Photo: Bùi Văn Tùng & Phan Huy Chương (NOMAFSI)

Implementation of feed intervention strategies for improved livestock nutrition and productivity in Mai Son district, Son La province, Vietnam

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Li-chăn is a project under the CGIAR Research Program on Livestock which aims at stimulating system transformation through bundled livestock-based interventions in North-West (NW) Vietnam, covering the areas of livelihoods, environment, equity, and market access to benefit highland farming communities. The project has been co-designed by both international and national partners. It is funded by the Livestock CRP and co-implemented by International Center for Tropical Agriculture (CIAT), International Livestock Research Institute (ILRI), Swedish University of Agricultural Sciences (SLU), Vietnam National Institute of Animal Science (NIAS), National Institute of Veterinary Research (NIVR), Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI), Sub-Department of Husbandry, Animal Health and Aquaculture of Son La Province, Mai Son Agriculture Division, Mai Son Agriculture Service Center.

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Abstract

Livestock production in Vietnam is critical in reducing poverty and increasing income particularly for ethnic minorities in the Northwest Highlands. Improved livestock management and productivity can be achieved through better feed management and increased cultivation of improved forages, to meet animal nutrition demand. This study aimed at assessing feed intervention strategies to address context-specific feed-related challenges, mainly winter-feed shortage, for improved animal nutrition and livestock productivity in Mai Son district, Son La province, Vietnam. These interventions included promoting the uptake of improved forage varieties (grasses and legumes) and capacity building on animal nutrition techniques including feed processing and preservation, feed mix and feeding regimes for cattle and pigs. Willing farmers selected various forage varieties, were provided with seeds and planting materials to grow on their farms and guided on forage planting, management, and utilization. Local partners and stakeholders supported various activities and ensured successful implementation amidst the restrictions arising from the Covid 19 pandemic. Farmers reported increased awareness on feed technologies, increased yield, and availability of high-quality feed for their livestock, as well as challenges encountered in applying different feed-related techniques. Initial results from this study show the potential of feed and forage technologies in improving livestock productivity and lays a foundation for scaling these interventions to other regions of Vietnam.

I. Introduction

In the Northwest Highlands (NWH) of Vietnam, the main feeding system for cattle and buffalo are mainly through tended native pasture (74%), stall feeding using crop residues and free grazing on communal land and forests. Feed and forage quality is generally of low quality resulting in low livestock output. Intensifying beef cattle production has been identified as a way of increasing livestock productivity and income of smallholder livestock farmers in this region (Huyen *et al*., 2010). Currently, cattle production systems have begun transitioning from extensive to semi-intensive and intensive systems (Ba *et al*., 2015). However, to fully achieve this goal, measures need to be put into place to address constraints of animal husbandry including feed-related challenges such as winter feed shortage.

Pig production also plays an important role in the livelihoods of livestock farmers in the NWH region. In remote areas, pig production is associated with indigenous pig breeds characterized by low productivity but well-adapted to local harsh conditions and showing better resistance to diseases than improved pig breeds (Le *et al*., 2016). Bản pigs are mainly fed with available feed resources such as rice bran, corn, banana trunk, vegetables, and leaves. Although there is a long-standing tradition of Bản pig production, farmers have limited knowledge in feed practices for pigs which greatly affects the productivity and health of the pig herd.

Assessments carried out in 2020, in Mai Son district identified the main feed-related challenges in the region including shortage of winter feed, poor diets and low yield and poor quality of available forages (Hammond *et al*., 2021). Most households rely on crop residues and collected feed such as rice straw, sugarcanes tops, banana stem, maize, sweet potato etc. Some villages have communal pastures where animals can graze (Atieno *et al*., 2021). However, the available feed is of either of low quality or limited especially during winter. Bản pigs have a high fat content and less lean meat which lowers the market value leading to low returns to the farmers. There is limited knowledge on suitable forage types and management, feed processing and preservation (Atieno *et al*., 2021). The results of this assessment informed the design of feed interventions to help address these challenges. This study aims to assess locally suited feed intervention strategies for cattle and pigs, for improved animal nutrition in the Mai Son district, Son La province, located in the Northwest Highlands of Vietnam.

II. Study area

The study area is located in 2 communes (Chieng Chung and Chieng Luong) of Mai Son district, Son La province, has different types of farming systems ranging from grazing and extensive systems at the mountain tops to mixed crop-livestock systems at the bottom of the mountains, with varying socio-economic and ecological conditions (Hammond *et al*., 2021). The study location is divided into 4 farming system types (A, B, C1 and C2) based on accessibility i.e., distance to the main road or nearby market, and production system. Six villages were selected for interventions in the 2 communes (Table 1).

