FINANCIAL ANALYSIS FOR HIGH-VALUE AGRICULTURE LIVELIHOODS FOR PREAH VIHEAR

I. THE PROJECT

1. The proposed Community Based Tourism COVID-19 Recovery Project will help accelerate post-coronavirus disease (COVID-19) recovery in rural communities living near Preah Vihear (Preah Vihear province) and Phnom Da (Takeo province) heritage sites. The project aims to (i) strengthen local capacity for inclusive community-based tourism (CBT) development and promotion; (ii) support tourism and commercial agricultural livelihood activities; and (iii) enhance community-based public facilities and services. Initially, the project will promote domestic tourism, which is less affected by COVID-19 related travel restrictions. As Cambodia's borders open to international travel the project focus will shift to promoting intra-regional tourism.

II. KEY FINDINGS ON AGRICULTURE FEASIBILITY STUDY

A. Existing and potential vegetables cultivation in Natural Techo village

2. Although the Natural Techo village is newly established with resettled families from the K1 area, villagers experienced in cultivating various vegetables and crops. Those might include maize (not for feeding the animal), cassava, sweet potato, cucumber, bitter melon, long bean, peanut, eggplant, cabbages, cucumber, tomato, French soybean, pumpkin, morning glory, carrot, lemon grass, ginger, onion, and chili. Based on the consultation with Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) on 27 July 2020 with participation from officers in charge of the existing project funded by IFAD and Swiss funded project/CHAIN as well as the local authority's verification on 28 July 2020, there are three main vegetables which are very potential to promote its cultivation through application of the nine assessment criteria (See Box 1. Explanation of the criteria). Those vegetables include lemon grass, cucumber and long bean. However, as confirmed by commune chief and Techo Natural village chief, there is no existing farmers who grow the lemon grass for commercial purpose. Therefore, the analysis of potential vegetables products was focused on cucumber and long bean (See Table 1).

Box 1: Explanation of the assessment criteria

1. Seed access: To what extent that vegetables seed could be easily accessed in the community?
2. Production cost: Is the production cost for the vegetables are low?
3. Uniqueness: Do the vegetables consider as the unique product of the village or Preah Vihear province?
4. Land & Climate Change Adaptation: Does the vegetables cultivation have less negative impact on land degradation?
5. Market Price: Whether the market price for vegetables is good?
6. Market demand: Do the vegetables are hugely needed in the village or surrounding areas?
7. Water economy: Does the vegetables cultivation consume less irrigated water?
8. Consumer's preference: Do the people in the village or surrounding areas prefer to consume these vegetables?
9. Women's economic empowerment: Is that the vegetables cultivation that women could effectively involved and managed?

3. The assessment used the scoring system from 1 point – 5 points of which 1 is the lowest score and 5 is the best score. The participants from PDAFF and authorities are requested to select the most relevant points and put in the criteria.

Table 1: Assessment of potential vegetables in Natural Techo village, Preah Vihear

Vegetables and crop	Assessment Criteria (Score from 1 lowest - 5 best)									Total score points
	Seed	Production cost	Uniqueness	Land &CC adaptation	Price	Demand	Water economy	Preference	WEE	
Maize (food)	4	3	3	4	3	4	3	3	4	31
Cassava	2	2	1	2	3	3	2	1	3	19
Sweet potato	1	2	1	3	3	4	2	3	4	23
Cucumber	5	4	2	4	4	5	3	4	5	36
Bitter melon	4	4	3	4	3	4	3	3	4	32
Long bean	4	4	3	4	4	5	3	4	5	36
Peanut	4	3	3	4	4	5	3	4	5	35
Eggplant	4	3	2	3	4	5	3	4	4	32
Cabbages	5	3	3	3	3	5	2	5	5	34
Cucumber	4	2	2	3	4	4	2	4	3	28
Tomato	3	3	2	2	2	2	2	2	4	22
French soybean	2	2	2	3	3	3	3	3	4	25
Pumpkin	4	4	2	4	2	2	3	2	4	27
Morning glory	4	3	2	4	4	5	3	5	5	35
Carrot	2	2	2	2	4	2	2	3	4	23
Lemon grass	5	3	3	4	5	5	2	5	5	37
Ginger	2	2	3	2	4	3	3	3	4	26
Onion	2	3	2	2	3	3	2	4	4	25
Chili (local)	5	3	4	2	4	5	2	5	5	35

B. Existing and potential livestock and aquaculture in Natural Techo village

4. The prioritization of the livestock production in Natural Techo village is applied the same procedure and methods as vegetables cultivation with PDAFF and local authority's verification. The result confirmed two prioritized livestock production including free range chicken (local breed) and the wild pig. Similarly, to the livestock production prioritization, there is only one suggested aquaculture development in the village is Tilapia (See Table 2 and Table 3).

Table 2: Assessment of potential livestock in Natural Techo village, Preah Vihear

Livestock production	Assessment Criteria (Score from 1 lowest - 5 best)									Total score points
	Seed	Production cost	Uniqueness	Land &CC adaptation	Price	Demand	Water economy	Preference	WEE	
Free range chicken	5	5	4	5	5	5	2	5	5	41
Hybrid chicken	3	3	2	5	3	4	1	3	5	29
Broiler	4	2	2	5	2	3	1	2	4	25
Domestic pig	4	2	2	4	2	3	1	3	4	25
Hybrid pig	1	2	1	4	2	2	1	2	4	19
Wild pig	4	4	4	3	4	5	3	4	4	35

Table 3: Assessment of potential fish raising in Natural Techo village, Preah Vihear

Aquaculture or Fish raising	Assessment Criteria (Score from 1 lowest - 5 best)									Total score points
	Seed	Production cost	Uniqueness	Land &CC adaptation	Price	Demand	Water economy	Preference	WEE	
Tilapia	4	4	3	4	3	4	5	3	4	34
Silver barb	3	4	3	4	4	4	4	3	4	33
Clarias	3	4	3	4	3	4	5	3	4	33
Frog	2	3	4	4	4	3	4	2	5	31

C. Special plants in Natural Techo village

5. Besides the vegetable products, livestock and aquaculture which have been prioritized, another two special plants including jasmine and lotus flower were put into consultation with local authorities and retailers at Preah Vihear temple to assess following the same criteria of the vegetables product but including other two special criteria for cultural and tourism relevance. However, based on the confirmation from lotus owners at O Svay reservoir reported that National Authority of Preah Vihear (NAPV) will not allow anyone to grow or plant lotus in the natural lake. Therefore, based on the existing conditions of the hand-made pond of the villagers, lotus plantation is not feasible due to it required large size and shallow water. Thus, there will be only one plant – jasmine have been confirmed through scoring system analysis and further discuss in details production chain in the next section.

