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HOW-TO GUIDES

IN AGRICULTURAL MARKET SYSTEM DEVELOPMENT

Developing Crop Budgets

CHAIN
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CHAIN

How-to Guides in Agricultural Market Systems Development

Developing Crop Budgets

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Foreword

Cambodia's agricultural sector shows continued growht bothe in production and export, despite the COVID 19 pandemic. Nevertheless, poverty remains largely a rural phenomenon, as about 80% of the 2.5 million poor people live in rural areas. Cambodian smallholder farmers' low productivity is the result of limited access to quality agricultural inputs, technical knowhow and innovation, as well as limited marketing opportunities and market information. Pressure on water resources and the effects of climate change are additional challenges. Limited involvement of the private sector in agricultural extension services and weak cooperation with public sector actors restrain the development of prosperous smallholders. Cambodia is not self-sufficient in vegetables and fast economic growth has resulted in a higher demand for safe and quality local fruits and vegetables. This provides a huge opportunity for smallholder farmers and processors, particularly women, to increase income and food security. Moreover, improved rural infrastructure has increased the mobility of rural poor people, providing them access to diversified markets and job opportunities.

Responding to these challenges and opportunities, the Swiss Agency for Development and Cooperation (SDC) has developed the Cambodian Horticulture Advancing Income and Nutrition (CHAIN) 2014-2022 programme in close cooperation with the Ministry of Agriculture, Forestry and Fisheries through the General Department of Agriculture (GDA) and the provincial departments of Agriculture, Forestry and Fisheries (PDAFF). CHAIN has used a market development approach aimed ad strenghtening the inclusion of poor people (with a strong focus on women) in the market to secure better access to agricultural goods and service and to gain higher incomes. The key element of this approach is a facilitation process for involving private and public partners as well as civil society organisations in the delivery of goods and services on the input and output side of the horticulture value chains (e.g. extention, inputs, marketing and market information) that appropriately meet the needs of poor farmers and processors. Over the past eight years, we were able to achieve impressive results. Cambodia vegetable production has increased remarkably over the last 3 years and is now covering %68 of domestic market demand (700,000 Mt in 2020) compared to 422,000 Mt in 2013. Great achievement!

This How-to Guides in Agriculture Market System Development Book is a collection of tools, principles, practices and approaches developed during CHAIN implementation. It shall provide a reference for all stakeholders in agricultural value chains from public and private sector as well as the civil society. It is also a guide book for sustainability that is at the core of chain as it aims at strengthening horticulture market systems and the capacity of the sector actors to provide services to the targeted farmers. The established networks, policies and market systems will continue to funciton, as sector actors and farmers will have reached a critical mass large enough to become a profitable and self-sustaining market.

I would like to thank MAFF, GDA, Provincial Authorities, PDAFFs, and SNV and all involved people for an excellent collaboration and for actively contributing to the implementation of the CHAIN Project.

Markus Buerli
Director of Cooperation

Other guides in this series

- Introduction to Market Systems Development
- Facilitating Agribusiness Cluster Development
- Facilitating Business to Business (B2B) Relationships
- Lead Farmer Incubator Approach
- Rural Business Accelerator
- Smart Water and Climate-Smart Solutions for Horticulture
- Farmer Videos for Digital Extension

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1. Introduction

The Cambodia Horticulture Advancing Income and Nutrition (CHAIN) project has produced a series of How-to Guides (HTGs) that are meant to be practical, informative instruction manuals for those wishing to replicate and further develop the successful approach es used during the three phases of CHAIN. We hope that these HTGs will be helpful to many organiza tionsglobally, especially those engaged in agricultural development projects that apply a market systems development approach (see Box 1). However, we have written the HTGs with Cambodian stakeholders in mind, mainly the Ministry of Agriculture, Forestry and Fisheries (MAFF), the General Department of Agriculture (GDA), the Provincial Departments of Agriculture, Forestry and Fisheries (PDAFFs), and local NGOs.

The present HTG focuses on how to conduct a cost-benefit analysis in horticulture using a crop budget, with the aim of determining whether a farmer can make or lose money by growing a specific vegetable. The HTG covers simple crop budget development, including tracking expenditures, determining selling prices for different vegetables, calculating costs and computing financial indicators such as profit and pay back period. CHAIN trained local extension staff on how to prepare crop budgets using these methods, and they, in turn, taught farmers. Though the meth odology has been devised especially for vegetable production, it can be applied to any crop type. (Note: to conduct a crop budget analysis, farmers must be able to read, write and make simple calculations.)

Box 1
Market Systems Development (MSD)

The MSD approach covers the entire systemthat surrounds a market. In the case of includes all the relevant participants (‘actors’ or ‘players’): the farmer who grows the crops, the retailer who sells seeds and other inputs to the farmer, the trader who buys the crops once harvested, and the wet market sellers who sell the vegetables to consumers. It may also encompass services that support the core market, such as government extension agents who provide advice to farmers and local market-structures that make physical space available for buyers and sellers to meet.

MSD aims to address poverty by improving the performance of markets in an inclusive manner, especially by modifying the incentives and behaviour of businesses and other market players to ensure large-scale change that is lasting and beneficial.

2. Background

Horticulture is an essential part of the agricultural economy of Cambodia due to the rapidly increasing consumption of fruits and vegetables. Until recently, more than 50% of all vegetables were imported from neighbouring countries equipped with better technologies and able to offer competitive prices. Imported vegetables, however, contain significant amounts of pesticide residue and are therefore a food safety concern. CHAIN worked on promoting safe, locally produced vegetables in four of Cambodia's northern provinces (Oddar Meanchey, Preah Vihear, Stung Treng, and Kratie).

To date, CHAIN has achieved the following overall results:

1. About 6,000 farmers have transitioned from household subsistence farming to semi-commercial or commercial operations and are earning higher profits from improved practices and technologies, backed up by crop budget calculations.

2. 3,400 commercial farmers (50% female) saw their production increase by 50%. Net annual income increased by USD 600 on average.

3. Yield-improving practices have created higher aggregate demand for inputs (seeds, fertiliser, pesticides) and technologies (drip irrigation, mulching, nethouses, solar water pumps). Crop budget analysis helped technicians and lead farmers understand the profitability and payback period of each technology. It also helped to determine whether an investment in a particular technology was worthwhile.

