coffee & climate
enabling effective response

Use of Mycorrhizae in Seedlings and Nursery

Case Study Background Data		
Tool Category: Adaptation on the farm		**Detail:** Planting Density: - Soil Type: - Shade Regime: - Farming System: - Yield Range (kg cherry/ha) - ⦸ rain : 1500 mm/y
Variety: Arabica		
Climatic Hazard: • Drought • Heat stress		
Expected Outcome: • Higher resilience to heat stress & drought		
Implementation Date: 01.05.13 – 25.04.14	Altitude: 800-1500 m GPS: 14.635278° N 89.437500° W	**Slope of plots:** no slope ⦸ **Age of trees:** <5 years
No. farmers: 9	⦸ **Area under coffee:** 0.5 ha/farmer	Tested on demo plots

Results

Young coffee trees are vulnerable to drought when transplanted to the field because the roots are still poorly developed. The initiative for coffee & climate looked for alternatives to stimulate the root system and thereby reduce mortality during transplantation. Mycorrhizae (symbiotic fungi that can supply increased levels of nutrients to plant roots) were identified as a promising tool. They were applied at two production stages, seedlings and nursery.

At the seedling stage mycorrhizae had a fairly small effect on root length: after 60 days, roots were on average 1.1 cm longer than control seedlings and slightly wider.

Mycorrhizae applied at the nursery stage measured an average of 17 cm long x 11 cm wide compared to 12 x 9 cm for the controls after 150 days to apply that.

Pros & Advantages + Learnings	**Cons, Disadvantages + Things to take into account**
• Better root system • Plants were more healthy with better vegetative growth • Improved root system can improve nutritional absorption, especially phosphorus • Less mortality in nursery • Increases the biological control • Reduces the use of application to chemical fungicide • Symbiosis coffee + Mycorrhizae	• Cost of application will increase in every stage that you advance (seedlings to nursery, nursery to plantation) • Access to product is limited due to the distance of the supplier

Acceptability	High	**Effectiveness**	High
Affordability	High	**Timing / Urgency**	High

What is the objective of applying the adaptation option and how do we expect the objective to be met?

Drought and extreme temperatures are two hazards that are affecting many communities in the Trifinio region. One aspect identified in the impacts generated by these hazards is the poor development of the root system. Mycorrhizae is a symbiotic fungi in the root system, it helps the plant to increase its ability to uptake water and nutrients. It is expected that plants treated with Mycorrhizae develop a better root system which increase the resilience in case of a drought or extreme temperatures.

Description of climatic hazard and associated problem: Through the triangulation process (*see also tool 'risk evaluation'*), drought and extreme temperatures had been identified as a major climatic risks for smallholder coffee farmers in Trifinio. Drought leads to a high mortality of coffee seedlings in new plantations but also poor development of the plant as roots are poorly developed.

Description of expected outcome: Increased plant resilience to drought and heat stress through a better developed root system.

How is the adaptation option applied?

Nr.	Step	Picture
1	Dosage: Seedlings – 5 g of Mycorhizae by plant on top Nursery – 60 g of Mycorhizae/by plant on top Mycoral *(Vesicular Arbuscular Mycorizae)* 8 spores/ 1 g. of substrate	

2	Irrigate as usual Fertilize as usual Spray as usual	
3	Results with seedlings in Guatemala Mycorrhizae treatment on the left, center with Trichoderma (please refer to the case study: *Use of Trichoderma in Seedlings and Nursery*) and control on the right	
4	Results with seedlings in Honduras	

5	Root system from nursery plants treated with Mycorrhiza and with control on the left		

Implementation framework

The study was implemented by the initiative for coffee & climate (c&c) in collaboration with the farmer organization – ADCASPE – located in Guatemala and the Cooperative "COCREBISTOL" located in Honduras. Both cooperatives have members who plant coffee below 1,300 m.a.s.l., this condition makes them vulnerable to drought. Prior evaluation with farmers of the various different conditions that make them vulnerable to climate change identified poor plant condition from the nursery stage. Research conducted by c&c established that one alternative to improve the quality of the plants and specially the roots, was the use of mycorrhizae VAM (8 spores/1 g of substrate), the identified product is distributed by the Soil Laboratory of the University of Zamorano. Farmers participating in both cooperatives were trained in the use of the product on demo plots.

