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(Final report)

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Abbreviations

ACP Agricultural Competitiveness Project-World Bank

CCB Coffee Coordinating Board

CDC Community Development Center

Cm Centimetre

CWD Coffee Wilt Disease

DARD Department of Agriculture and Rural Development

DCP Department of Crop Production (Cropping Department)

FAO Food and Agriculture Organization of the United Nations

FOB Free On Board

GOV Government of Viet Nam

ha Hectares

ICA International Coffee Agreement

ICARD Information Centre for Agricultural and Rural Development

ICO International Coffee Organization

ICCRI Indonesian Coffee and Cocoa Research Institute

IDH The Sustainable Trade Initiative

IPSARD Institute of Policy and Strategy for Agricultural and Rural Development

kg Kilogram

L Litre

LAREC Lam Dong Agro-Forestry Research and Experiment Centre

LRU Land Rights Use

MARD Ministry of Agriculture and Rural Development

m Metres

mm Millimeters

Mt Metric Tonnes

NIAPP National Institute of Agricultural Planning and Projection

NEZ New Economic Zone

NGO Non-Governmental Organization

NPK Nitrogen, Phosphorus, Potassium

OXFAM Oxford Committee for Famine Relief, United Kingdom

PPRI Plant Protection Research Institute

RKN Root Knot Nematode

RLN Root Lesion Nematode

SA Sulphate of Ammonia

SCP Sustainable coffee Programme of IDH

SFRI Soils and Fertilizers Research Institute

SOE State Owned Enterprise

USD United States Dollar

VAAS Vietnam Academy of Agricultural Sciences

VBARD Viet Nam Bank for Agricultural and Rural Development

VFU Vietnamese Farmers’ Union

VICOFA Viet Nam Coffee and Cocoa Association

VINACAFE Viet Nam Coffee Corporation

VND Vietnamese Dong

WASI Western Highland Agroforestry Scientific and Technical Institute

EXECUTIVE SUMMARY

This report is the combination of three reports including: (i) Review technical aspects of coffee rejuvenation in the World and Vietnam; (ii) Technical analysis of alternative coffee rejuvenation strategies in practice in Vietnam; (iii) Economic and financial analysis of alternative coffee rejuvenation strategies in Vietnam.

The first report (conducted by Keith Chapman – a World Bank Vietnam consultant) reviews extensively the problems associated with replanting of coffee around the world and in Viet Nam, with an analysis of the findings and recommendations for the alternative rejuvenation strategies that are agronomically viable and should be adopted and further evaluated by the second and third reports.

The second report (conducted by a WASI’s team) provides technical summary detailing how the process of rejuvenation/replanting applied, prerequisites for its successful application in terms of agronomics, farmer characteristics, and key success/failure factors in each coffee rejuvenation strategies.

The third report (conducted by a IPSARD’s team) provides an economic and financial analysis (e.g. cost benefit analysis) detailing the costs of implementing the rejuvenation option(s) on a standard farm (per ha) and the expected results e.g. yields and income, farmer’s cash flow, needs for additional financial resources.

This combination report reviews alternative coffee rejuvenation strategies currently applied in Vietnam to provide evidence-based recommendations of a menu of viable alternative rejuvenation strategies to be adopted. The report covers agricultural and socio-economic factors and their assessment in terms of feasibility, effectiveness and efficiency of each of the strategy. The report also includes a range of options for financing each of the approaches highlighted and detail the cash flow requirements of a coffee grower during the rejuvenation process. All these provides evidence-based for the recommendation of viable alternative rejuvenation strategies suitable for different agronomic and socio-economic conditions.

Data used for analysis in the report comprising: (1) in-depth interviews with different stakeholders in the coffee sector in Dak Lak and Lam Dong provinces, and MARD; and (2) a questionnaire survey of 240 coffee rejuvenation households in Dak Lak and Lam Dong provinces conducted from May – June/2014.

International experience shows that only two countries in recent times have reported undertaking major replanting programmes, namely Indonesia and Uganda. For Indonesia, the main reason for large scale replanting was nematodes, while in Uganda was Coffee Wilt Disease caused by *Fusarium xylariodes* (Syn. *Gibberella* *xylariodes*). For other large coffee production countries like Brazil, Colombia, Central America, India, Eastern and Central Africa, there is no large Robusta replanting program has been undertaken in recent years.

For both Indonesia, Uganda and other countries, with Robusta coffee nematode problems have had to use nematode resistant clonal rootstocks to ensure replanting success. The government of Indonesia and Uganda had support to research, multiplication, and dissemination of coffee lines resistant to CWD, the control of pests and diseases capacity building.

For Vietnam, the report identifies two alternative rejuvenation strategies that commonly being applied in practice by farmers in Vietnam consisting of: (1) grafting; and (2) replanting. The first strategy consists of two options: full grafting and partial or rolling grafting. The second one embraces full replanting and partial or rolling replanting in combination with two options on using a land 6 month land dry fallow or a 1 year crop rotation.

Coffee grafting is agronomically viable for healthy old trees usually not more than 20 years old - if termites not a problem and trees are in good health and vigorous. The purpose of grafting is to replace the old varieties that have low yields, leaf rust affected and small bean size.

Coffee replanting is applied for old trees usually more than 20 years old, or the ones that have low yields: removal of old coffee trees and re-planting alternatives. The coffee gardens in successful replanting households were mainly old-age, without much disease and at the end of their economic cropping cycle.

Total investment cost of grafting is lower than replanting. The partial option has lower investment cost as compared to the full ones regardless of grafting or replanting. Total cost of partial, and full grafting options is 116 million VND and 107 million VND respectively for grafting period (2 – 3 years). While total investment cost for coffee replanting of 100%, 50% and 30% options are 210 million VND, 235 million VND, and 234 million VND respectively for the plantation establishment period ranging from 3 - 6 years depending on options.

Farmers apply more fertilizers than recommended from 15 to 40%. This implies that farmers are overused of fertilizers. Optimizing fertilizer application rates would result in lower investment cost for coffee rejuvenation.

The replanting cost in Lam Dong is higher than in Dak Lak province. This is the consequence of higher wage rates in Lam Dong province and the amount of loan borrowed in Lam Dong is higher than in Dak Lak which results in a higher amount of loan interest.

The partial option is more economically feasible despite a higher investment cost. The full grafting and replanting options have a lower investment cost and higher return as compared to the partial ones. However, the latter option is more feasible since they require lower loan amounts, and farmers can utilize of family labor, while still having a partial of income from coffee production to maintain livelihoods during the plantation establishment period. At the same time, the internal rates of return of partial replanting models are higher than for the full options.

Access to credit is important to facilitate and promote grafting of old coffee tree areas. With the current income and saving, farmers have inadequate resources for coffee rejuvenation and maintaining livelihoods during the plantation establishment period (ranging from 2 to 5 years depending on options). The replanting strategy requires more loan amount than the grafting strategy. Similar, full option requires more loan amount than the partial ones.

The grace period of a coffee grafting credit program should extend to cover break-even point period ranges from 52 to 54 months depending on full or partial grafting options and from 82-83 months for full or partial grafting replanting options.

Support for farmers to attain optimal yield is more important than the preferential interest rate. Sensitivity analysis shows that yield and coffee price have a significant impact on return from coffee rejuvenation, while interest rate has a minor impacts for the whole life cycle of coffee rejuvenated.

Based on evidence from reviewing of alternative rejuvenation strategies that currently applied in practices, the study proposes the following recommendations:

* Review the existing Coffee Master Plan and revise the proposed rejuvenation programme area targets to take account of the essential move to nematode resistant tissue cultured rootstocks to ensure high replant survival.
* Promulgate rejuvenation plan for Robusta coffee, in which specify and layout options/a menu of rejuvenation strategies that suitable with different agronomic, socio-economic conditions.
* Review and revise the existing replanting and grafting protocol to reflect different rejuvenation options and strategies applied in practices.
* Promote collaboration between different stakeholders to link R&D, technology development and transfer, extension and financing under the coffee rejuvenation plan developed.
* Support to research, multiplication, and dissemination of coffee lines resistant to diseases, the control of pests and diseases capacity building, and provide extension support to farmers.
* Facilitate the accessibility of small-scale growers to long-term credit for coffee rejuvenation. Issue a lending protocol to facilitate and reflect the cash flow projection of alternative rejuvenation strategies and options. The grace period without interest rate payments of a coffee rejuvenation credit program should be extent to cover the break-even point period.

SECTION A: PROBLEM STATEMENT

Coffee sector plays an important role in generating employment and foreign exchange earning in Vietnam. It is the second largest agricultural export earner after rice, and directly employs more than 1 million workers, and is the main source of income for 637,509 households (as of 2011), of which 90 percent are smallholders holding less than 2 hectares (Agro Census, 2011)[[1]](#footnote-1).

In the last two decades, Vietnam’s coffee sector has experienced the rapid expansion of coffee production area. During the 1994 – 2013 period, coffee production areas had expanded four times. At the same time, production practices and varieties for better cultivation productivity had been improved. As of 2013, the total coffee production area was 633,295 hectares, which produced 1.7 million tons with an average yield of 2.3 tons/hectare (MARD). Since 1997, Vietnam has been among the world’s top four coffee exporters, along with Brazil, Colombia and Mexico (ICO).