4. Several local partners reported that their views had changed over the life of CHAIN, and that they saw the benefit of encouraging farmers to think like businesspeople and connecting all the actors within a market.

3. Methodology Overview

What were the problems?

Farmers want to improve yields and the quality of their crops in order to achieve a higher income. In the case of vegetables, Cambodian farmers compete with imported products, so they have to adopt yield-improving horticultural technologies, which are sometimes costly. Farmers will only do so if the investment is within their means and if they can be reasonably certain of increasing their profits. For a farmer to make an investment decision and change her method of production, she needs to understand the financial implications clearly. From a farmer's perspective, the most common questions are (1) Can I make more money if I invest in a new technology, method or crop? (2) Will the new method or crop require too much labour? (3) How risky is the investment? and (4) Can I afford it?

Without accurate crop budget calculations, a farmer cannot answer these questions. Without knowing how much she will earn per crop cycle and whether she can pay back the loan she is likely to have to take, she cannot decide whether or not to make the investment, or which crop to prioritise. For many farmers, detailed cost-benefit calculations are probably too much to ask, so technical extension staff should be able to assist them with the analysis and provide the right advice, including which crops to produce and which technologies to invest in.

During the first phase of CHAIN, we noticed that many field, government and NGO staff we collaborated with were not used to conducting financial analyses to determine crop profitability. They advised farmers to make changes, apply technologies and grow certain crops, but without these recommendations being rooted in financial calculations, such as cost estimates and forecasts of profit and return on labour.

SNV believes that technicians should have a clear understanding of the financial implications of the advice they give to smallholder farmers, so that they may help them make informed decisions. We hope that this HTG will train extension staff and field technicians in the quantitative skills needed for financial analysis, and that compiling crop budgets will become a habit for them.

What were the solutions/methods?

We designed an easy-to-follow method of calculating crop profitability. It can be done simply, taking only direct costs into account; or it can be taken to a higher level of sophistication by including the depreciation of fixed costs farmers may incur to purchase machinery and install infrastructure.

We first trained agronomists who worked as extension staff in government departments and partner organisations. In turn, they taught lead farmers, who then discussed crop profitability with farmers in their clusters.

What did we expect to achieve?

Our aim was to equip field and extension staff with the ability to quickly calculate the profitability of proposed interventions. (In this guide, we show calculations pertaining to vegetables, but the same method can be applied to any crop, such as fruit, rice, cassava, cashew, rubber, etc.). The ultimate goal is for farmers to better understand the costs and profits of their cultivation practices and crop choices, so that they may make informed decisions and, hopefully, earn higher incomes.

The CHAIN Experience

PROVINCIAL MARKET FACILITATOR

Un Raeun is a provincial market facilitator based in Stung Treng province. He worked for CHAIN for more than five years providing technical assistance to field extensionists and lead farmers, and linking farmers with market actors. He has participated in several training courses, including crop budget analysis. He says that the crop budget course was very beneficial. 'I learned how to analyse budgets, how much a farmer would spend if he grew this or that crop, how much income he would receive, and which type of crop would be best to grow. Now I can also compare several alternatives for crop production and advise farmers on their investments.

" I'd like to send a message to all technicians and farmers: please read this guide and learn about crop budget analysis. You won't regret it! "

PDAFF EXTENSION STAFF

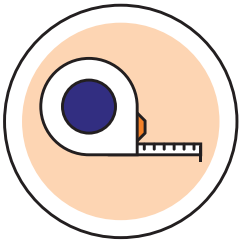
Lun Pul is an extension officer at the PDAFF in Preah Vihear province. He has collaborated with CHAIN since 2015. CHAIN provides various training courses, including capacity building development and business training. **"** Crop budget is the most interesting one,**"** he beams, **"** because it teaches budget analysis, how to set crop production costs, make a budget for crop production, calculate the variable and depreciation costs, and a lot more. I think crop budget analysis is a vital topic that farmers should learn before growing anything. I cannot stop myself from sharing this knowledge with others, including farmers, friends and people in my community.**"**

3. Definitions

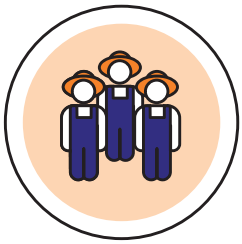
Before starting a crop budget analysis, it is essential to understand key financial terms and their formulas, as explained in the table below.

Term	Definition	Example and formula
Variable cost	Variable costs are short-term costs that increase proportionally with the amount of cultivated land: the bigger the plot, the higher the variable cost. The type of crop being grown can also affect variable costs.	Examples: Costs incurred for land preparation, seed, compost or fertiliser, fuel and hired labour. The quantities of these inputs change depending on the size of the plot of cultivated land and the crop type (e.g. some crops require more fertiliser than others).
Fixed cost	Fixed costs are investments in assets or goods that last for more than one year. They remain the same regardless of plot size. The cost of these long-term investments is usually distributed over a number of years, from the time of purchase to the end of the asset's useful life. The amount of fixed cost debited in each year is known as 'depreciation'.	Example: A drip irrigation system – purchasing and installing it requires a substantial upfront investment, but it is expected to be in use for several years. Formula: Annual depreciation = Fixed investment cost ÷ Number of years of the asset's useful life
Total production cost	The total cost of production, including both variable cost and fixed cost (depreciation).	Formula: Total cost = Total variable cost + Total fixed cost (depreciation)
Total value of production	The total value of production is the money received from the sale of produce at the farm gate (i.e. revenue) plus the value of any produce consumed by the farmer's family and/or stored for later use.	Formulas: Revenue = Quantity sold x Sales price Value of stored or consumed production = Quantity stored or consumed x Market price at harvest Total value of production = Revenue + Value of stored or consumed production
Gross margin	The gross margin for a crop is obtained by subtracting the variable cost from the total value of production.	Formula: Gross margin = Total value of production – Variable cost
Profit	Profit is the money left over after all variable and fixed expenses have been paid.	Formula: Profit = Gross margin – Fixed cost
Labour budget	The amount of own and hired labour used to produce the crop for one cycle or one year, usually specified in days/ha for each activity.	Formula: Sum of labour days invested per hectare
Return on labour	The value of production per own labour day invested in each hectare of a specific crop.	Formula: Total value of production ÷ Number of own labour days invested