- Type A – intensive systems in the lowlands with good market access and relatively better capacity for innovation.
- Type B - mixed crop-livestock systems in the mid-altitudes with mainly Thai ethnic minorities
- Type C1 - remote extensive system in the high altitudes, with low access to market, fragile environment, mainly Hmong ethnic group

- Type C2 – remote mixed crop-livestock system in the high altitudes, with low access to market, fragile environment, mainly Hmong ethnic group

Table 1: Selected intervention villages and farming system types

Type	Chiềng Chung Commune	Chiềng Lương commune
Type A		Mờn 1 and Mờn 2
Type B	Khoa	Oi
Type C1	Xam ta	
Type C2		Buôm Khoang

III. Feed intervention strategies

To propose context-specific measures on animal nutrition, feed-related challenges need to be identified. In 2020, a survey was conducted in 6 villages of Chieng Chung and Chieng Luong communes, Mai Son district, Son La province, using the Gendered Feed Assessment Tool (G-FEAST) (Atieno *et al.,* 2021). G-FEAST was designed to identify opportunities and constraints in animal feeding practices for different household types by assessing the availability and use of local feed resources, identify challenges and constraints affecting livestock production through the gender lens, opportunities for improved animal nutrition and propose context-specific interventions on livestock feed for improved animal nutrition (Lukuyu et al., 2019a; Lukuyu *et al.,* 2019b). The G-FEAST survey informed the design of context-specific feed interventions to be implemented in Chieng Chung and Chieng Luong communes such as promoting improved forage varieties, knowledge on better utilization of crop residues, feed processing and preparation and feeding regimes (Atieno *et al.,* 2021).

Based on this survey, feed interventions were designed as follows:

1. **Improved animal nutrition:** Trainings on feed utilization, processing & preservation, and feeding regimes for cattle/buffalo and pigs
2. **Improved forage varieties** – Promote adoption of improved forage varieties – high yielding, high nutrient, cold-tolerant varieties.

1. Improved animal nutrition

a) Overview of topics covered and training materials

Farmers in the intervention villages were trained on different animal nutrition techniques such as feed processing and preservation, better utilization of crop residues, feed mixing and improved diets for cattle and pigs. The training was conducted from March 22-26th, 2021, one day per village and covered the following topics (more information and details of the training materials can be found at (https://bit.ly/3bHMfRH; https://bit.ly/3bEoz0N):

Training topics covered included:

i) Feed and feeding regimes for cattle and buffalo

- Feed classification (forages, concentrates, minerals)
- Feed processing: silage preparation (grass, maize, crop residue…), urea-treated rice straw
- Feeding regimes for cattle (lactating cows, suckling calf, weaning calf, heifer and fattening diets)

ii) **Feed and feeding regimes for Bản pigs**

- Feed classification (protein feed, energy feed, minerals, vitamins)
- Feed processing: concentrate mixing, concentrate feed fermentation by probiotics
- Feeding regimes for Bản pigs (gilts, pregnant sow, lactating sow, grower-fattener pigs)

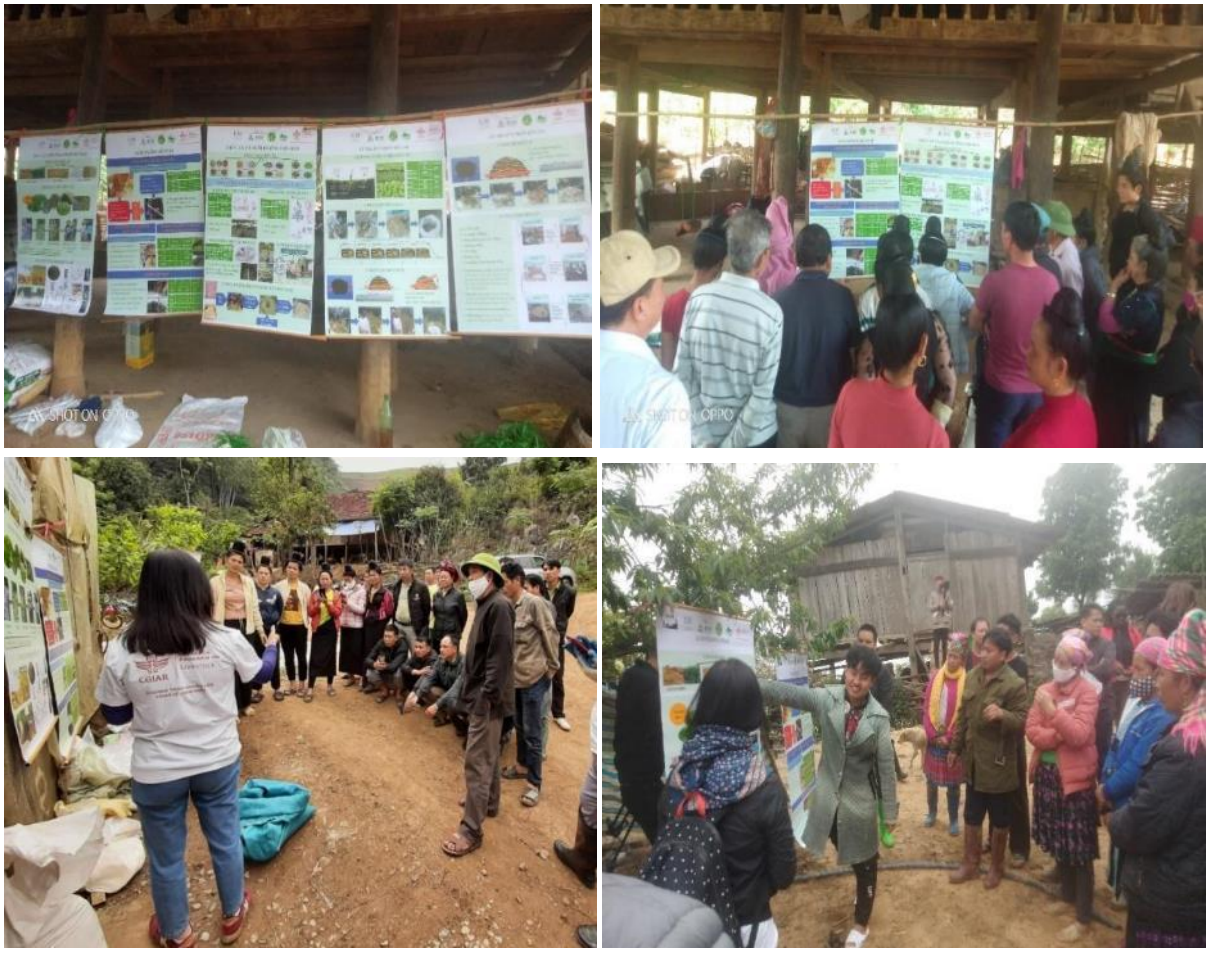
The first session involved poster presentation with easy-to-follow illustrations. The posters were also translated to local languages (Vietnamese and Hmong) so farmers could understand and follow through. The second part of the training involved practical demonstrations on various techniques with participants taking part in preparing materials and hands-on demonstration. Feed materials were prepared for practical training sessions depending on the available feed resources in the different villages at the time of the training. Materials included banana trunk, sugarcane tops, rice straw, rice bran, cornmeal and cassava meal.