Currently, the key issue in the coffee sector is decreasing coffee yield as coffee trees are aging above the average productive period (20 - 25 years).[[2]](#footnote-2) As estimated by the Crop Production Department, the area with ageing coffee trees is 140,000 – 160,000 ha, and up to 200,000 ha in 2020 (accounts for about 30% of total coffee plantation area). Most of the ageing areas are concentrated in Dak Lak and Lam Dong province, the two largest production areas of the country. Dak Lak, the largest coffee production area, has about 50 percent of coffee production area or more than 100,000 hectares is above the average productive period. It means that if there is no action to rejuvenate the aging areas of coffee trees in the next 5 to 10 years, Vietnam’s coffee output will decrease dramatically.

This highlights the need for large-scale coffee rejuvenation (e.g. through replanting or grafting) in the coming years. Government agencies, coffee companies and coffee processors also recognise the need for rejuvenation of the aging and de-grading coffee estates and are carrying out a number of supporting initiatives. In addition to maintain the current production level, the rejuvenation of ageing coffee tree area is an opportunity for the improvement of yield and quality, as well as sustainable production through extending the adoption of improved varieties, applying latest replanting and other rejuvenation technology.

In recent year, coffee tree rejuvenation has been being conducted by smallholder coffee growers in their small-scale farms for years. Reportedly, as of 2014, there were about 20,000 hectares replanted by farmers (Dak Lak DARD and Lam Dong DARD, 2014). However, there are major obstacles to successful replanting in practice. Firstly, there are prevailing problem of a damaged root system due to parasite microorganisms. This disease affects to the successful of the rejuvenation program if its causes and measures cannot be found. Secondly, it takes a minimum 3 years for the newly planted coffee trees to produce a crop. This gap reduces the income of coffee producers considerably and they are therefore, often hesitant to replant. Thirdly, rejuvenation requires a large investment to cover a 3 year period for soil preparation, techniques transfer and the purchasing of seedlings, fertilizer and so on, and then preventing them, especially small-size ones from re-planting, or just able to replant small areas of their farms.

To guide the implementation of the rejuvenation program, MARD has issued Decision no. 273/QD-TT-CCN on protocol for Robusta coffee replanting in Vietnam. However, since the agronomic conditions and socio-economic environment for coffee production in Vietnam are varied, a single strategy mentioned in the MARD’s protocol might not be suitable.

Therefore, to support the formulation and implementation of more efficient and socially and environmentally sustainable investments in coffee rejuvenation at a large scale, it is necessary to review alternative rejuvenation strategies currently being applied in practice by farmers in Vietnam. This review will provide evidence-based for the recommendation of viable alternative rejuvenation strategies suitable for different agronomic and socio-economic conditions.

**1. Objective**

* 1. ***Overall Objectives***

The overall objective of this study is to review alternative coffee rejuvenation strategies currently applied in Vietnam to provide evidence-based recommendations of a menu of viable alternative rejuvenation strategies to be adopted in Vietnam.

***1.2 Specific Objectives***

* To identify and layout in a clear manner appropriate rejuvenation options (e.g. tree re-planting, and tree grafting) available to coffee farmers in the Central Highlands based on an in-depth and evidence-based review of existing farmers’ rejuvenation strategies in various agronomic conditions, farm’s characteristics and local economic environment from both agronomic and economic/financial perspectives.
* To identify the needs for public support necessary for famers to address difficulties/ challenges of each approach to be provided alongside mitigations and other relevant measures in order to ensure Vietnam’s coffee rejuvenation program is conducted effectively, efficiently and environmentally sustainability and mitigate risks facing the farmers.

**2. Data Collection**

***2.1 Secondary Data***

Second data used in this study were collected from GSO (Vietnam Household Living Standards Survey, 2010; the 2011 Rural, Agricultural and Fishery Census; Statistical Yearbook, 2013); relevant reports, rejuvenation protocol from Crop Production Department, Dak Lak DARD and Lam Dong DARD,the Western Highlands Agriculture and Forestry Science Institute (WASI),Vietnam Bank for Agriculture and Rural Development, Dak Lak, and Lam Dong branch, World Bank, IDH, FAO, and other relevant sources.

***2.2 Primary Data***

*2.2.1 Data collection method*

* *In-depth interview*: in-depth interviews were conducted with the following specialists:
* Department of Agriculture and Rural Development in Dak Lak and Lam Dong**:** to collect information related to local picture on coffee rejuvenation: area, coffee rejuvenation strategies adopted, support from provincial and central government for coffee rejuvenation strategies.
* Vietnam Agriculture and Rural Development Bank Lam Dong branch: to collect information on lending program of the bank for rejuvenation (lending period, interest rate, collateral, procedures for lending,…), the bank point of view on rejuvenation strategies.
* Coffee specialists.
* Coffee farmers.
* *Coffee farmers survey*: A questionnaire survey of 240 coffee rejuvenation households in Dak Lak and Lam Dong provinces. The survey was conducted from May – June/2014 (See appendix 15 for sampling criteria).

**Table 1: Survey sample by provinces and rejuvenation methods (household)**

| **Prov** | **District** | **Commune** | **Grafting** | **Replanting** | **Total** |
| --- | --- | --- | --- | --- | --- |
| **Dak Lak** | Cu Mgar | 6 | 8 | 27 | **35** |
| Cu Kuin | 7 | 9 | 96 | **103** |
| Krong Pak | 7 | 7 | 20 | **27** |
| **Lam Dong** | Di Linh | 7 | 27 | 20 | **57** |
| Lam Ha | 1 | 18 | 0 | **18** |
| **Total** | **5** | **28** | **69** | **171** | **240** |

*Source: Survey data*

*2.2.2 Sampling method*

The study adopts stratified sampling and simple random sampling techniques. At first, stratified sampling technique was adopted to select districts and communes in Dak Lak and Lam Dong province. Coffee districts were selected in Dak Lak and Lam Dong provinces following the below three criteria:

* + Located in main coffee areas of Lam Dong and DakLak Province
  + Being in a provincial plan of coffee rejuvenation
  + Having 15% or above of coffee area has already been rejuvenated

In each district, communes were selected by the following criteria: (i) Being in a plan of coffee rejuvenation of selected districts; and (ii) Having at least 25 % of coffee area has already been rejuvenated.

Finally, in each selected communes, the study applies simple random sampling technique to select coffee growers for the survey within groups of growers meeting with two criteria: (1) Households having coffee farm size of at least 0.4 ha; and (2) Households conducted coffee rejuvenation of minimum three years.

SECTION B: SUCCESSFUL REJUVENATION – DEFINITION AND INTERNATIONAL EXPERIENCE

**1. Definition of successful rejuvenation**

In this study, the coffee rejuvenation program is defined as success if achieving both technical, economic, environmental viability; and bankability as follows:

* *Technical viability*:
  + Leaf chlorosis ratio is 10% or less;
  + Dead tree ratio is 10% or less
  + Yield is 1.8 tons of green beans/ha and above (3 years after rejuvenation).
* *Economic viability*:
* A rejuvenation strategy that helps coffee farmers to maintain production and income of their coffee gardens before ageing period. In addition, it is expected to increase yield and reduce production cost by applying new seed and sustainable farming practices during rejuvenation process.
* A rejuvenation strategy that allows coffee smallholders to utilize more family labor instead of using hired labor and thus reduce investment costs for rejuvenation.
* *Environmental viability*: In addition to the primary purpose of maintain production and income, it is expected that coffee rejuvenation in practice will reduce the negative environmental impact via applying sustainable practices including less water, fertilizers and plant protection application and thereby reducing the greenhouse gas emissions (GHG).
* *Bankability:* A rejuvenation strategy in which investment costs for rejuvenation meeting with loan disbursement and repayment profile required commercial banks.

**2. International Experience in Coffee Rejuvenation**

***2.1 Scale of rejuvenation***

International experience shows that only two countries in recent times have reported undertaking major replanting programmes, namely Indonesia and Uganda.

***For Indonesia***, the main reason for large scale replanting was nematodes. In Indonesia, *Pratylenchus coffeae* (Root Lesion Nematode-RLN) is the most common and devastating nematode associated with coffee. It is present in almost all coffee-producing provinces, at altitudes ranging from zero to over 1,000 masl. According to Wiryadiputra (1995), in Robusta plantations the yield losses caused P. coffeae may reach 78%, with an average around 57%.[[3]](#footnote-3) In Arabica plantations, total loss has been observed, since the coffee plants may decline and die. *R. similis*, although is widely accepted as causing damage to plantations, but there have been no studies to identify the nematode race(s) present in these damage areas. The program was government funded.

***For Uganda*** the reason for the major replanting of Robusta coffee was Coffee Wilt Disease (CWD) caused by *Fusarium xylariodes* (Syn. *Gibberella* *xylariodes*). [[4]](#footnote-4) Recent surveys showed that CWD is present in most of the coffee growing areas of Uganda, where 90% of farms were infected. The Uganda programme was donor and government funded.

Ethiopia has a major problem with CWD so major replanting may already be occurring, but no reports available to date. For other large coffee production countries like Brazil, Colombia, Central America, India, Eastern and Central Africa, there is no large Robusta replanting program has been undertaken in recent years. Therefore, there is no strategic guideline for such programmes.

