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Grow Against the Flow

Monitoring, Evaluation and Learning Strategy

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This study is conducted within the project "Grow Against the Flow: Scaling off-season vegetable innovations to improve incomes and nutrition in Cambodia and Lao PDR" by the Federal Ministry for Economic Cooperation and Development for the period 2020-2022.

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Basic project information

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Local research partners:	Genearal Directorate of Agriculture in Cambodia; Department of Agriculture's Clean Agriculture Standards Center in Laos

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1 Description of research

Production of vegetables worldwide is steadily increasing. In Asia, according to an FAO (2020)'s report, the share of cereals, roots and tubers in total production value declined from 1993 to 2016 while the shares of fruits and vegetables increased. Despite the increased production, vegetable intake in most parts of the world remains below the recommended levels. Low vegetable intake is a serious concern as it is associated with malnutrition and a wide range of diseases (WHO, 2015; Willett *et al.*, 2019). In Southeast Asia, vegetable consumption is strongly influenced by seasonal variations in production and price. During the regular cropping seasons, vegetable production is high and prices are low, but outside the regular cropping calendar, vegetable production is low and prices are high making it challenging for households, and especially the poor, to consume. In addition to production and prices, the changing climatic conditions and perishable nature of vegetables challenge the continuous supply of vegetable to families year-round. Identifying and promoting approaches that can address technological constraints to production of vegetables year-round is, a pressing challenge for policy makers in Southeast Asia.

One way to increasing year-round supply of vegetables is through promoting innovative production technologies that can be used by farmers both in-season and off-season. For instance, the use of high-yielding varieties, grafting and integrated-pest management, have exhibited high-yielding potential and adaptability, especially during the off-seasons (also called counter-season) (Gautam *et al.*, 2017). Off-season vegetable production is the growing of vegetables under adverse climatic or economic conditions (Schreinemachers *et al.*, 2016). Off-season technologies, if adopted, can play a vital role not only in increasing production but also in the overall economic development by improving the nutritional status of households, generating incomes and jobs in both the farm and non-farm sectors (Ali & Abedullah, 2002). Most importantly, off-season vegetable production is likely to offer women a source of income when their counterpart men are not using the land for production. Given these benefits, governments and development practitioners in Southeast Asia are becoming more interested in off-season vegetable production and many technologies have been proposed and tested (Schreinemachers *et* *al.*, 2018). However, adoption of off-season vegetable production practices remains low in many countries in the region.

In attempts to increase the adoption of off-season practices, scientists are promoting agricultural training as an effective pathway (Anderson & Feder, 2007; Kiptot & Franzel, 2019). Training supports transfer of information and has been linked to increased productivity and profits (Gautam *et al.*, 2017; Luther *et al.*, 2018). However, training approaches are poorly organized, especially the public extension in most countries making it is impossible (given the large and heterogenous number of farmers) for extension officers to reach all individual farmers to increase their awareness and knowledge of new technologies, and thus promote technology adoption and productivity (Takahashi *et al.*, 2020). This is especially true in Southeast Asia where agricultural production is undertaken mainly by smallholder farmers who are geographically dispersed and farm many different crops.

The identification of effective agricultural training approaches, such as a farmer-trainer approach in which a small number of trained farmers demonstrate technologies to their peers, is key to improving technology adoption. **This study examines the impact of training farmers in off-season production technologies on vegetable production and profitability.**

Farmer-trainer approach employs social learning and neighborhood networks in disseminating information and technologies to a larger number of farmers at low cost. Evidence shows that social learning or 'learning from others' improves technology dissemination and adoption (Lukuyu *et al.*, 2012; Nakano *et al.*, 2018; Shikuku & Melesse, 2020). The farmer-trainer approach further enables farmers to adapt, make better decisions, and provide feedback to researchers and policy makers, and promotes the sustained use of technologies introduced by projects (Kiptot & Franzel, 2019).

While the farmer-trainer approach is promising, it is not without drawbacks which may amplify the already existing inequalities if not carefully designed. For instance, if the design of farmer-trainer approach does not consider the gender differences, it may widen the gender gap (Kondylis *et al.*, 2016). In a study on gender differences in access to extension and productivity in Ethiopia, Ragasa *et al.* (2013) finds that women are less likely to get extension services through various channels and less likely to access quality services than their male counterparts. This is because the contextual and cultural gendered constraints are slowing down women's access to training, which negatively impacts their adoption of agricultural technologies and agricultural productivity (Kondylis *et al.*, 2016). To improve women's learning, studies underscore the importance of gender sensitive training approaches (Achandi *et al.*, 2018; Mudege *et al.*, 2015) and information linkages formed among women peers (Takahashi *et al.*, 2020). Shikuku (2019), in his study on information exchange and adoption of technologies in Uganda, finds an increased likelihood of information exchange when the farmer-trainer is a female. In Kenya, training women increases their control over production and marketing decisions and income from dairy (Basu *et al.*, 2019).