Measurement Strategy for effectiveness

The evaluations were made at two different stages of nursery, application at the seedling stage and at the nursery stage when the seedlings are planted into bags.

Seedlings - After the process of germination the plants are transferred to individual bags where they will receive water, fertilizer and spraying if required. Two treatments were established, one with mycorrhizae (dosage of 5 g/plant) and a control (testigo) without any product (as farmers usually plant). After 60 days, when farmers usually transplant the seedlings to bags, 50 plants from each treatment group were selected and roots were measured in length and width.

Nursery - After the process of germination the plants are transferred to individual bags where they will receive water if it's required. Two treatments, one with mycorrhizae (dosage of 60 g/plant) and control were established. Both treatments were managed in the same way (labour, fertilizers and

agrochemicals) during 5 months, after this period the roots of 3 plants were washed completely of all soil to evaluate the length and width.

Indicator N°1 - Length

Indicator	**Length of the root system**
Definition	a. Measure the length of the seedling's root after 60 days of planting (in cm) b. Measure the length of the root after 150 days (5 months) of treatment in the nursery (in cm)
Purpose	A better developed root system will increase the plants ability to uptake water and nutrients.
Baseline	N/A - first experiment with Mycorrhizae
Target	Root treated with Mycorrhizae is 10% longer than the control (testigo) without Mycorrhizae treatment.
Data Collection	Data had been collected from demo plot with seedlings, it has a control and a treatment of: **Seedlings:** 5 grams per plant **Nursery:** 60 grams/plant
Tool	Measuring tape and data collection sheet
Frequency	After 60 days of planting and after 150 days of treatment in the nursery
Responsible	M&E Director, c&c Coordinator
Reporting	Farmer (demo plot holder) and the technician measure the root system and fill in the data collection sheet to compare treatment in seedlings and in the nursery with the testigo. Where a camera was available, pictures had been taken as evidence. The results of the comparison are discussed during Farmer Field School meetings and c&c trainings within the farmer groups on the demo plots.
Quality Control	The team jointly defined a procedure to measure root development. M&E and c&c Coordinator evaluate the data to analyze effectiveness.

Indicator N°2 - Width

Indicator	**Width of the root system**
Definition	a. Measure the width of the seedling's root after 60 days of planting (in cm) b. Measure the width of the root after 150 days (5 months) of treatment in the nursery (in cm)
Purpose	A better developed root system will increase the plants ability to uptake water and nutrients.
Baseline	N/A - first experiment with Mycorrhizae
Target	Root treated with Mycorrhizae is 10% wider than the control (testigo) without Mycorrhizae treatment.
Data Collection	Data had been collected from demo plot with seedlings, it has a control and a treatment of: **Seedlings:** 5 grams per plant **Nursery:** 60 grams/plant
Tool	Measuring tape and data collection sheet
Frequency	After 60 days of planting and after 150 days of treatment in the nursery
Responsible	M&E Director, c&c Coordinator
Reporting	Farmer (demo plot holder) and the technician measure the root system and fill in the data collection sheet to compare treatment in seedlings and in the nursery with the testigo. Where a camera was available, pictures had been taken as evidence. The results of the comparison are discussed during Farmer Field School meetings and c&c trainings within the farmer groups on the demo plots.
Quality Control	The team jointly defined a procedure to measure root development. M&E and c&c Coordinator evaluate the data to analyze effectiveness.

Measurement Strategy for acceptability, affordability, timing & urgency

The data was also discussed with the farmer organization and their farmers to evaluate their perception about the use of Mycorrhizae.