***2.2 Key Elements of a Successful Rejuvenation***

***Indonesia***

The core factor contributing to the success of Indonesia is the Indonesian Government has funded ICCRI for the production of thousands of Robusta BP 42 and BP 358 grafted onto Robusta clone BP 308 for farmers re-plantings. This approach seems to have been the most successful. Genetic resistance has a very good prospect of solving nematode problems in Indonesia. Good varieties grafted on to clonal rootstocks such as BP 308 offer the best solution. The research program on nematode coffee resistance will continue at the ICCRI. Use of antagonistic species such as French Marigold and others would be a further boost to genetic control. The *vesicular-arbuscular mycorrhizal fungus Gigaspora margarita* may work to reduce nematode population in the root system for Pratylenchus spp. and PL-251 Samson strain of *Paecilomyces lilacincus fungus* has suppressed *Pratylenhus coffeae* in coffee in Indonesia.

***Uganda***

Uganda had an effective Robusta coffee breeding program, which began in 1956 leading to six clonal varieties. These were propagated by cuttings initially but later by tissue culture in the 1990’s for the Coffee Rehabilitation project. Initially, nurseries were established in all growing areas for mass propagation of those genotypes to replace old Robusta coffee plantations.

These nurseries were supplemented in 1993 by a tissue culture facility that was established at the Kawanda Agricultural Research Institute to carry on in vitro propagation. In the years 1998/1999, 10.3 million Robusta clonal seedlings were produced under the Coffee Nursery Programme. These clonal varieties with resistance to *Fusarium xylariodes*, coffee wilt disease (CWD) helped rehabilitate the industry. However, government discontinued providing free trees and distribution in 2004. Early planting losses using seedlings were very high at levels of 50% or more until clonal varieties with resistance were introduced.

In addition to the coffee breeding program that is essential to the success of rejuvenation program in Uganda, other factors related to the implementation of the program that contribute to this success (IDH, 2013), including:

* Gradual replanting and intensification of input use. For the Uganda case, farmers are recommended to replace old coffee tree gradually over the 5 to 10 years period to minimize disruptions to cash flow and provides a mechanism for future cycling of tree stock.
* The support for coffee rejuvenation program is not spread to all coffee farmers, only active farmers are prioritized for training.
* Support farmers to access to finance that enable them undertaking coffee rejuvenation with sustainable practices and offset for income disruption during rejuvenation period.

*In summary*, for both Indonesia, Uganda and other countries, with Robusta coffee nematode problems have had to use nematode resistant clonal rootstocks to ensure replanting success. Therefore, support to research, multiplication, and dissemination of coffee lines resistant to CWD, the control of pests and diseases capacity building is necessary.

SECTION C. COFFEE REJUVENATION PRACTICES IN VIETNAM

1. Agronomic Practices

* 1. ***Grafting***

Coffee grafting is agronomically viable for healthy old trees usually not more than 20 years old - if termites not a problem and trees are in good health and vigorous. The purpose of grafting is to replace the old varieties that have low yields, leaf rust affected and small bean size. Shoot grafting was undertaken to replace the old parent variety with new varieties with high yield, large bean size (Bean type R1 > 65 %), high resistance to leaf rust to increase productivity and economic efficiency by about 15-20 %. The old variety becomes the rootstock which we say is top worked to a new high performance TR clonal or hybrid variety. There are two grafting options that commonly applied in practice:

* Full grafting: farmers apply full grafting of their coffee farm with 1 year (100% model)
* Partial or rolling grafting: farmers apply grafting 50% of their coffee garden in the first year and the rest in the second year (50% model).

According to coffee farmers survey’s result, in Lam Dong, about 59.7% of successful households had conducted grafting of coffee gardens under 20 year-old. The time for cutting the trees for grafting is mainly from November to May next year and the time for grafting begins mainly from February to July. The highest ratio of successful grafting is from Feb-Apr (account for 59.7% of the successful households). The grafting time in the dry season and beginning rainy season using the close grafting method has the highest survival rate, reduced costs and ease of care during and after grafting. The coffee farmers survey data shows that 48.4 percent of the success households conduct cutting coffee stems at height of 30-35 cm. In addition the height of 35.1-40 cm can increase the ratio of standard scions for grafting and decrease replanting ratio. Topping at height of ≤1.2 m has a high successful rate (43.5%).

* 1. ***Replanting***

Coffee replanting is applied for old trees usually more than 20 years old, or the ones that have low yields: removal of old coffee trees and re-planting alternatives. The replanting options that commonly applied are as follows:

* Full replanting: farmers apply full replanting of their coffee garden within 1 year (100% model)
* Partial replanting or rolling replanting:
* 50% model: farmers apply replanting 50% of their coffee garden in the first year, the rest will be replanted in the second year from starting rejuvenation.
* 30% model: farmers apply replanting 30% of their coffee garden in the first year, the rest will be replanted in the second and third year from starting rejuvenation.
* Replanting after six months short dry fallow no-cropping
* Replanting after a 1 year crop rotation

The coffee gardens in successful replanting households were mainly old-age, without much disease and at the end of their economic cropping cycle. The successful households adopt soil ploughing and root collecting 2 - 3 times (representing 42.6% and 53% of the successful households, respectively). About 54.1% and 41.9% of successful replanting households fallowed 6 months androtated 1 year treated hole by chemicals. The average amount of manure that the successful replanting households used for pre-fertilizing was 15 kg/hole in the models of 6 months fallowing and 12.8 kg/hole in the model of 1 year crop rotation. Applying of 10 kg manure/tree annually in the models of 6 months fallowing or applying 2 years per time for the model of 1 year crop rotation are highly adopted by the successful households (representing 36.6% and 25.7%, respectively). Rotating with crops from 2-3 times is adopted by more than 53%of the success households. 100% of the successful replanting households uses plant residues with high effectiveness.

**2. Input Use and Cost of Rejuvenation**

***2.1 Grafting Models***

Total cost and cost structure for two grafting models are shown in Table 3. Total cost of partial 50% grafting model, and full grafting 100% model is 116 million VND and 107 million VND for 1 hectare, respectively for the grafting period (2 – 3 years depending on full or partial models). The difference in the total grafting cost between 2 models is small at only about 10 million VND. This difference results from cost of caring after grafting, the utilization of family labor, and cost of purchasing pumping system (Table 3). Since the partial 50% model involves grafting of coffee garden spread over two years (50% of the garden area each year), it takes more labour cost for caring as compared to the full grafting model (Table 3). If the cost of purchasing pumping system is not included, the total cost of 100% grafting model is much lower than the 50% ones.

**Table 2: Grafting costs for two grafting models**

Unit: Million VND

| **No.** | **Item** | **Model 100%** | **Model 50%** |
| --- | --- | --- | --- |
| **1** | **Rootstock preparation** | **4.74** | **1.97** |
| **2** | **Scions** | **0.59** | **0.66** |
| **3** | **Care after grafting** | **37.69** | **47.37** |
| 3.1 | Weeding, scooping | 4.46 | 3.95 |
| 3.2 | Shading, intercropping | 1.69 | 1.46 |
| 3.3 | Fertilizers | 13.41 | 15.80 |
| 3.4 | Water irrigation | 14.93 | 20.88 |
| 3.5 | Insecticides | 3.20 | 5.29 |
| **4** | **Payment for loan’s interest** | **25.65** | **31.35** |
| **5** | **Family labor** | **18.63** | **30.25** |
| **6** | **Purchasing pumping system** | **15.18** | **-** |
| **7** | **Other** | **4.50** | **4.63** |
| **8** | **Total Cost** | **106.99** | **116.23** |

*Source: Survey data*

Note: - Grafting cost is calculated for 2 years in 100% model and 3 years for 50% model for 1 ha of grafted coffee

In the cost structure, the cost of caring makes up the largest share of total cost (35% to 41% of the total cost for grafting), followed by payment for loan interest[[5]](#footnote-5) (24 - 27% of total grafting cost). Among the caring costs, fertilizers and water irrigation represents 75% of the caring cost or 26% to 31% of the total grafting cost for 100% model and 50% model, respectively.

The partial 50% model allows farmers utilizing more of their family labor instead of hired labor. Farmers apply the partial or rolling model to reduce investment cost for rejuvenation by utilizing family labor and reduce the risk of failure. In addition, farmers apply the partial model for maintaining their source of livehood from 50% of their coffee garden in the first year of conducting rejuvenation, while at the end of the year 2, they get the first harvest from the 50% area area grafted in the first year. This enables them to maintain family income to continue consumption.

In practice, grafting costs are higher than recommended by MARD and WASI caused by: purchasing water irrigation system (not-included in the MARD’s protocol); and higher level of fertilizer applied than recommended, from 15 - 40% more. This implies that farmers are over using of fertilizers. Therefore, optimizing fertilizer application rates would result in lower investment cost for coffee grafting.

***2.2 Replanting Models***

Total replanting costs are varied from 200 million VND to 238 million VND per ha between alternative replanting models. Partial replanting models (30% model and 50% model) have higher investment cost as compared to the full replanting model. Also, the 1 year crop rotation model has lower investment cost than the 6 months land fallow. This is largely explained by the lower caring cost and payment for loan of the 1 year crop rotation model. The crop rotation with soil-enriching crops improves the fertility of the soil and hence reduces the level of fertilizer application required.