While studies on the role of farmer-trainers in dissemination of technologies and gendered impacts of farmer-training are on the rise in Sub-Sharan Africa (Achandi *et al.*, 2018; Fisher & Carr, 2015) evidence from Southeast Asia remains scarce. Promoting farmer trainer approaches without evaluating the role of gender means that the potential effects of training remain unexploited. We contribute to this research gap. **Thus, the second objective of the study is to explore the effect of the farmer-trainer approach on women's access to training, time use, adoption of technologies, production and profitability.**

To address our objectives, this study will investigate the effectiveness of the farmer-trainer approach on the adoption of vegetable production technologies for the off-season. The training is provided by World Vegetable Center (WorldVeg), East-West Seed International (EWS), International Development Enterprises (iDE), the General Directorate of Agriculture (GDA), Cambodia and the Department of Agriculture (DAR) in Lao PDR. Cambodia and Lao PDR form an interesting case because of the strong market demand for locally grown, high quality, safe and fresh vegetables, especially during the off-seasons when smallholder farmers struggle to produce high value vegetables. Low production in off-seasons imply that vegetable farmers in Cambodia and Lao PDR are missing out on the lucrative opportunity to supply markets when prices are high. Particularly during the off-season, many farmers (often men) migrate in search of off-farm jobs to urban areas or abroad as there are few other income-generating opportunities in rural areas (Bylander, 2015). This has social consequences with many rural households left to be run by women or by the elderly. Training farmers on technologies for producing vegetables during off-season may benefit women who are left behind as men migrate to urban areas.

In this research project, we intend to answer two research questions: 1) what is the impact of the farmer-trainer approach on technology adoption, labor, productivity and profitability? 2) is the impact different for women and men?

2 The intervention

The Grow Against the Flow (GAF) project runs for 3 years from 2020-2022. The goal of this scaling project is to make vegetables more available, affordable and accessible by enabling smallholder farmers in Cambodia and Lao PDR to increase year-round production of vegetables. The immediate purpose of the project is that 105,750 smallholder farmers and households in Cambodia and Lao PDR benefit from increased production and consumption of vegetables through the scaling of off-season vegetable production technologies.

Before implementing the project, meetings were held with partners from Cambodia and Laos to get information on the vegetable's seasons, technologies to be promoted and the scaling approach. Three vegetable production seasons were identified:

i) **The cool-dry vegetable growing season from November to February**, which is the main vegetable production season. During this season farmers produce vegetables on rainfed plots;

ii) **The hot-dry season between March and May**. The dry conditions make production of vegetables difficult in this season; and

iii) **The rainy season found between June and October**. This season is normally not suitable for vegetable production because of wetness.

In this study, the hot-dry and rainy seasons form what we refer to as the "off-seasons".

Each year, technical officers from project partners, namely EWS, iDE and the government's agricultural departments set up demonstration sites to train farmers in off-season innovations. The technologies promoted include improved cultivars, integrated pest management (IPM), protective structures and water conservation. IPM practices involve the use of colored sticky traps, pheromones, bio-pesticides [microbial pesticides and neem oil], and tomato grafting while protective structures involve the use of pink net houses/rain shelters, poly-houses, low-cost tunnels. Water conservation technologies focus on the use of drip irrigation and mulching for the dry season.

The GAF project uses a farmer trainer approach to scale innovations. The farmer trainer approach is structured as follows. First, technical staff from EWS, iDE and the Department of Agriculture organize farmers in groups (also called core groups) of 20 farmers each. These farmers are typically neighbors. Second, one lead farmer is selected from each group to provide space in their farm for setting up demonstrations. Lead farmers provide free labor and physical resources but they also receive subsidy from the project to adopt protective measures. Criteria for selecting lead farmers includes membership in farmer groups, personality traits like (e.g., risk taker, cooperative), social position (e.g., a leader) and assets (e.g., own a minimum of 500sqm of land). Women are encouraged to take a "lead farmer" role. Thirdly, group members are invited at the demonstration farm, where both the group members and the lead farmer receive training from technical officers. Field days are also organized at the demonstration plots. During field days, group members, lead farmers and other farmers interested in the innovations attend and receive training mainly from the lead farmer with support from technical officers where needed.

Table *1: GAF farmer trainer participants* shows the participants in the farmer trainer approach of the GAF project.

Table 1: GAF farmer trainer participants

Participants	Support received	Role
Lead farmers	Training by EWS, iDE and Department of Agriculture technical field officers	Host and manage demonstration plots Train farmers during field days
Group member farmers	Training received through demonstration plots and field days	Not specified
Village farmers	Training events held by technical field officers and lead farmers	Not applicable

The technical officers train lead farmers and group members on five modules as follows. 1) how to select quality seed, land preparation, seedling, mulching, bed making and grafting, 2) transplanting, spacing, water management, and low external input, 3) plant nutrition, fertilizer and application, pest and disease identification and management, 4) safe and efficient use of pesticide, and 5) cost-benefit analysis and record keeping. Training is done on one module per day, with each module taking about four hours. Technical backstopping is done on lead farmers and group members once a week throughout the year. In addition, one field day per crop is organized per season to disseminate technical knowledge and share financial and marketing information to group members and other neighbors. About 30-35 farmers participate in each field-day. We consider the first-year (2020) as a learning phase for the project. The project will expand its sites and target locations in 2021 and a further expansion is expected in 2022 and 2023.

