions.

We will also conduct exploratory correlational analysis of the diary and income survey data (which has both revenue and cost information) to explore which aspects of each technology package are the most expensive for farmers to adopt. To allow for this analysis, the farmers completing the diaries will be among the farmers recruited to participate in the income survey.

4.3 Gender considerations

Given the considerations outlined in Section 1.3, we do not have *a priori* hypotheses about how effects on yield and income may be differentiated by gender. We will explore gender-based differences in these critical outcomes using both quantitative and qualitative methods, collecting data on gendered household structure and on intra-household roles and responsibilities in production, marketing, and decision-making regarding rice production and sales. We will use our qualitative inquiries to enrich our understanding of these issues and to identify any other unanticipated, gender-differentiated outcomes at the farmer level.

5. Evaluation Question 4: Impact of the project on poor consumers' demand for derivative products

The AgResults Vietnam Challenge Project does not seek to increase consumption of 'low-emissions rice'; rather it is a supply-side project oriented to affecting production methods for rice with the objective of reducing GHG emissions and farmer yields. Some competitors may capitalise on the demand for high-quality rice, speciality rice, and even latent demand of consumers to have 'safe rice' or rice grown with fewer chemical inputs. However, these projects are not marked to poor consumers and there is no authorized, standardized, and audited label for low-emissions rice. If there are any developments that lead competitors to create a low-emissions rice product, and create demand for it, the SCP framework used for Evaluation Question 1 will uncover this fact and assess the market for low-emissions rice products.

6. Evaluation Question 5: Evidence for sustainability

To evaluation the project's sustainability, we will draw on results of Evaluation Questions 1 through 3. In particular, we will examine whether at the end of the project, conditions are right for any market developments to continue after direct project incentives stop—that is, whether preconditions for a sustainable market have been established. Qualitative contributions to the evaluation of sustainability will come from the SCP, and will focus on whether basic conditions are present that provide incentives for continued private sector and farmer engagement in the market. We will also conduct a 'sustainability' survey several seasons after the end of the project to assess whether farmers from the randomised incentive design's treatment group are continuing to use ERTs.

In the AgResults context, sustainability means the project has initiated significant contributions to its motivating development goals *that continue after the project has concluded*. Assuming a positive initial impact, the sustainability of the Vietnam project will depend on whether market developments the project has stimulated remain in place after cessation of the direct project prize incentives; that is, whether preconditions for a sustainable market have been established.

Qualitative contributions to the evaluation of sustainability will come from the forward-looking hypothesis from SCP, and will focus on whether the basic conditions that provide incentives for continued private sector and farmer engagement in the market would sustain the market. These include:

- Whether actors engaged in ERTs (including farmers) say their engagement is adequately rewarding to want to sustain it following the conclusion of the project
- Whether there are other exogenous factors that will affect the sustainability of the project's effects, such as evolving demand or changes to the enabling environment.

The team will also evaluate market actors' actual behaviour, their perspectives on the viability of the market, and their intentions for continued engagement in the market after the project ends. Specifically, we will:

- Assess the economic incentives to adopt key technology components, particularly those that are tied to GHG emissions reduction
- Assess competitors' expected engagement with the technologies after the project concludes
- Ask market actors about their interest and intentions around continuing production and marketing of technology packages
- Inquire of market actors what conditions they see as necessary to successfully carry out their plans and their assessments of the likelihood that these conditions will be fulfilled in the future.

Exhibit 6- summarises key evaluation methods and the key outcome measures to answer Evaluation Question 5. The team will collect data from private sector actors and farmers, and other industry experts in the development community as well as from other public and private stakeholders. The in-country agricultural economist, who is responsible for conducting the questionnaires, will compile the results. The qualitative lead will analyse and report the data in conjunction with the in-country agricultural economist.

The team will also use quantitative information to address this evaluation question. To track events beyond the farmer survey, if possible, we use secondary data on project-related outcomes (particularly on farmer uptake of ERTs and on their rice-related income). One potential source of data is provincial agricultural data. Examining these data after the project's end to determine the uptake of ERTs by farmers will be a cost-effective way to

gauge the sustainability of the project, assuming that data collection continues at regular intervals and the data are made available to the evaluation team.

Exhibit 6-1. Evaluation methods and outcome measures for Evaluation Question 5

Evaluation Question 5: What evidence exists that the effects of the AgResults projects will be sustainable in the medium to long term?	
Evaluation method	**Outcome measures**
• SCP analysis • Analysis of farmer uptake and income effects (Evaluation Questions 2 and 3)	• Farmers' perceptions of the attractiveness and likelihood of continued use of ERTs • Suppliers' perceptions of the attractiveness and likelihood of continued engagement in the technologies following cessation of the project • Consumer demand for safe rice or, if a market develops, low-emissions rice • External factors that might impact uptake of ERTs

7. Evaluation Question 6: Cost-effectiveness

To provide evidence describing the project's scale and cost-effectiveness, we will determine the scale of uptake of ERTs. In particular, we will investigate the extent to which the technology is used in Thai Binh province, and to which it expands beyond the province. We will assess the cost-effectiveness of the project at endline when the total project costs are known, by estimating the cost of the project per unit of impact (on farmer uptake and on rice income) measured in response to Evaluation Questions 2 and 3.

This question involves two separate but related elements: scale and cost-effectiveness. We will determine the scale of project impact on private sector investment and uptake of ERTs by drawing on the results of the SCP analysis, used in Evaluation Question 1. In terms of scale, we will consider if the technologies have been adopted province-wide. Market structure estimates from the SCP will provide information on the numbers and characteristics of private sector investors and participants in the value chain.

We will also examine the project's cost-effectiveness, an important question in its own right to assess the PfR approach as a use of donor funding. Cost-effectiveness is also important for scaling up. Central to the motivation behind the use of incentive-based PfR initiatives is the expectation that they will be more cost-effective than traditional development interventions, and hence more scalable. The private sector, it is argued, can be closely attuned and responsive to the needs of agricultural markets if the sector's incentives align to support development of those markets. However, incentive-based mechanisms have not yet been applied to any significant extent in agricultural development programming, so evidence about their cost-effectiveness is as yet unavailable.

The team will compute the cost-effectiveness of AgResults at endline once the total project costs are known. Cost-effectiveness is measured as a ratio, cost per unit of impact (e.g., the cost incurred for a farmer to adopt ERTs). Its determination will require estimates of both cost and project impact. We will use as the numerator the gross cost of the project, and as the denominator, the results of our analysis for Evaluation Questions 2 and 3; namely, measured change in uptake of low-emissions technology by farmers and any attendant increase in farmers' rice income. The gross costs of the project will be based on the Project Manager's actual project expenditures throughout the project's duration using project monitoring data. The gross costs will exclude the cost incurred by the Secretariat only because these costs were not available to the evaluator. The project expenditures will cover incentive payments, verification procedures, and other expenses incurred in the course of project implementation.

We will also compare the cost-effectiveness ratio of a given project to that of other AgResults projects. This will not be a cost-benefit analysis—that is, we will not assign a monetary value to changes in the affected agricultural markets and will not compare the projects' overall value in dollars to their costs. Comparisons of AgResults' cost-effectiveness results to the findings for other interventions outside AgResults will include adjustments so that costs are expressed in comparable dollars when measured in different years. In

addition, the cost-effectiveness analysis will include sensitivity tests for alternative discount rates.

Exhibit 7-1 summarises the evaluation methods and key outcome measures to answer Evaluation Question 6.

Exhibit 7-1. Evaluation methods and outcome measures for Evaluation Question 6

Evaluation Question 6: What is the evidence on the scale of any effect on private sector investment and uptake, and the cost-effectiveness of AgResults as an approach?	
Evaluation methods	**Outcome measures**
Scale of private sector investment and uptake	
• SCP market analysis	• Market linkages, interest, and scale of investment in low-emissions technology packages
• Cost-effectiveness • Cost-effectiveness analysis comparing cost against outcomes of the project	• Cost per unit of uptake of ERTs • Cost per unit reduction in 1MT CO2E • Cost per $100 increase in annual net income from rice

8. Evaluation Question 7: Lessons learnt

To identify best practices and lessons learnt, we will synthesise results from Evaluation Questions 1 through 6 to determine in what respects the project intervention worked well and where it fell short. Using a common framework across all AgResults Challenge Projects, we will also identify and draw lessons from the design and contextual conditions that influenced the project's outcomes and relate what has happened in Vietnam to the learning from the other AgResults Challenge Projects. Specifically, we will generate lessons along the key elements of PfR approaches as outlined in the first lessons learned brief (Mainville and Narayan, 2017).

9. Management

9.1 Implementation timeline

This section presents the timeline for all major activities in the AgResults Vietnam Challenge Project evaluation plan. Prior to writing this report, the team completed the initial qualitative assessment and baseline survey of commune-level characteristics, which are both part of our Phase 2 evaluation. The next steps are the GHG emissions data collection (household diaries), the household-level income survey, and qualitative data collection. Exhibit 9-1 illustrates the timeline for these activities.