Similar to grafting models, farmers who apply partial replanting (50% and 30% models) can utilize more family labor as compared to the full replanting model. Within partial models, the 30% model also has a higher level family labor utilization, as compared to the 50% model.

Regarding to cost structure, the cost of caring after replanting constitutes the largest cost, following by spending on purchasing irrigation system and payment for a loan. Similar to grafting models, fertilizers and irrigation accounts up to 23% - 26% of total replanting cost.

**Table 3: Costs for replanting using different models**

| **No** | **Cost items** | **Cost norm** | **100% model** | **50%**  **model** | **30%**  **Model** | **1 year crop rotation** | **6 months fallow** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **Soil preparation** | **41.88** | **27.95** | **31.69** | **31.23** | **31.82** | **30.64** |
| **2** | **Rootstock** | **8.61** | **7.99** | **4.25** | **5.95** | **14.11** | **5.48** |
| **3** | **Take care after replanting** | **90.50** | **80.26** | **83.94** | **91.74** | **75.46** | **95.95** |
| 3.1 | Weeding, scooping, enrichment planting | 23.10 | 10.87 | 4.85 | 8.76 | 8.48 | 11.28 |
| 3.2 | Fertilizers | 27.14 | 30.56 | 39.20 | 36.19 | 30.71 | 40.25 |
| 3.3 | Water irrigation | 25.55 | 17.00 | 23.14 | 20.77 | 16.32 | 16.71 |
| 3.4 | Shaping | 5.70 | 5.49 | 4.22 | 12.20 | 5.52 | 7.37 |
| 3.5 | Shading, intercropping | 1.55 | 13.31 | 10.08 | 10.02 | 11.75 | 17.89 |
| 3.6 | Insecticides | 7.46 | 3.03 | 2.45 | 3.80 | 2.69 | 2.44 |
| **4** | **Payment for loan** | **25.58** | **35.58** | **33.52** | **28.18** | **25.21** | **55.15** |
| **5** | **Family labor** | **-** | **26.38** | **44.32** | **51.72** | **24.71** | **27.34** |
| **6** | **Purchasing pumping system** | **-** | **33.77** | **44.65** | **29.68** | **29.07** | **25.91** |
| **7** | **Others** | **19.55** | **4.70** | **7.44** | **7.12** | **4.66** | **4.43** |
| **8** | **Total cost** | **186.12** | **210.06** | **235.88** | **234.14** | **198.25** | **238.08** |

*Source: Survey data*

Note: - Replanting cost is calculated for the period of: (1) 3 years for 100% model; (2) 4 years for 50% model; and (3) 5 years for 30% model.

- Replanting cost is calculated for 1 ha.

- Family labor cost is calculated by family labor man-days multiplied by wage rate

Lam Dong has higher coffee replanting cost as compared to Dak Lak province. This is mainly because the wage rate in Lam Dong is higher than in Dak Lak province (150,000 VND vs. 120,000 VND/day).[[6]](#footnote-6) In addition, cost of caring (including fertilizer application) is much higher in Lam Dong province. This is partly explains why coffee yield is higher in Lam Dong province as mentioned above.

In practice, replanting costs are higher than recommended by MARD and WASI caused by: purchasing water irrigation system (not-included in the MARD’s cost norm); and higher level of fertilizer applied than recommended from 15 - 40%. Thus farmers are applying more fertilizers than recommended. Therefore, optimizing fertilizer application rates would result in lower investment cost for coffee replanting.

**Table 4: Replanting cost by provinces**

*Unit: million VND*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **No** | **Item** | **Cost norm** | **Dak Lak** | **Lam Dong** |
| **1** | **Soil preparation** | **41.88** | **32.47** | **39.05** |
| **2** | **Rootstock** | **8.61** | **10.13** | **8.34** |
| **3** | **Take care after replanting** | **90.50** | **77.98** | **96.21** |
| 3.1 | Weeding, scooping, enrichment planting | 23.10 | 6.64 | 14.24 |
| 3.2 | Fertilizers | 27.14 | 31.32 | 49.30 |
| 3.3 | Water irrigation | 25.55 | 17.19 | 11.74 |
| 3.4 | Shaping | 5.70 | 6.68 | 13.54 |
| 3.5 | Shading, intercropping | 1.55 | 13.51 | 4.69 |
| 3.6 | Insecticides | 7.46 | 2.64 | 2.71 |
| **4** | **Payment for loan** | **25.58** | **29.11** | **48.22** |
| **5** | **Family labor** | **-** | **24.78** | **21.30** |
| **6** | **Purchasing pumps** | **-** | **28.06** | **17.71** |
| **7** | **Others** | **19.55** | **4.76** | **4.14** |
| **8** | **Total cost** | **186.12** | **200.54** | **231.37** |

*Source: Survey data*

Note: - Replanting cost is calculated for 1 ha.

**3. Maintaining Household Incomes**

***Coffee Household Income and Consumption***

As of 2011, there were 637,509 coffee farm households in the whole country, in which 545,169 households located in the Central Highlands accounting for 86% of total coffee farmers. Most of the coffee farmers are smallholders holding on average 0.92 ha per household and about 90% of households holding less than 1 ha of coffee (AgroCensus, 2011).

In the Central Highlands, the concentrated area for coffee production in Vietnam, the average farm-size of coffee household is 0.96 ha. About 60% of coffee farmers in the Central Highlands holding less that 1 ha; farmers with farm-size from 1-2 ha represents 30% of total households, while only 0.61% holdings are 5 ha and above (Figure 1).

**Figure 1: Share of households by farm-size in the Central Highlands**

*Source: AgroCensus, 2011*

According to the coffee farmers survey data, coffee farmers have diversified income from farm activities and non-farm activities. However, income of coffee farmers is dependent on coffee production. On average, income from coffee makes up 36% of total household income in DakLak and 60% in Lam Dong (Table 6). Average annual income in Lam Dong is 40 million VND higher than in Dak Lak province. The difference is coffee income in Lam Dong is nearly double than that in Dak Lak. This can be explained by coffee yield in Lam Dong which is much higher than in Dak Lak (3.45 vs. 1.70 ton/ha). Also, average coffee farm size of households in Lam Dong province is larger (1.87 ha vs. 1.42 ha) (Survey data).

**Table 5: Sources of coffee household annual income by provinces**

*Unit: 000 VND*

| **Source** | **Dak Lak** | **Lam Dong** |
| --- | --- | --- |
| **Total** | **140.3** | **179.1** |
| **1. Wage** | **8.3** | **7.9** |
| **2. Agriculture Income** | **114.8** | **166.7** |
| 2.1 Agriculture activity | 73.5 | 129.8 |
| *In which, income from coffee* | 50.9 | 112.1 |
| 2.2 Livestock | 6.1 | 5.4 |
| 2.3 Forestry | 36.0 | 299.0 |
| 2.4 Agriculture services | 519.0 | 761.0 |
| 2.5 Intercropping, shading tree | 33.7 | 28.0 |
| **3. Non-agricuture income** | **10.7** | **10.1** |
| **4. Other income** | **14.8** | **2.3** |

*Source: Survey data*

The dependency on coffee income is proportional to the farm-size. Large-holders are more dependent on income from coffee as compared to the small ones (Table 7). Households holding more than 3 ha have on average 78% of total income from coffee production in Dak Lak and 82% in Lam Dong. Meanwhile, households holding less than 1 ha only have 30% and 23.7% income from coffee production in Dak Lak and Lam Dong, respectively.

**Table 6: Annual average income of coffee households by province and farm-size**

*Unit: 000 VND*

| Household scale | **Total income** | **Income from coffee** | **Proportion of coffee in total (%)** |
| --- | --- | --- | --- |
| Dak Lak |  |  |  |
| Under 1 ha | 81,786 | 24,767 | 30 |
| From 1 to under 2 ha | 127,189 | 49,137 | 39 |
| From 2 ha to under 3 ha | 196,492 | 85,608 | 44 |
| 3 ha and above | 295,131 | 229,709 | 78 |
| **Lam Dong** |  |  |  |
| Under 1 ha | 96,111 | 57,455 | 60 |
| From 1 to under 2 ha | 171,440 | 91,465 | 53 |
| From 2 ha to under 3 ha | 251,280 | 175,350 | 70 |
| 3 ha and above | 262,067 | 215,556 | 82 |

*Source: Team survey data*

Despite of the high saving ratio, ranging from 17% to 55% of disposable income depending on farm-size and province, the actual saving amount of coffee households is still low, on average about 35 million VND/year in Dak Lak và 68 million VND/year in Lam Dong. The saving amount is generally proportional to the farm-size (Table 8).

**Table 7: Average annual saving amount of coffee households**

*Unit: million VND*

|  |  |  |
| --- | --- | --- |
| Household scale | **Dak Lak** | **Lam Dong** |
| Under 1 ha | 14.1 | 35.4 |
| From 1 to under 2 ha | 34.0 | 76.8 |
| From 2 ha to under 3 ha | 89.0 | 138.6 |
| 3 ha and above | 87.4 | 107.4 |
| **Average** | **35.2** | **67.8** |

*Source: Team survey data*

SECTION D: REJUVENATION AS A COMMERCIAL VENTURE

**1. Cash flow projection**

***1.1 Grafting Models***

For the whole basic life cycle of a grafted coffee tree (15 years starting from when coffee tree is grafted), the full model (100%) produces a higher revenue from coffee production and eventually higher benefit in comparison with the 50% model (Table 9). However, the benefit-cost ratio of 100% model is only marginally different from the 50% model (1.69 vs. 1.5) (Table 9).