A crop budget can be prepared via the following steps:

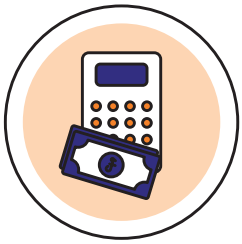


1. Choose crop and plot size

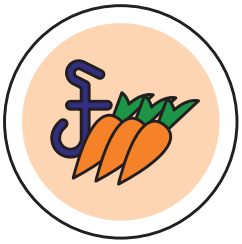


2. Estimate the amount of labour needed

3. Calculate variable costs

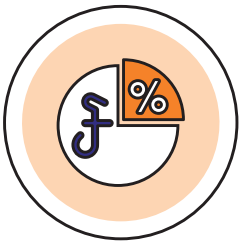


4. Calculate fixed costs



5. Calculate total production cost

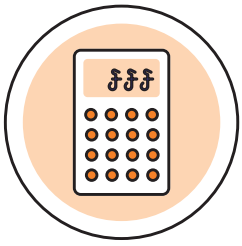
6. Calculate revenue and total value of production



7. Calculate gross margin

8. Calculate profit

9. Return to labour



10. Analyse loans and investments:

- Payback period
- Interest rate
- Return on investment

5. STEP BY STEP GUIDANCE

The MSD approach covers the entire system that surrounds a market. In the case of horticulture, this holistic view of the market includes all the relevant participants ('actors' or 'players'): the farmer who grows the crops, the retailer who sells seeds and other inputs to the farmer, the trader who buys the crops once harvested, and the wet market sellers who sell the vegetables to consumers. It may also encompass services that support the core market, such as government extension agents who provide advice to farmers and the local market structures that make physical space available for buyers and sellers to meet.

MSD aims to address poverty by improving the performance of markets in an inclusive manner, especially by modifying the incentives and behavior of businesses and other market players to ensure large-scale change that is lasting and beneficial.

5.1 Plot size and technology for crop production

The first step is to list the different crops produced by the farmer and, for each crop, the plot area dedicated to it and the season (dry or wet) when it will be produced. Different crops have different growth cycles, so it's important to know how many cycles can be grown in one year.

The required technology will depend on the season and the type of crop. For example, a farmer who wants to grow vegetables in the dry season will need irrigation equipment and access to water. Some crops require drip irrigation, while a sprinkler system or a rain-spray hose may be more appropriate for others. If she wants to produce year-round, she may need a nethouse or greenhouse. Some crops, like cucumber, require trellis nets, while others require string wires (e.g. tomatoes). Below are examples of how to tabulate the necessary information.

Disclaimer

Development projects often choose village or community leaders as lead farmers. They are natural authority figures and often act as points of contact for development projects.

Note on standardising all costs to one ha:

Some commercial smallholder farmers cultivate one ha of a crop, but most of them cultivate smaller plots. When surveying data or recording data all the information should be re-calculated on the base of 1 ha so clearly comparisons can be made. Different crops have different cultivation lengths so the crop budget should be done per cycle, but for comparisons done over one year.

Crops grown (with drip irrigation, open field):

No.	Crop	Growing cycle (days from transplanting)	Area in dry season (m^2)	No. of cycles in dry season	Area in wet season (m^2)	No. of cycles in wet season
1	Chilli	120–150	1,000	1	1,000	1
2	Cucumber	60–70	400	2	200	1
3	Curly mustard	40	400	3	–	–
4	Tomato	70–120	1,000	1	–	–

Technologies and methods to be adopted:

Crop	Nethouse	Drip	Sprinkler	Spray tube	Plastic mulch	Trellis	Solar pump	Compost	Fertiliser	Pesticide	Cultivator machine
Chilli		Yes			Yes		Yes	Yes	Yes	Yes	Yes
Cucumber		Yes			Yes	Yes	Yes	Yes	Yes	Yes	Yes
Curly mustard	Optional			Yes	No		Yes	Yes	Yes	Yes	Yes
Tomato		Yes			Yes		Yes	Yes	Yes	Yes	Yes
Onion			Yes		No		Yes	Yes	Yes	Yes	Yes

5.2 Labour budget

The labour budget captures the amount of labour needed to cultivate a crop for one crop cycle on one hectare of land. The farmer needs to list all the activities necessary to produce the crop and estimate the number of full days (eight hours each) of labour required, specifying whether the work will be done by hired labour or family labour.

Examples for comparison

In this guide we have taken two crops, chilli and cucumber, as examples. We calculate margins and profits for both crops and then compare the results. We have assumed open-field cultivation using raised beds 1.5 m wide with drip irrigation and mulch. Spacing for cucumber is 0.5 x 0.75 m, with two rows per bed, whilst for chilli we use a triangular spacing of 0.75 x 0.75m. Water is supplied by a borehole and high-quality solar panels driving a submersible pump. In one year, three cycles of cucumber can be produced, or two cycles of chilli.

Labour requirements for 1 ha of chilli

Crop: Chilli	Expected number of labour days		
Activities for 1 ha	Own	Hired	Total
Land preparation with two-wheel tractor	6	0	6
Preparation of raised beds with tractor	10	10	20
Installation of plastic mulch and drip irrigation	5	20	25
Seedling production and transplanting	10	40	50
Pumping water	15	5	20
Weeding	10	0	10
Pest management	15	10	25
Harvesting	60	120	180
Sorting	5	0	5
Packaging	4	3	7
Transport	8	0	8
Total	**148**	**208**	**356**

The cost of hired labour is typically KHR 20,000 (USD 5) per day, so the total cost of hired labour for one hectare of chilli is KHR 20,000/day x 208 days = KHR 4,160,000.