Table 4: Assessment of potential plants in Natural Techo village, Preah Vihear

Plants	Assessment Criteria (Score from 1 lowest - 5 best)										Total score points
	Seed	Production cost	Uniqueness	Land &CC adaptation	Competitive price	Demand	Water economy	Preference	WEE	Cultural relevance	Tourism relevance	
Jasmine	3	4	3	4	5	5	3	4	5	5	4	45
Lotus	4	4	3	3	5	5	2	4	4	5	4	43

D. Analysis of production chains of vegetables and plants in Natural Techo village

1. Cucumber

1.1 Input materials and costs

6. The analysis of cucumber cultivation is based on randomly consultation with villagers who are currently producing the cucumber in Natural Techo village. The input materials of cucumber cultivation are easily access especially from Sra Em market (the biggest market in the commune) such as fertilizer, worn pesticide, enzyme, tens, bamboo, and yarn except the cucumber seeds that farmers need to purchase from Phnom Penh market of which the quality is better than the stores of Sra Em market. Besides these materials, farmers could easily find tractor for plough and

two laborers for supporting the caring, irrigating and harvesting job. Farmers also need to establish the dripping irrigation system and pond in order to regularly irrigate the water to cucumber field. The cost of input materials for one year of cucumber cultivation is based on the current market price with the size of operation: 0.3 ha of cultivated land and 4 cycles of production. The detailed input costs are as below:

Table 5: Input costs for cucumber cultivation in 1 year

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Dripping irrigation system	3 000 m2	1	550	550	3 years	183	183
Pond	1,690 m3	1	200	200	10 years	20	20
Seed from Phnom Penh	Box	2	50	100	4 cycles per year	400	400
Bamboo	Pole	2000	0.05	100	3 years	33	33
Yarn	Kg	3	2.5	7.5	1 year	7.5	7.5
Tens	Meter	1500	0.5	75	1 year	75	75
Fertilizer	Pack	2	30	60	4 cycles per year	240	240
Enzyme	Pack	45	0.5	22.5	4 cycles per year	90	90
Worn pesticide	Bottle	1	7.5	7.5	4 cycles per year	30	30
Plough fee (tractor)	Set	1	37.5	37.5	4 cycles per year	150	150
Labor	Day	100	6.25	625	4 cycles per year	2500	2500
Water Tank	Tank (5000 liter)	1	1	500	5 years	100	100
Pumping machine	Set	1	1	300	3 years	100	100
Gasoline	Day	240	2	480	4 cycles per year	480	480
					Total input costs	**4408.5**	**4408.5**

7. The investment capital for cucumber cultivation is estimated USD 4408.5 per year for four harvesting times. This investment is taken from the accumulated saving of the farmer family's government salary.

Table 6: Alternative input cost for cucumber cultivation for 1 year with diesel water pumping engine (upgrade)

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Dripping irrigation system	3 000 m2	1	550	550	3 years	183	183
Pond	1,690 m3	1	200	200	10 years	20	20
Seed from Phnom Penh	Box	2	50	100	4 cycles per year	400	400
Bamboo	Pole	2000	0.05	100	3 years	33	33
Yarn	Kg	3	2.5	7.5	1 year	7.5	7.5
Tens	Meter	1500	0.5	75	1 year	75	75
Fertilizer	Pack	2	30	60	4 cycles per year	240	240
Enzyme	Pack	45	0.5	22.5	4 cycles per year	90	90
Worn pesticide	Bottle	1	7.5	7.5	4 cycles per year	30	30
Plough fee (tractor)	Set	1	37.5	37.5	4 cycles per year	150	150
Labor	Day	100	6.25	625	4 cycles per year	2500	2500
Water Tank	Tank (5000	1	1	500	5 years	100	100

	liter)						
Diesel water pumping machine (upgrade capacity)	Set	1	1	300	3 years	100	100
Diesel cost	Day	240	0.83	200	4 cycles per year	67	67
					Total input costs	**3,995.5**	**3,995.5**

8. Alternatively, if the farmer would apply diesel water pumping engine (upgrade) to irrigate water for cucumber, the investment capital for cucumber cultivation is estimated USD 3995.5 per year for four harvesting times.

1.2 Technical capacity

9. There are totally 6 farmers who grow cucumbers in the village of which they obtained the technical capacity from different trainings such as in Thailand (recently) under PDAFF ASPIRE program, onsite training from CHAIN project of SNV organization and coached from their parents before 2008 at the lowland provinces (Prey Veng, Kandal and Takeo).

1.3 Production calendar

10. The cucumber cultivation is done almost along the year starting from late April to November once the water is much available and relaxing from December to March once the water starts decreasing.

Table 7: Calendar of cucumber cultivation

	Year											
Vegetables	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Cucumber cultivation	x	x	x	x	xx	xx	xxx	xxx	xxx	xxx	xxx	xx

11. Although the farmers could grow cucumber with eight months period of the year, they could harvest only four times including May and November within medium production level (24 tons) and July and September (48 tons). The duration of cucumber production is 37 days to be ready for harvesting. Every cycle of 37 days, the farmers could harvest around 20 days non-stop. As the farmers could not harvest with 8 months period, it is suggested that diversified crop either small scale or commercial scale will be grown during those months such as lemon grass, short term fruit including dragon fruit and lemon etc. However, it requires technical capacity to equip to the farmers.

Table 8: Calendar of cucumber harvesting time along the year

	Year											
Vegetables	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Harvest cucumber (kg) per day for 6 farmers[1]	0	0	0	0	1200	0	2400	0	2400	0	1200	0
Harvest cucumber (kg) for 20 days for 6 farmers	0	0	0	0	24000	0	48000	0	48000	0	24000	0

[1] In the Natural Techo village, there are only 6 farmers who grow the cucumber as they could have access to financial capital and technical knowhow from PDAFF ASPIRE programme to run their production. They have high commitment and solid experiences for few years production. Other villagers who have very limited access to resources to start up.

1.4 Market demand and supply

12. The market demand for cucumber of the whole Sra Em commune is huge of which cucumber products are consumed around 1 ton per day or equivalent to 30 tons per month. In Due to the limited production and supply from the different villages in Sra Em commune from January to April, June, August and October; the cucumber is imported from Siem Reap and Battambang replaces the demand gaps which is approximately 30 tons and 6 tons in May and November. However, during the period of July and September of the year once the farmers could produce more cucumber, the market supply is surplus and price is going down compared to the demand of the rest 10 months therefore farmers have to transfer the around 18 tons to sell in Chorm Khsan district market (See Table 9).

Table 9: Market demand and supply for cucumber along the year

	Year											
Vegetables	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Demand for cucumber (ton)	30	30	30	30	30	30	30	30	30	30	30	30
Cucumber supply from Natural Techo (ton)	0	0	0	0	24	0	48	0	48	0	24	0
Market Gap or Surplus (ton)	-30	-30	-30	-30	-6	-30	+18	-30	+18	-30	-6	-30
Cucumber supply from other areas (ton)	-30	-30	-30	-30	-6	-30		-30		-30	-6	-30

1.5 Water consumption and cost

13. The water consumption is around 10 cubic meters per day or 2,400 cubic meters (240 days irrigating water) per annual within eight months production (4 cycles) for 0.3 ha of irrigated land for cucumber and it costs nothing by diesel water pumping engine (upgrade) except the deprecation cost of USD 267 per annual production within the period of eight months (including water tank and diesel pumping engine cost). However, if diesel water pumping engine (upgrade) would not be applied and alternatively used the ordinary pumping machine (USD 300 – depreciation 3 years = 100 USD), water tank (USD 500 with five years depreciation 100 USD per annual) plus the cost for gasoline around USD 480[2], the water cost goes up to USD 651 for the irrigating the cucumber cultivation with 0.3 ha of land (See Table 10. Volume and cost of water). Therefore, the difference between using diesel water pumping engine (upgrade) and ordinary system to pump the water is USD 413 per annual production of cucumber.

Table 10: Water volume and cost for cucumber along the year

	Cost for diesel water pumping engine (upgrade) (USD)		**Cost of ordinary Pumping (USD)**		
Vegetables	**Diesel water pumping engine (upgrade) and diesel cost**	**Water tank**	**Pumping machine**	**Water tank**	**Gasoline**

[2] Everyday gasoline cost is USD 1.5 and full deployment of water along the whole eight months.

2,400 cubic meters of water for 0.3 ha of cucumber cultivated land	167	100	100	100	480
Comparative cost	**267**		**680**		

1.6 Return of internal investment analysis

14. The return of internal investment for one farmer cucumber cultivation could be confirmed that positive based on the existing conditions of Natural Techo village. The total cost of investment during the period of one year or four cycles of cucumber cultivation is USD 4408.5 covering system, equipment, materials, laboring fee and other related costs. Compared to the four times harvesting productivities of 24 tons with 15% of production loss, farmers could sell cucumbers around 20.4 tons[3] to different market with different price varieties (USD 0.375 per kilogram from July to August with 6.8 tons and USD 0.625 per kilogram from September to June with 13.6 tons). Thus, total gross income whole year of the cucumber farmer is USD 11,050 therefore the annual net profit is USD 6,641.5 USD. However, if the farmers apply diesel water pumping engine (upgrade) for pumping water to irrigate the cucumber, the margin of profit supposes to be USD 7,054.5 per annual (See Table 11).