The payback period in 100% models is shorter compared to the 50% model (4.28 vs. 4.49 years or 52 to 54 months). However, the IRR in the 50% model is higher than those in the 100% models reflecting that the former is more feasible for farmers than the latter (1.04 vs. 0. 7) (Table 9).

**Table 8: Cost – benefit of grafting models for the whole basic life cycle (15 years) for grafted coffee**

*Unit:* million VND

| **Model** | **100%** | **50%** |
| --- | --- | --- |
| **Total cost**[[7]](#footnote-7) | 646.5 | 641.2 |
| Revenue from intercropping, shading trees | 431.8 | 393.0 |
| Revenue from coffee | 1820.0 | 1785.0 |
| **Benefit** | 1088.0 | 1012.0 |
| Benefit Cost ratio | 1.7 | 1.5 |
| Internal Rate of Return (IRR) | 0.7 | 1.0 |
| Payback Period (years) | 4.3 | 4.5 |

*Source: Survey data*

Note: - The basic life cycle of coffee tree grafted: 15 years starting from when coffee tree is grafted.

- Total cost includes grafting cost for the first three years (100% model; 6 months land fallow, 1 year crop rotation), four years (50% model), and five years (30% models), and annual cost after replanting until the year 20th year, but not including payment for interest rate.

- Grafting cost and benefit is calculated for 1 ha.

***1.2 Replanting Models***

For the whole basic life cycle of coffee replanted (20 years), the 100% models bring higher benefit from coffee production and intercropping as compared to the 50% and 30% models. However, the 30% model achieves highest cost-benefit ratio following by the 50% model. The 6 month land fallow model also attains a higher cost-benefit ratio compared to the 1 year crop rotation model (Table 8).

The 50% model has the highest IRR following by 100% and 30% models. The 6 months land fallow models also has higher IRR compared to the 1 year crop rotation model (Table 10).

The payback period is slightly different among alternative replanting models ranging from 82-83 months after replanting.

**Table 9: Cost – benefit of replanting models for the whole basic life cycle of coffee replanted**

Unit: million VND

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model** | **Model 100%** | **Model 50%** | **Model 30%** | **1 year crop rotation** | **6 months fallow** |
| **Total Cost** | 1,206 | 837 | 781 | 1,238 | 1,083 |
| Revenue from intercropping | 697 | 552 | 650 | 680 | 643 |
| Revenue from coffee | 2,380 | 2,170 | 2,111 | 2,380 | 2,380 |
| **Benefit from coffee** | 992 | 1,088 | 956 | 929 | 1,102 |
| **Cost-benefit ratio** | 1.40 | 1.96 | 2.06 | 1.30 | 1.61 |
| IRR | 0.23 | 0.30 | 0.17 | 0.19 | 0.23 |
| Payback period (years) | 6.860 | 6.910 | 6.940 | 6.780 | 6.970 |

*Source: Survey data*

Note: **-** The basic life cycle of coffee tree replanted: 20 years starting from when coffee tree is replanted.

- Total cost includes grafting cost for the first three years (100% model), and four years (50% model), and five years (30% model) and annual cost after replanted until the year 20th, but not including payment for interest.

- Replanting costs and benefits are calculated for 1 ha.

Dak Lak province achieves a higher Cost Benefit ratio as well as IRR, while the payback period is shorter as compared to Lam Dong province (Table 11).

**Table 10: Cost – benefit for replanting models during the basic life cycle of coffee tree replanted by province**

*Unit: million VND*

|  |  |  |
| --- | --- | --- |
| **Province** | **Dak Lak** | **Lam Dong** |
| **Cost** | 854 | 948 |
| Revenue from intercropping | 691 | 518 |
| Revenue from coffee | 2,380 | 2,380 |
| **Benefit from coffee** | 1,296 | 1,234 |
| **Cost-benefit ratio** | 2.33 | 1.85 |
| IRR | 0.28 | 0.26 |
| Payback period (year) | 6.59 | 7.11 |

*Source: Survey data*

Note: - The basic life cycle of coffee tree replanted: 20 years starting from when coffee tree is replanted.

- Total cost includes replanting cost for the first three years, and annual cost from year 4th to year 20th, but does not include payment for interest rate.

- Replanting costs and benefits are calculated for 1 ha.

**2. Demand for loans for alternative replanting models**

With the current income and saving, farmers, especially smallholders have inadequate resources for coffee rejuvenation and maintaining livelihoods during the plantation establishment period (ranging from 2 to 5 years depending on models). Loan demand for alternative rejuvenation models is calculated by household total income (includes income from other farm and non-farm activities) minus consumption expenditure and rejuvenation investment cost (separated between including family labor cost and not including family labor cost). Demand for loan is also calculated for total demand as well as loan demand for each year during the plantation establishment period of alternative models.

Demand for loans for the replanting models is higher than that of grafting models since coffee replanting requires higher investment as compared to grafting.

In relation to full or partial replanting models, the 100% model requires highest loan amount (following by the 50% and 30% model) both in cases of including or not including farmily labor cost (Table 12 -14). This difference results because farmers applying the 30% and 50% models can more utilization of family labor, and they still have coffee income from remaining area of coffee for 1 or 2 years before replanting is completed.

**Table 11: Loans demands of the 100% replanting model**

Unit: million VND

| **Item** | **100% model** | | |
| --- | --- | --- | --- |
| **Year 1** | **Year 2** | **Year 3** |
| **1. Income** | **86.8** | **86.8** | **86.8** |
| **2. Expenditure** | **95.3** | **95.3** | **95.3** |
| **3. Replantingting cost** | 112.0 | 73.8 | 52.9 |
| Demand for loan /year (including family labor) | 120.5 | 82.4 | 61.4 |
| Total demand for loan/2 years (including family labor) | 264.3 | | |
| Demand for loan /year (not including family labor) | 113.8 | 75.0 | 49.1 |
| Total demand for loan/2 years (not including family labor) | 237.9 | | |

*Source: Survey data*

In 100% model, the plantation establishment period takes 3 years. The first year requires highest amount of the loan following by the second and third year since farmers have to invest both capital and family labor in replanting of the whole coffee garden, while maintaining their livelihoods with no income from coffee production. In the second and third year, farmers only have to care for the replanted coffee and thus with less investment cost and labor requirement, hence, the amount of the loan required is lower.

The plantation establishment period of the 50% model is 4 years, and farmers have to invest in replanting (land preparation, rootstock, weeding etc.,) in the first 2 years for50% of the coffee garden each, and just caring in the last two years. Farmers get their first harvest at the end of year 3 for the 50% of coffee garden replanted in the first year. As a result, demand for credit for with the 50% model is concentrated in the first two years and reduces after that. In year 4, demand for credit is lowest thanks to the first harvest from 50% of the garden replanted in the first year.

**Table 12: Loan demands of the 50% replanting model**

Unit: million VND

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Item** | **50% model** | | | |
| **Year 1** | **Year 2** | **Year 3** | **Year 4** |
| **1. Income (mil. VND)** | 92.8 | 66.7 | 66.7 | 85.9 |
| **2. Expenditure** | 73.3 | 73.3 | 73.3 | 73.3 |
| **3. Replanting cost** | 88.7 | 53.2 | 50.5 | 44.3 |
| Demand for loan /year (including family labor) | 69.2 | 59.8 | 57.1 | 31.7 |
| Total demand for loan/2 years (including family labor) | 217.8 | | | |
| Demand for loan /year (not including family labor) | 62.3 | 51.4 | 41.2 | 18.1 |
| Total demand for loan/2 years (not including family labor) | 173.5 | | | |

*Source: Survey data*

The plantation establishment period of the 30% replanting model is 5 years. Farmers spend investment focused in the first three years with 30% of their garden replanted each year. Farmers obtain first harvest for 30% of their garden replanted in the first year in year 4, and 60% in year 5. From year 6, farmers get full harvest of their replanted coffee garden. The amount of loan required by farmers for replanting of coffee is highest in year 3, when farmers have no income from coffee production, while having investment for replanting and caring of the whole coffee garden. After year 3, demand for loans is reduced sharply (Table 13).

**Table 13: Loan demand of the 30% replanting model**

Unit: million VND

| **Item** | **30% model** | | | | |
| --- | --- | --- | --- | --- | --- |
| **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Year 5** |
| **1. Income (mil. VND)** | 118.8 | 90.5 | 74.6 | 99.6 | 137.1 |
| **2. Expenditure** | 86.4 | 86.4 | 86.4 | 86.4 | 86.4 |
| **3. Replanting cost** | 68.0 | 49.9 | 55.9 | 30.2 | 45.5 |
| Demand for loan /year (including family labor) | 35.6 | 45.9 | 67.7 | 17.0 |  |
| Total demand for loan/2 years (including family labor) | 166.2 | | | | |
| Demand for loan /year (not including family labor) | 28.9 | 38.1 | 56.1 | 4.3 |  |
| Total demand for credit loan/2 years (not including family labor) | 127.4 | | | | |

*Source: Survey data*

Despite income from the crop rotation and lower investment cost, the 1 year crop rotation model requires a higher amount of loan for replanting as compared to the 6 months land fallow model (276 million VND vs. 242 million VND including family labor cost or 251 million VND vs. 215 million VND not including family labor cost). This implies that income from coffee production is higher than from rotation crops and an important income source of coffee farmers. With 1 more harvest in the 6 month land fallow model compares to 1 year crop rotation, farmers will have more savings and therefore a lower loan amount required (assuming both of these two models are replanted at the same time).