3 Methods and data

3.1 Study area

Before elaborating on the sampling technique, technical officers were consulted with respect to areas under vegetable cultivation. We note that the areas of concentration of vegetables include Kampong Cham, Tbong Khmum and Kampot provinces in Cambodia and Luang Prabang, Vientiane, Vientiane Capital, Khammouane and Champassak provinces in Laos. These form the main project areas. For cost reasons, we will limit the survey to two provinces in each country, which will be selected based on vegetable production intensity.

3.2 Sampling strategy

We purposively select districts in each province retaining those with high vegetable production activities and those that are accessible to our project partners. A list of all the villages is then generated by the project partners ensuring that there is 5 to 10 km buffer zone between villages. Using this list, we randomly pick 28 villages. Inside each village, two to five lead farmers are identified with the help of technical officers and 16 households (group members with the lead farmer) assigned to the lead farmers. After collecting the baseline data, we randomly assign treatment (14 villages) and control (14 villages).

3.3 Power calculations

We conduct power calculations for a typical quasi-experimental design as suggested by Gertler *et al.* (2016). As the number of clusters (i.e., villages) and cluster sizes are fixed, we do the power calculations by estimating the Minimum Detectable Effect (MDE) that we can measure given a power of 80%. Additionally, considering that the intervention will be implemented in two different countries and most importantly that the implementing agencies are not the same and village selection (e.g., manual matching) will be done independently in each country, we use a use a multi-site (or blocked) clustered approach to do the power calculations with the following assumptions (Table 2):

Table 2: Assumptions for power calculations

Item	Assumption	Justification
Alpha	0.05	Default value
Cluster size	14 farmers	Based on intervention design
Number of clusters per site	28	Considering that 14 clusters will receive the intervention in each country
Number of sites	2	Representing the two countries, Las and Cambodia
ICC	0.05 – 0.20	We calculate ICC using farmers' gross income from vegetable production based on a previous study under WorldVeg's "Teach and Text" project (2019) involving 777 farmers in Cambodia.
Effect size variability	0	Mixed effects model (with site dummies) will be used
Proportion of explained variance by the blocking variable	0% – 30%	No strong reasons to believe that the blocking with have effect on the variance. Nevertheless, we consider two scenarios: 0% and 30%
Proportion of explained variation by covariates	0%	We will control for some covariates but we use a conservative value of 0%

We did the power calculations in Optimal Design Plus. Figure 1 illustrates the results of the power calculations:

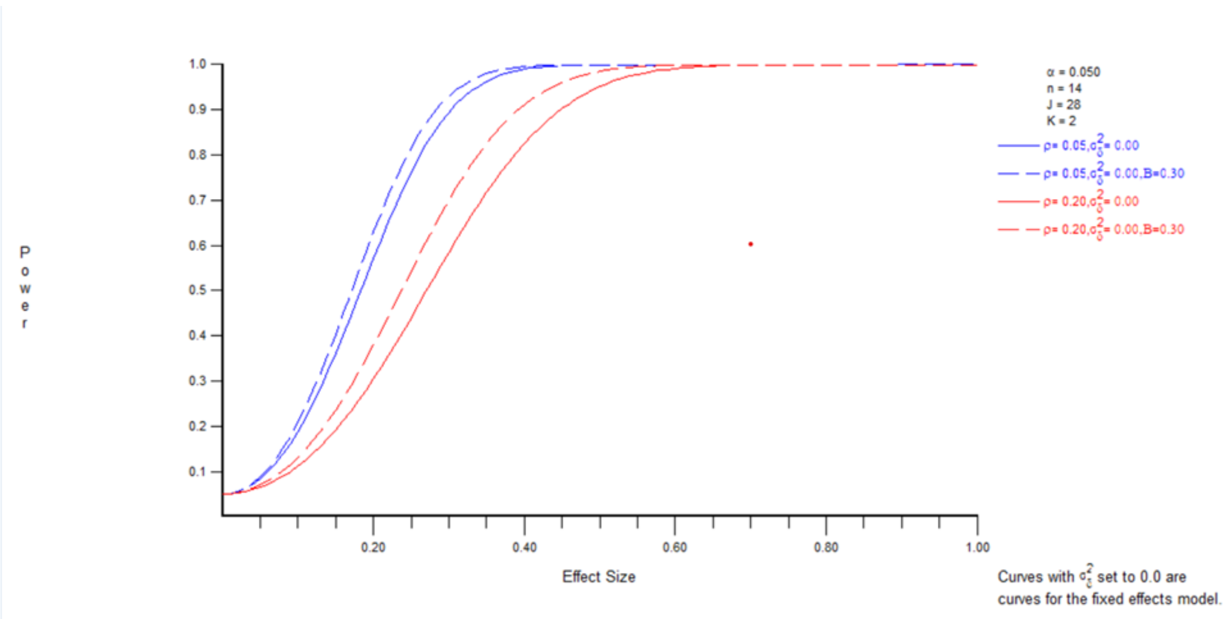

Figure 1: Graphs of power calculations

This figure suggests that we can detect an effect size between 0.23 and 0.40. We further conduct the power calculations at the country-level based on a typical clustered quasi-experimental design and by using the following assumptions (Table 3):