Table 11: Economic return for cucumber cultivation in one year

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Dripping irrigation system	3 000 m2	1	550	550	3 years	183	183
Pond	1,690 m3	1	200	200	10 years	20	20
Seed from Phnom Penh	Box	2	50	100	4 cycles per year	400	400
Bamboo	Pole	2000	0.05	100	3 years	33	33
Yarn	Kg	3	2.5	7.5	1 year	7.5	7.5
Tens	Meter	1500	0.5	75	1 year	75	75
Fertilizer	Pack	2	30	60	4 cycles per year	240	240
Enzyme	Pack	45	0.5	22.5	4 cycles per year	90	90
Worn pesticide	Bottle	1	7.5	7.5	4 cycles per year	30	30
Plough fee (tractor)	Set	1	37.5	37.5	4 cycles per year	150	150
Labor	Day	100	6.25	625	4 cycles per year	2500	2500
Water Tank	Tank (5000 liter)	1	1	500	5 years	100	100
Pumping machine	Set	1	1	300	3 years	100	100
Gasoline	Day	240	2	480	4 cycles per year	480	480
					Total input costs	**4408.5**	**4408.5**

Total economic return			
Description	**Unit**	**Qty**	**Amount**
Total production yields	Time	4	24 tons

[3] 24 tons + 48 tons + 48 tons + 24 tons = 144 tons and divided with 6 farmers = 24 tons. Therefore, with 15% production loss, the cucumber production sale is 20.4 tons per each farmer.

Total economic return			
Description	**Unit**	**Qty**	**Amount**
Total production loss or gap	%	15	3.6 ton
Total production sale from July – August (including 15% loss)	Time	1	6.8 tons
Total production sale from September – June (including 15% loss)	Time	1	13.6 tons
Product price from July - August	Kg	1	USD 0.375
Product price from September - June	Kg	1	USD 0.625
Total gross income from July - August	**Kg**	**6800**	**USD 2550**
Total gross income from September - June	**Kg**	**13600**	**USD 8500**
Total gross income whole year	**USD 11,050**		
Option A: Total investment cost whole year by ordinary water pumping	**USD 4408.5**		
Total net income whole year by ordinary water pumping	**USD 6641.5**		
Option B: Total investment cost whole year by diesel water pumping engine (upgrade)	**USD 3995.5**		
Total net income whole year by diesel water pumping engine (upgrade)	**USD 7054.5**		

1.7 Production challenges

15. The consulted farmers reported that land condition is quite fit to cucumber cultivation (mixed composed and sandy soil) and availability of 0.5 ha of land allocated by the government to each villager family, water is available from different sources (e.g. wells, pond, reservoir and rainwater). However, the cost of pumping water for irrigating cucumber, input supplies are not easily access of which it needs to purchase from Phnom Penh for better quality. However, there are not so many farmers could effort to produce cucumber even though the demand is high. This is because of the limited access to financial capital except the existing 6 farmers who sourced it from the government salary. Furthermore, limited number of farmers who could obtain the appropriate technique from different agencies in the village while the risk of pest and competitive price from the imported cucumbers from Battambang and Siem Reap are the dangerous factor which needs to be properly managed and facilitated. However, there are many potential opportunities for cucumber cultivation which could help farmers to generate additional income for the family if the project could connect to vegetables wholesale company such as Natural Agriculture Village (NAV) where they could buy the product from farmers to sell in Phnom Penh in case that farmers' products are aligned with Good Agriculture Product (GAP) and Participatory Monitoring System (PGS) of the company. Furthermore, the huge demand for cucumber consumption by households and different shops for the period of 10 months except July and September (peak season of cucumber product) and tourism development initiative under National Authority of Preah Vihear (NAPV).

Table 12: Intervention Arrangement for Cucumber

Intervention logic	Addressed issues	Beneficiaries	Responsibilities
Diesel water pumping engine (upgrade)	• High water cost • Time spent in water irrigation of women and men • Climate resilience	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/female farmers.	• Farmers are subjected to co-finance the other operational cost such as access to seed and other input materials and land space • The project supports diesel water pumping engine (upgrade) cost depending on the size of

Intervention logic	Addressed issues	Beneficiaries	Responsibilities
			production • Farmers and project personnel will coordinate with suppliers for equipment maintenance manual/guide as well as amortization.
Drip irrigation system	• High cost for water pumping • Saved water consumption	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/female farmers.	• Farmers are subjected to co-finance the other operational cost such as access to seed and other input materials and land space • The project supports drip irrigation system cost depending on the size of production • Farmers and project personnel will coordinate with suppliers for equipment maintenance manual/guide as well as amortization.
Technical training, follow up on cucumber production	• Low productivity • Low number of farmers producing cucumber due to lack of appropriate skills such as PGS, seed selection, caring etc.	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/female farmers. • Family members of 20 farmers who received echo-coaching.	• Natural Agriculture Village (NVA) under project support, provide capacity building for 2 courses together with several follow up coaching to 20 farmers on PGS for cucumber. • Farmers are subjected to participate and implement the cucumber productions.
Facilitating market access through contract farming	• Lower sale price of cucumber • Lack of access to market	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households. • Family members of 20 farmers who participate in production • Other villagers who grow cucumber	• NAV under the project support shall visit, check and establish contract farming with clear instruction to farmers on the quality of required cucumber. • Farmers are subject to follow the PGS and purchasing standard.

2. Long bean

2.1 Input materials

16. Similar to cucumber, the input materials of long bean cultivation are also easily access from both Sras Kdol and Sra Em market. It is only 1 km distance for Sras Kdol market and 7 km for Sra Em market. The input materials use for long bean cultivation from the consulted farmers include seed, water pumping machine, water pipe, wooden poles, water wells and plough fee for tractor. The consulted farmers do not apply water dripping irrigation system with water tank to stock the water as cucumber's farmers. Furthermore, the farmers do apply organic fertilizer to the long bean. The cost of input materials for one year of long bean cultivation is based on the current market price with the size of operation: 625 square meters or 0.0625 ha of cultivated land and 5 cycles of production and 5 harvesting times (1 cycle and harvesting time is 70 days. The detailed

input costs are as below:

Table 13: Input costs for long bean cultivation in 1 year

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Water wells	Set	1	212.5	212.5	10 years	21.25	21.25
Seed from Sra Em market	Box	1	5	5	5 cycles per year	25	25
Wooden pole	Pole	300	0.05	15	3 years	5	5
Organic fertilizer	Pack	2	5	10	5 cycles per year	50	50
Water pipe	Meter	60	0.33	19.8	3 year	6.6	6.6
Land preparation - Plough fee (tractor)	Set	1	18.75	18.75	5 cycles per year	93.75	93.75
Pumping machine	Set	1	1	66	3 years	22	22
Gasoline for pumping water 3.125 cubic meter per day (2 hours and 30 minutes) or 781.25 cubic meters for 250 days of 5 cycles	Day	250	2.5	625	5 cycles per year	625	625
					Total input costs	**848.6**	**848.6**

17. The investment capital for long bean cultivation is estimated USD 848.6 per year for five harvesting times. Most of the farmers use their saving cash from retirement pension.

18. Alternatively, if the farmer would apply diesel water pumping engine (upgrade) and installation of water tank to irrigate water for long bean, the investment capital for long bean cultivation is estimated USD 529.6 per year for five harvesting times. It implies that the diesel water pumping engine (upgrade), water tank and dripping irrigation system would save the cost of gasoline for water pumping around USD 319 per five cycles of production.