Labour requirements for 1 ha of cucumber:

Crop: Cucumber	Expected number of labour days		
Activity for 1 ha	Own	Hired	Total
Land preparation with two-wheel tractor	6	0	6
Preparation of raised beds	10	10	20
Installation of plastic mulch and drip irrigation	10	15	25
Installation of trellis nets	5	20	25
Seedling production and transplanting	10	40	50
Pumping water	10	10	20
Weeding	10	0	10
Pest management	5	20	25
Harvesting	25	100	125
Sorting	5	10	15
Packaging	5	10	15
Transport	5	0	5
Total	**106**	**235**	**341**

The cost of hired labour is typically KHR 20,000 (USD 5) per day, so the total cost of hired labour for one hectare of cucumber is KHR 20,000/day x 235 days = KHR 4,700,000.

5.3 Variable cost

Variable costs pertain to inputs used directly in crop production that are determined by the size of the area under cultivation and the number of crop cycles within one year. Variable costs increase when the area of land cultivated with a particular crop increases, or more inputs are applied. If less land is planted or fewer inputs are used, the variable costs decrease. Variable costs are compiled by estimating the number of units (in kg, litres, etc.) of inputs needed for each hectare of cultivated land, as shown in the examples below.

Variable costs for 1 ha of chilli:

No.	Variable cost	Unit	Quantity	Unit price (KHR)	Total cost (KHR)
	Land preparation & seed				2,240,000
1	Machine hire for land preparation (ploughing, harrowing, raising beds)	day	3	160,000	480,000
2	Seed	bag	200	3,200	640,000
3	Peat compost	bag	14	80,000	1,120,000
	Fertiliser				9,408,000
4	Mg (15-14-0)	kg	128	5,000.00	640,000
5	MAP (12-61-0)	kg	128	11,000.00	1,408,000
6	KCL (00-00-61)	kg	520	5,000	2,600,000
7	Calcium (15-0-0-24)	kg	160	6,000	960,000
8	Cow dung	kg	20,000	50	1,000,000
9	Lime	kg	500	900	450,000
10	Foliar fertiliser	cycle	1	1,000,000	1,000,000
11	Pesticide & fungicide	litre	30	45,000	1,350,000
	Fuel				1,331,000
12	Diesel (for tractor)	litre	400	3,200	1,280,000
13	Oil (for tractor engine)	litre	3	17,000	51,000
	Labour				**4,160,000**
14	Hired labour	man-day	208	20,000	4,160,000
Total variable cost					**17,139,000**

The total variable cost (without own labour) for one hectare of chilli is the sum of items 1 through 14 in the table, or KHR 17,139,000 per crop cycle.

Variable costs for 1 ha of cucumber:

No.	Variable cost	Unit	Quantity	Unit price (KHR)	Total cost (KHR)
	Land preparation & seed				**1,330,000**
1	Machine hire for soil preparation (ploughing, harrowing, raising beds)	day	3	160,000	480,000
2	Seed	kg	0.85	1,000,000	850,000
	Fertilisers & pesticides				**7,685,000**
3	UREA (46-0-0)	kg	106	2,500	265,000
4	Mg (15-14-0)	kg	120	5,000	600,000
5	MAP (12-61-0)	kg	110	11,000	1,210,000
6	KCL (00-00-61)	kg	376	5,000	1,880,000
7	Calcium (15-0-0-24)	kg	130	6,000	780,000
8	Cow dung	kg	20,000	50	1,000,000
9	Foliar fertiliser	litre	100	5,000	500,000
10	Lime	kg	500	900	450,000
11	Insecticide & fungicide	litre	40	25,000	1,000,000
	Fuel				**531,000**
12	Diesel (for tractor)	litre	150	3,200	480,000
13	Oil (for tractor engine)	litre	3	17,000	51,000
	Labour				**4,700,000**
14	Hired labour	man-day	235	20,000	4,700,000
	Total variable cost				**14,246,000**

The total variable cost (without own labour) for one hectare of cucumber per crop cycle is thus equal to KHR 14,246,000.

Note on water pumping costs

In this calculation, we assumed the use of a solar-powered pump, which has a fixed cost only (operation is basically free). For a diesel-powered pump, we would need to add diesel expenses as a **variable cost**

5.4 Fixed cost

Costs that can be termed 'fixed' usually apply to the whole business or enterprise and do not vary with changes in production. They are associated with inputs or assets that last for several crop cycles and usually several years, including farming equipment.

Fixed costs are calculated by the depreciation method, that is, by dividing the purchase cost of farming equipment by the economic lifespan of the equipment.

Note on fixed costs

Fixed costs are not affected by production or yield. Whether vegetable production increases or decreases, the yield is high or low, fixed costs remain the same. Most of the costs of owning farm equipment remain the same whether the item is used frequently or not. Note also that we did not include thevalue and mortgage costs of land.

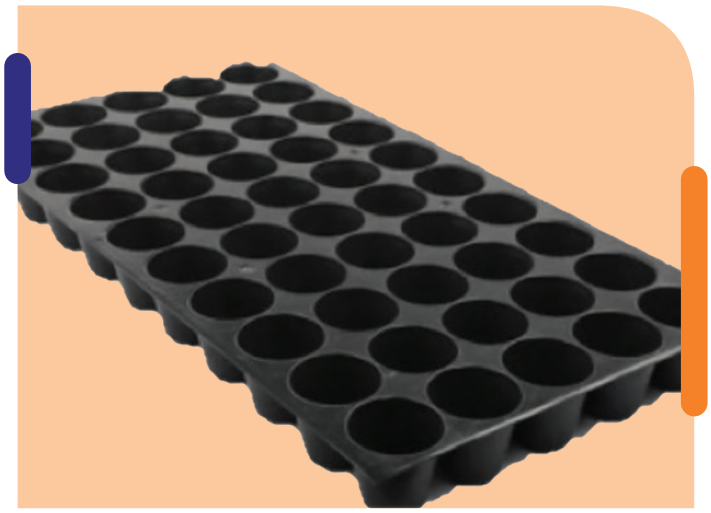
1. Drip irrigation system

- The useful life of a dripline is three years.
- Each year the system can be used for two or three crop cycles (i.e. two or three times per year), depending on the crop. For chilli, due to longer growing and harvesting periods, we assume only two cycles per year, or a total of six times over the dripline's useful life. For cucumber, we assume three cycles, or nine times in total.
- The number of drip irrigation kits used on one hectare of land depends on plant and bed spacing. Raised beds are 1 m wide, 50 m long and 0.5 m apart. One hectare is equivalent to four 50 x 50 m plots. Each plot has 33 beds (50 ÷ 1.5), so one hectare has 33 x 4 = 132 beds. Each bed has one dripline in the middle. We therefore need 132 x 50 m = 6,600 m of dripline. Driplines usually come in rolls of 950 m, so we need 6,600 ÷ 950= 7 rolls.
- The farmer needs seven rolls of dripline to irrigate one hectare of land, each costing KHR 120,000. Therefore, the total cost is 7 x KHR 120,000 = KHR 840,000.
- Hence, the depreciation cost of drip irrigation equipment per crop cycle is KHR 840,000 ÷ 6 cycles = KHR 140,000 for chilli, and KHR 840,000 ÷ 9 cycles = KHR 93,000 for cucumber.