Additional cost incurred by applying Mycorrhizae:

Seedlings – 1000 plants germinate per 1 square meter. The dosage used is 5 grams/plant. 1 bag of mycorrhizae weighs 46 kg and costs USD 25. The additional cost of using Mycorrhizae:

By square meter: USD 2.7

By plant: USD 0.0027

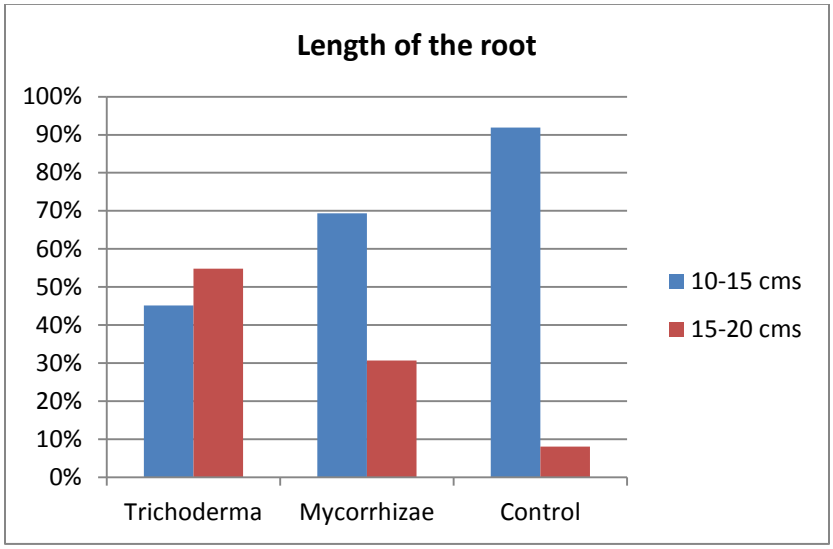
Labour for applying in seedlings would be around 0.5 hour/ square meter

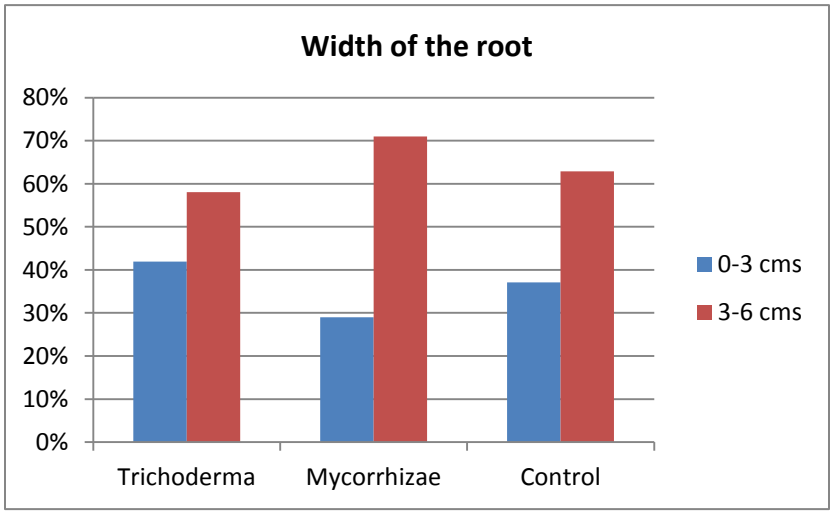
Nursery – 60 grams/plant.

By plant: USD 0.03

Labour for applying in nursery would be around 1 hour/ 500 plants.

Main Findings of Case Study





Mycorrhizae applied at the seedling stage performed better than control treatment when referring to root development. At this stage the roots of the coffee measure 14.8 cm on average with Mycorrhizae and control measuring 13.7 cm. More than 69% of the Mycorrhizae treated roots measure more than 15-20 cm, the control had more than 90% measuring at least 10 cm. All the measures were taken 60 days after planting. Concerning root width, Mycorrhizae performed better than controls, with 71% of the roots measuring between 3-6 cm compared to 63% for controls.