Table 14: Alternative input cost for long bean cultivation for 1 year with diesel water pumping engine (upgrade)

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Dripping irrigation system	625 m2	1	183	183	3 years	61	61
Water wells	Set	1	212.5	212.5	10 years	21.25	21.25
Seed from Sra Em market	Box	1	5	5	5 cycles per year	25	25
Wooden pole	Pole	300	0.05	15	3 years	5	5
Organic fertilizer	Pack	2	5	10	5 cycles per year	50	50
Water pipe	Meter	60	0.33	19.8	3 year	6.6	6.6
Land preparation -Plough fee (tractor)	Set	1	18.75	18.75	5 cycles per year	93.75	93.75
Water Tank	Tank (5000 liter)	1	1	500	5 years	100	100

Diesel water pumping engine (upgrade)	Set	1	1	300	3 years	100	100
Diesel cost	Day	250	0.8	200	5 cycles per year	67	67
					Total input costs	**529.6**	**529.6**

2.2 Technical capacity

19. Five consulted farmers reported that they have not followed the technical appropriate as they have never been trained by other agencies. The long bean production is done by generation and even the size of land and preparation of the shelter is done according to their farming experience of the neighbors at the hometown. It is required the demonstration from relevant agencies such as PDAFF and development projects and programmes to improve the standard of productivity.

2.3 Production calendar

20. The long bean cultivation is best to grow from January to June of the year before the plenty of rainwater. The abundant of rainwater could damage the long bean. Normally, the long bean cultivation is restarting from September to December with less intensification.

Table 15: Calendar of long bean cultivation

	Year											
Vegetables	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Long bean cultivation	xxx	xxx	xxx	xxx	xxx	xxx	x	x	xx	xx	xx	xx

21. Although the farmers could grow long bean with 10 months period of the year (5 cycles or 50 days cultivation and 10 days harvesting), they could harvest only five times including February, April and June (Peak season) and October and December (normal season). The farmers could harvest long bean 15 kg per day or 150 kg for 10 days harvesting times for 3 cycles from January to June. During July and August, farmers do not grow and treating the land. Then, they would grow again in September and harvest in October and December with yield of 8 kg per day or 80 kg per 10 days harvesting times.

Table 16: Calendar of long bean harvesting time along the year

	Year											
Vegetables	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Harvest long bean (kg) for 10 day for 1 farmers	0	150	0	150	0	150	0	0	0	80	0	80
Harvest long bean (kg) for 10 days for 5 farmers	0	750	0	750	0	750	0	0	0	400	0	400

2.4 Market demand and supply

22. Market demand of long bean is considered moderately good because there are regular 10 brokers who come to the village to purchase the long bean from the farmers. The most peak period for purchasing order is April, July, August, November and December with amount of 100 kg per day or 3 tons per month while the moderate peak period is February, September and October with the amount of 66.66 kg per day or 2 tons per month. However, low period of purchasing order is January, March, May and June with the required amount of 33.33 kg per day

or 1 ton per month. Although there is moderately good long bean demand, the farmers are not capable to supply due to limited number of producers (only 5 farmers) and technical intensification (traditional and organic practice together with small size of cultivated land). They totally could produce up to 3.05 tons along the year therefore the brokers need to explore the products from Sra Em and Chorm Khsan markets approximately 21.95 tons per annual (See Table 17).

Table 17: Market demand and supply for long bean along the year

Vegetables	Year												Total (ton)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Demand for long bean (ton)	1	2	1	3	1	1	3	3	2	2	3	3	25
Long bean supply from Natural Techo (ton)	0	0.75	0	0.75	0	0.75	0	0	0	0.4	0	0.4	3.05
Market Gap or Surplus (ton)	1	1.25	1	2.25	1	0.25	3	3	2	1.6	3	2.6	21.95
Long bean supply from other areas (ton)	1	1.25	1	2.25	1	0.25	3	3	2	1.6	3	2.6	21.95

2.5 Water consumption and cost

23. The water consumption is around 3.125 cubic meters per day or 781.25 cubic meters per annual within 10 months production (5 cycles) for 0.0625 ha of irrigated land for long bean. The cost for gasoline in daily pumping is USD 2.5 with irrigating time of 2 hours and 30 minutes pumping per day. Therefore, 50 days for one cycle costs USD 125 and 250 days for 5 cycles cost USD 625 for water supply excluding the cost of pumping machine. However, if the farmers use diesel water pumping engine (upgrade) together with drip irrigation system and water tank to irrigate the long bean, the cost would be only USD 328 per 250 days of 5 cycles of production (See Table 18). Volume and cost of water). Therefore, the difference between using diesel water pumping engine (upgrade) and current ordinary system to pump the water is USD 319 per annual production of long bean.

Table 18: Water volume and cost for long bean along the year

Vegetables	Cost for diesel water pumping engine (upgrade) (USD)			Cost of current ordinary Pumping (USD)	
	Diesel water pumping engine (upgrade) and diesel cost	Water tank	Drip irrigation system	Pumping machine	Gasoline
3.125 cubic meters per day or 781.25 cubic meters for 250 days or 5 cycle of water for irrigating 0.0625 ha of long-bean cultivated land.	167	100	61	22	625
Comparative cost	**328**			**647**	

2.6 Return of investment analysis

24. The return of internal investment for long bean cultivation of one farmer with existing practice could be confirmed that slice positive based on the size of 0.0625 ha of land and ordinary water irrigation system. The total cost of investment during the period of one year or five cycles of long bean cultivation is USD 848.6 covering system, equipment, materials and other input

costs. Compared to the five times harvesting productivities of 3.05 tons with 15% of production loss, farmers could sell long-bean around 2.5925 tons to 10 brokers who come to Natural Techo village with different price varieties (USD 0.375 per kilogram in February, April and June with 1.9125 tons and USD 0.625 per kilogram in October and December with 0.68 tons). Thus, total gross income whole year of a long-bean farmer is USD 1142.18 therefore the annual net profit is USD 293.58 USD under existing ordinary system. However, if the farmers apply diesel water pumping engine (upgrade) for pumping water to irrigate the long-bean, the margin of profit supposes to be USD 612.58 per annual (See Table 19).

Table 19: Economic return for long bean cultivation in one year

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Water wells	Set	1	212.5	212.5	10 years	21.25	21.25
Seed from Sra Em market	Box	1	5	5	5 cycles per year	25	25
Wooden pole	Pole	300	0.05	15	3 years	5	5
Organic fertilizer	Pack	2	5	10	5 cycles per year	50	50
Water pipe	Meter	60	0.33	19.8	3 year	6.6	6.6
Land preparation - Plough fee (tractor)	Set	1	18.75	18.75	5 cycles per year	93.75	93.75
Pumping machine	Set	1	1	66	3 years	22	22
Gasoline for pumping water 3.125 cubic meter per day (2 hours and 30 minutes) or 781.25 cubic meters for 250 days of 5 cycles	Day	250	2.5	625	5 cycles per year	625	625
					Total input costs	**848.6**	**848.6**

Total economic return			
Description	**Unit**	**Qty**	**Amount**
Total production yields	Time	5	3.05 tons
Total production loss or gap	%	15	0.4575 ton
Total production sale in February, April and June (including 15% loss)	Time	1	1.9125 tons
Total production sale in October and December (including 15% loss)	Time	1	0.68 tons
Product price in February, April and June	Kg	1	USD 0.375
Product price in October and December	Kg	1	USD 0.625
Total gross income in February, April and June	**Kg**	**1912.5**	**USD 717.18**
Total gross income in October and December	**Kg**	**680**	**USD 425**
Total gross income whole year	**USD 1142.18**		
Total investment cost whole year by ordinary water pumping	**USD 848.6**		
Option A: Total investment cost whole year by ordinary water pumping	**USD 293.58**		
Total investment cost whole year by diesel water pumping engine (upgrade)	**USD 529.6**		
Option B: Total net income whole year by diesel water pumping engine (upgrade)	**USD 612.58**		

2.7 Production challenges

25. The consulted farmers on long bean cultivation have never been trained by PDAFF or other agriculture related agencies. Therefore, the current practice obtains less profit margin especially the water irrigation cost and growth ratio as well as the illness of the long bean. Furthermore, the farmers do not use any enzyme to speed up the growth beside organic fertilizer that they collect from the animals. Land is available for each village of 0.5 ha, however, the limited access to financial capital therefore they work with only 0.625 ha for long bean cultivation. Although market demand is relatively good for long bean product, they farmers still depend on the 10 brokers who manage and control over the price of which the brokers could sell to consumers in Sra Em market with the price of USD 1.25 per kilogram of long bean. This is because of the farmers have not aware of any market information in the area. There is a great opportunity to scale up the long bean production with proper mobilization of the farmer to join hand and supply their products to both Sra Em market and upcoming tourism restaurants and shops inside the village.