- The GHG emissions data collection makes use of household diaries. Farmers will be recruited in February, 2020, to maintain diaries for both their spring and summer crops in 2020.
- The household-level income survey will be fielded a few weeks after harvest in both the spring and summer crops of 2020. This timing allows the farmer to have sold his harvest so that the survey can collect information on sales revenue.
- The qualitative data collection will take place in January, 2021, to allow for the possibility of informing both what happened in the last two crops of the project, and also the likelihood that any project impacts are sustainable.

Exhibit 9-1. Evaluation timeline

Vietnam Challenge Project and evaluation timeline

Phases	**Phase 2, Crop 1 (January 2019)**	**Prize awards**	**Phase 2, Crop 2 (July 2019)**	**Prize awards**	**Phase 2, Crop 3 (January – May 2020)**	**Prize awards**	**Phase 2, Crop 4 (July – October 2020)**	**Final prize awards**
Project Activities	First rice planting season of Phase 2 begins		Second rice planting season of Phase 2		Third rice planting season of Phase 2		Summer 2020 or July 2020, beginning of the fourth rice planting season of Phase 2	
Evaluation Activities					Farmer diary for emissions study, Crop 3	1, 2	Farmer diary for emissions study, Crop 4	3 4, 5

Evaluation milestones

1	RCT adherence report, middle of Crop 3
2	Farmer income survey, end of Crop 3
3	Farmer income survey, end of Crop 4
4	Qualitative data collection
5	March 2021: Evaluation report presented at Steering Committee meeting.

9.2 Deliverables and communication plan

We will continue to provide an update on the evaluation at each semi-annual Steering Committee meeting. We will post key evaluation updates and reports on the AgResults website following DFID approval, and where relevant on the Abt Associates website and

social media (e.g., Facebook, Twitter). We will submit the endline report to DFID for formal review, after which they will be posted on the DFID external website.

9.3 Evaluation risks and mitigation approach

The risk of collecting biased or poor-quality data exists in every evaluation. To avoid this, we will employ a number of safeguard measures and data collection best practices. For quantitative data, we will use an electronically scripted survey instrument with built-in skip patterns and range checks to reduce data entry error. We will observe interview administration in select instances and back-check at least 10% of interviews. Both Abt and our survey sub-contractor will review data at least weekly during data collection to ensure accuracy, consistency, and adherence to the sampling plan. For qualitative data, we will use 'naïve' questioning approaches (rather than 'leading' questions, which introduce bias), triangulation of data sources (for example, seeking information from multiple levels of the marketing chain to obtain diverse explanations of phenomena), and the careful documentation of the evidence supporting results (Yin, 2003). Much like quantitative research, the validity of qualitative research is bolstered by leading with theory-based models (such as the SCP framework we are using), as well as actively seeking out disconfirming evidence in addition to confirming evidence.

Other risks are more specific to the evaluation design. The most significant is that competitors do not adhere to the random assignment design, and either contaminate the comparison communes, or do not engage an appreciable number of farmers in the treatment communes. To mitigate this risk, we propose the project design clearly outline the evaluation design and the plans to set aside control, with clear communication of this plan to the competitors. The project design should clearly indicate that competitors will not receive incentives for their work in control communes. We will work with the Secretariat to ensure these details are written in the contracts with the competitors. An advantage to the Vietnam design is that competitors have to identify farmers before the rice season, which will serve as a critical point for us to review their plans and ensure they do not include any farmers from control communes.

Another risk is that the competitors do not cooperate with in answering the semi-structured questions. To mitigate this risk, the evaluation team will work with the Secretariat to ensure that all key stakeholders understand the importance of the evaluation to AgResults and, where possible, include in their contracts and agreements that participation in or association with AgResults involves interacting with our evaluators; we have used this approach successfully in other projects. As part of our effort to ensure buy-in for the evaluation, we also participated in the project launch and shared information about the evaluator's role. The Secretariat and the project manager emphasized the importance of our role with stakeholders, which will also help mitigate risk.

9.4 Ethical considerations

To ensure that we collect data in an ethical and responsible way, the team will submit the data collection instrument and draft design report to Abt's Internal Review Board (IRB) for review prior to conducting any data collection. Further, as we begin work with the contracted survey firm, and any other data collection partners, we will work with the IRB to execute the project's data security plan—a continuously updated document that tracks how data will be handled and by whom, and the security measures we have undertaken to maintain respondent confidentiality.

Another ethical concern is excluding the control communes from eligibility to count towards the prize. There are three ways we view this concern. First, competitors and farmers are still free to do business-as-usual in both areas; in fact, competitors are even free to promote low-emissions technologies in the control commune. In fact, if the technology is successful for all parties, there is a risk that we would not be able to product the control communes from the AgResults Vietnam Challenge Project. Second, just as in other AgResults Challenge

Projects the competitors have demonstrated and stated that they are not able to work in the entire target area. Therefore, randomisation is just as fair a mechanism as any other in terms of influencing the farmer groups with whom the competitors will work. Third, without the evaluation, it is unclear if the project does result in improving farmer outcomes. If the project does indeed positively impact farmer outcomes, its success will be in its continued expansion in the province and across all of Vietnam through investments by private sector with support from the GoV.

9.5 Quality assurance

Quality assurance is an integral part of our evaluation. Abt employs both internal and external quality assurance to review the data collection instruments, the study design, and all reports on findings. External peer reviewers will provide quality review of both the evaluation's methodology and its results. Cris Price—an Abt Principal Associate—provides internal quality control as the team member responsible for quality assurance of all evaluation documents and methodologies.

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Annex A: Stakeholders met (names of interviewees redacted)

Stakeholders met in August 2017		
Name of Interviewee	**Position**	**Organisation**
[Redacted]	Advisory committee member	Can Tho University
[Redacted]	Competitor #4	An Dinh company
[Redacted]	Competitor #21	Que Lam company
[Redacted]	Competitor #2	Institute of Vegetables and Fruits
[Redacted]		Institute of Agriculture and Environment
[Redacted]	Advisory committee member	
[Redacted]	Verifier	
[Redacted]	Crop Production Department	
[Redacted]	Advisory committee member	An Giang University
[Redacted]	Competitor #6	Rynan Agrifoods
[Redacted]	Competitor #2	Research institute
[Redacted]	Winrock International	Forest and Deltas Program
[Redacted]	Potential push contractor, consultant for evaluation, survey entity	CT-DAE/VAAS
[Redacted]	Cooperative leader	Dong Hai commune
[Redacted]	Commune leader	Phuong Cat commune
[Redacted]	Co-applicant of An Dinh #4	Biotech company
[Redacted]	Extension Center	
[Redacted]	Director	Institute of Agriculture and Environment
[Redacted]	Nam Dinh Extension Center	
[Redacted]	Farmers	Hai Ha commune, Hai Hau district
[Redacted]	Farmer	Hai Trung commune, Hai Hau district
[Redacted]	Commune leader	Hai Trung commune, Hai Hau district
[Redacted]	Toan Xuan Company	Nam Dinh
[Redacted]	Department of Agriculture and Rural Development	Nam Dinh

Stakeholders interviewed in October 2019		
Name of Interviewee	**Position**	**Organization**
[Redacted]	Director	An Dinh Company (I4)
[Redacted]	Head of Division	Fertiliser research and development of Binh Dien Company (I23)
[Redacted]	General Director of (I5)	Thai Binh Seed (I5)
[Redacted]	Technical staff	Thai Binh Seed (I5)
[Redacted]	Director	Fari (I18)
[Redacted]	Cooperative leader	Quynh Nguyen Cooperative, Quynh Phu district
[Redacted]	Cooperative leader	Quynh Hoa Cooperative, Quynh Phu district
[Redacted]	Cooperative leader	Diep Nong cooperative, Hung Ha district
[Redacted]	Cooperative leader	Canh Tan cooperative, Hung Ha district
[Redacted]	Cooperative leader	Control Commune Hong Minh cooperative, Hung Ha district