Table 3: Assumptions for power calculations at country-level

Item	Assumption	Justification
Alpha	0.05	Default value
ICC	0.05 – 0.20	We use farmers' gross income from vegetable production based on a previous study under WorldVeg's "Teach and Text" project (2019) in Cambodia involving 777 farmers.
Beta (power)	80%	Default value
Number of clusters per site	28	Considering that 14 clusters will receive the intervention in each country
Cluster size	14 farmers	Based on intervention design
Proportion of explained variation by covariates	0%	We will control for some covariates but we use a conservative value of 0%

Figure 2 illustrates the results of the power calculations at the country-level:

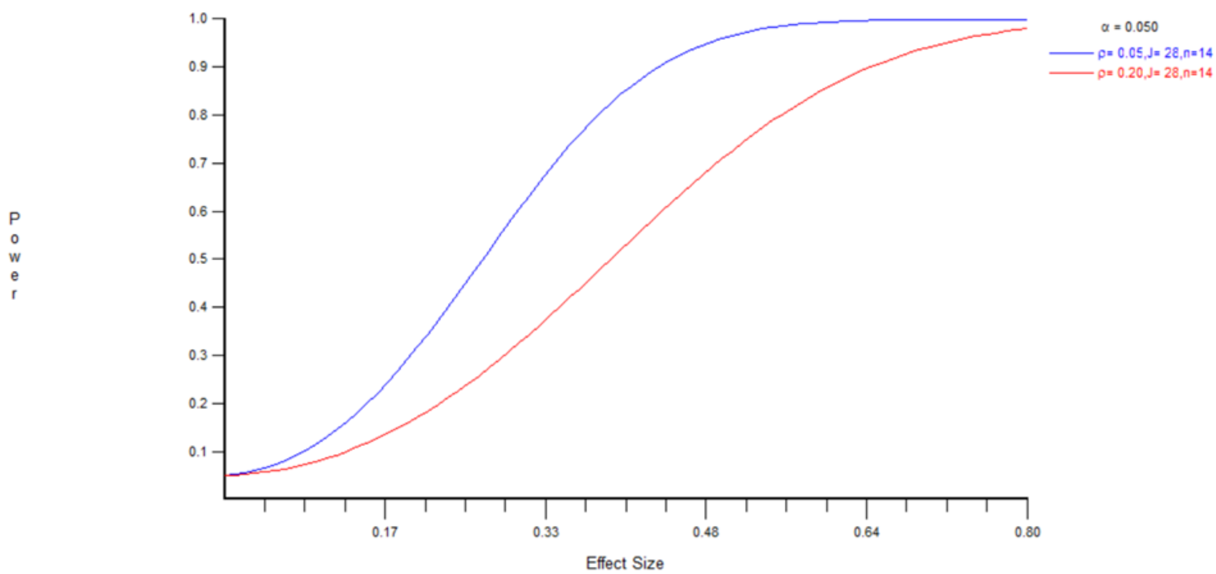

Figure 2: The results of the power calculations at the country-level

This figure suggests that we can detect a medium effect size between 0.34 and 0.58.

In sum, with a total number of 56 clusters and 14 farmers per clusters we can detect a small to medium effect size with 80% power. Considering that attrition rate will not exceed 15% the final sample will involve a total of 896 farmers, implying 16 farmers per clusters.