Suggested interventions to support long bean cultivation for farmers in Natural Techo village should be focused on three elements including firstly to work on improved water dripping irrigation system together with diesel water pumping engine (upgrade) in order to reduce the cost of water supply around USD 319 per annual for 781.25 required cubic meters for the whole 5 cycles, secondly establishment of farmer field school in order to demonstrate appropriate agriculture technology specifically on long bean cultivation such as land size requirement, planting method, management of pest and care with possible scale up of the cultivated land size (from 0.0625 ha to 0.1 ha) in order to increase the margin of profit and thirdly, work to improve access to market for long bean farmers or even other vegetables farmers in Natural Techo village to increase the selling price such as integrating farmers as the producers of the CBT which will be established shortcoming. However, due to the lower economic return than cucumber, the project prioritized the cucumber or integrate this long bean production with cucumber farmers as the integrated vegetables supporting farms.

3. Free range local chicken

3.1 Input materials

26. The chicken production in the Natural Techo village is very popular and almost every household raising chicken but only for household subsistence (less than 10 heads of chicken) especially free-range chicken – local breed, which is almost 80% based on the commune consultation. However, chicken raising families who are considered as micro commercial are accounted for 1% or equal to 12 families. The consultation with chicken raising families identified series of input materials deployment in order to raise local breed free range chicken including finish feed, homemade feed (rice husk, broken rice and vegetables), vaccine, medicine, chicken house, small water cup, water well, water pumping machine and pipe, water and cost. The input materials are locally available including chick buys from chick producer in the village (in front of O Svay lake), broken rice and rice husk buys from rice miller in the village, chicken house built by their own with bought wooden/bamboo except the pumping machine, pipe, water cup and vaccine is bought from Sra Em market. Furthermore, access to chick is a constraint as there is only one chick producer with 200 capacity of chick delivery per month while the demand for chick order is more than 100% (500 chicks per month).

27. The cost of input materials chicken production is based on the current market price with the size of production including 250 heads of chicken and 3 chicken houses – big chicken house size 36 cubic meters (3 m x 4 m x 3 m) and 2 small chicken houses size 1 cubic meter (1 m x 1

m x 1 m) with duration of 315 days (3 cycles per annual, 1 cycle spends 105 days). The detailed input costs are as below:

Table 20: Input costs for local breed chicken raising for 1 year (3 cycle or 315 days)

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Chick	Head	250	1	250	1 cycle	250	250
Finish feed for chicks with age of 25 days	Kg	3	0.875	2.625	75 days	196.875	196.875
Rice husk	Kg	3	0.15	0.45	315 days	141.75	141.75
Broken rice	Kg	1.5	0.25	0.375	315 days	118.125	118.125
Vegetables	Kg	2	0.5	1	315 days	315	315
Vaccine and medicine	Bottle	1	0.25	0.25	315 days	78.75	78.75
Water cup	Cup	10	1.1	11	3 years	3.67	3.67
Chicken houses (3)	Set	1	500	500	3 years	167	167
Water pumping machine	Set	1	66	66	3 years	22	22
Pipe	Meter	50	0.33	16.5	3 years	5.5	5.5
Water well	Set	1	212.5	212.5	10 years	21.25	21.25
Water (30 liters per day or 9.45 cubic meters for 1 year 3 cycles) Note: 1-hour pumps 1.25 cubic meter and cost USD 1 for gasoline.	Cubic meter	9.45	0.8	7.56	Whole 3 cycle	7.56	7.56
					Total input costs	**1327.48**	**1327.48**

28. The investment capital for local breed chicken raising is estimated USD 1327.48 per year for three cycle of chicken production. Most of the farmers use their saving cash from retirement pension.

3.2 Technical capacity

29. The consulted chicken raising families are trained by PDAFF under ASPIRE program of which they have followed the technical procedures stated in the manual. The mortality ratio is not highest compared to the lowland provinces due to size of space is large and secure for prevention of disease outbreak.

3.3 Production calendar

30. The local breed chicken raising is not concerned about the time except the first month of raining season regularly in May and the hottest month of the dry season in April. Normally the villagers raise chicken for the whole year. However, they normally keep the stock in January, March and September in order to supply during the peak price of Chinese New Year, Khmer New Year and Pchum Ben ceremony. After these ceremonies, the production becomes regular and normal.

Table 21: Calendar of chicken raising

	Year

Local breed chicken	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Local breed chicken	xxx	xx	xx	xxx	xx	xx	xx	xx	xxx	xx	xx	xx

31. The chicken could be sold 1 head (1 head equal to 1.5 kg) every day per villager during year except 1 day for Chinese New Year around 60 heads or 90 kg, Khmer New Year 60 heads or 90 kg and Pchum Ben 60 heads or 90 kg.

3.4 Market demand and supply

32. Market demand of local breed chicken is really good as it is preferable for both household consumption, tourist food and beverage restaurants and the special ceremony. Currently, there are 6 brokers who comes from Sra Em market to explore chicken purchase in Natural Techo village of which each of them orders 10 heads or 15 kg every day or 2700 kg per month in order to sell to the market and restaurants who serve local breed chicken rice. Moreover, 3 days before Chinese New Year, Khmer New Years, and Pchum Ben, all of them additionally put the order 200 kg each in order to transfer to Phnom Penh. Therefore, the regular daily demand from only 6 brokers is around 2700 kg and 3810 kg for three mentioned events along the year. Totally, there are approximately around 35.73 tons of chicken meat requires per year or even each family (among the total of current 12 families) need to supply 2.9775 tons per year.

33. However, the chicken producers of 12 families could produce only 1.5 kg each or 18 kg every day or 540 kg per month for 12 families to supply to the brokers for the regular order while during the special events, they could produce up to 1080 kg (90 kg each). It is confirmed that all current 12 chicken raising farmers could produce a maximum of 9.72 tons per annual to supply or in average 0.81 tons per each chicken raising family.

34. Therefore, the gaps in supplying local breed chicken is approximately 2160 kg for regular market and 2190 kg during the special events. In order to fulfil the gap, the wholesaler in Sra Em market has ordered the Thai local breed chicken from Ann Ses zone and Anlong Veng district approximately 4000 kg per month to supply in three different markets including Preah Vihear town market, Sra Em market and Chom Khsan market (See Table 22).