Stakeholders interviewed in October 2019		
Name of Interviewee	**Position**	**Organization**
[Redacted]	Cooperative leader	Song Lang cooperative, Vu Thu district
[Redacted]	Cooperative leader	Nguyen Xa cooperative, Vu Thu district
[Redacted]	Cooperative leader	Hiep Hoa cooperative - Control commune, Vu Thu district
[Redacted]	Cooperative leader	Vu Hoa cooperative, Kien Xuong district
[Redacted]	Cooperative leader	Binh Dinh Commune, Kien Xuong district, Thai Binh Seed Treatment
[Redacted]	Farmer	Hoa Binh Village, Binh Dinh Commune, Kien Xuong District, Thai Binh Province
[Redacted]	Farmer	Cong Binh Village, Binh Dinh Commune, Kien Xuong District, Thai Binh Province
[Redacted]	Farmer	Luu Xa Dong Village, Canh Tan Commune, Hung Ha District, Thai Binh Province
[Redacted]	Farmer	Duyen Nong Village, Diep Nong Commune, Hung Ha District, Thai Binh Province
[Redacted]	Farmer	An De Village, Hiep Hoa Commune, Vu Thu District, Thai Binh Province
[Redacted]	Farmer	Tinh Thuy Village, Hong Minh Commune, Hung Ha District, Thai Binh Province
[Redacted]	Farmer	Kien Xa Village, Nguyen Xa Commune, Vu Thu District, Thai Binh Province
[Redacted]	Farmer	Bo Trang 2 Village, Quynh Hoa Commune, Quynh Phu District, Thai Binh Province
[Redacted]	Farmer	Van Lang Village, Song Lang Commune, Vu Thu District, Thai Binh Province
[Redacted]	Farmer	Trinh Uyen Village, Quynh Nguyen Commune, Quynh Phu District, Thai Binh Province
	Farmer	Thon 4 Village, Vu Hoa Commune, Kien Xuong District, Thai Binh Province

Annex B: SCP interview guides

Competitor questionnaire

Introductory statement
Thank you for agreeing to speak with me. My name is XXX and I am part of the Independent Evaluation Team for AgResults. I would like to interview you about your experience with and perceptions of AgResults and/or rice markets more generally. The interview should last from 45-60 minutes and your participation is entirely voluntary. Your responses will be confidential, and you are not obligated to respond to any question that you'd prefer not to. Are you willing to participate in the interview?
If participant agrees to interview, ask:
May I have your permission to sound record the interview, as this will help to facilitate the flow of the interview by allowing me to focus on our discussion instead of note taking? Any recording will be kept secure and confidential, and I can stop recording at any time that you wish.
Questionnaire
Firm name
Date of interview
Interview information
Interviewee name
Interviewee position
Interviewee contact information
Interview location
After recording this information, request permission to sound-record the interview. If permission is granted, save recording with a file name that doesn't directly identify the respondent or his/her firm.
Brief background on firm and its activities with rice
Please provide a brief description of the firm and its activities
Background on community and rice production
Retail
Tell me about the cooperative/commune (size, members, and how they occupy themselves)
How do people make their living--i.e. what are the most important economic activities for income and food security?
Grower
How important is rice in the coop/commune's agricultural production portfolio?

Background on GHGs and GHG ERTs
Production Inputs/Services
Other (describe)
What are the firm's activities with respect to rice?
How many full-time permanent employees does the firm have supporting its rice activities?
Do members of the cooperative/commune grow, or have they previously grown, rice using a GHG ERT production system?
What was your experience with AgResults during Phase 1? What were key successes and challenges or failures?
How many?
How would you characterize farmers using that system?
Do they still produce rice using that system?
How does the GHG ERT system differ from the rice production system they used previously?
What has the experience been like?--What do farmers like and dislike about the GHG ERT production system?
Compared to the system used previously,
How are yields?
If yes, what changes, and why?
How will you promote your GHG ERTs to farmers?
How are prices for the rice?
How easy is it to sell the rice?
What motivated farmers to adopt it?
How will you monitor farmers' use of the technologies?
What incentives will farmers have to use your GHG ERT system?
Where do farmers obtain inputs and other services to support production?
To whom do you sell rice produced using the system?
% reduction in production cost
% market premium for rice produced using technology
Other incentives (describe)
Will you provide farmers with a market for rice produced using these technologies?
If yes, what market, and how will you facilitate farmers' access to this market?

What relationship do you have with GHG ERT-using rice producers? (select among options, and embellish as appropriate)
Production contracts (farmers are contracted to produce rice for competitor and provided with inputs and/or services on advance credit)
Marketing contracts (agreement to buy/sell rice but no advance provision of inputs or services)
Cash purchases at harvest--no advance contract or agreement
Other (describe)
What price do you pay for GHG ERT rice?
How does this price compare to the market price for commodity rice at the same point in time?
What do you anticipate will be key challenges for uptake of these technologies by farmers?
How will you address these challenges?
Strategies for sourcing rice produced with GHG ERTs
Do you have any plans to source GHG ERT-produced rice from any sources other than farmers participating in AgResults?
If yes, please describe.
What do you feel will be strengths/weaknesses of your sourcing arrangements?
How do you market rice produced with GHG ERTs?
How do you price rice produced with GHG ERTs?
What have been strengths/weaknesses of your marketing arrangements?
How important are rice produced with GHG ERTs in your overall rice portfolio?
Has that importance been increasing or decreasing? Why?
What plans do you have for promoting rice produced with GHG ERTs in the future?
Will you partner with any other firms or organisations to promote awareness/uptake/production/distribution of GHG ERT-produced rice?
If yes, please describe.
Investments
Have you made any investments (e.g., in staffing, facilities) to support your work with GHG ERT-produced rice?
If yes, please describe
Do you anticipate continuing to transact GHG ERT-produced rice after AgResults ends?
Why or why not?

If yes, what are your plans (i.e., what changes might you make) with respect to…
…Procurement (sources, relationships with suppliers, etc.)
…Logistics and value-addition
…Merchandising and sales
…Other (describe)
Viewpoint on market for GHG ERT-produced rice
What is firm's perspective on demand for GHG ERT-produced rice?
What buyers/market niches are there for GHG ERT-produced rice?
What demand-side challenges are there and how can they best be addressed??
What is firm's perspective on supply of GHG ERT-produced rice?
Who do you think are the best producers of GHG ERT-produced rice (i.e., what farmer characteristics)?
What supply-side challenges are there and how are they best addressed??
What other factors affect the development of GHG ERT-produced markets?
How do dynamics in commodity (non-GHG ERT-produced) rice markets affect the development of markets for GHG ERT-produced rice?
Are there any important institutional/policy issues/challenges that affect development of GHG ERT-produced markets?
What public sector institutions have a role to play? What roles?
Any other issues, challenges, or opportunities not mentioned?
How has AgResults affected your involvement in markets for rice produced with GHG ERTs?
…Choice of market outlets/buyers
…Choice of and/or relationships with suppliers
…Logistics and/or value addition
Overall, do you feel that the market for rice produced with GHG ERTs is viable?
Why or why not?
Is the market sustainable?
Why or why not?
How has AgResults affected the development of the market for GHG ERT-produced rice?
What are their reflections on participation in AgResults?
What has gone well and not?

What implementation and other challenges have existed and how have they tried to overcome them?
How could AgResults have been better structured to motivate investment in GHG ERT-produced rice?
What have they learned/gained through participating in AgResults (besides the financial incentive)?
If they were to do it over, would they choose to participate in the AgResults project?
How would their engagement in the market differ if not for AgResults?
Do you consider AgResults to be a costly proposition? A risky one? Is there a potential downside to participation? Please describe
Any further comments about the AgResults project and/or market for GHG ERT-produced rice?
Thank you for your participation.

Questionnaire for Advisory Council members

Introductory statement
Thank you for agreeing to speak with me. My name is XXX and I am part of the Independent Evaluation Team for AgResults. I would like to interview you about your experience with and perceptions of AgResults and rice markets more generally. The interview should last from 45-60 minutes and your participation is entirely voluntary. Your responses will be confidential, and you are not obligated to respond to any question that you'd prefer not to. Are you willing to participate in the interview?
If participant agrees to interview, ask:
May I have your permission to sound record the interview, as this will help to facilitate the flow of the interview by allowing me to focus on our discussion instead of note taking? Any recording will be kept secure and confidential, and I can stop recording at any time that you wish.
Advisory Council member questionnaire
Interviewee name
Date of interview
Interview information
Interviewee association
Interviewee position
Interviewee contact information
Interview location
After recording this information, request permission to sound-record the interview. If permission is granted, save recording with a file name that doesn't directly identify the respondent or his/her firm.
Background
Please tell me about your background/experience in rice markets and/or climate change issues that led to you being part of the AgResults advisory council.
Background on community and rice production
Tell me about the cooperative/commune (size, members, and how they occupy themselves)
How do people make their living--i.e. what are the most important economic activities for income and food security?
In addition to any direct effects, has it had any derivative, or indirect, effects?
How important is rice in the coop/commune's agricultural production portfolio?
Background on GHGs and GHG ERTs
What do you think the market for GHG ERT-produced rice would look like today, if there were no AgResults initiative?