**Table 14: Loan demand of 1 year crop rotation and 6 months land fallow replanting models**

Unit: million VND

| **Item** | **1 year crop rotation** | | | **6 months land fallow** | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Year 1** | **Year 2** | **Year 3** | **Year 1** | **Year 2** | **Year 3** |
| **1. Income (mil. VND)** | 53.6 | 53.6 | 53.6 | 103.7 | 103.7 | 103.7 |
| **2. Expenditure** | 76.4 | 76.4 | 76.4 | 105.5 | 105.5 | 5.5 |
| **3. Replanting cost** | 115.2 | 42.1 | 50.3 | 116.4 | 59.7 | 60.7 |
| Demand for loan /year (including family labor) | 138.1 | 64.9 | 73.2 | 118.2 | 61.5 | 61.5 |
| Total demand for loan/2 years (including family labor) | 276.2 | | | 242.1 | | |
| Demand for loan /year (not including family labor) | 132.0 | 58.2 | 61.2 | 112.0 | 52.8 | 50.0 |
| Total demand for loan/2 years (not including family labor) | 251.5 | | | 214.8 | | |

*Source: Survey data*

Note: Assuming that farm income (not including coffee production) and expenditures are the same for three years.

**3. Financing for rejuvenation**

As mentioned above, with the current income and expenditure, farmers have inadequate resource financing for rejuvenation without relying on borrowing. *The survey results show that farmers’ savings can only finance about 20% to 30% of capital needed for the investment in coffee rejuvenation and maintaining livelihoods during coffee plantation establishment period.* To compensate for this shortfall, farmers have to rely on loans from agricultural lenders. Borrowing from commercial banks accounts for about 50% to 60% of the loans required. The rest is obtained from informal sources comprising input provider agents, coffee traders (in the form of trade credit) with interest rate three times higher than commercial banks (Table 16 -17).

However, as reported by respondents, the reasons prevent them to borrowing from commercial banks include: (1) Complicated procedures. This creates other costs of accessing credit beside interest rate; (2) It takes a rather long time from the application submission to obtain loan approval; (3) Having no collateral assets. A number of farmers reported that they had already used the Redbook as collateral for borrowing from commercial banks and they can no longer use the Redbook for obtaining additional loans; (4) high additional fees include official and unofficial ones in addition to the interest rate. Some farmers reported that they have to purchase a credit insurance product of a commercial bank provided together with the loan.[[8]](#footnote-8) These fees make the loan more costly and additional to the official interest rate. Furthermore, farmers often borrow short-term loans from commercial banks (1 year) for investing in coffee rejuvenation that require medium-term loan. At the date of loan maturity, a number of farmers have to borrow from informal sources with very high interest rate for rollover of the loan. This results in additional fee for the loans borrowed from commercial banks.

**Table 15: Sources of credit for grafting**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Grafting** | **Year 1** | | **Year 2** | |
| **Source of credit (%)** | **Interest rate %/year** | **Source of credit (%)** | **Interest rate %/year** |
| Capital for grafting and maintaining livelihood | 100% |  | 100% |  |
| 1. Self-financing | 32% |  | 19% |  |
| 2. Loans | 68% |  | 81% |  |
| *2.1 Commercial banks* | *54%* | *10.68* | *66%* | *10.41* |
| *2.2 Other sources* | *46%* | *23.6* | *34%* | *25.82* |

*Source: Survey data*

Despite diversified sources for borrowing, farmers still have problems in accessing to credit: 72% of respondents said they still lack capital for investing in coffee rejuvenation. High interest rates and short term duration are the main reasons preventing from borrowing for rejuvenation. As reported by farmers, the acceptable interest rate of loans for rejuvenation is about 7% per year (equivalent to commercial interest rate for short-term loan as of May 2014), and the loan duration is on average about 52 months.

**Table 16: Sources of capital for replanting**

| **Replanting** | **Year 1** | | **Year 2** | | **Year 3** | |
| --- | --- | --- | --- | --- | --- | --- |
| Source of credit (%) | Interest rate %/year | Source of credit (%) | Interest rate %/year | Source of credit (%) | Interest rate %/year |
| Capital for grafting and maintaining livelihood | 100% |  | 100% |  | 100% |  |
| 1. Self-financing | 33% |  | 27% |  | 30% |  |
| 2. Loan | 67% |  | 73% |  | 70% |  |
| *2.1 Commercial banks* | *50%* | *13.77* | *59%* | *1.30* | *48%* | *11.14* |
| *2.2 Other sources* | *50%* | *34.99* | *41%* | *33.83* | *52%* | *26.56* |

*Source: Survey data*

SECTION E: POSSIBLE STRATEGIES FOR REJUVENATION AND IMPACT ANALYSIS

**1. Possible Strategies for Successful Rejuvenation**

From the above analysis, the alternative rejuvenation strategies available for Viet Nam Robusta coffee are summarised as follows:

**Alternative 1.** **Grafting of healthy old trees usually not more than 20 years old**

**\* Pros:**

* Success rates of cutting down and grafting new shoots on healthy old trees < around 20 years old can be more than 90%, when using trained operators.
* New trees come back to cropping quickly (2 years after grafting).
* Costs are much less than for replanting.

**\* Cons:**

* The old parent rootstock is still vulnerable to nematode attack in the future since it is not generally resistant.
* Vigour may continue to decline after some years and yields may drop away faster than for newly grafted plants with clonal nematode resistant rootstocks.
* Grafting skills may have to be taught to farmers and easy access to bud wood of new clonal varieties might be a constraint.

**Alternative 2. Replanting with Six Months Short Dry Fallow- No Cropping Rotation**

**\* Pros:**

* The 6 month dry fallow works and is agronomically viable if careful management is used and the process can be further enhanced as described above and elsewhere in the document.
* 6 month rotations elsewhere in the world are successful, but all use nematode resistant rootstocks grafted with recommended clonal varieties.
* Cropping can begin more quickly.
* Income lost is much reduced.
* The practices will be attractive to farmers

**\* Cons:**

* Failure to correctly follow the protocol and enhanced processes noted may result in greater replant losses.
* Clean disease free trees, grafted onto nematode resistant rootstocks are essential to guarantee the best outcomes and future success. If not used losses may still be high at 30-40%.
* Some farmers may not have access to good quality organic matter supplies or they are considered too expensive.
* Farmers may not have good access to correct replanting information and advice needed to ensure success.
* Clay soils should be avoided as they may be likely to have more RKN, and the RLN resistant rootstocks might not be so effective. (In reality clay soils should be avoided for coffee in Viet Nam.)
* Overseas experience suggests that losses of 5-6% will still occur, even when all measures including resistant rootstocks are employed.

**Alternative 3. One Year Cropping Rotation**

**\* Pros:**

* Up to a 1 year crop rotation is a practice employed in other countries with coffee nematode problems. However, all seem to employ nematode resistant rootstocks along with the rotations. This one year rotation is agronomically viable as shown in many countries, ***when nematode resistant rootstocks are used.***
* Success may be higher than for 6 month alternative depending on the rotations chosen and the enhancement with new procedures, note earlier and nematode resistant rootstocks. Nematode levels may be lower at the outset than for 6 months alternative, but unless careful attention is paid to the site preparation and site maintenance for at least 3-4 years or more tree losses can still be high, 30-40% as shown earlier in Viet Nam.
* A one year rotation allows a cash crop like maize or peanuts to be grown in the first wet season to provide some income for farmers before replanting. Other legumes may be used such as soybean, black bean/mung bean.
* Other option is to grow another cash crop before at and during the planting year of the coffee. Others still may elect to grow suppressive crops such as Velvet Bean (Mucuna pruriens) during this time. Thus the one year rotation has flexible options to suit a farmers livelihood support needs.
* Advanced 18-20 month old plants for planting can be used to shorten the time to a return to cropping.

**\* Cons:**

* Return to coffee cropping is delayed for 1 year more, than with the 6 month alternative.
* Losses of income from coffee to the farmer may be greater, depending on the success of the cash crops grown and the percentage of his area he elects to replant in any one year.
* Replanting procedures/protocols/guidelines must be carefully followed to reduce losses from replanting.
* A clonal nematode resistant rootstock is more expensive than seedling rootstocks or hybrids, but without them higher losses will occur.
* Additional measures above as noted earlier may not be undertaken by farmers and so tree survival may be lower than anticipated.
* Lack of good information and understanding of the replanting protocols will limit success.

**Alternative 4: Rejuvenation with full grafting or replanting option**

**\* Pros:**

* Lower total investment costs for rejuvenation as compared to the partial option.
* Bring higher return (higher benefit cost ratio) for the whole life cycle of coffee tree after rejuvenated.
* Shorter payback period.
* Easier for the treatment of pests and diseases.

**\* Cons:**

* Require higher loan amounts.
* More dependent on hired labor.
* Lower level of financial feasibility since IRR is lower than in the partial option.
* Higher risk in the case of failures.