2. Plastic mulching

- Plastic mulching can be used for just two crop cycles of chilli, or three crop cycles of cucumber.
- We need 6,600 m ÷ 380 m/roll = 18 rolls. The price per roll of good quality plastic is KHR 125,000. Therefore, the total purchase cost is 18 x KHR 125,000 = KHR 2,250,000.
- Hence, the depreciation cost of plastic mulching for chilli is KHR 2,250,000 ÷ 2 cycles = KHR 1,125,000 per cycle. For cucumber, it is KHR 2,250,000 ÷ 3 cycles = KHR 750,000 per cycle.

3. Seedling trays



- Seedling trays are used to germinate the seed and produce seedlings. A seed tray's economic life is about two years, irrespective of crop type. It can be used for three crop cycles per year, or six cycles in total.
- Chilli plants are planted in a triangle pattern, with 75 cm between each plant. Approximately 17,800 seedlings are needed for each hectare, or 10,000 m2 ÷ (0.75 m x 0.75 m).
- Cucumber are planted in two rows per bed, with 50 cm spacing between rows, and 75 cm between plants.Approximately 26,700 seedlings are needed for each hectare, or 10,000 m2 ÷ (0.75 m x 0.5 m).
- One tray can hold 104 seedlings. Assuming a 5% extra margin for non-germination or low-quality seedlings, we would need 17,800 ÷ 104 x 1.05 = 180 trays for chilli, and 26,700 ÷ 104 x 1.05 = 270 trays for cucumber
- The chilli farmer purchases 180 trays at KHR 2,500 per tray, totalling KHR 450,000. The cucumber farmer purchases 270 trays totalling KHR 675,000.
- Therefore, the depreciation cost of seedling trays per crop cycle for chilli is KHR 450,000 ÷ 6 cycles = KHR 75,000. For cucumber, it is KHR 675,000 ÷ 6 cycles = KHR 112,500.

4. Water pump

- Pumps can be operated using different energy sources, for example, a diesel pump with inverter connected to a submersible electric pump, or a solar-powered pump. Here, we assume a 1 HP solar-powered pump.
- A high-quality solar pump with sun tracker will last for 15 years with maintenance after year 5. The cost of purchase and installation is KHR 14,000,000. Yearly maintenance cost after year 5 for 10 years is KHR 1,200,000 x 10 = KHR 12,000,000. Therefore, the total cost for 15 years is KHR 14,000,000 + KHR 12,000,000 = KHR 26,000,000. For chilli, with two yearly cycles, the cost per cycle is KHR 26,000,000 ÷ (15 x 2 cycles) = KHR 867,000. For cucumber, with three yearly cycles, the cost is KHR 26,000,000 ÷ (15 x 3 cycles) = KHR 578,000.

5. PVC pipe

- Each hectare has four 50 x 50 m plots where PVC pipes of different diameter are needed. The useful lifespan of PVC pipes is three years.
- PVC 50 (, 4 m long), 250 meters = 250 ÷ 4 m = 63 units x KHR 10,000 per unit = KHR 630,000.
- PVC 34 (4 m long), 200 meters = 200 ÷ 4 m = 50 units x KHR 9,000 per unit = KHR 450,000.

- PVC valve 50: 4 units x KHR 10,000 per unit = KHR 40,000.

- The total cost is KHR 630,000 + KHR 450,000 + KHR 40,000 = KHR 1,120,000.

- For chilli, the depreciation is KHR 1,120,000 ÷ 6 cycles = KHR 187,000 per cycle. For cucumber, it is KHR 1,120,000 ÷ 9 cycles = KHR 124,000 per cycle

6. Off-take valves

- These valves connect the PVC pipe to the dripline. The useful life of an off-take valve is three years.

- The cost per unit is KHR 1,000, and we need 135 units for one hectare. The total cost is KHR 1,000 x 135 = KHR 135,000.

- Hence, the depreciation for chilli is KHR 135,000 ÷ 6 cycles = KHR 22,500. For cucumber, it is KHR 135,000 ÷ 9 cycles = KHR 15,000.

7. Water filter

- A filter's useful life is three years.

- The cost per unit is KHR 150,000. We need only one unit for one hectare.

- Hence, the depreciation cost per crop cycle for chilli is KHR 150,000 ÷ 6 cycles = KHR 25,000. For cucumber, it is KHR 150,000 ÷ 9 cycles = KHR 16,700.

8. Pressure gauge

- A pressure gauge's economic life is three years.

- The cost per unit is KHR 64,000.

- Hence, the depreciation cost per crop cycle for chilli is KHR 64,000 ÷ 6 cycles = KHR 10,700. For cucumber, it is KHR 64,000 ÷ 9 cycles = KHR 7,100.

9. Seedling nursery

- A seedling nursery is a bamboo structure used to germinate seeds in seed trays. Its economic life is two years.
- The cost per unit is KHR 1,200,000.
- Hence, the depreciation cost per crop cycle for chilli is KHR 1,200,000 ÷ 4 cycles = KHR 300,000. For cucumber, it is KHR 1,200,000 ÷ 6 cycles = KHR 200,000.

The last two fixed costs pertain to trellising and are for growing cucumber only. (Other vegetables typically grown using trellises are yard-long beans and sometimes watermelon in the rainy season).