What have been the strengths of AgResults?
What have been its weaknesses?
What design changes do you feel could have helped AgResults to have a greater impact?
Do members of the cooperative/commune grow, or have they previously grown, rice using a GHG ERT production system?
…what about most successful in markets for GHG ERT-produced rice?
How many?
How would you characterize farmers using that system?
Do they still produce rice using that system?
How does the GHG ERT system differ from the rice production system they used previously?
What has the experience been like?--What do farmers like and dislike about the GHG ERT production system?
Compared to the system used previously,
How are yields?
How has the development of the market for GHG ERT-produced rice been affected by other issues, outside the purview of AgResults, such as:
…policy/regulatory environment
How are prices for the rice?
How easy is it to sell the rice?
What motivated farmers to adopt it?
Those are all my questions. Do you have any questions for me, or are there any issues that we haven't discussed or that you'd like to discuss further?

Farmer questionnaire

Introductory statement
Thank you for agreeing to speak with me. My name is XXX and I am part of the Independent Evaluation Team for AgResults, a donor-funded project that seeks to promote improved rice production technologies in Vietnam. I would like to interview you about your experience with and perceptions around the production and sale of rice and rice production systems. The interview should last from 60 minutes and your participation is entirely voluntary. Your responses will be confidential, and you are not obligated to respond to any question that you'd prefer not to. Are you willing to participate in the interview?
If participant agrees to interview, ask:
May I have your permission to sound record the interview, as this will help to facilitate the flow of the interview by allowing me to focus on our discussion instead of note taking? Any recording will be kept secure and confidential, and I can stop recording at any time that you wish.
Questionnaire
Farmer name
Date of interview
Interview information
Interviewee name
Interviewee position
Interviewee contact information
Interview location
Farmer city
Farmer province
Background on community and rice production
Tell me about your family (size, members, and how they occupy themselves)
Tell me about the cooperative/commune (size, members, and how they occupy themselves)
How do people make their living--i.e. what are the most important economic activities for income and food security?
Have you learned about GHGs and climate change as an issue?
How important is rice in the coop/commune's agricultural production portfolio?
Background on GHGs and GHG ERTs
Have you learned about GHG Emissions Reduction technologies (GHG ERTs) and their use in rice production?
If yes, what do you know? How and when did you learn it?

Have you ever grown rice using a GHG ERT production system?
If yes, for how long?
Do members of the cooperative/commune grow, or have they previously grown, rice using a GHG ERT production system?
How does the GHG ERT system differ from the rice production system you used previously?
How many?
How would you characterize farmers using that system?
Do they still produce rice using that system?
How does the GHG ERT system differ from the rice production system they used previously?
What has the experience been like?--What do farmers like and dislike about the GHG ERT production system?
Compared to the system used previously,
How are yields?
How are prices for the rice you produce?
How easy is it to sell the rice you produce?
How are prices for the rice?
How easy is it to sell the rice?
What motivated farmers to adopt it?
Where do you obtain inputs and other services to support production?
To whom do you sell rice produced using the system?
Where do farmers obtain inputs and other services to support production?
To whom do you sell rice produced using the system?
Do you expect to continue to produce using the system?
Why, or why not?
(If already stopped using the system, why did s/he stop?)
Overall, do you feel that the market for rice produced with GHG ERTs is viable?
Why or why not?
Is the market sustainable?
Why or why not?
Conclusion
Do you have any further comments or questions about the topics we have discussed?

Cooperative/commune leadership questionnaire

Introductory statement
Thank you for agreeing to speak with me. My name is XXX and I am part of the Independent Evaluation Team for AgResults, a donor-funded project that seeks to promote improved rice production technologies in Vietnam. I would like to interview you about your experience with and perceptions around the production and sale of rice and rice production systems. The interview should last from 60 minutes and your participation is entirely voluntary. Your responses will be confidential, and you are not obligated to respond to any question that you'd prefer not to. Are you willing to participate in the interview?
If participant agrees to interview, ask:
May I have your permission to sound record the interview, as this will help to facilitate the flow of the interview by allowing me to focus on our discussion instead of note taking? Any recording will be kept secure and confidential, and I can stop recording at any time that you wish.
Questionnaire
Cooperative/Commune name
Date of interview
Interview information
Interviewee name
Interviewee position
Interviewee contact information
Interview location
Cooperative/commune city
Cooperative/commune province
Background on community and rice production
Tell me about the cooperative/commune (size, members, and how they occupy themselves)
How do people make their living--i.e. what are the most important economic activities for income and food security?
How does agricultural production fit in?
How important is rice in the coop/commune's agricultural production portfolio?
Background on GHGs and GHG ERTs
Have you learned about GHGs and climate change as an issue?
If yes, what do you know? How and when did you learn it?
Have you learned about GHG Emissions Reduction technologies (GHG ERTs) and their use in rice production?

If yes, what do you know? How and when did you learn it?
Do members of the cooperative/commune grow, or have they previously grown, rice using a GHG ERT production system?
If yes, for how long?
How many?
How would you characterize farmers using that system?
Do they still produce rice using that system?
How does the GHG ERT system differ from the rice production system they used previously?
What has the experience been like?--What do farmers like and dislike about the GHG ERT production system?
Compared to the system used previously,
How are yields?
How are input costs?
How do labour requirements compare? (If they differ, who contributes more or less labour?)
How are prices for the rice?
How easy is it to sell the rice?
What motivated farmers to adopt it?
What was easiest about adopting the system?
What was hardest?
Where do farmers obtain inputs and other services to support production?
To whom do farmers sell rice produced using the system?
Do farmers have any advance agreement with input/service providers or rice buyers?
If yes, please describe.
Do farmers expect to continue to produce using the system?
Why, or why not?
How would you characterize farmers who have used the system most successfully?
How would you characterize those that have struggled most to use it?
How would you characterize those who started using it but stopped after a time?
Role of cooperative/commune
What role did the cooperative/commune play in rice production?
What role does the cooperative/commune play in promoting GHG ERTs specifically?

Overall, do you feel that the market for rice produced with GHG ERTs is viable?
Why or why not?
Is the market sustainable?
Why or why not?
Conclusion
Do you have any further comments or questions about the topics we have discussed?

Questionnaire for other value chain players (agro-input dealers, traders, processors, retailers)

Introductory statement
Thank you for agreeing to speak with me. My name is XXX and I am part of the Independent Evaluation Team for AgResults, a donor-funded project that seeks to promote improved rice production technologies in Vietnam. I would like to interview you about your experience with and perceptions around the production and sale of rice and rice production systems. The interview should last from 20 minutes and your participation is entirely voluntary. Your responses will be confidential, and you are not obligated to respond to any question that you'd prefer not to. Are you willing to participate in the interview?
If participant agrees to interview, ask:
May I have your permission to sound record the interview, as this will help to facilitate the flow of the interview by allowing me to focus on our discussion instead of note taking? Any recording will be kept secure and confidential, and I can stop recording at any time that you wish.
Questionnaire
Firm name
Date of interview
Interview information
Interviewee name
Interviewee position
Interviewee contact information
Interview location
Firm city
Firm province
After recording this information, request permission to sound-record the interview. If permission is granted, save recording with a file name that doesn't directly identify the respondent or his/her firm.
Background on community and rice production
Brief background on firm and its activities with rice/rice production technologies/systems
Tell me about the cooperative/commune (size, members, and how they occupy themselves)
How do people make their living--i.e. what are the most important economic activities for income and food security?
Is respondent male or female
How important is rice in the coop/commune's agricultural production portfolio?

Background on GHGs and GHG ERTs
Perspectives on GHG ERTs in rice production
Have you learned about GHGs and climate change as an issue?
If yes, what do you know? How and when did you learn it?
Do members of the cooperative/commune grow, or have they previously grown, rice using a GHG ERT production system?
If yes, what do you know? How and when did you learn it?
How many?
How would you characterize farmers using that system?
Do they still produce rice using that system?
How does the GHG ERT system differ from the rice production system they used previously?
What has the experience been like?--What do farmers like and dislike about the GHG ERT production system?
Compared to the system used previously,
How are yields?
What are benefits to farmers of working with these technologies?
% yield increase
How are prices for the rice?
How easy is it to sell the rice?
What motivated farmers to adopt it?
What market or markets for rice produced with GHG ERTs are available? Do you know farmers selling rice to these markets?
What were the results of efforts to promote GHG ERTs among farmers?
Where do farmers obtain inputs and other services to support production?
To whom do you sell rice produced using the system?
Strategies for transacting GHG ERTs for rice and/or rice produced with GHG ERTs
Where do you source GHG ERT/rice produced w/GHG ERTs?
What arrangement(s) do you have with your supplier(s)?
What have been strengths/weaknesses of your sourcing arrangements?
How do you market GHG ERTs/rice produced with GHG ERTs?
How do you price GHG ERTs/rice produced with GHG ERTs?
What have been strengths/weaknesses of your marketing arrangements?

How important are GHG ERTs/rice produced with GHG ERTs in your overall rice/rice input portfolio?
Has that importance been increasing or decreasing? Why?
What plans do you have for promoting GHG ERTs/rice produced with GHG ERTs in the future?
Overall, do you feel that the market for GHG ERTs/rice produced with GHG ERTs is viable?
Why or why not?
Is the market sustainable?
Why or why not?
Conclusion
Do you have any further comments or questions about the topics we have discussed?
Thank you for your participation in the interview.