**Alternative 5: Rejuvenation with partial grafting or replanting option**

**\* Pros:**

* Require lower loan amounts.
* Farmers are more utilize of family labor and thus reduce the labor cost.
* Famers still have a partial of income from coffee production to maintain livelihoods during the plantation establishment period.
* Higher level of financial feasibility since IRR is higher than in the full option.
* Reduce the risk in the case of failures.

**\* Cons:**

* Higher total investment costs for rejuvenation as compared to the full option.
* Bring lower return (lower benefit cost ratio) for the whole life cycle of coffee tree after rejuvenated.
* Longer payback period.
* More difficult for the treatment of pests and diseases.

**2. Impact analysis of alternative scenarios on coffee rejuvenation**

To analyze how the possible variations economic conditions impact the returns of households conducting coffee rejuvenation, the study builds different scenarios for yield, coffee price, and interest rates and examine their influence on costs, benefits, and break-even points of alternative rejuvenation models.

* Scenarios on coffee yield: based on experimental results from WASI and VAAS, the coffee yield after replanting ranges from 4 to 8 tons per ha; coffee yield after grafting ranging from 3 – 7 tons per ha depending on different caring methods (level of fertilizers application, water irrigation, etc.). Thus the study proposes three scenarios of coffee yield for each of the rejuvenation methods:
  + Scenarios of coffee yield in coffee grafting models: 3, 5, and 7 tons/ha
  + Scenarios of coffee yield in coffee replanting models: 4, 6, and 8 tons/ha
* Scenarios on interest rate: As of September 2014, the market commercial interest rate for medium term loan is 9%, and 7% per year for short term loan duration. Based on the current market commercial interest rate, the study identifies three scenarios on interest rate changes of 7%, 9% and 10%.
* Scenarios on loan duration: Scenarios on loan duration are analyzed for 3 years, 5 years, and 7 years duration.
* Scenarios on coffee price: The study identifies three scenarios on coffee price based on the coffee price as of June 2014 which was 35,000 VND. Then 29,750 VND per kg of fresh coffee (15% less than current price) and 40,250 VND/kg (an increase of 15% on the current price).

The main findings from scenario analyses are[[9]](#footnote-9):

* Yield has a significant impact on returns from coffee rejuvenation
  + For grafting models, yield increases from 3 tons to 5 tons/ha would double benefits from coffee grafting for the whole basic life cycle of coffee (15 year period). If grafted coffee achieves yield of 7 tons/ha, the benefits would increase three fold as compared to 3 tons/ha.
  + The replanting models show similar results: increase in yield from 4 to 6 or 8 tons would significantly impact on the returns received by coffee farmers implementing alternative coffee replanting models (full or partial replanting) for the whole life cycle of coffee replanted.
* Interest rate and loan duration have a minor impact on the returns from coffee rejuvenation regardless of the alternative rejuvenation models.
* Price variability has a high impact to the return from coffee rejuvenation of coffee farmers. An increase or decrease of coffee price by 15% would result in an increase or decrease of about 25% to 35% of returns received depending on rejuvenation models.

SECTION F: POLICY RECOMMENDATIONS

From the above analysis, the research team propose the following policy recommendations:

* Review the existing Coffee Master Plan and revise the proposed rejuvenation programme area targets to take account of the essential move to nematode resistant tissue cultured rootstocks to ensure high replant survival.
* It is recommended that a rejuvenation plan for Robusta coffee should be in place. In this plan, it is necessary to specify and layout options/a menu of rejuvenation strategies that suitable with different agronomic, socio-economic conditions. The menu needs to specify under what conditions farmers might select their preferred option(s).
* Review and revise the existing replanting and grafting protocol to: (1) Reflect different rejuvenation options and strategies specified in the above mentioned menu; and (2) Address the practices of coffee rejuvenation in which farmers prefer 6 month land dry fallow and 1 year crop rotation instead of 3 year crop rotation as recommended in the protocol. Despite of a 3 year rotation further reduces nematodes, it is too costly, particularly for smallholders. It is recommended that each province should issue their own rejuvenation protocol adjusted from MARD protocol to address the differences in local basic agronomic conditions, the availability of necessary technical support, and socio-economic conditions.
* Promote collaboration between SBV, MARD agencies, DARD, provincial, district and local authorities and research institutes, NGOs, financial institutions, donors to link R&D, technology development and transfer, extension and financing under the plan developed.
* All countries with Robusta coffee nematode problems have had to use nematode resistant clonal rootstocks to ensure replanting success. It is strongly recommended that Viet Nam do the same. This suggests a research program to strengthen the evidence base and for varietal research. Provide support for nematode resistant coffee tree multiplication and distribution by: (1) support for infrastructure expansion and operation of Tissue culture facilities, to provide the essential clonal nematode resistant rootstocks for the millions of coffee trees to be replanted yearly; (2) support for selecting certified nurseries to quickly produce grafted plants on the tissue cultured nematode resistant clonal rootstocks; and (3) Support for development of provincial and district bud wood gardens and hybrid seed gardens for scion wood for grafting on to Clonal nematode resistant rootstocks.
* Enact policy and set up monitoring inspection system for coffee nurseries to enforce plant quality standards and essential phyto-sanitary management. Only clonal nematode rootstocks are used for grafting with high quality, high yielding varieties. This will reduce costly replanting tree losses and farmer’s costs since the 6 month fallow plan can be fully utilised.
* It is recommended that the most agronomically viable and desirable strategy, will be replanting good coffee lands, (with water and good water-saving irrigation systems available) using high yielding clonal varieties grafted onto nematode resistant clonal rootstocks with a 6 month rotation and 18-20 month old and normal sized trees planted and carefully managed according to WASI guidelines. To these guidelines, other key measures are suggested including use of additional ploughing, planting of antagonistic/nematode suppressive intercrops for 1-2 years and adding to planting site, plus the use of companion crops such as French marigolds as well as nematode suppressive shade tree species.
* Provide extension support for farmers conducting coffee rejuvenation: rejuvenation techniques, sustainable farming practices, etc. to achieve optimal yield. The sensitivity analysis shows that support for farmers to attain optimal yield is more important than the preferential interest rate. Provide support for the application of sustainable practices, and national/international quality standards.
* Facilitate the accessibility of small-scale growers to long-term credit for coffee rejuvenation. It is recommended to issue a lending protocol to facilitate and reflect: (1) Different coffee rejuvenation options/strategies identified in the above mentioned menu, and different schemes for disbursement; (2) Varied in total cost for coffee rejuvenation in different locations and strategies/options. The grace period without interest rate payments of a coffee rejuvenation credit program should be extent to cover the break-even point period (time that necessary to reach the break-even point) ranging: (1) from 52 – 54 months depending on full or partial grafting models, respectively; (2) from 81 – 83 months depending on full or partial replanting models.
* Provide and support farmers access to coffee rejuvenation insurance package in parallel with the lending progam to reduce the risk rejuvenation failures.

APPENDIX

**Appendix 1: Distribution of coffee farm-size in Vietnam**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Red River Delta** | **North Mountainous and Midlands** | **North and South Central Coast** | **Central Highlands** | **South East** | **Mekong River Delta** | **Total number of HHs** |
| Below 0.5 ha | 99 | 18,152 | 6,234 | 160,378 | 15,869 | 22 | 200,754 |
| From 0.5 to 1 ha | 18 | 4,597 | 4,482 | 166,529 | 15,533 | 27 | 191,186 |
| From 1 ha to 2 ha | 42 | 1,978 | 5,625 | 156,308 | 13,142 | 50 | 177,145 |
| From 2 ha to 5 ha | 20 | 367 | 1,695 | 58,644 | 4,016 | 38 | 64,780 |
| From 5 ha and above | 2 | 35 | 77 | 3,310 | 190 | 2 | 3,616 |
| **Total** | **181** | **25,129** | **18,113** | **545,169** | **48,750** | **139** | **637,481** |

*Source: Coffee farmers survey*

**Appendix 2: Share of surveyed households by farm-size in Dak Lak and Lam Dong**

|  |  |
| --- | --- |
| **Farm size** | **Share (%)** |
| Under 0.5 ha | 42.42 |
| 0.5 to under 1 ha | 39.83 |
| 1 ha to under 2 ha | 9.96 |
| 2 ha and above | 7.79 |

*Source: Coffee farmers survey*

**Appendix 3: Yield change scenarios and impact to grafting models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Yield (ton/ha)** | **Model 100%** | | | **Model 50%** | | |
| **3** | **5** | **7** | **3** | **5** | **7** |
| Total benefit per year (million VND) | 47.9 | 97.2 | 150.3 | 47.1 | 94.9 | 109.7 |
| Total benefit per after financing per year (million VND) | 42.2 | 91.2 | 144.1 | 38.3 | 86.1 | 103.1 |

*Source: Coffee farmers survey*

**Appendix 4: Interest rate change scenarios and impact to grafting model**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenarios** | **Model 100%** | | | **Model 50%** | | |
| **Interest rate (%/year)** | | | **Interest rate (%/year)** | | |
| **7** | **9** | **10** | **7** | **9** | **10** |
| Total benefit per year (million VND) | 47.9 | 47.9 | 47.9 | 47.1 | 47.1 | 47.1 |
| Total benefit per after financing per year (million VND) | 42.8 | 42.2 | 41.9 | 38.9 | 38.9 | 38.0 |