10. Trellis nets

- Trellis nets lasts for two years. For one hectare we need 6,600 m ÷ 60 m per unit = 110 units. Each unit costs KHR 10,000, so the total investment cost is KHR 1,100,000.
- Depreciation for trellis nets is KHR 1,100,00 ÷ 6 cycles = KHR 183,300 per cycle.

11. Wooden stakes

- Trellis nets are fixed with wooden stakes placed at 2 m intervals. A stake lasts for two years (i.e. six cucumber cycles).
- For one hectare, the farmer needs 6,600 m ÷ 2 m = 3,300 units.
- Each stake costs KHR 1,500, so the total cost is KHR 1,500 x 3,300 = KHR 4,950,000.
- The depreciation cost is KHR 4,950,000 ÷ 6 cycles = KHR 825,000.

Fixed costs of 1 ha of chilli production:

No.	Fixed cost	Unit	Quantity	Unit price (KHR)	Total cost (KHR)	Depreciation per crop cycle (KHR)
1	Drip irrigation system	roll	7	120,000	840,000	140,000
2	Plastic mulching	roll	18	125,000	2,250,000	1,125,000
3	Seedling trays	tray	180	2,500	450,000	75,000
4	Solar water pump	unit	1	26,000,000	26,000,000	867,000
5	PVC pipes	set	1	1,120,000	1,120,000	187,000
6	Off-take valves	unit	135	1,000	135,000	22,500
7	Water filter	unit	1	150,000	150,000	25,000
8	Pressure gauge	unit	1	64,000	64,000	10,700
9	Seedling nursery	unit	1	1,200,000	1,200,000	300,000
Total fixed cost					**32,209,000**	**2,752,000**

Fixed costs of 1 ha of cucumber production:

No.	Fixed cost	Unit	Quantity	Unit price (KHR)	Total cost (KHR)	Depreciation per crop cycle (KHR)
1	Drip irrigation system	roll	7	120,000	840,000	93,000
2	Plastic mulching	roll	18	125,000	2,250,000	750,000
3	Seedling trays	tray	270	2,500	675,000	112,500
4	Solar pump	unit	1	26,000,000	26,000,000	578,000
5	PVC pipes	set	1	1,120,000	1,120,000	124,000
6	Off-take valves	unit	135	1,000	135,000	15,000
7	Water filter	unit	1	150,000	150,000	16,700
8	Pressure gauge	unit	1	64,000	64,000	7,100
9	Seedling nursery	unit	1	1,200,000	1,200,000	200,000
10	Trellising nets	kit	110	10,000	1,100,000	183,300
11	Wooden stakes for trellising	unit	3,300	1,500	4,950,000	825,000
Total fixed cost					**34,484,000**	**2,905,000**

Source: iDE & SNV data

5.5 Total production cost

The total production cost equals the total variable cost plus the total fixed cost (depreciation) per cycle. Based on the exercise above, we can calculate the total production cost for each crop as follows:

- **Chilli:**

Total production cost per hectare per cycle = KHR 17,139,000 (variable cost) + KHR 2,752,000 (fixed cost) = **KHR 19,891,000**

- **Cucumber:**

Total production cost per hectare per cycle = KHR 14,246,000 (variable cost)+ KHR 2,905,000 (fixed cost) = **KHR 17,151,000**

TIPS

To calculate costs, you can use average or standardised market pric es of inputs and equipment; they are accurate enough to provide viable budgeting results. However, before you recommend an invest-ment to a farmer, do some research to determine whether thereare big price differences between different brands of equipment and between shop locations, as choosing the more competitively priced products and shops can save the farmer a considerable amount of money.

5.6 Total value of production

Once a crop has been harvested, the farmer can do one of three things: sell it, consume it or store it. The total value of production is the money received from the sale of produce (revenue) plus the value of produce consumed or stored (i.e. unsold produce). It is sometimes referred to as the 'value of output'.

Sales revenue is easily calculated: the quantity of produce sold multiplied by the unit price that the farmer receives. The price is normally assumed to be the farmgate price.

Revenue = Quantity sold x Sales price

Total value of production for 1 ha of chilli:

Item	Unit	Amount
Total production (yield)	kg	10,000
Price	KHR/kg	4,000
Total value of production (Total production x Sales price)	**KHR**	**40,000,000**

Total value of production for 1 ha of cucumber:

Item	Unit	Amount
Total production (yield)	kg	35,000
Price	KHR/kg	1,200
Total value of production (Total production x Sales price)	**KHR**	**42,000,000**

Note on total value of production

The total value of production includes the value of unsold produce – produce consumed by the farmer's family or stored for later use. A convenient method of valuing unsold produce is by using the market price for which the produce could have been sold, that is, the same farmgate price used to compute revenue.

A more precise way to measure the value of unsold produce would be to ask, 'What would we have had to pay for food if we had not eaten our own produce?' However, in rural areas there is little difference between selling prices and buying prices, so the sales value can be used as a good approximation. The more commercial a smallholder farmer becomes, the more vegetables are produced for the market, so the amount of self-consumed produce will be only a small percentage of the total volume produced.

5.7 Gross margin

Gross margin is used to compare the profitability of different crops. It is a measure of how much value a crop adds to the farm's output irrespective of fixed costs. The gross margin of a crop is obtained by subtracting the total variable cost from the total value of production.

Revenue = Quantity sold x Sales price

Gross margin for 1 ha of chilli:

Item	Unit	Amount
Total production (yield)	kg	10,000
Price	KHR/kg	4,000
Total value of production (Total production x Sales price)	KHR	40,000,000
Variable cost	KHR	17,139,000
Gross margin (Total value of production – Variable cost)	**KHR/ha**	**22,861,000**

Gross margin for 1 ha of cucumber:

Item	Unit	Amount
Total production (yield)	kg	35,000
Price	KHR/kg	1,2000
Total value of production (Total production x Sales price)	KHR	42,000,000
Variable cost	KHR	14,246,000
Gross margin (Total value of production – Variable cost)	**KHR/ha**	**27,754,000**

Source: iDE & SNV data

Note on gross margin analysis

Calculating gross margins is essential when deciding between different crop choices. If a farmer wants to know whether to continue with a certain crop or grow another, he or she should compare the gross margins of the two crops. If a farmer changes crops, the **fixed costs** will probably not change. What will change are the **variable costs** and the **value of production**. Using the gross margin will help the farmer decide whether switching to a different crop will be profitable or not.

