

## Enabling a sustainable Vietnamese coffee industry

The Vietnamese coffee industry has great challenges ahead! Future coffee yields are threatened as soils are degrading from the high use of chemical fertilizers, and emissions from the coffee processing result in health issues and low sustainability of the industry. Using the outer layers (coffee husk) of the coffee cherries, which surround the coffee beans, to produce *biochar* could however resolve these issues.

Biochar is a type of carbon made from carbonizing biomass. Coffee husk is a type of biomass and can therefore be carbonized into biochar. Biochar can for example be put in soils to better retain nutrients and water, which decreases the need for chemical fertilizers. The process of producing biochar is also smoke-free and generates heat that can be used to replace current activities in the coffee processing that create emissions. Producing biochar from coffee husk does therefore solve the mentioned issues. Even so, uncertainties that occur due to establishment of a new supply chain, and the underdeveloped processes in this supply chain might prevent these issues from being resolved. Uncertainties from customers of the coffee husk-biochar should however always be expected to be low. This is because the biochar is a product with low contribution margin, long product life cycle and few varieties. Products with such characteristics should always expect a stable demand with low uncertainties. Uncertainties from the supply of the biochar are more prominent, as we found that unplanned disruptions in production are likely to occur. This is because the machine for biochar production, which we investigated for this research, still is somewhat immature with many historical and future design changes. Safety procedures could also be improved as operational guidelines are not yet created.

Overall supply chain uncertainties are however low, despite the more prominent uncertainties from supply, which implies that the supply chain should be cost-efficient and therefore always prioritize cost-reductions. If not being cost-efficient, producing biochar is less attractive as profits get too low, and the issues in the coffee industry will remain. Implications of the desired cost-efficiency is that facilities for production and inventory should be centralized to reach economies of scale, transportation must be cheap and inventory levels should be kept low. Centralization can reach economies of scale as it can increase the potential of utilizing both the machine capacity and human labour capacity. Transportation costs can be kept low through using full truck loads, which lowers the shipping rates. Inventory levels can be kept low for finished goods, but not for the raw material which is coffee husk. This is because the machine must be utilized all year long to reduce costs although the coffee husk only is generated during the coffee season, which lasts a couple of months. The implications of this is that coffee husk must be collected during the coffee season, and then stored during the remaining parts of the year to sustain production all year. Cost-efficiency is therefore not fully applicable for the inventory management.

Actors that could follow the suggested measures and produce the biochar are for example an intermediary actor with no current presence in the coffee industry. This actor could locate closeby coffee processors, as these generate coffee husk through their coffee processing. The intermediary could thereby decrease the needed transports of raw material and also focus on the biochar production as core business. An intermediary would however not have a natural application area for the excess heat generated from the machine. If a coffee processor instead would produce the biochar, it could replace current activities that generate emissions in the coffee processing, and one of the initially mentioned issues would thereby be resolved. It could also use its already existent relationships with coffee farmers to sell the biochar to them. This would also enable the issue with the degrading soils to be resolved as the farmers could use the biochar for their soils and thereby decrease their need for chemical fertilizers. Following our recommended actions regarding cost-efficiency, along with promoting our suggested biochar producers, should enable an expansion of production of coffee husk-biochar and thereby a sustainable Vietnamese coffee industry.