Annex C: Rice cultivation diary (for use in emissions study)

Thai Binh, 2020

DIARY SPRING CROP, 2020

□ Sun calendar □ Lunar calendar

Cooperative name:……

Commune name: ……

District: ……Thai Binh province

Name of co-op leader: ……

Tel: ……

E-mail: ……

Total rice area cultivated this season by the farmer:……..……ha

Total number of rice fields cultivated this season by the farmer ……..

Work with the following companies: ……..

- □ An Dinh
- □ Thai Binh Seeds
- □ Fari Seed
- □ Binh Dien Fertiliser

Total rice field of the cooperative this season: ……

Rice area transplant for competitor: ……ha.

Name of the scribe: ……

Tel: ……E-mail: ……

Field No. 1 - work with ex. I5

Parameter Name	Parameter Description	Information
Field details		
Site id		
Site _Name	Field name	
Field type	Low/Medium or High elevation	□ Low elevation □ Medium elevation □ High elevation
Is drainage possible in your field in this season?	1-Good Drainage, with consent of other farmers in the common field 2-Good Drainage, without consent of other farmers in the same field 3-Poor Drainage 4. Naturally Flooded 5. Other	□ Good Drainage, with consent of other farmers in the common field □ Good Drainage, without consent of other farmers in the same field □ Poor drainage □ Naturally flooded □ Other_____
Soil type	1- Sand 2- loam sand 3- sandy loam 4- loam 5- limon / silty clay 6- clay loam clay	□ Sand □ Loam sand □ Sandy Loam □ Loam □ Limon/Silty clay □ Clay loam □ Other_____
Area of the field (m^2)	(m^2)	
Field_lat		
Field_lon		
Previous crop	e.g., rice, vegetable, corn	
Residue fraction	Amount of previous crop residue that is left in the field before rice crop.	
Planting Activities		
Plant_date	YYYY-MM-DD	
Number of tilling applications planned this season	Number	
Tillage_1 date	YYYY-MM-DD	
Tillage_1 depth	depth in cm	
Hired labor cost of tilling	Vnd/field	
Machinery rental cost of tilling	Vnd/field	
Household labor used for tilling	Manhours/ field	
Rice_variety	Current varieties: BC15, BT7, DS1, HT1, T10, ,…..	*Put check boxes to tick and one field for "other"*
Transplant	Transplanted (T) or Sown (S)	*Put the two options here as check box*
Sowing date		

Parameter Name	Parameter Description	Information
Seedling_age	seeding age - days (For transplanted only)	
Planting_density	seedlings per hill (or kg seed per ha for sown)	
Hill_density	hills per m^2 (For transplanted only)	
Cost of seeds/seedlings	VND/field	
Hired labor cost for planting/transplanting cost	Vnd/field	
Machinery rental cost for planting/transplanting	Vnd/field	
Household labor used for planting/transplanting	Manhours	
Tilloring date	YYYY-MM-DD	
Flowering date	YYYY-MM-DD	
Apply Fertilisers		
First application time of the fertiliser – Time 1		
Fertilizer_1_date	YYYY-MM-DD	
Fertilizer_1_type1	Name of fertiliser	
Fertilizer_1_rate1(kg/ha)	Application rate of the product	
Price of fertilizer type1	vnd/kg	
Fertilizer_1_type2	Name of fertiliser	
Fertilizer_1_rate2(kg/ha)	Application rate of the product	
Price of fertilizer type2	vnd/kg	
Fertilizer_1_type3	Name of fertiliser	
Fertilizer_1_rate3(kg/ha)	Application rate of the product	
Price of fertilizer type3	vnd/kg	
Hired labor cost of applying first application of fertilizer	Vnd/field	
Household labor used to apply first application of fertilizer	Man hours/field	
Second application time of the fertilizer – Time 2		
Fertilizer_2_date	YYYY-MM-DD	
Fertilizer_2_type1	Name of fertilizer	
Price of fertilizer type1	vnd/kg	
Fertilizer_2_rate1(kg/ha)	Application rate of the product	
Fertilizer_2_type2	Name of fertilizer	
fertilizer_2_rate2(kg/ha)	Application rate of the product	
Price of fertilizer type2	vnd/kg	
Fertilizer_2_type3	Name of fertilizer	

Parameter Name	Parameter Description	Information
Fertilizer_2_rate3(kg/ha)	Application rate of the product	
Price of fertilizer type3	vnd/kg	
Hired labor cost of applying second application of fertilizer	Vnd/field	
Household labor used to apply second application of fertilizer	Man hours/field	
Third application time of the fertilizer – Time 3		
Fertilizer_3_date	YYYY-MM-DD	
Fertilizer_3_type1	Name of fertilizer	
Fertilizer_3_rate1(kg/ha)	rate of the product	
Price of fertilizer type1	vnd/kg	
Fertilizer_3_type2	Name of fertilizer	
Fertilizer_3_rate2(kg/ha)	rate of the product	
Price of fertilizer type2	vnd/kg	
Fertilizer_3_type3	Name of fertilizer	
Fertilizer_3_rate3(kg/ha)	rate of the product	
Price of fertilizer type3	vnd/kg	
Hired labor cost of applying third application of fertilizer	Vnd/field	
Household labor used to apply third application of fertilizer	Man hours/field	
Fourth application time of the fertilizer – Time 3		
Fertilizer_4_date	YYYY-MM-DD	
Fertilizer_4_type1	Name of fertilizer	
Fertilizer_4_rate1(kg/ha)	rate of the product	
Price of fertilizer type1	vnd/kg	
Fertilizer_4_type2	Name of fertilizer	
Fertilizer_4_rate2(kg/ha)	rate of the product	
Price of fertilizer type2	vnd/kg	
Fertilizer_4_type3	Name of fertilizer	
Fertilizer_4_rate3(kg/ha)	rate of the product	
Price of fertilizer type3	vnd/kg	
Hired labor cost of applying fourth application of fertilizer	Vnd/field	
Household labor used to apply fourth application of fertilizer	Man hours/field	
Manure application – type 1		
Manure amendment_1 _date	YYYY-MM-DD	
Manure amendment rate_1_rate	kg/ha	
Manure 1 cost	VND/kg	

Parameter Name	Parameter Description	Information
Manure type_1_type	1 = pig; 2 = chicken; 3 = cow/buffalo; 4: compost, 5: other farmyard manure	
Hired labor cost of applying type 1 manure		
Household labor used to apply type 1 manure		
Manure application- type2		
Manure amendment_1 _date	YYYY-MM-DD	
Manure amendment rate_1_rate	kg/ha	
Manure 1 cost	VND/kg	
Manure type_1_type	1 = pig; 2 = chicken; 3 = cow/buffalo; 4: compost, 5: other farmyard manure	
Hired labor cost of applying type 1 manure		
Household labor used to apply type 1 manure		
Water Management		
Water event 1		
Flood_1_date	YYYY-MM-DD	
Drain_1_date	YYYY-MM-DD	
Flood depth	cms	
Hired labor cost for flooding/draining	Vnd/field	
Waterpump/other machinery cost for flooding/draining	Vnd/field	
Household labor used for flooding/draining	Man hours	
Water event 2		
Flood_2_date	YYYY-MM-DD	
Drain_2_date	YYYY-MM-DD	
Flood depth	cms	
Hired labor cost for flooding/draining	Vnd/field	
Waterpump/other machinery cost for flooding/draining	Vnd/field	
Household labor used for flooding/draining	Man hours	
Water event 3		
Flood_3_date	YYYY-MM-DD	
Drain_3_date	YYYY-MM-DD	
Flood depth	cms	
Hired labor cost for flooding/draining	Vnd/field	
Waterpump/other machinery cost for flooding/draining	Vnd/field	
Household labor used for flooding/draining	Man hours	

Parameter Name	Parameter Description	Information
Water event 4		
Flood_4_date	YYYY-MM-DD	
Drain_4_date	YYYY-MM-DD	
Flood depth	cms	
Hired labor cost for flooding/draining	Vnd/field	
Waterpump/other machinery cost for flooding/draining	Vnd/field	
Household labor used for flooding/draining	Man hours	
Harvest		
Harvest_start_date	YYYY-MM-DD	
Total quantity of rice harvested from the field	Dried, kg	
Hired labor cost for harvesting	Vnd/field	
Machinery cost for harvesting (e.g. harvester)	Vnd/field	
Household labor used for harvesting	Man hours	

Pest and disease management

Time 1	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 2	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 3	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field

Time 4	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 5	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 6	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 7	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 8	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 9	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	

Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Time 10	
Spraying date	YYYY-MM-DD
Pesticide type	
Pesticide cost (vnđ/sào)	
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Crop residue and straw management	
Proportion of stubble & straw removed from field	
Proportion of stubble & straw incorporated into the soil	
Added treatment	__EMZ-USA fungi __Sumitri __Fito __AT_YTB
Hired labor cost to apply pesticide	Vnd/field
Household labor used to apply pesticide	Man hours/field
Cost to purchase treatment	
Cost of production	
Other cost of production not included above	'000 VND/Season
Value of production	
Total quantity of rice sold from the field	Kg
Sale price	VND/kg
Total rice saved for consumption	Kg
Revenue from sale of rice bran	'000 VND/Season
Revenue from sale of rice husks	'000 VND/Season

Reference for fertilizer

product	N fraction	ammonium	Ammonium_bicarbonate	Anhydrous_ammonia	nitrate	urea	phosphate	sulphate	day_release	ni_duration	ni_efficiency	urease_duration	urease_efficiency	depth
DAP Humic	0.18	1	0	0	0	0	0.194296	0.02	1	0	0	0	0	0
DAP-avail	0.18	1	0	0	0	0	0.203028	0	1	0	0	0	0	0
dau trâu TE +Agrotain 01	0.2	0	0	0	0	1	0.067676	0.004	1	0	0	14	1	0
dau trâu TE +Agrotain 02	0.18	0	0	0	0	1	0.019648	0.004	1	0	0	14	1	0
NPK 16-5-10 + TE (Luc Than Nong)	0.16	0	0	0	0	1	0.024014	0	1	0	0	0	0	4
NPK con cò (20-20-15)	0.2	0.4	0	0	0	0.6	0.089507	0	1	0	0	0	0	0
Phân Vi?t Nh?t (16:16:8)	0.16	1	0	0	0	0	0.072042	0.13	1	0	0	0	0	0
Phu My NPK 16 16 8 + 13S + TE	0.16	1	0	0	0	0	0.072042	0.13	1	0	0	0	0	4
Van Dien NPK 6-11-2	0.06	0	0	0	0	1	0.050211	0	1	0	0	0	0	0
KCl	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Dau Trau 46 A+	0.46	0	0	0	0	1	0	0	1	0	0	14	1	0
Urea	0.46	0	0	0	0	1	0	0	1	0	0	0	0	0
NPK 5-10-3	0.05	0.2	0	0	0	0.8	0.043662	0.08	1	0	0	0	0	0
NPK 17-5-16	0.17	0.61	0	0	0	0.39	0.021831	0	1	0	0	0	0	0

Annex D: Rice farming survey instrument

Module 1: Household Identification, Demographics and Assets

Outstanding questions/items for module 1:

What is the enterprise? (Section 1.3)

How extensive is the farmer's knowledge of his household's classifications? (i.e., we need to test the first few questions in 1.3 to see if they can answer them)

Identity and Background Information

Question Number	Question	Response
1.	Date of Survey	
2.	Team Leader ID	*NAME:* *ID:*
3.	Enumerator ID	*NAME:* *ID:*
4.	Province, city	*NAME:* *CODE:*
5.	District, urban district, town	*NAME:* *CODE:*
6.	Commune, ward	*NAME:* *CODE:*
7.	Census Block	*NAME:* *CODE:*
8.	Household ID	*CODE:* *Phone number:*
9.	Are you the person responsible for rice farming?	*1. Yes →* ***go to Q11*** *0. No →* ***identify the person responsible for rice farming***
10.	Is the person responsible for rice farming available today?	*1. Yes →* ***locate the person and go to Q9*** *2. No →* ***make another appointment***
11.	Permission to conduct the interview?	*1. Yes* *0. No →* ***Stop the survey***
12.	Is the person household head?	*1. Yes →* ***go to Q 14*** *0. No*
13.	Education of the respondent	***(Choose one)*** *1-No Schooling* *2-PreSchool* *3-Primary* *4-Lower Secondary* *5-Upper Secondary* *6-Primary, technical worker* *7-Secondary Training* *8-College* *9-University and above*

Question Number	Question	Response
14.	Education of the household head (if the respondent is not the household head).	***(Choose one)*** *1-No Schooling* *2-PreSchool* *3-Primary* *4-Lower Secondary* *5-Upper Secondary* *6-Primary, technical worker* *7-Secondary Training* *8-College* *9-University and above*
15.	Location of the interview	***(Choose one)*** *1. At the house* *2. At the rice field* *4. Other (Specify):_____*
16.	GPS Latitude	
17.	GPS Longitude	
18.	Ethnic group of the household	

Household Details

Question Number	Question	Response
1.	Number of adult male in the households (above 18 years of age)	
2.	Number of adult females in the households (above 18 years of age)	
3.	Number of children >5-18 in the household	
4.	Number of children <= 5 years of age.	

Household Characteristics and Finances

Question Number	Question	Type	Response
1.	Does your household belong to a commune classified as poor in 2012?	*Choose one*	*1. Yes* *0. No*
2.	Is your household listed as farming household?	*Choose one*	*1. Yes* *0. No*
3.	How much land does your household own?		_____ *square meters*
4.	Are you part of any farmer cooperative?	*Choose one*	0. No 1. Yes

Household Assets

Question Number	1. Do you or any members of your household have the following assets in usable condition:	Response (Choose One)
1	Car	*1. Yes* *0. No*
2	Motorbike	*1. Yes* *0. No*
3	Bicycle	*1. Yes* *0. No*
4	TV (Color or B/W)?	*1. Yes* *0. No*
5	Video Player?	*1. Yes* *0. No*
6	Radio, Cassettes, CD Player, MP3?	*1. Yes* *0. No*
7	Audio System?	*1. Yes* *0. No*
8	Desk Phone?	*1. Yes* *0. No*
9	Mobile Phone?	*1. Yes* *0. No*
10	Air Conditioner?	*1. Yes* *0. No*

Question Number	1. Do you or any members of your household have the following assets in usable condition:	Response (Choose One)
11	Washing Machine?	*1. Yes* *0. No*
12	Refrigerator or Freezer	*1. Yes* *0. No*
13	Electric Fans?	*1. Yes* *0. No*
14	Water Heater Tank?	*1. Yes* *0. No*
15	Microwave oven?	*1. Yes* *0. No*
16	Gas stove, electric stove, rice cooker or pressure cooker?	*1. Yes* *0. No*
17	Type of house (enumerator observation)	*1. Permanent* *2. Semi-Permanent* *3. Temporary*
18	Do you have a separate kitchen?	*1. Yes* *0. No*
19	What type of toilet does your house have?	*1. Flush toilet with septic tank/sewage pipes* *2. Double vault compost latrine* *3. Simple toilet* *4. Toilet directly over the water* *5. No toilet* *6. Other type*
20	What is the main source of lighting in your house currently?	*1. National grid electricity* *2. Battery Lamp, generator* *3. Gas, oil, kerosene* *4. Resin torch* *5. Solar* *5. Other*
21	Which is the main material as poles (or pillars, or carrying walls) of the main house where you live now? ***(Please ask them these details about their main house where their family lives, if the person has many houses)***	*1. Reinforcement concrete* *2. Bricks/stones* *3. Iron/steel/good wood* *4. Poor-quality wood/bamboo* *5. Others (specify_____)*

Question Number	1. Do you or any members of your household have the following assets in usable condition:	Response (Choose One)
22	Which is the main material as roofing of the main house where you now? ***(Please ask them these details about their main house where their family lives, if the person has many houses)***	*1. Reinforcement concrete* *2. Tiles (cement, terracotta)* *3. Roof slabs (cement, metal)* *4. Leave/straw/rolled roofing* *5. Others (specify_____)*

Farming Equipment

Question Number	What farming equipment is owned by the household?	Number owned (enter zero if it is not owned)
1.	☐ Larger tractor(s)/plough (>35 CV)	
2.	☐ Medium tractor(s)/plough (12-35 CV)	
3.	☐ Small tractor(s)/plough (<12 CV)	
4.	Motorized boat(s)	
5.	☐ Non-motorized boat(s)	
6.	☐ 2-wheeler vehicle(s)	
7.	☐ 4-wheeler vehicle(s)	
8.	☐ Generator	
9.	☐ Harvester(s)	
10.	☐ Sowing machine(s)/Seeder	
11.	☐ Water pump(s) mainly for Cultivation (kW)	
12.	☐ Water pump(s) mainly for livestock management (kW)	
13.	☐ Water pumps mainly for other production purposes (kW)	
14.	☐ Animal food processing machine(s)	
15.	☐ Composting barrel	
16.	☐ Window machine for composting	
17.	☐ Fans for composting	
18.	☐ Manure spreaders	
19.	☐ Front-end loaders	
20.	☐ Manure solids separation equipment	
21.	☐ Manure scrapers	
22.	☐ Manure injectors	
23.	☐ Manure agitators	

Question Number	What farming equipment is owned by the household?	Number owned (enter zero if it is not owned)
24.	☐ Manure Pump (kW)	
25.	☐ BioChar Burner	

Module 2. Inputs to Production for two rice seasons

Outstanding questions/items for module 2

Household Awareness

<table>
<tr><th>Question Number</th><th colspan="3">Household Awareness</th></tr>
<tr><td>1</td><td colspan="3">Do you know about any of the following technologies for growing rice?