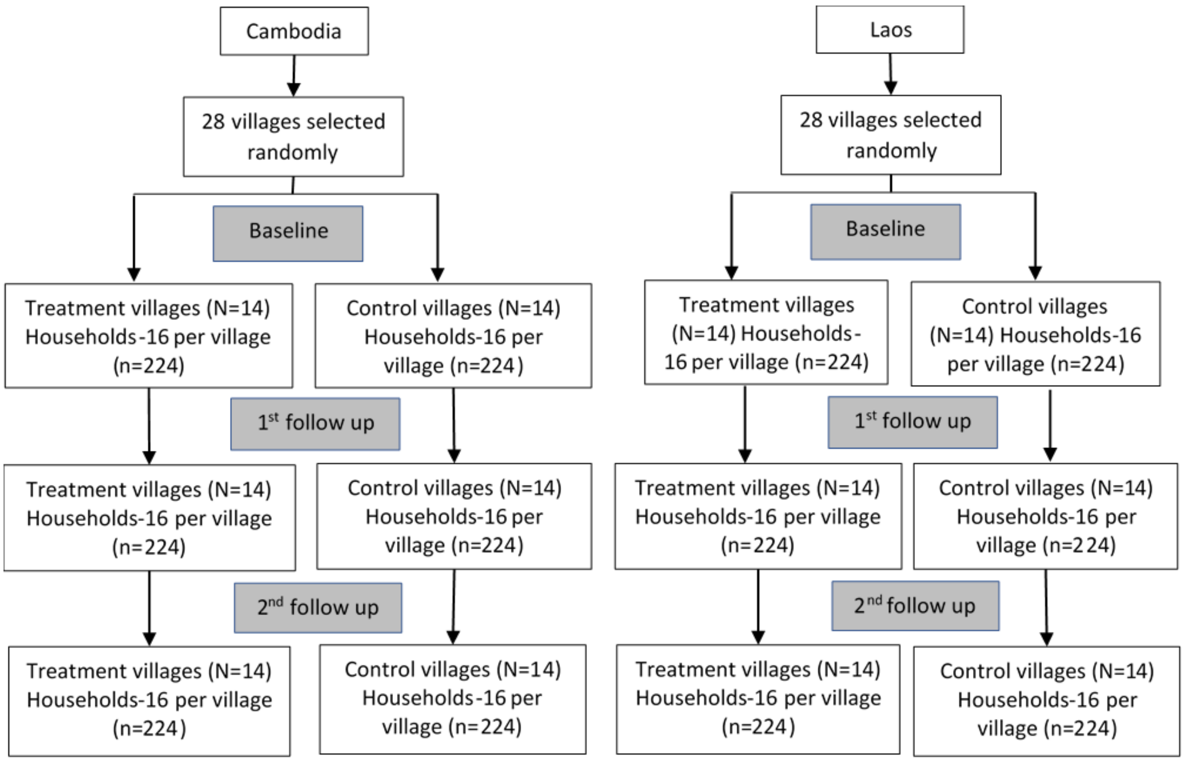

Figure 3 displays the sampling procedure.

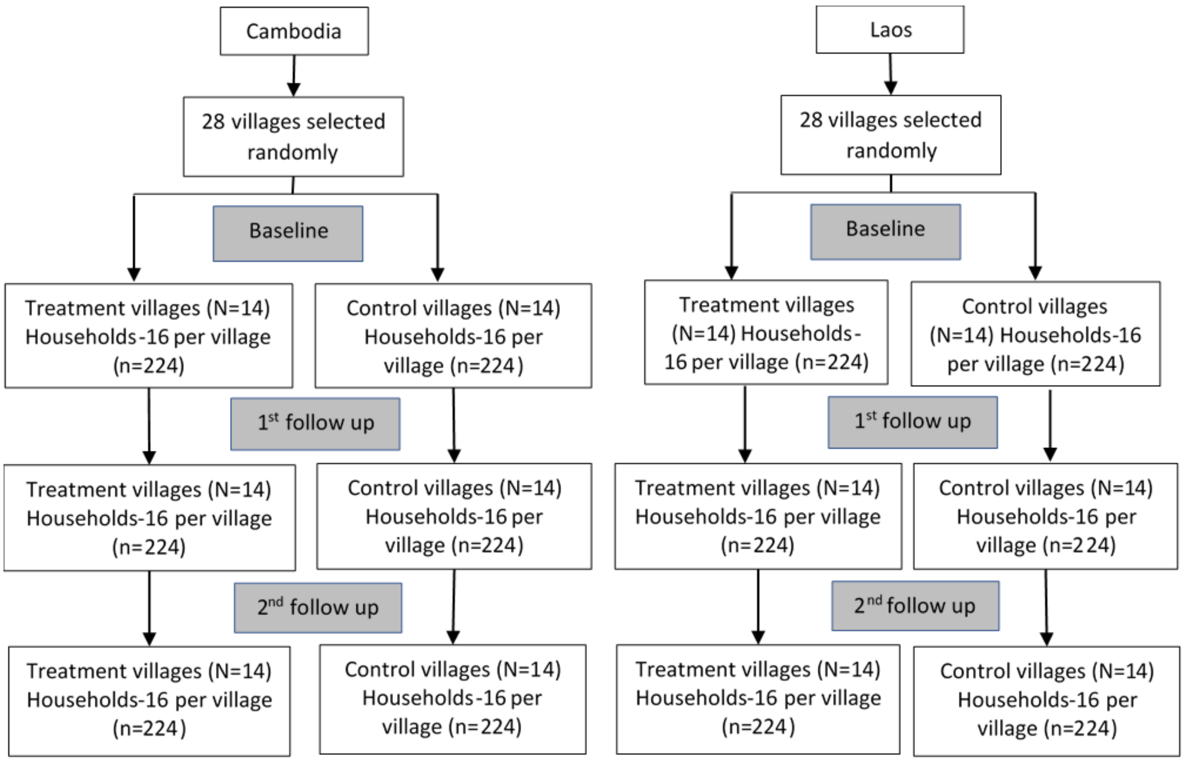

Figure 3: Flow diagram for sample selection

3.4 Intervention plan

Data is to be collected in June 2021 before the treatment is rolled-out. The first round of endline data will be collected approximately a year later, potentially in June 2022. This will be not too long after the end of the off-seasons, during which the intervention is intending to provide trainings. Pending funding, an additional round of endline data collection could be collected in the third year to assess the long-term effects of the three-year intervention. Data on number of farmers receiving trainings, lead farmers, and training events organized will be collected at a regular basis for monitoring the progress of the project.