Example: An undecided farmer

Currently, I am growing chilli, but I want to grow cucumber instead. Should I do that? Is it a good decision?

To help this farmer make a decision, let us compare all the features and costs of growing chilli and cucumber on one hectare of land:

Feature/cost	Unit	Chlli	Cucumber
Life cycle	days	100	60
Hired labour cost	KHR	4,160,000	4,700,000
Variable cost (incl. hired labour)	KHR	17,139,000	14,246,000
Total production cost	KHR	19,891,000	17,151,000
Total value of production	KHR	40,000,000	42,000,000
Gross margin	KHR	22,861,000	27,754,000

The table above shows that producing cucumber has a better gross margin than growing chillies. A higher gross margin suggests that growing cucumber is more effective at generating a higher income based on the labour and other costs incurred in producing that crop than chili.

Gross margin analysis helps farmers make a final decision when selecting which crop to grow. As fixed costs do not change that much when changing crops, it can give a reasonable indication of which crop the farmer should grow. The area of land to be cultivated with the chosen crop will depend on expected market volume and availability of land, labour and investment financing.

Other important points should also be kept in mind, such as crop life cycle, land size, market price, management requirements of the crop, and farming/technical skills.

5.8 Profit

Profit is the money left over after all variable costs and fixed costs have been paid.

Profit = Gross margin – Fixed cost

Note on profit

If the amount obtained after subtracting fixed costs from gross margin is **positive**, then there is a **profit**. If the amount obtained is **negative**, there is a loss. Because fixed costs do not vary much with changes in production, it is almost always the case that if farmers can increase their gross margin, they will also increase profits. Furthermore, because smallholder farmers usually have few fixed costs, gross margin is often very similar to profit.

Profit analysis for chilli production per cycle on 1 ha of land without valuing own family labour:

Item	Unit	Amount
Total production	kg	10,000
Price	KHR/kg	4,000
Total value of production (Total production x Sales price)	KHR	40,000,000
Variable cost	KHR	17,139,000
Gross margin (Total value of production – Variable cost)	KHR	22,861,000
Fixed cost (depreciation)	KHR	2,752,000
Profit (Gross margin – Fixed cost)	**KHR**	**20,109,000**

Profit analysis for cucumber production per cycle on 1 ha of land without valuing own family labour:

Item	Unit	Amount
Total production	kg	35,000
Price	KHR/kg	1,200
Total value of production (Total production x Sales price)	KHR	42,000,000
Variable cost	KHR	14,246,000
Gross margin (Total value of production – Variable cost)	KHR	27,754,000
Fixed cost (depreciation)	KHR	2,905,000
Profit (Gross margin – Fixed cost)	**KHR**	**24,849,000**

As expected, the profit per cycle for cucumber (without valuing family labour) is higher than for chilli. If we wish to analyse the profit per year, then we have to multiply the profit per cycle by the number of cycles, and correct for the costs which are not necessary in the second or third cycle, such as land preparation and installation of drip/mulch and trellises.

Year profit = Profit Cycle 1 + Profit Cycle 2 + Cost saved cycle 2.

Chilli:

- Saved cost items for each extra cycle
    - Land preparation machine hire, diesel & oil = 1,011,000
    - Hired labour for installation = 30 days x KHR 20,000/day = KHR 600,000
    - Total saved cost for second cycle = 1,611,000
- (Variable cost Chilli second cycle = 15,528,000)
- Total yearly profit (two cycles) = (KHR 20,109,000 x 2) + KHR1,611,000 = KHR 41,829,00

Cucumber

- Saved cost items for each extra cycle
    - Land preparation machine hire, diesel & oil = 1,011,000
    - Hired labour for installation = 45 days x KHR 20,000/day = KHR 900,000
    - Total saved cost for second cycle = 1,911,000
- For 2 extra cycles = 3,822,000)
- Total yearly profit (three cycles) = (KHR 24,849,000 x 3) + (KHR 3,822,000) = KHR 78,369,000

	Unit	Chilli	Cucumber
Profit for one year without saved cost adjustments	KHR	40,218,000	74,547,000
Saved hired labour per additional cycle	day	30	45
Value Saved labour per cycle	KHR	600,000	900,000
Saved Machine, Diesel per additional cycle	KHR	1,011,000	1,011,000
Total saved cost / cycle	KHR	1,611,000	1,911,000
# of additional cycles	cycle	1	2
Total saved cost/ year	KHR	1,611,000	3,822,000
Profit for one year	**KHR**	**41,829,000**	**78,369,000**

Although the per-cycle gross margins and profits per cycle of the two crops do not differ that much, comparing the annual profits shows that cucumber is much more profitable.

Note that these calculations will depend largely on the LOCAL MARKET PRICES of the crops, and the local SUPPLY and DEMAND. Good production planning in the community balancing DEMAND and SUPPLY will keep prices stable. If everybody would shift to doing only cucumber, and no chilli it will be likely that the price of cucumber will go down and chilli will go up, affecting the profitability.

5.9 Return on labour

In many cases, farmers do not value their own labour, or that of their family members. A good measure to know what generates a better income is to calculate the return on labour invested.

Return on labour = Profit for one year ÷ Invested family labour days

In one year, a farmer can grow two chilli crops or three cucumber crops. The family labour for one hectare of crop, per cycle, is 148 days for chilli. For every extra cycle of chili its 127 days, or for one year is 275 days. For one cycle of cucumber 106 family labour days are needed. For every additional cycle its 75 days. For one year (3 cycles) a total of 256 family days are used.

	Unit	Chilli	Cucumber
Profit for one year	KHR	41,829,000	78,369,000
Invested family labour per year	man-day	275	256
Return on labour (approx.)	**KHR/day**	**152,000**	**306,000**

This confirms that cucumber is a more rewarding crop to grow, it pays almost double per day invested. It also shows that the return on labour for both crops is higher than any paid wage for unskilled labour, so growing either chilli or cucumber provides a better income than wage labour or migrating for work.