<table><tr><th></th><th>Yes</th><th>No</th></tr><tr><td>Low seeding density</td><td></td><td></td></tr><tr><td>Alternate Wetting and Drying</td><td></td><td></td></tr><tr><td>Use of a decomposer or bioproduct for rice stubble/straw</td><td></td><td></td></tr><tr><td>Smart technology solar and smart sensored tubes to monitor AWD</td><td></td><td></td></tr><tr><td>Wide-narrow transplanting</td><td></td><td></td></tr><tr><td>Deep drain events</td><td></td><td></td></tr><tr><td>Biochar</td><td></td><td></td></tr><tr><td>Use of organic fertilisers</td><td></td><td></td></tr></table></td></tr>
<tr><td>2</td><td><If yes to any of the above> How did you hear about this technology?</td><td></td><td><list of competitors, other sources></td></tr>
<tr><td>3</td><td>Do you know of any of the following organisations?</td><td></td><td><List of competitors></td></tr>
<tr><td>4</td><td>If yes, did you learn any farming techniques from them in the spring or summer growing season?</td><td></td><td>a. Spring
b. Summer
c. Both
d. Neither</td></tr>
</table>

Plot level

Plot-Level Details of Cultivated Land in the past 12 months.

Ask this information of each RICE plot cultivated by the households –includes rice plots rented in from other households, and excludes plots rented out to other households.

GSO Ref	1. Plot Code	2. Name of the Plot *Ask Farmer to list all the rice growing plots first.*	3. Field Code *(The smallest unit that has the same topology. Field in the north, and subplot in the South)*	4. At what elevation is the plot? ***(Choose One)*** 1-Low Relative Elevation 2- Medium Relative Elevation 3-High Relative Elevation	5. Area (Meter Square, M^2)	6. Is the plot served by an irrigation Channel ***(Choose One)*** 1-Yes 2-No
Seasonal survey	1					
	2					
	3					
	4					
	5					

Plot Level Rice Cultivation for Both Seasons

Complete information on all seasons for the plots

Question Number	Plot-Level Rice Cultivation Details	Response	Plot Number/Name		
			1.	2.	3.
1.	Rice Variety ***(Please record the rice variety. For example Jasmine.)***				
2.	What is the density with which you planted?				
3.	Planting month ***(Please record month and year)***				
4.	Harvest month ***(Please record month and year)***				
5.	Total number of days in the season (***calculate and repeat to the farmer***.)				

Question Number	Plot-Level Rice Cultivation Details	Response	Plot Number/Name		
			1.	2.	3.
6.	Do you do direct seeding for rice?	***(Choose One)*** 1-Yes → **Go to question 14** 2-No			
7.	How much seed did you apply? (Kg) ***In case the seeds are lost/eaten and the farmers plant seeds the multiple times, please take the total number***				
8.	Did you use any of the following technologies on this plot?				
		Yes / **No**			
	Low seeding density				
	Alternate Wetting and Drying				
	Use of a decomposer or bioproduct for rice stubble/straw				
	Smart technology solar and smart sensored tubes to monitor AWD				
	Wide-narrow transplanting				
	Deep drain events				
	Biochar				
9.	If you did transplanting, what area (meter square) was set aside for seedlings? ***In case of transplanting on the yards/roads or on other farmers' land, please record the total square***				
10.	How many tilling applications did you perform this season? ***If farmer answers 1, go to 16, and skip 17 and 18.*** ***If farmer answers 2, go to 16 and skip 18.*** ***If farmer answers3 complete all.***				
11.	What was the tilling method you used for application 1	***(Choose One)*** 1-Hoe 2-Cattle 3-Small Machine			

Question Number	Plot-Level Rice Cultivation Details	Response	Plot Number/Name		
			1.	2.	3.
		4-Big machine 5-Other (Specify)			
12.	What was the tilling method you used for application 2? ***(Skip if farmer only has one tilling application)***	***(Choose One)*** 1-Hoe 2-Cattle 3-Small Machine 4-Big machine 5-Other (Specify)			
13.	What was the tilling method you used for application 3? ***(Skip if farmer only has one tilling application)***	***(Choose One)*** 1-Hoe 2-Cattle 3-Small Machine 4-Big machine 5-Other (Specify)			

Plot-Level Irrigation by Season

Question Number	Question	Response	Plot Number/Name		
			1.	2.	3.
1.	How many times did you flood the plot in the season?				
2.	When did you flood the field?	***(Choose All that Apply)*** 1-Before planting 2-After planting and before tilloring 3-After tilloring and before pinnacle Formation			

Question Number	Question	Response	Plot Number/Name		
			1.	2.	3.
		4-After Pinnacle and before harvesting			
1.	(If Q2!=4) What is the main reason you do not drain water in the plot between pinnacle formation and harvesting? ***(Do not read out the options. Hear out the response and pick an answer appropriately)***	***(Choose All that Apply)*** 1- It will increase risk of crop failure 2-Labor costs go up for planting; 3-Labor costs go up for weeding 4- It will reduce yield 5-Our generations have always cultivated with flooded rice 6-To assure quality 7- This is based on commune-level planning 8-Other			
2.	How many days was the plot flooded in this season?				
3.	How many times did you drain the field?				
4.	How many days was the field without water for harvesting?				
5.	How many days was the field without water after pinnacle formation and before drying for harvest?				
	Flooding 1-Before Planting (*Ask the farmer to tell you about the flooding before planting if he did flood it at this time based on question number 4)*				
6.	How many days did the field stay flooded from this flooding?				
	Flooding 2- After planting and before tilloring (Ask only if the farmer flooded at this time from question number 4)				
7.	How many days did the field stay flooded from this flooding?				
	Flooding 3- After Tilloring and before Pinnacle Formation (Ask only if the farmer flooded at this time from question number 4)				
8.	How many days did the field stay flooded from this flooding?				
	Flooding 4- After Pinnacle Formation and before drying for harvest (Ask only if the farmer flooded at this time from question number 4)				
9.	How many days did the field stay flooded from this flooding?				

Fertiliser Types Used by Farmer

Ouestion	Please provide detail on the four most important types of fertilisers used for rice cultivation this season?	What is the name of the fertiliser?	).What is the price of the fertiliser per kg? (VND/kg)
1	Fertiliser 1		
2	Fertiliser 2		
3	Fertiliser 3		
4	Fertiliser 4		

Plot-Level Fertiliser Use

Ouestion	Plot-Level Fertiliser Use by Stage of Rice Cultivation		Response	Plot Number/Name		
				1.	2.	3.
1	How many applications of fertiliser did you have in the season?					
2	When did you apply the fertiliser?		**(Choose all that apply)** 1-Before Transplanting (or seeding) 2-Tilloring 3-Pinnacle Formation 4- Other (Specify)			
	Before transplanting or seeding					
3	What kind of fertilisers did you use at this time for the plot? **Please record the fertiliser number from section 7.**		**(Choose all that apply)** 1-Fertiliser 1 2-Fertiliser 2 3- Fertiliser 3 4- Fertiliser 4 5-Other (specify)			
4	How did you apply	fertiliser 1	**(Choose One)** 1.surface application (0.2cm) 2. injection 3. Other If injection, at what depth?			
		fertiliser 2				
		fertiliser 3				
		fertiliser 4				
5	How much did you apply,(in Kg) of	fertiliser 1				
		fertiliser 2				
		fertiliser 3				

Question	Plot-Level Fertiliser Use by Stage of Rice Cultivation		Response	Plot Number/Name		
				1.	2.	3.
		fertiliser 4				
	Tilloring					
3	What kind of fertilisers did you use at this time for the plot? **Please record the fertiliser number from section 7.**		**(Choose all that apply)** 1-Fertiliser 1 2-Fertiliser 2 3- Fertiliser 3 4- Fertiliser 4 5-Other (specify)			
4	How did you apply	fertiliser 1	**(Choose One)** 1.surface application (0.2cm) 2. injection (15cm) 3. Other			
		fertiliser 2				
		fertiliser 3				
		fertiliser 4				
5	How much did you apply,(in Kg) of	fertiliser 1				
		fertiliser 2				
		fertiliser 3				
		fertiliser 4				
3	What kind of fertilisers did you use at this time for the plot? **Please record the fertiliser number from section 7.**		**(Choose all that apply)** 1-Fertiliser 1 2-Fertiliser 2 3- Fertiliser 3 4- Fertiliser 4 5-Other (specify)			
4	How did you apply	fertiliser 1	**(Choose One)** 1.surface application (0.2cm) 2. injection (15cm) 3. Other			
		fertiliser 2				
		fertiliser 3				
		fertiliser 4				
5	How much did you apply,(in Kg) of	fertiliser 1				
		fertiliser 2				
		fertiliser 3				
		fertiliser 4				