The intervention plan for the project is detailed in *Table 4*.

Table 4: Intervention plan

	2021			2022				2023			
Activity	Apr-Jun	Jul-Sep	Oct-Nov	Dec-Feb	Mar-May	Jun-Aug	Sep-Nov	Dec-Feb	Mar-May	Jun-Aug	Sep-Nov

Training on EWS data system in Laos Lead: Consultant and partners											
Sampling Lead: Consultant, partners and WorldVeg											
Baseline data collection (survey and FGDs) Lead: Consultant											
Training of farmers Lead: partners											
1st follow up (survey and FGDs) Lead: Consultant											
2nd follow up (survey and FGDs) Lead: Consultant											
Data analysis											
Writing article=1st draft Lead: WorldVeg											
Monitoring Lead: WorldVeg and partners											
Monitoring report writing Lead: WorldVeg and partners											

A structured questionnaire will be used during the baseline and endline survey to collect information from smallholders on agricultural production including plot characteristics, input use, and output. Data collection technique will involve one-on-one interviews or phone interviews using the Kobo application depending on the state COVID-19 restrictions. An external team of enumerators will be hired to help in data collection. Data analysis will be done using STATA.

We will further conduct focus group discussions (FGDs) to collect information on factors that promote adoption of off-season practices, constraints of adoption, and farmers' opinion on gender roles as related to vegetable production. Discussions will be recorded using audio recorders and transcribed in English. ATLAS.ti software will be used to code and content analysis technique applied to analyze the qualitative data.

4 Description of variables

Consistent with the study's two objectives, the impact pathway for this project can be defined as that pertaining to the knowledge and adoption of off-season vegetable technologies, production and welfare outcomes. These impacts are predicted to differ by gender.

4.1 Effects on knowledge and adoption of off-season practices

Knowledge and adoption of off-season technologies form the main primary outcomes of the intervention. This intervention relies on a farmer trainer extension model that has recently gained attention for its potential effect on the diffusion of information and technologies (Lukuyu *et al.*, 2012; Ragasa, 2012) through social networks (Shikuku, 2019). By training fellow farmers and hosting demonstrations, lead farmers complement local extension services and improve learning on improved technologies (Kondylis *et al.*, 2017). This is particular true because farmers 'learn by seeing' what fellow farmers are practicing. Peer learning is also likely to be pronounced during trainings and field days thus improving farmers knowledge and adoption of off-season technologies.

We focus on three measures of knowledge and adoption: a knowledge score, the number of off-season practices the respondent identifies by name, and the number of practices the respondent adopted. The knowledge score is a continuous measure based on the number of correct responses provided in a 26-question exam, covering all off-season practices. The majority of the analysis on adoptions rests on farmer's self-reported number of adopted practices.

4.2 Effects on production, profitability and nutrition

The adoption of off-season practices has the potential to achieve livelihood impacts for rural communities in several ways (Wollni & Brümmer, 2012). First, WorldVeg improved off-farming technologies and quality training services (offered by project partners) are expected to convey significant productivity gains for farmers. Increasing productivity in off-seasons when prices are high and supply is low is expected to generate higher income and profits from farming households than producing during on-seasons (Schreinemachers *et al.*, 2016). This is a particularly important step towards rural and agricultural development, especially in South-East Asia where vegetable farming is an important source of food and income (Takaheshima & Joshi, 2019).

Beyond the potential commercial output and opportunities generated, increased productivity, especially during off-seasons, can lead to positive effects on household nutritional status. Household members' nutritional status can be improved if they consume the generated surplus of vegetable produced in off-seasons. Vegetables are key sources of micronutrients needed for improving nutrition and for a healthy diet particularly during and post- COVID-19 pandemic (Harris *et al.*, 2020).

Some unintended effects may, however, take place and should be accounted for. In particular, vegetable production systems can increase agricultural pesticide use, which can have damaging effects on farmers' and environmental health if not applied properly (Schreinemachers *et al.*, 2017; Schreinemachers *et al.*, 2020). Addressing such risk through the training and demonstrations is important.

4.3 Gendered effects

The gender of the lead farmer can have important implications for the adoption and the success of a farmer trainer approach (Kondylis *et al.*, 2016). The inclusion of female lead farmers, wherever feasible, should help to scale up the intervention to efficiently reach rural women. This should theoretically foster the adoption of improved technologies, knowledge transfer and consequently production and profitability by lead farmers, their associated group members and potentially other interested farmers in the villages.