Table 22: Market demand and supply for local breed chicken along the year

Local breed chicken supply from Natural Techo (kg)	Year												Total (kg)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Demand for local breed chicken (kg)	3810	2700	2700	3810	2700	2700	2700	2700	3810	2700	2700	2700	35730
Local breed chicken supply from Natural Techo (kg)	1620	540	540	1620	540	540	540	540	1620	540	540	540	9720
Market Gap or Surplus (kg)	2190	2160	2160	2190	2160	2160	2160	2160	2190	2160	2160	2160	26010
Alternative hybrid chicken supply from other areas (kg)	2190	2160	2160	2190	2160	2160	2160	2160	2190	2160	2160	2160	26010

3.5 Water consumption and cost

35. The volume of water consumption for chicken raising is not really high and cost is relatively low. For the whole year of 3 cycles production, it consumes only 9.45 cubic meters for each farmer and cost around USD 56.31 including water well, pipe, pumping engine and gasoline. There should not be a problem for water supply in chicken production.

3.6 Return of investment analysis

36. The return of internal investment for local breed chicken raising of one farmer with existing practice could be confirmed that small but could be an extra income for the family based on the 250 heads of chicken raising. The total cost of investment during the period of one year or 3 cycles of chicken raising is USD 1327.48 covering system, equipment, materials and other input costs. Compared to the regular and special events sales of 810 kg with 20% of loss, farmers could sell chicken around 648 kg to 6 brokers who come to Natural Techo village with different price varieties (USD 4.5 per kilogram for regular sale for 324 kg and USD 5 per kilogram for special events for 324 kg). Thus, total gross income whole year of a local breed chicken farmer is USD 3078 therefore the annual net profit is USD 1750.52 under existing ordinary system (See Table 23).

Table 23: Economic return for local breed chicken production in one year

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Chick	Head	250	1	250	1 cycle	250	250
Finish feed for chicks with age of 25 days	Kg	3	0.875	2.625	75 days	196.875	196.875
Rice husk	Kg	3	0.15	0.45	315 days	141.75	141.75
Broken rice	Kg	1.5	0.25	0.375	315 days	118.125	118.125
Vegetables	Kg	2	0.5	1	315 days	315	315
Vaccine and medicine	Bottle	1	0.25	0.25	315 days	78.75	78.75
Water cup	Cup	10	1.1	11	3 years	3.67	3.67
Chicken houses (3)	Set	1	500	500	3 years	167	167
Water pumping machine	Set	1	66	66	3 years	22	22
Pipe	Meter	50	0.33	16.5	3 years	5.5	5.5
Water well	Set	1	212.5	212.5	10 years	21.25	21.25
Water (30 liters per day or 9.45 cubic meters for 1 year 3 cycles) Note: 1-hour pumps 1.25 cubic meter and cost USD 1 for gasoline.	Cubic meter	9.45	0.8	7.56	Whole 3 cycle	7.56	7.56
					Total input costs	**1327.48**	**1327.48**

Total economic return			
Description	**Unit**	**Qty**	**Amount**
Total production of local breed chicken	Time	3	810 kg
Total production loss or gap	%	20	162 kg
Total production sale during regular period (including 20% loss)	Time	1	324 kg
Total production sale during peak period (including 20% loss)	Time	1	324 kg
Product price during regular period	Kg	1	USD 4.5
Product price during peak period	Kg	1	USD 5
Total gross income during regular period	**Kg**	**324**	**USD 1458**
Total gross income during peak period	**Kg**	**324**	**USD 1620**
Total gross income whole year	**USD 3078**		
Total investment cost whole year by ordinary water pumping	**USD 1327.48**		
Total net income whole year by ordinary water pumping	**USD 1750.52**		

3.7 Production challenges

37. Local breed chicken production is tolerance to climate condition and disease outbreak. Moreover, the preference of villagers and tourists in the area on local breed is relatively high due to the very good taste and quality. The consumption demand for local breed chicken is also a great opportunity as it requires 2700kg – 3810kg per month for the whole Sra Em commune while producers could reach up to 540kg – 1620kg and still there is a gap of 2160kg – 2190kg every month. Local breed chicken technical production is not a constraint for farmers as they have learned from PDAFF under ASPIRE program with proper production including vaccination, care, watering, feeding and disease treatment. However, there are 2 major constraints that farmers are facing recently on the high cost of input materials including access to low cost chick which currently cost USD per head which cost USD 250 (250 heads) during the first cycle of the chicken production and the high cost of feed which is almost USD 574.875 for 3 cycles production (rice husk, broken rice and vegetables – USD 315 alone) while finish feed costs almost USD 200 for the first 25 days age of chicken.

Table 24: Intervention Arrangement for Chicken Production

Intervention logic	Addressed issues	Beneficiaries	Responsibilities
Provision of chick production cases	• Unclear and unhealthy chicks' access • High chick price (USD1 per unit with improper vaccination)	• 2 farmers including existing and new inspired farmers	• Farmers are subjected to co-finance the other operational cost of chick production such as electricity, water, vaccination and other related costs and land space for establishing chick breeding place • Farmers are subjected to agree in selling chick with chicken raising farmers for USD0.75 price for chick purchase. • Project supports two chick production cases. • Project facilitates the connection between chick producer with suppliers of the equipment.
Feed mixing and balling machines	• High cost of finishing feed and grow out feed	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/women.	• Farmers are subjected to co-finance the other operational cost such as access to subsidized chick cost, raw materials for feed making, and other input materials and land space for chicken production • The project supports 20 feed making machines cost • Farmers and project personnel will coordinate with suppliers for equipment maintenance manual/guide as well as amortization.
Technical training, follow up on chicken production	• Low productivity and high mortality ratio • Low number of farmers raising chicken due to	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/women. • Family members of 20	• Khmer Organic Cooperative (KOC) under project support, provide capacity building for 2 courses together with several follow up coaching to 20 farmers on PGS for chicken raising. • Farmers are subjected to

Intervention logic	Addressed issues	Beneficiaries	Responsibilities
	lack of appropriate skills such as PGS, vaccination and disease treatment, caring etc.	farmers who received echo-coaching.	participate and implement the chicken raising productions.
Facilitating market access through contract farming	• Lack of access to higher value-market	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/women. • Family members of 20 farmers who participate in chicken production • Other villagers who raise chicken.	• KOC under the project support shall visit, check and establish contract farming with clear instruction to farmers on the quality of required live chicken. • Farmers are subject to follow the PGS and purchasing standard.

4. Tilapia

4.1 Input materials

38. Currently, there are only 3 families in the Natural Techo village who raise Tilapia fish in late 2018 with extensive technique of which they have never received any trainings from PDAFF and other development projects.

39. The consultation with 3 families identified series of input materials deployment in order to raise Tilapia fish including finish feed, rice husk, fish fingerling, pond, net, water supply, pumping machine, pipe and gasoline. The input materials are locally available including finish feed buys from Sra Em market, rice husk, and water supply equipment and materials except the fish fingerlings where it needs to order from VN through Neak Leung fish hatchery station. The access to fish fingerling is the most constraint as there is no fish fingerling hatchery station available in Natural Techo village. Farmers have to order at least 30000 fish fingerlings with the price of USD 0.0625 per head in order to receive free transportation. However, currently the fish raising families just ordered 1000 fish fingerlings each with the cost of USD 0.125 with additional transportation cost of USD 20 per time.

40. The cost of input materials is based on the current market price with the size of production including 1000 fish fingerlings and pond size of 900 cubic meters (15 m x 20 m x 3 m) with duration of 10 months (2 cycles per annual, 1 cycle spends 5 months). The detailed input costs are as below:

Table 25: Input costs for Tilapia raising for 1 year (2 cycle or 10 months)

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Fish fingerlings	Head	1000	0.125	125	1 cycle	125	125
Pond (900 cubic meters)	Set	1	100	100	10 years	10	10
Finish feed for 30 days	Pack	3	13.75	41.25	2 cycles or 60 days	82.5	82.5
Rice husk	Kg	3	0.15	0.45	120 days	54	54

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Net	Meter	30	0.5	15	1 year or 2 cycles	15	15
Water pumping machine	Set	1	66	66	3 years	22	22
Pipe	Meter	50	0.33	16.5	3 years	5.5	5.5
Bought water (1800 cubic meters for 2 cycles or 1 year)	Year	1	25	25	1 year	25	25
Regular water exchange by pumping 100 cubic meters per month or 800 cubic meters for 8 months)	Liter	8	0.375	3	2 cycles or 1 year	3	3
					Total input costs	**342**	**342**

41. The investment capital for Tilapia fish raising is estimated USD 342 per year for 2 cycle of production. Most of the farmers use their saving cash from retirement pension.

