

**CANSEA** a R&D Network on Agroecology Transition in South East Asia

## Do legume-based intercrops concurrently halt soil erosion and boost soil health in cassava cropping systems of Northern Vietnam? (LEGINCROP)

Trung Thanh Nguyen<sup>1,2,3</sup>, Timothée Herviault<sup>2,4</sup>, Hai Thi Thanh Nguyen<sup>5</sup>, Esther Fouillet<sup>2,4</sup>, Vinh Le Bui<sup>1,2</sup>, Mary Otieno<sup>2</sup>, Dung Le Viet<sup>5</sup>, Hang Le Thuy<sup>1,2</sup>, Tuan Anh Nguyen<sup>1,2</sup>, Laetitia Herrmann<sup>2</sup> and Didier Lesueur<sup>2,6,7</sup>

<sup>1</sup> Vietnam National University of Agriculture (VNUA), Hanoi, Vietnam; <sup>2</sup> International Center in Tropical Agriculture-Asia (CIAT-Asia), Hanoi, Vietnam;

<sup>3</sup> Kasetsart University, Bangkok, Thailand; <sup>4</sup> AgroParisTech, Paris, France; <sup>5</sup> Northern Mountainous Agriculture and Forestry Science Institute, Hanoi, Vietnam;

<sup>6</sup> Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD), UMR Eco&Sols, Montpellier, France; <sup>7</sup> Deakin University, Melbourne, Australia





## Key results and lessons learned from the Action

In the Yen Bai Province, some farmers intercropped maize and cassava with legume species, mainly cowpea as it is easy to sale on local markets. However, most of the farmers were mainly doing cassava or maize mono cropping instead of intercropping crops with cowpea. After 2 years, the number of farmers doing intercropping has more than doubled and the surface of land dedicated to intercropping cassava with cowpea was three times higher than in 2017 when we started the project.

Absence of commercial rhizobial inoculants nodulating cowpea in Northern Vietnam (and may be in the whole Vietnam). Need to isolate and screen under control conditions effective rhizobia strains nodulating cowpea for identifying the most effective strains. Twenty-one strains were isolated and tested under greenhouse conditions and about we selected eight strains as being very effective. Inoculated farm-trials were set up in the Mao Dong commune in Van Yen District.

In 2017, in both Van Yen and Van Chan districts, we have not practiced any inoculation with rhizobia. The field nodulation was most of the time low and very variable from one place to another one even within the same field. By practicing the inoculation of cowpea with native selected rhizobial strains, the nodulation, the yield, and the biomass were significantly higher than for the non-inoculated cowpea. The best inoculum was the one containing two native strains isolated from nodules collected in Mao Dong farms in 2017.

Intercropping with legumes is described as a way to increase soil biodiversity, soil health and soil bio functioning. LEGINCROP has demonstrated and quantified how soil fauna (macrofauna and microfauna) is significantly higher and more diverse in intercropping system than in the mono cropping fields.

Arbuscular Mycorrhizal Fungi (AMF) form root symbiosis with most of the tropical crops enhancing phosphorus nutrition and tolerance to drought. LEGINCROP has assessed the capacity of both intercropped cowpea and cassava to

form root symbiosis with native AMF concerning the landscape. Our results showed that if the mycorrhization of cowpea is much higher than the mycorrhization of cassava, there is no significant differences according to the landscape. Both crops are largely mycorrhized and there is no need to think about a possible utilization of commercial mycorrhizal inoculants to sustain the yields.

LEGINCROP has demonstrated that by inoculating intercropped legumes with effective native rhizobia isolated on the Yen Bai Province, nodulation and yield are significantly higher compare to un-inoculated legumes. It is possible to make available effective rhizobial inoculants for cowpea on local. Meanwhile, by taking more benefits of the legumes, farmers can significantly reduce the applications of mineral fertilizers and save money and move on with more friendly environmental agricultural practices.