5.10 Analysis of loans and investments

Many farmers do not have the savings to pay for all crop production costs, or to pay upfront for machinery or irrigation equipment. Therefore, agricultural financing is often needed to enable them to obtain capital to pay for these expenditures. Financing can be provided by MFIs or banks in the form of loans. Some simple concepts and analyses are needed for farmers – with the help of agronomists, extension staff and lead farmers – to determine whether they should take a loan to make the required investment.

Below are some analyses that can be used to evaluate loans and investments – payback period, interest rate, and return on investment.

A. Payback period

Before making any investment decision, it is helpful for horticulture farmers to think about how long it will take to recover the cost of the investment. This is known as 'payback period'. The shorter the payback period, the more attractive the investment.

To calculate the payback period of an investment, simply divide the initial cost of the investment by the amount of net cash flow, that is, the amount of net profit that the project generates each year. The resulting number is expressed in years or fractions of years.

Payback period = Initial investment ÷ Annual net cash flow

For example, let us assume that a farmer in Kratie province invests KHR 36,000,000 in a hydroponic system to grow leafy vegetables that will allow her to produce many crop cycles per year. The investment is expected to result in a positive annual cash flow of KHR 12,517,000.

Payback period = KHR 36,000,000 ÷ KHR 12,517,000/year = 2.87 years (2 years and 10 months)

In this example, the farmer can expect to recoup her outlay in less than three years, so the investment is well worth making. After the end of the payback period of 2 years and 10 months, the net cash flow will no longer be required to pay back the investment, so it will become profit.

B. Interest rate

All loans involve interest. For the borrower, the interest is the cost of the loan; for the lender, such as a bank, the interest is the profit from the loan. Interest is expressed as a percentage of the loan amount collected annually or monthly – the interest rate. For most loans, interest is paid in addition to partial repayment of the amount originally borrowed (known as 'principal'). Farmers seeking loans can use an online interest calculator to calculate the actual interest amount, in riel, to be paid to lenders based on their advertised lending rates

Interest = Principal × Interest rate × Term (period of borrowing)

There are two distinct methods to compute interest: simple interest and compound interest. The following is a basic example of how to calculate simple interest. Compound interest is more commonly used by MFIs and banks, but in this guide we focus on simple interest only. For more advanced calculations and training in compound interest, please consult other resource guides on financial literacy.

The same farmer in Kratie province who grows leafy vegetables using a hydroponic system would like to borrow KHR 36,000,000 (the principal) from an MFI for one year. The bank wants to earn 10% interest on this loan. The annual interest to be paid is therefore 10% of KHR 36,000,000, or KHR 3,600,000. This interest is added to the principal, and the sum becomes the farmer's required repayment to the MFI at the end of the one-year term of the loan: KHR 36,000,000 + KHR 3,600,000 = KHR 39,600,000.

Let's assume the farmer wants to borrow KHR 36,000,0000 for two years instead of one, and the MFI calculates simple interest annually. She would simply be charged the interest rate twice, once for each year that the loan is outstanding:

KHR 36,000,000 (principal) + KHR 3,600,000 (interest year 1) + KHR 3,600,000 (interest year 2) = KHR 43,200,000

Therefore, the farmer owes the MFI **KHR 43,200,000** at the end of two years, **KHR 36,000,000** for the principal and **KHR 7,200,000** in interest.

TIPS

Many farmers are already indebted with multiple loans. These simple calculations can help them understand whether they can make a new investment and earn enough money to pay off their other loans. This is part of basic financial literacy training.

C. Return on investment

Return on investment (ROI) is a performance measurement used to evaluate the efficiency or profitability of an investment, especially to compare its profitability against other investments.
There are multiple ways to calculate ROI. One commonly used method is to divide the gross margin by the total production cost for one cycle, then multiply by 100.

ROI = Profit for one cycle ÷ Total production cost (for one cycle) x 100

By way of example, let's assume that a chilli and cucumber farmer has the following gross margin and costs (without family labour) for one cycle, as previously calculated:

Chilli:

- Profit one cycle = 20,109,000
- Total variable cost = KHR 17,131,000
- Total fixed cost (depreciation per cycle) = KHR 2,752,000
- Total production cost = KHR 19,891,000

Therefore, the **ROI for chilli** for one cycle is (**KHR 20,109,000 ÷ KHR 19,891,000) x 100 = 101%**. This is without taking family labour into account. If we would do so then the return of investment of 1 ha of chilli would be 88%. This is much higher then an interest rate the bank would require of 18% so profitable to do this.

Cucumber

- Gross margin = KHR 27,754,000
- Total variable cost = KHR 14,246,000
- Total fixed cost (depreciation per cycle) = KHR 2,905,000
- Total production cost = KHR 17,151,000
- Profit one cycle = 24,849,000

Therefore, her **ROI for cucumber** is (KHR 24,849,000 ÷ **KHR 17,151,000) x 100 = 145%**

This means that her farming activity returns 2.3 times the amount she has invested in it; therefore, it is highly profitable. Since the ROI is much higher than the interest rate which would have to be paid to a bank, it is worthwhile for the farmer to take a loan so that she can invest in cucumber production.

D. Other parameters

Some other useful calculations are production cost per square metre, profit per square metre and production cost per kilogram of produce.

	Chilli	Cucumber
Total cost per m^2 (KHR)	1,981	1,751
Profit per m^2 (KHR)	2,011	2,489
Production cost per kg (KHR)	1,989	490

The production cost per kilogram is the total cost for one cycle divided by the yield of one cycle. It tells us how much it costs to produce each kilogram of the crop. If it is lower than the sales price per kilogram, then the farmer makes a profit.

6. CONCLUSION

This HTG is designed to help farmers make production plans and decide how to spend their money on agricultural production. The guide is a simple, practical and useful tool to explain which crops to grow; it can be used to calculate the expected income, expenses and profit of a given cropping plan, and for comparative profit analysis of alternative cropping plans. Technical staff and extensionists can assist farmers with the analysis and its simple calculations. It also teaches farmers how to determine whether it is wise to take out a bank loan for an investment or not.

For more information on CHAIN's multiple phases, including manuals (in Khmer) on specific technologies and horticultural techniques, please visit the web site at **[https://elibrary.maff.gov.kh]**.

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