4.2 Technical capacity

42. Currently, the fish farmers have not concrete capacity to raise Tilapia fish as they are performing according to de facto knowledge from the one to another. The fish raising does not apply technical for pond preparation with lame deployment, dry up, measuring the water quality especially pH as well as no regular fish treatment. However, farmers are aware of growth ratio of Tilapia fish, e.g., during the May to September the fish size could be around 0.4 kg per head with the mortality ratio 30%.

4.3 Production calendar

43. Tilapia fish raising is implementing along the year with 2 cycles of production. 1st cycle from May to September and 2nd cycle from October to February while farmers take rest in March – April once the water is dried up. The farmers just store water in another pond that rent from other villagers. Due to the areas where farmers are raising fish are not flooded therefore there is no risk due to overflow.

Table 26: Calendar of Tilapia raising

	Year											
Tilapia	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Tilapia culture	xxx	xxx	x	x	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx

44. Normally, the fish harvests in September during the first cycle and in February in the 2nd cycle. However, from September and October (Peak period), the fish price is lower due to plenty of wild fish diversities. During this period from September to March, the cultured fish especially Tilapia is USD 3 per kg while it would be increased to USD 5 per kg from April to April (Lower period of wild fish).

4.4 Market demand and supply

45. Market demand of cultured fish is relatively high in Natural Techo village of which it requires 1000 kg per month with diversified fish including wild and cultured.

46. The current fish raising could supply 1200 kg in February (1200 kg from aquaculture – 3 farmers) and in September cultured fish could supply 1200 kg and 600 kg of wild fish (totally 1800 kg) while October there is only 360 kg of wild fish supply. (See Table 27).

Table 27: Market demand and supply for Tilapia along the year

Tilapia supply from Natural Techo (kg)	Year												Total (kg)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Demand for fish (kg)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	12000
Fish supply from Natural Techo (kg)	0	1200	0	0	0	0	0	0	1800	360	360	360	4080
Market Gap or Surplus (kg)	1000	200	1000	1000	1000	1000	1000	1000	-600	400	1000	1000	9000
Alternative fish supply from other areas (kg)	1000	-	1000	1000	1000	1000	1000	1000	-600	400	1000	1000	8800

4.5 Water consumption and cost

47. The volume of water consumption for Tilapia fish raising is moderately high and cost is relatively at the medium level. For the whole year of 2 cycles production, it consumes only 1800 cubic meters for each farmer and cost around USD 65.5 including pond, pipe, pumping engine and gasoline.

4.6 Return of investment analysis

48. The return of internal investment for Tilapia fish raising of one farmer with existing practice could be confirmed that relatively middle level but could be an extra income for the family based on the 1000 heads of fish fingerling raising. The total cost of investment during the period of one year or 2 cycles of Tilapia fish raising is USD 342 covering water purchase, pond development, feed, fish fingerlings and other input costs. Compared to the fish production sales of 800 kg with 30% of loss, farmers could sell Tilapia fish around 560 kg to brokers who come to Natural Techo village with price of USD 3 per kg. Thus, total gross income whole year of a fish raising farmer is USD 1680 therefore the annual net profit is USD 1338 under existing ordinary system (See Table 28).

Table 28: Economic return for Tilapia production in one year

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Fish fingerlings	Head	1000	0.125	125	1 cycle	125	125
Pond (900 cubic meters)	Set	1	100	100	10 years	10	10
Finish feed for 30 days	Pack	3	13.75	41.25	2 cycles or 60 days	82.5	82.5
Rice husk	Kg	3	0.15	0.45	120 days	54	54
Net	Meter	30	0.5	15	1 year or 2 cycles	15	15
Water pumping machine	Set	1	66	66	3 years	22	22
Pipe	Meter	50	0.33	16.5	3 years	5.5	5.5
Bought water (1800 cubic meters for 2 cycles or 1 year)	Year	1	25	25	1 year	25	25

Regular water exchange by pumping 100 cubic meters per month or 800 cubic meters for 8 months)	Liter	8	0.375	3	2 cycles or 1 year	3	3
					Total input costs	**342**	**342**

Total economic return			
Description	**Unit**	**Qty**	**Amount**
Total production of Tilapia	Time	2	800 kg
Total production loss or gap	%	30	240 kg
Total production sale in February (cultured fish) with 30% loss ratio	Time	1	280 kg
Total production sale in September (cultured fish) with 30% loss ratio	Time	1	280 kg
Product price in September to March	Kg	1	USD 3
Product price in April to August	Kg	1	USD 5
Total gross income for 2 cycles in February and September	**Kg**		**USD 1680**
Total gross income whole year	**USD 1680**		
Total investment cost whole year by ordinary water pumping	**USD 342**		
Total net income whole year by ordinary water pumping	**USD 1338**		

4.7 Production challenges

49. The potential opportunities of fish production are relatively middle demand of which fish meat is required an average of 1000 kg per month while the farmers are few and could produce only 2400 kg with 30% of loss or 1680 kg together with wild fish 1680 kg to supply. Therefore, wholesaler and brokers from Sra Em market have to import cultured fish from Siem Reap and Battambang to supply around 1000 kg per month to Natural Techo village. The production of Tilapia does not require high technology as this fish species is fast grown and productivity with any water conditions except high muddy composition. However, the farmers still need appropriate technique such as pond preparation, water quality control, feeding process in order to improve Tilapia fish productivity in order to improve income from the current conditions especially reducing the mortality ratio. Furthermore, the farmers are concern about easily access to fish fingerlings although currently could be access from hatchery station in Neak Leung area.

Table 29: Intervention Arrangement for Tilapia fish raising

Intervention logic	**Addressed issues**	**Beneficiaries**	**Responsibilities**
Fish fingerling access	• Lack of access to fish fingerlings unless order from Vietnam through Kampong Thom and Kampong Cham • High fingerling cost USD 0.125 per unit	• 20 farmers who pilot the Tilapia farming • The 20 farmers must compose by poor families and at least 30% of female headed households/women.	• Farmers are subjected to spend their own cost for buying the fish fingerling from the Tilapia hatchery stations established by TERAO LITECH (Cambodia) Co. Ltd.
Feed mixing and balling machines	• High cost of finishing feed and grow out	• 20 farmers including existing and new inspired farmers • The 20 farmers must	• Farmers are subjected to co-finance the other operational cost such as access to

Intervention logic	Addressed issues	Beneficiaries	Responsibilities
	finishing feed	compose by poor families and at least 30% of female headed households/women.	subsidized fingerling by the hatchery cost, raw materials for feed making, and other input materials and pond space for fish raising • The project supports 20 feed making machines cost • Farmers and project personnel will coordinate with suppliers for equipment maintenance manual/guide as well as amortization.
Technical training, follow up on fish raising	• Low productivity and high mortality ratio (30%) • Low number of farmers raising fish due to lack of appropriate skills and fingerling support and disease treatment, caring etc.	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/women. • Family members of 20 farmers who received echo-coaching.	• Provincial Department of Agriculture, Forestry and Fisheries (PDAFF) in Preah Vihear province under project support, provide capacity building for 4 courses together with 4 follow up coaching to 20 farmers on appropriate Tilapia fish raising. • Farmers are subjected to participate and implement the Tilapia fish raising productions.
Facilitating market access through contract farming	• Lack of access to higher value-market at Osvay lake tourism place and Preah Vihear temple site.	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/women. • Family members of 20 farmers who participate in Tilapia fish raising • Other villagers who raise Tilapia fish.	• PDAFF under the project support shall visit, check and establish connection between Tilapia fishing raising farmers with vendors at Osvay lake and Preah Vihear templae with clear instruction to farmers on the quality of required fish. • Farmers are subject to follow the technical instruction by PDAFF.