## Context of the Action

Soil erosion is very critical in uplands in Northern Vietnam. Diversified cropping systems such as those based on intercropping have attracted much interest in recent years, because they are more stable and resource conserving. Cassava grown as a crop removes large amounts of nitrogen. Because of the long period to attain harvest maturity, typically 10–14 months in regions with bimodal rainfall and altitudes ranging between 1400 and 2000m above sea level, farmers often intercrop cassava with cereals (most often maize) or with grain legumes. Legumes are highly compatible with cassava in terms of growth pattern, canopy development and nutrient demands, as they require mostly P and can satisfy part of their N needs through BNF while cassava requires large amounts of K for storage root formation and N for leaf production. Intercropping systems have higher yield stability, reduced disease severity, and benefits weed control, especially when combined with nutrient addition. Maize is widely grown as cereal crop in many developing countries including Vietnam. In Northern Vietnam, in Van Chan district, currently there are mainly intercropped with cowpea (farmers can sale cowpea grain up to US\$ 2.5 kg<sup>-1</sup>). Unfortunately, not enough farmers keep intercropping cassava or maize with cowpea and the LEGINCROP's challenge is to see how to inverse this by promoting a balanced cropping system combining high BNF activity, less applications of mineral fertilizers and sustainable crop yields.

## Objectives of the Action

- Field assessment of the natural nodulation by native rhizobia of intercropped legumes and assessment of the rate mycorrhizal root infection.
- Soil mapping of both areas to make a link between BNF, soil fertility and crop yields.
- Selection under greenhouse conditions of effective strains of rhizobia nodulating cowpea to identify possible inoculants for further inoculation field trials.
- Field inoculation of intercropped legumes with selected strains of rhizobia to identify very effective inoculants to scale up through farmer associations.
- Assess the impact of intercropping with legumes on soil fauna (diversity and richness).

## Partnership

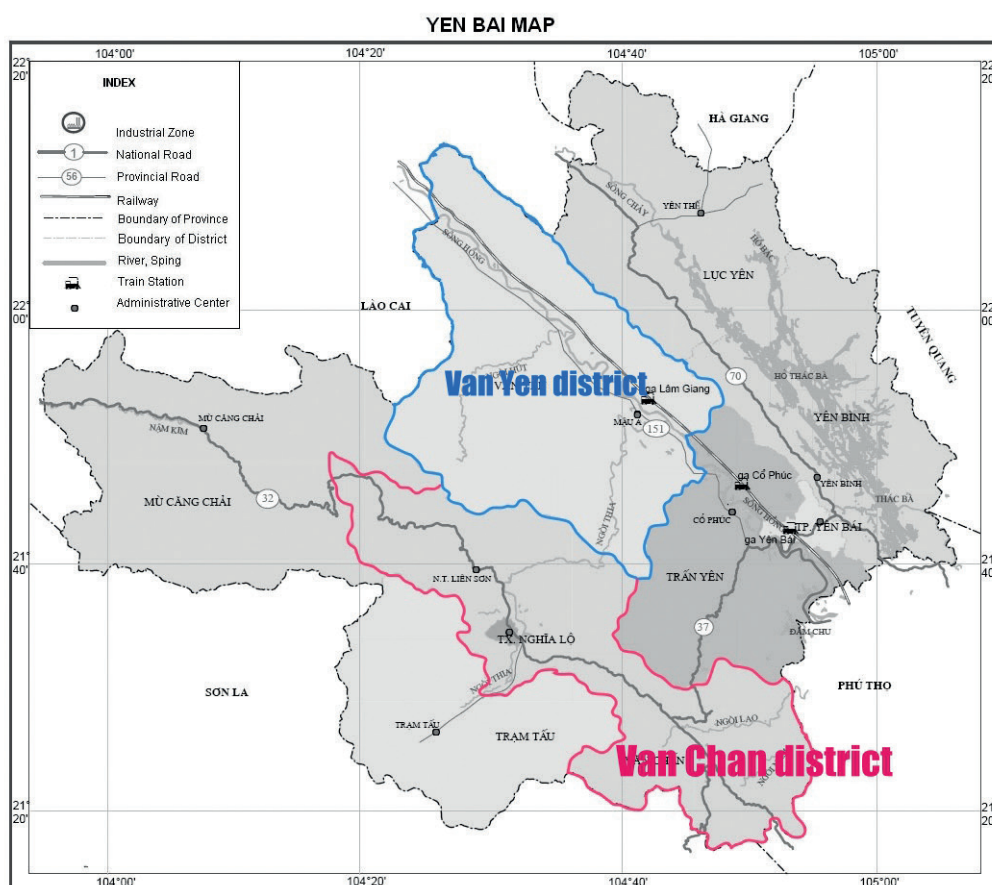
The Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) and the Northern Mountainous Agriculture and Forestry Science Institute have a long-history of collaboration through the Platform in Partnership entitled CANSEA (Conservation Agriculture Network in South East Asia). NOMAFSI has people on the ground working closely with farmer associations Yen Bai Province.