*Source: Coffee farmers survey*

**Appendix 5: Loan duration change scenarios and impact to grafting models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenarios** | **Model 100%** | | | **Model 50%** | | |
| **Loan duration (year)** | | | **Loan duration (year)** | | |
| **3** | **5** | **7** | **3** | **5** | **7** |
| Total benefit per year (million VND) | 47.9 | 47.9 | 47.9 | 47.1 | 47.1 | 47.1 |
| Total benefit per after financing per year (million VND) | 42.6 | 42.0 | 41.7 | 38.6 | 38.0 | 37.3 |

*Source: Coffee farmers survey*

**Appendix 6: Price change scenarios and impact to grafting model**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scenario** | **Model 100%** | | **Model 50%** | |
| ***40,250 VND/kg*** | ***29,750 VND/kg*** | ***40,250 VND/kg*** | ***29,750 VND/kg*** |
| Total benefit per year (million VND) | 61.5 | 34.2 | 60.6 | 33.6 |
| Total benefit per after financing per year (million VND) | 41.9 | 28.5 | 51.8 | 24.8 |

*Source: Coffee farmers survey*

**Appendix 7: Yield change scenarios and impact to replanting full/partial models**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Yield (ton/ha)** | **Model 100%** | | | **Model 50%** | | | **Model 30%** | | |
| **4** | **6** | **8** | **4** | **6** | **8** | **4** | **6** | **8** |
| Total benefit per year (million VND) | 59 | 111 | 163 | 67 | 109 | 152 | 67 | 103 | 140 |
| Total benefit per after financing per year (million VND) | 50 | 102 | 153 | 54 | 97 | 139 | 49 | 86 | 122 |

*Source: Coffee farmers survey*

**Appendix 8: Yield change scenarios and impact to replanting crop rotation/land fallow models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenarios** | **1 year crop rotation** | | | **6 months land fallow** | | |
| **Yield (Ton/ha)** | | | **Yield (Ton/ha)** | | |
| **4** | **6** | **8** | **4** | **6** | **8** |
| Total benefit per year (million VND) | 57 | 117 | 176 | 65 | 124 | 184 |
| Total benefit per after financing per year (million VND) | 46 | 106 | 165 | 55 | 115 | 174 |

*Source: Coffee farmers survey*

**Appendix 9: Interest rate change scenarios and impact to full/partial replanting models**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scenarios** | **Model 100%** | | | **Model 50%** | | | **Model 30%** | | |
| **Interest rate/year (%)** | | | **Interest rate/year (%)** | | | **Interest rate/year (%)** | | |
| **7** | **9** | **10** | **7** | **9** | **10** | **7** | **9** | **10** |
| Total benefit per year (million VND) | 59 | 59 | 59 | 67 | 67 | 67 | 67 | 67 | 67 |
| Total benefit per after financing per year (million VND) | 51 | 50 | 49 | 56 | 54 | 54 | 51 | 49 | 48 |

*Source: Coffee farmers survey*

**Appendix 10: Interest rate change scenarios and impact to crop rotation/land fallow replanting models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenarios** | **1 year crop rotation** | | | **6 months land fallow** | | |
| **Interest rate/year (%)** | | | **Interest rate/year (%)** | | |
| **7** | **9** | **10** | **7** | **9** | **10** |
| Total benefit per year (million VND) | 57 | 57 | 57 | 65 | 65 | 65 |
| Total benefit per after financing per year (million VND) | 48 | 46 | 46 | 56 | 55 | 55 |

*Source: Coffee farmers survey*

**Appendix 11: Price change scenarios and impact to full/partial replanting models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenarios** | **Model 100%** | | **Model 50%** | | **Model 30%** | |
| **Price** | | **Price** | | **Price** | |
| 40,250  VND/kg | 29,750  VND/kg | 40,250  VND/kg | 29,750  VND/kg | 40,250  VND/kg | 29,750  VND/kg |
| Total benefit per year (million VND) | 77 | 41 | 83 | 50 | 80 | 53 |
| Total benefit per after financing per year (million VND) | 67 | 32 | 71 | 38 | 63 | 35 |

*Source: Coffee farmers survey*

**Appendix 12: Price change scenarios and impact to crop rotation/land fallow replanting models**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Scenario** | **1 year crop rotation** | | **6 months land fallow** | |
| **Price** | | **Price** | |
| 40.250  VND/kg | 29.750  VND/kg | 40.250  VND/kg | 29.750  VND/kg |
| Total benefit per year (million VND) | 75 | 39 | 83 | 47 |
| Total benefit per after financing per year (million VND) | 64 | 29 | 73 | 37 |

*Source: Coffee farmers survey*

**Appendix 13: Loan duration change scenarios and impact to full/partial replanting model**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | **Model 100%** | | | **Model 50%** | | | **Model 30%** | | |
| **Loan duration (year)** | | | **Loan duration (year)** | | | **Loan duration (year)** | | |
| **3** | **5** | **7** | **3** | **5** | **7** | **3** | **5** | **7** |
| Total benefit per year (million VND) | 59 | 59 | 59 | 67 | 67 | 67 | 67 | 67 | 67 |
| Total benefit per after financing per year (million VND) | 50 | 49 | 48 | 55 | 54 | 53 | 50 | 48 | 47 |

*Source: Coffee farmers survey*

**Appendix 14: Loan duration change scenarios and impact to crop rotation/land fallow replanting models**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Scenario** | **1 year crop rotation** | | | **6 months land fallow** | | |
| **Loan duration (year)** | | | **Loan duration (year)** | | |
| **3** | **5** | **7** | **3** | **5** | **7** |
| Total benefit per year (million VND) | 57 | 57 | 57 | 65 | 65 | 65 |
| Total benefit per after financing per year (million VND) | 47 | 46 | 45 | 56 | 55 | 54 |

*Source: Coffee farmers survey*

**Appendix 15: Criteria for sampling**

|  |  |  |
| --- | --- | --- |
| **#** | **Criteria** | **Notes** |
| **A** | **COFFEE DISTRICTS SELECTED** |  |
| 1 | Located in main coffee areas of Lam Dong and DakLak Province |  |
| 2 | Being in a provincial plan of coffee rejuvenation |  |
| 3 | 15% or above of coffee area has already been rejuvenated |  |
| **B** | **COFFEE COMMUNES SELECTED** |  |
| 1 | Located in selected districts |  |
| 2 | Being in a plan of coffee rejuvenation of selected districts |  |
| 3 | 25 % or above of coffee area has already been rejuvenated |  |
| **C** | **FOR SELECTING COFFEE GROWERS** |  |
| 1 | Smallholders |  |
| 2 | Experienced farmers in coffee cultivation |  |
| 3 | Coffee areas ≥ 0.4 ha/sample |  |
| 4 | Rejuvenation duration > 3 years | A minimum of 3 years to identify success/failure of rejuvenation. |
| 5 | Coffee grown on red soils | Red soils are major ones of coffee cultivation in Central Highlands. Soils >100 cm deep, slope less than 15% and farm has water and irrigation available. |
| 6 | Successful rejuvenation | - Leaf chlorosis ratio ≤ 10%;  - Dead tree ratio 10% or less  - Yield ≥ 1,777.8 kg green beans/ha /ha. |
| 7 | Unsuccessful rejuvenation | - Leaf chlorosis ratio >10%;  - Dead tree ratio >10%;  - Yield< 1,777.8 kg green beans/ha. |
| 8 | - Fallow of 6 months  - Fallow and/crop rotation of one year  - Grafted trees less than 20 years old. | Note crops grown. Some such as Mucuna (Velvet Bean and many others we know suppress nematodes). Maize does not suppress nematodes but is relatively unaffected. |

1. See appendix for distribution of coffee farm-size. [↑](#footnote-ref-1)
2. A number of research in coffee production countries and in Vietnam showed that a coffee tree starts to reduce its yield after 15 - 16 years of age (World Bank 2010; Tran Cong Thang, 2008). For more detailed, see appendix. [↑](#footnote-ref-2)
3. Wiryadiputra S (1995) Estimation of yield losses caused by *Pratylenchus coffeae* on Robustacoffee.

   Proceedings XII Cong and Nat Sem Indones Phytopathol Soc: 980–985. [↑](#footnote-ref-3)
4. Rutherford, M. 2006. Promotion of current knowledge on pests of coffee in East Africa -R8513 (ZA0726)-Final Technical Report. CABI. UK. [↑](#footnote-ref-4)
5. The survey shows that farmers often borrow short-term loan (1 year) from commercial banks, and/or trading agents (often short-term with less than 1 year duration, in the form of trade credit of inputs for coffee production – mainly fertilizers, and repayment when coffee is harvested). For loan borrowing from a commercial bank, after the term is ended, farmers apply for a new loan for rollovers. [↑](#footnote-ref-5)
6. Labor resource is scarce in Lam Dong since it is absorbed to many high value economic activities including vegetable and flower production, and tourism. Since labor is costly, farmers tend to apply more fertilizers instead. [↑](#footnote-ref-6)
7. Does not include finance cost [↑](#footnote-ref-7)
8. According to VBARD Lam Dong branch, the credit insurance is an optional product, and VBARD has no criteria of whom will have to buy. [↑](#footnote-ref-8)
9. The detailed results of the scenarios analysis are presented in appendix [↑](#footnote-ref-9)