Question	Plot-Level Fertiliser Use by Stage of Rice Cultivation		Response	Plot Number/Name		
				1.	2.	3.
	Other(specify)					
3	What kind of fertilisers did you use at this time for the plot?		**(Choose all that apply)** 1-Fertiliser 1 2-Fertiliser 2 3- Fertiliser 3 4- Fertiliser 4 5-Other (specify)			
4	How did you apply	fertiliser 1	**(Choose One)** 1.surface application (0.2cm) 2. injection (15cm) 3. Other			
		fertiliser 2				
		fertiliser 3				
		fertiliser 4				
5	How much did you apply,(in Kg) of	fertiliser 1				
		fertiliser 2				
		fertiliser 3				
		fertiliser 4				

Plot-Level Organic Fertiliser Use for Seasons

Question Number	Plot-Level Organic Fertiliser Use	Response	Plot Number/Name		
			1.	2.	3.
	Did you apply organic manure to this plot?	0-No 1-Yes			
1	What types of organic manures did you apply?	***(Choose all that apply)*** 1-Green Manure 2-Farmyard Manure 3-Cattle Manure 4-Pig Manure 5 Compost 6 Biochar 7-Other (specify)			
	Now answer the questions by each manure type that you used for each plot				
	GREEN MANURE				
2	How many applications of Green Manure did you have in the season?				

Question Number	Plot-Level Organic Fertiliser Use	Response	Plot Number/Name		
			1.	2.	3.
	How did you apply the Green Manure?	(choose one) 1- Incorporation 2- Other (specify)			
3	When did you apply Green Manure?	**(Choose all that apply)** 1-Before Transplanting (or seeding) 2-Tilloring 3-Pinnacle Formation 4-Before Flooding 5-After Flooding 6-Before draining 7-After Draining 8- Other (Specify)			
4	How much of this manure did you apply (in Kg)? (total of all applications)				
5	What was the price of green manure? ('000 VND/kg) ***Enter N/A if farmer used his own.*** (total of all applications)				
	MANURE (Farmyard, cattle, pig, poultry)				
6	How many applications of manure did you have in the season?				
7	How did you apply?	***(Choose One)*** 1- surface spreading 2- incorporation 3-Injection 4-Irrigation with manure liquid 5-Other			
	When did you apply Manure?	**(Choose all that apply)** 1-Before Transplanting (or seeding) 2-Tilloring 3-Pinnacle Formation 4-Before Flooding 5-After Flooding 6-Before draining 7-After Draining 8- Other (Specify)			
8	How much of farmyard manure did you apply (in kg)? (total of all applications)				
9	What was the price of farmyard manure? ('000 VND/ kg) (**MACC ONLY**)***Enter N/A if farmer used his own.*** (total of all applications)				
	COMPOST				

Question Number	Plot-Level Organic Fertiliser Use	Response	Plot Number/Name		
			1.	2.	3.
1	How many applications of compost did you have in the season?				
2	How did you apply? ***(Do not read out the options, let the farmer respond and select the appropriate response, or write it if it should be other.)***	***(Choose One)*** 1-surface spreading 2- incorporation 3-Other			
	When did you apply the compost?	**(Choose all that apply)** 1-Before Transplanting (or seeding) 2-Tilloring 3-Pinnacle Formation 4-Before Flooding 5-After Flooding 6-Before draining 7-After Draining 8- Other (Specify)			
10	How much of compost did you apply (in Kg)? (total of all applications)				
11	What was the price of compost? ('000 VND/ton) (**MAC ONLY**)***Enter N/A if farmer used his own.*** (total of all applications)	.			
	BIOCHAR				
12	How many applications of biochar did you have in the season?				
13	How did you apply? ***(Do not read out the options, let the farmer respond and select the appropriate response, or write it if it should be other.)***	***(Choose One)*** 1- surface spreading 2- incorporation 3-Other			
	When did you apply the biochar?	**(Choose all that apply)** 1-Before Transplanting (or seeding) 2-Tilloring 3-Pinnacle Formation 4-Before Flooding 5-After Flooding 6-Before draining 7-After Draining 8- Other (Specify)			
14	How much of biochar did you apply (in Kg)?				
15	What was the price of biochar? ('000 VND/kg) (**MACC ONLY**)***Enter N/A if farmer used his own.***				

Residue Management by Plot

	What fraction of stubble remained in this field after harvesting?				
	What fraction of straw remained in the field after harvesting?				
	What type of crop amendment did you apply to your field?	1- Fungi 2- Micro bio-fungi 3- Decomposer Etc.			
	How much of <crop amendment> did you apply?				
	When did you apply the <crop amendment>?	**(Choose all that apply)** 1-Before Transplanting (or seeding) 2-Tilloring 3-Pinnacle Formation 4-Before Flooding 5-After Flooding 6-Before draining 7-After Draining 8- Other (Specify)			

Household level

Labor use for rice cultivation by season

Question Number	Labor Use for Rice Cultivation
	Household-Level Use of Own Labor by Season
1.	How many days of own household labor -- your own plus your family members-- did you use on the farm for land preparation before planting rice?
2.	How many days of own household labor -- your own plus your family members-- did you use for seeding on the plot. Enter N/A if transplanted rice
3.	How many days of own household labor -- your own plus your family members-- did you use for weeding?
4.	How many days of own household labor -- your own plus your family members-- did you use for transplanting (Enter N/A if seeding)?
5.	How many days of own household labor -- your own plus your family members-- did you use for applying any kind of manure?
6.	How many days of own household labor -- your own plus your family members-- did you use for applying fertiliser?

Question Number	Labor Use for Rice Cultivation
7.	How many days of own household labor -- your own plus your family members-- did you use for other activities (excluding those listed above, such as pesticide spraying, rice harvesting, transportation, plucking rice, drying, field security)?
	Household-Level Cost of Hired Labor by Season
8.	What was the labor cost that you incurred for land preparation for rice?
9.	What was the labor cost that you incurred for seeding on the plot. Enter N/A if transplanted rice
10.	What was the labor cost that you incurred for weeding
11.	What was the labor cost that you incurred for transplanting (***Enter N/A if seeding)***?
12.	What was the labor cost that you incurred for applying any kind of manure?
13.	What was the labor cost that you incurred for applying fertiliser?
14.	What was the labor cost that you incurred for other activities excluding those listed above, such as pesticide spraying, rice harvesting, transportation, plucking rice, drying, field security?

Machine Use by Season

Question Number	Question	Response
1	Did you use a rototiller machine on your plot?	***(Choose One)*** 1-Yes 2-No
2	What was the cost of seeder rental/service on your plot this season? ('000 VND)	
3	What was the cost of harvester machine rental/service on your plot this season? ('000 VND)	
4	What was the cost of thresher machine rental/service on your plot this season? ('000 VND)	
5	What was the cost of generator rental/service on your plot this season? ('000 VND)	
6	What was the cost of combine (machine with harvester and thresher) machine rental/service on your plot this season? ('000 VND) Specify	
7.	What was the cost of any other machine rental/service?	
8.	Please specify the other machine that you rented.	

Other Input/Technology Use

Question Number	Question
1	How many hours did you run the water pump (rental or own) for flooding rice in the season?
2	What was the horsepower of the pump that was used?
3	What was the rental cost for water pump use at the plot in the season? (‘000 VND) (Enter N/A if farmer does not rent the water pump)
4	Electricity Cost (‘000VND/Season)
5	Fuel Cost (‘000VND/Season)
7	What was the price for seed that you paid? (‘000 VND/kg)
8	From whom did you get this seed?
9	What is the name of the seed that you used?
10	What is the total amount of dry chemical pesticide that you applied on the plot for the season? (‘000 VND)
11	What was the total cost of chemical pesticide that you applied on the plot for the season? (‘000 VND/season)
12	From whom did you get this chemical pesticide?
13	Crop insurance (‘000 VND/season)
14	Other direct costs (not included above) (‘000 VND)

Module 3: Harvest and Marketing (repeat for both seasons)

Question Number	Question	Response
1	How much rice did you harvest this season? (kg)	
2	How much of the rice that you harvested did you sell? (kg)	
3	Were you paid in cash or in kind for this rice?	a. Cash – skip to 4 b. In kind – skip to 5 c. Both – skip to 4
4	How much VND did you receive for this <amt from 2> rice you sold?	
5	What was the value in VND of what you were paid in kind?	
6	Who did you sell this rice to?	
7	Did you have an advance agreement with <answer from question 6> to sell him/her/it the rice you produce?	0. No 1. Yes