The International Center in Tropical Agriculture has been working with both NOMAFSI and CIRAD through collaborative projects for many years and the leader of the project is one CIRAD's scientist posted at CIAT-Asia in Hanoi since March 2016. CIAT has a MOU with the Province of Yen Bai and leads the Climate Smart Agriculture activities undertaken at Ma Village by the Climate Change Agriculture and Food Security project.

## Location and description of the Action

NOMAFSI has a long-history collaboration with farmer associations in Ban Loong village, located in Son Think Commune. This village represents about 3100 ha and the population living there is about 8500 residents. The size of the land cultivated by farmers from this village about 46.5 ha. The intercrop systems mainly used by these farmers are maize + peanut. The commune's people committee is supportive for scaling up such technology through farmer associations because sustain maize yields and soil fertility are key priorities for the agriculture in the district.

CIAT-Asia run projects in Van Yen, especially on promoting grass barriers on mono-cropped cassava fields, since the early 2000's. CIAT cassava scientists have introduced high yield cassava varieties and forage grass varieties to the region. Muoi village in Mau Dong commune participated in this promoted conservation agriculture since the beginning of the program. The village has a total land area of over 200 ha and 95 households. Land capacity per capita is rather average of 5,000 square meters per household. Muoi village is among the most productive cassava areas of Van Yen district, and therefore cassava is the number one priority crop in the village. Besides grass barriers, intercropped cassava with cowpea is promoted to improve soil nutrient stocks. However, not all farmers follow this intercropping option because it is time consuming to them and some do not believe in its good impacts. The government of Van Yen has been trying to out scale this practice yearly with an effort of mitigating soil degradation and improving soil health.





## Expected impacts and prospects

Rhizobial inoculants for cowpea: When we launched the project, there was no rhizobial inoculants available for farmers willing to grow cowpea in both Van Yen and Van Chan districts. After two years, we demonstrated that after inoculation of the legume with effective rhizobial strains originated from Mao Dong commune, cowpea yields in intercropping systems (especially with cassava) was sustained. Of course, obviously, the field-testing of these strains in other agro ecological zones in uplands of Northern Vietnam where farmers grow cowpea to confirm their effectiveness shall be undertaken. However, there is needs for further scientific and technical investigations to make effective rhizobial inoculants available on the market. A collaboration with the private sector manufacturing biofertilizers becomes strategic for being in position to provide to farmers what they ask for in order to improve their livelihoods. About the important surfaces of lands use every years in Northern Vietnam for growing legumes without any rhizobial inoculants, the LEGINCROP's project has significantly shown the way forward for promoting an agro ecological practice combining Biological Nitrogen Fixation and sustainable yields with a positive impact on soil degradation.



Capacity building: several students (Vietnamese of the Vietnam National University of Agriculture in Hanoi and French of AgroParisTech in Paris) have carried out LEGINCROP's activities under the supervision of the coordinator of the project. The balance sheet is as follows: 1 Vietnamese PhD student who will graduate in 2019, 2 French Master students whom graduated in 2018 and 2 Vietnamese undergraduate students whom graduated in 2018. In addition, of this, the collaboration with the NOMAFSI on soil biology has benefited a lot from the project and by the way is strengthened with possible further developments such as one or two PhD scholarships with Deakin University in Melbourne for some of the Vietnamese scientists involved.

## Useful links and contacts

<https://www.cirad.fr>

<https://ciat.cgiar.org/where-we-work/asia/>

<http://www.nomafsi.com.vn/>