Mycorrhizae is a product in the form of a powder, at the application a thick layer is at the top of the substrate, this could influence that roots didn´t develop in length but in width. Other ways to apply the substrate should be evaluated (mixture of the soil and substrate).

Mycorrhizae applied at nursery performed better than control treatment. The roots measured 17 cm on average compared 12 cm for the control group. The width of the root was with Mycorrhizae 11 cm compared with 9 cm of the controls. Plants without Mycorrhizae showed signs of rotting at the bottom, suggesting that the applied Mycorrhizae product was acting to suppress rotting fungi.

Acceptability					
Leading Question: To what extent did farmers readily accept this tool as useful for implementation and implement it as planned?					
High	X	**Low**		**Don't Know**	
High: Farmers readily accepted this tool for implementation and continue to implement it as planned.			**Low:** Farmers generally did not accept this tool; *Or* the tool was met with resistance later on, even though farmers initially accepted it.		
Please Comment:					
If there was resistance to adopting this tool, why?			The product is widely unknown in the region. Most of the farmers worked for the first time with a fungus as agricultural input.		
If farmers discontinued tool implementation later on in the process, even though they initially accepted it, why?			-		
Did this tool have any external issues or impacts (positive or negative) which influenced its acceptability? (community, value chain?)			-		
Any other comments:			Main issue with Mycorrhizae is distribution, as the regions where it is produced and where it can be used are at a distance of 500 km.		

Affordability					
Leading Question: Are the costs of the tool affordable to farmers taking into account the initial investment, maintenance costs and the availability of inputs?					
High	X	**Low**		**Don't Know**	
High: The initial investment and the maintenance costs of this tool are affordable to farmers from their regular operations and the time it takes to recover the investment is reasonable to farmers. *Inputs (e.g. labor, electricity..) are available when they are necessary so that no extra costs are incurred from timing related issues.*			**Low:** The initial investment or the maintenance costs of this tool go beyond what is affordable to farmers from their regular operations *or the amount of time it takes to recover the investments are unreasonable to farmers*.		
Please Comment:					
Are there any external costs? (to society or environment?)			No		
If costs are high because inputs are not available, what inputs? And why?			The application of Mycorrhizae should be done in seedling stage and not in the nursery stage, to reduce the impact on cost production by plant. It is necessary to purchase by volume for maximum affordability.		
Any other comments:			-		

Effectiveness					
Leading Question: Does the tool provide the expected benefits to farmers?					
High	X	**Low**		**Don't Know**	
High: The objective of the tool has been met for the farmers.			**Low:** The tool did not fulfill its objective entirely.		
Please Comment:					
What benefits did farmers expect from this tool?			Better root system which will lead to: Less stress by drought Improved access to nutrients Reduced attack of damping off - disease		
If the objective has not been met, why?			Some plants were discarded because of the quality of the root that wasn´t rectilinear, this could be caused by the thick layer, an alternative could be to evaluate mixture the substrate with Mycorrhizae.		
Have there been any significant external issues which influenced the effectiveness (positive or negative) of this tool? Please explain.			-		
Any other comments about effectiveness			Further analysis on development of plant during plantation the crop cycle is needed.		

Timing / Urgency					
Leading Question: Is the amount of time that this tool takes to implement (from starting implementation until benefits accrue) reasonable to farmers?					
High	X	**Low**		**Don't Know**	
High: The tool takes a reasonable amount of time to implement (taking into account the coffee growing season, inputs necessary, preparation time and implementation time); *And* this tool accrues the effects expected within a reasonable amount of time.			**Low:** It takes too long to implement this tool (taking into account the coffee growing season, inputs necessary, preparation time and implementation time); *Or* it simply takes too long for this tool to accrue benefits.		
Please Comment:					
If implementation takes too long why?			-		
Any other comments about timing:			Further development is needed.		