5. Jasmine

5.1 Input materials

50. Currently there are no one producer of jasmine in Natural Techo village for commercial purpose. There are only two families who plant for recreation. The jasmine plantation is done by farmer's learning by doing. They just learned from Youtube instruction and tried to plant by themselves. The input costs of jasmine plantation are calculated based on the actual equipment, materials and utilities deployment with the size of land 60 square meters (5 meters x 12 meters) or 12 jasmine trees. Those include:

Table 30: Input costs for jasmine plantation for 1 year (8 months to harvest and 20 days harvest 1 time onward or 6 harvesting times)

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Jasmine tree	Tree	12	2.5	30	1 cycle or 1	30	30

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
					year		
Dripping irrigation system	60 m2	1	11	11	3 years	3.67	3.67
Water wells	Set	1	212.5	212.5	10 years	21.25	21.25
Composed fertilizer	Pack	8	1.25	10	1 cycle or 1 year	10	10
Water Tank	Tank (1000 liter)	1	1	200	5 years	40	40
Pumping machine (small motor)	Set	1	1	60	3 years	20	20
Gasoline for pumping water of 240 cubic meters or 1 cubic meter per day with gasoline cost of 1 liter.	Liter	240	0.375	90	1 cycle or 1 year	90	90
					Total input costs	**214.92**	**214.92**

51. The total investment for jasmine plantation with 60 square meters is USD 214.92 with 6 times of harvesting during the period of 1 year and onward. The lifespan of jasmine is 3 years.

5.2 Technical capacity

52. As mentioned earlier, the farmers who plant jasmine have not received any technical training from development partners, NGOs or government agencies. They just grow naturally.

5.3 Production calendar

53. Due to the jasmine planting farmers use the water well for irrigating, therefore, there is no specific calendar to grow. They just grow anytime once the jasmine tree is ready.

5.4 Market demand and supply

54. Although there is commercial arrangement for jasmine plants, the consultation with jasmine sellers at the top of Preah Vihear temple, it has been confirmed that there are currently 30 jasmine and lotus sellers serving the tourists who come to visit the temple. For the regular period such as weekend, there is an average of 350 tourists per weekend (2 days) or 16800 tourists per annual of which 0.78% are foreigners. However, during the Khmer New Year event, the tourists go up to 4500 persons a day or 13500 persons for 3 days. The sellers confirmed that at least 50% of the domestic tourists who buy the jasmine with a combination with other praying stuff. Therefore, the demand of jasmine is really high which is approximately 8400 sticks during the weekend occasion plus 6750 sticks during Khmer New Year. The price of sale jasmine is USD 2.5 per stick combined with other praying materials. As currently, there is one villager in Natural Techo village produces jasmine, it has been imported from Siem Reap with the cost of USD 10 per kg during the regular period and USD 20 during 3 days of Khmer New Year.

5.5 Water consumption and cost

55. The water consumption for irrigating jasmine during the period of 8 months before first time harvesting is 240 cubic meters which cost around USD 90 to cover the gasoline for watering, USD 21.25 for water well establishment, USD 3.67 for drip irrigation system, USD 40 for 200 liters

water tank and USD 20 for small pumping machine.

5.6 Return of investment analysis

56. The return of internal investment for jasmine plantation of one farmer with existing recreational practice could be confirmed that relatively positive. The total cost of investment during the period of one year or 8 months with 6 times of harvesting of jasmine is USD 214.92 covering seed, water supply, equipment and materials and other input costs. Compared to the jasmine sales of 720 sticks, farmers could sell it to the jasmine and lotus sellers at the temple with price of USD 2.5 per stick. Thus, total gross income whole year is USD 1800 therefore the annual net profit is USD 1582.08 under existing ordinary system (See Table 31).

Table 31: Economic return for jasmine plantation in one year (8 months to harvest and 20 days harvest 1 time onward or 6 harvesting times)

Input material items	Unit/size	Quantity	Unit cost USD	Total cost USD	Duration of Usage	Depreciation 1 year	Total cost USD
Jasmine tree	Tree	12	2.5	30	1 cycle or 1 year	30	30
Dripping irrigation system	60 m2	1	11	11	3 years	3.67	3.67
Water wells	Set	1	212.5	212.5	10 years	21.25	21.25
Composed fertilizer	Pack	8	1.25	10	1 cycle or 1 year	10	10
Water Tank	Tank (1000 liter)	1	1	200	5 years	40	40
Pumping machine (small motor)	Set	1	1	60	3 years	20	20
Gasoline for pumping water of 240 cubic meters or 1 cubic meter per day with gasoline cost of 1 liter.	Liter	240	0.375	90	1 cycle or 1 year	90	90
					Total input costs	**214.92**	**214.92**

Total economic return (forecast for commercial)			
Description	**Unit**	**Qty**	**Amount**
Total production of jasmine (6 times of harvesting per year and 1 jasmine tree could produce 10 sticks therefore 12 trees produce 120 sticks per 1 time of harvesting or 720 sticks.	Time	6	720 sticks
Total production loss or gap (unknown)	%		
Total production sale	Time	1	720 sticks
Product price	Stick	1	USD 2.5
Total gross income whole year (6 times of harvesting)	**USD 1800**		
Total investment cost whole year by ordinary water pumping	**USD 214.92**		
Total net income whole year by ordinary water pumping	**USD 1582.08**		

5.7 Production challenges

57. Due to farmers do not plant jasmine for commercial purpose as well as have not been trained therefore they do not really know about the challenge of the jasmine production except the cost of gasoline for water pumping along the year and unaware of jasmine market and its advantage of which they could even generate more income than the fish raising and other

agricultural activities.

Table 32: Intervention Arrangement for jasmine and herb

Intervention logic	Addressed issues	Beneficiaries	Responsibilities
Diesel water pumping engine (upgrade)	• High water cost • Time spent in water irrigation of women and men • Climate resilience	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/female farmers.	• Farmers are subjected to co-finance the other operational cost such as access to jasmine and local herb seed and other input materials and land space • The project supports diesel water pumping engine (upgrade) cost depending on the size of production • Farmers and project personnel will coordinate with suppliers for equipment maintenance manual/guide as well as amortization.
Drip irrigation system	• High cost for water pumping • Saved water consumption	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/female farmers.	• Farmers are subjected to co-finance the other operational cost such as access to seed and other input materials and land space • The project supports drip irrigation system cost depending on the size of production • Farmers and project personnel will coordinate with suppliers for equipment maintenance manual/guide as well as amortization.
Technical training, follow up on jasmine and local herb cultivation	• Lack of production expericnes and capacity	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households/female farmers. • Family members of 20 farmers who received echo-coaching.	• Local Master Trainers in Preah Vihear under project support, provide capacity building for 4 courses together with several follow up coaching to 20 farmers on jasmine and local herb cultivation. • Farmers are subjected to participate and implement the jasmine and local herb cultivation.
Facilitating market access at Vendors at Osvay lake and Preah Vihear temple site	• Lack of access to market • Low sale price	• 20 farmers including existing and new inspired farmers • The 20 farmers must compose by poor families and at least 30% of female headed households. • Family members of 20 farmers who participate in cultivation • Other villagers who grow jasmine and local herb	• Local Master Trainers under the project support will visit, check and establish market connection between farmers and vendors at Osvay lake and Preah Vihear temple site with clear instruction to farmers on the quality of required jasmine and local herb. • Farmers are subject to follow the standard of jasmine and local herb cultivation.