Adoption of off-season vegetable production has the potential to disrupt gender roles in a number of ways. As labor-intensive crops, vegetables have the potential to increase women's labor and time poverty especially if production is done during off-seasons when men members of households have moved to cities in search of other jobs and women are left at home to manage the farm and care for the family. More so, adopting vegetable mechanized innovations such as irrigation may lead to loss of job opportunities and income, in contexts where women provide manual labor (Farnworth *et al.*, 2020). However, women can benefit from increased control over resources and decision-making, leading to empowerment (Bushamuka *et al.*, 2005). If women take over decisions from men on the consumption of off-season vegetables and use of income from the sale of these vegetables, we expect improvement in nutrition. Previous studies have shown a positive correlation between women empowerment and improvement in nutrition in South East Asia (Kassie *et al.*, 2020; Quisumbing *et al.*, 2020).

For a detailed description of variables please see Appendix 1.

5 Data analysis plan

We causally estimate average treatment effect of training on the indicators (i.e., knowledge, adoption, productivity, profit, nutrition) among farmers using ANCOVA:

$$Y_t = \beta_0 + \beta_1 G + \beta_2 Y_{t0} \qquad \text{(i)}$$

Where Y_t is the outcome measured at baseline and endline; G is a treatment indicator ($G_i=0$ for controls, $G_i=1$ for treated); β_1 is the overall treatment effect, and Y_{t0} is the baseline outcome; and *e* is normally distributed with zero mean and constant variance. We cluster the standard errors at the village level to allow for arbitrary correlation of treatment effects within the village.

We further use ANCOVA to estimate the average treatment effect of training on knowledge and adoption of offseason practices among women in the treatment group versus women in the control group. An impact assessment of the effect of adoption on decision-making and control over resources among women in treatment and women in control is also assessed. Distinguishing training effects between men and women is also possible.

Heterogenous effects of training on knowledge, adoption and welfare will be analyzed with respect to farmer's social networks (contact with lead farmers and extension agents), age and plot size.

6 Monitoring of the project (Different from the impact study)

Data collection for monitoring is done using the EWS KT app. In each target village the trainers collect data from the demo farmer and five group members. The collection follows the outline of the EWS KT app to collect:

1) Key-farmer details: This includes detailed registration data and exact plot level data on production, yield, and economics of the demo plot
2) Farmer registration and evaluation: 5 farmers are interviewed at least at baseline and endline on their technology adoption and basic measures of vegetable production per season (area, total yield) for each target crop
3) Trainings/Field days: The trainers record who attended the trainings, the content covered, and the if it was a field day.

EWS KT sends a monthly download of the data to WorldVeg. WorldVeg conducts a cross-check and uploads the data into AkvoLumen to generate a password protected dashboard that is accessible to all partners and BMZ/GIZ. Selected indicators (

Table 5) can be integrated into the project homepage to be accessed by the public.

Table 5: Monitoring plan

Indicator	Data source	Timing
Field demonstrations (GPS location, status, farmer, gender-disaggregated)	EWS KT App (as is): Demo monitoring	Continuous
Farms receiving project support	EWS KT App (as is): Demo monitoring of farmers	Continuous
Farmers exposed to project activities	EWS KT App (as is): Demo monitoring of participants (occasional visitors)	Continuous
Rating of training (Likert scale & comments)	EWS KT App (**to be added**): Evaluation sheets	Interview >=2 registered farmers after each training; Proceed alphabetically through the list & restart at the top
Adopted technologies (gender disaggregated)	EWS KT App (as is): Registration and Evaluation sheets	Farm registration & end of the training; Survey in Nov 2021 & May 2022
Vegetable production area and harvest per vegetable and season	EWS KT App: Registration and Evaluation sheets	Farm registration & end of the training; Survey in June 2021 & June 2022
Detailed vegetable production data (production, costs, income, labor, pesticides & fertilizers, supply chain) on plot level	Survey	Survey in June 2021 & June 2022
Other household income data, by month	Survey	Survey in June 2021 & June 2022

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Appendix 1: Variable description

Variable	Variable definition	Explanation	Literature
Knowledge	Knowledge score	Does the farmer have knowledge on (correct answer=1)? a. High quality commercial seed b. Preparing compost/organic matter c. Protecting seedling nursery d. Mulching e. Establishing a trellis f. Spacing of plants and plant population g. Fertilizer use and application h. Use of bio-fertilizers i. Use of plant growth regulators or micronutrients j. Appropriate pest management practices k. Use of bio-pesticides for seed or seedling treatment l. Use of colored sticky traps m. Use of pheromone traps n. Safe and efficient use of pesticides o. Knows how to choose and calibrate chemicals and biopesticides p. Practice of grafting q. Use of rain shelters to protect plants r. Use of net or plastic tunnels to protect plants s. Use of a net-house to protect plants	Practices obtained from teach and text questionnaire
	The number of off-season practices the respondent identifies by name	Can the farmer correctly identify any of these off-season practices (correct answer=1): a. Protected seedling nursery b. Mulching c. Trellis	Practices obtained from teach and text questionnaire

		d. Colored sticky traps e. Pheromone traps f. Grafting g. Rain shelters h. Plastic tunnels i. Net house	
Technology adoption	Number of practices the farmer uses	Did you use any of these practices? (Yes=1; 0, otherwise) a. High quality commercial seed b. Prepare compost/organic matter c. Protected seedling nursery d. Mulching e. Trellis high enough f. Spacing of plants and plant population g. Fertilizer use and application h. Use bio-fertilizers i. Use of plant growth regulators or micronutrients j. Appropriate pest management practices k. Use of bio-pesticides for seed or seedling treatment l. Use of colored sticky traps m. Use of pheromone traps n. Safe and efficient use of pesticides o. Knows how to choose and calibrate chemicals and biopesticides p. Practice of grafting q. Use of rain shelters to protect plants r. Use of net or plastic tunnels to protect plants Use of a net-house to protect plants?	Practices obtained from teach and text questionnaire
Production	Plot size and amount of vegetables harvested	Types of vegetable grown	(Verkaart *et al.*, 2017)

		1a. On how many square meters did you grow this vegetable during the last hot-dry season (March-May)? 1b. In total, how many kg did you harvest during that time? 2a. On how many square meters did you grow this vegetable during the last cool-dry season (November to February)? 2b. In total, how many kg did you harvest during that time? 3a. On how many square meters did you grow this vegetable during the last rainy season (June to October)? 3b. In total, how many kg did you harvest during that time?	
Income	Amount of vegetables sold and price per kg	1a. What amount was sold from vegetables harvested during the last hot-dry season (March-May)? 1b. What was the average price per kg? 2a. What amount was sold from vegetables harvested during the last cool-dry season (November to February)? 2b. what was the average price per kg? 3a. What amount was sold from vegetables harvested during the last rainy season (June to October)? 3b. what was the average price per kg?	(Verkaart *et al.*, 2017)
Costs	Cost of producing vegetables	Did you incur any of the following costs in producing (__) type of vegetable? 1=Land Preparation 2=Seeds 3=Fertilizer 4=Chemicals 5=Hired labor 6=Harvesting 7=Transporting -888=Other (specify) _____ If yes, how much?	

Social networks	Relationship between ordinary framer and the lead farmer	If not a lead farmer, we ask: a. Does the ordinary farmer belong to the same livestock group or financial group with the lead farmer? b. Is the ordinary farmer a relative of the lead farmer? c. Is the ordinary farmer a neighbor of the lead farmer? d. How often does the ordinary farmer interact with the lead farmer (daily, weekly, bi-weekly, monthly, irregularly)	(Nakano *et al.*, 2018; Shikuku & Melesse, 2020)
	Relationship with extension agent	a. Farmer knows extension agents b. If yes, how often does the ordinary farmer interact with the extension agent (daily, weekly, bi-weekly, monthly, irregularly)	(Kondylis *et al.*, 2017)
Geographical proximity	Distance	e. What is the distance from the ordinary farmers' homestead to the lead farmer's homestead?	(Nakano *et al.*, 2018)
Training	Training	For ordinary farmers: a. Did you attend a demonstration organized in another farmer's homestead in this village to train co-villagers about vegetable farming? b. What was the gender of the farmer who hosted the demonstrations/training?	(Kondylis *et al.*, 2016)
Socioeconomic characteristics	Age	Age of the farmer	(Farnworth *et al.*, 2015; Tsige *et al.*, 2020)
	Sex	Sex of the farmer	
	Farming experience	Number of years the farmer has been growing vegetables	
	Education	Number of years of formal schooling	

	Wealth proxied by land ownership	Size of the land owned with title deed	
	Household size	Number of members living and sharing food with the farmer for the past 3 months	
Nutrition	Consumption	Compared to the past year, how do you rate your household consumption of vegetables during the off-seasons of this year?	(Kassie *et al.*, 2020)
Women empowerment	Input in production decisions	Has some input or feels can make a decision at least two activities: a. Which vegetable variety to plant b. Vegetable technology to adopt c. Sale of vegetable in market d. Amount of vegetables to be used for home consumption	(Alkire *et al.*, 2013; Gupta *et al.*, 2019)
	Decisions on credit	The individual can self/joint make decisions regarding taking an agricultural loan for off-season farming: a.	
	Control over income	The individual has some control over Income from sale of vegetable	
	Group membership	Adequate if a woman is a member of agricultural group: a. Member of vegetable group and participates (through selling, accessing inputs, meetings, etc) Member of another agricultural group	
	Leisure	b. Adequate if satisfied in leisure	
	Workload	Time spent in vegetable production and marketing in the past 24hrs	
Instrumental variables		a. Number of lead farmers known to the farmer b. Number of lead farmers in the farmers village	