b) Farmers' participation

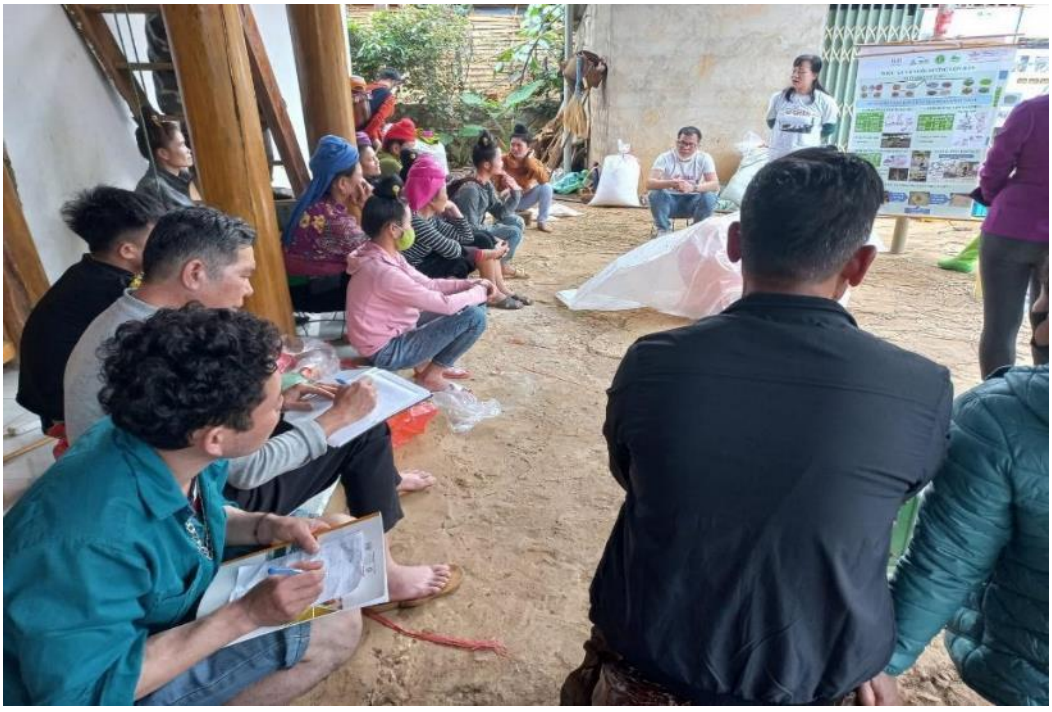
About 145 farmers (70 men and 75 women) participated from the six villages of Chieng Chung and Chieng Luong communes (Table 2). Most of the invited households participated in the trainings while in some villages e.g., Buom Khoang, recorded more participants in attendance. More female participants enthusiastically participated in the hands-on practical sessions including preparation on silage and urea-treated rice straw, feed mixing and feed fermentation. The training approach used was interactive and allowed participants to actively participate and freely ask questions and seek clarifications. Some farmers took notes and videos of the training sessions.

Table 2: Number of participants

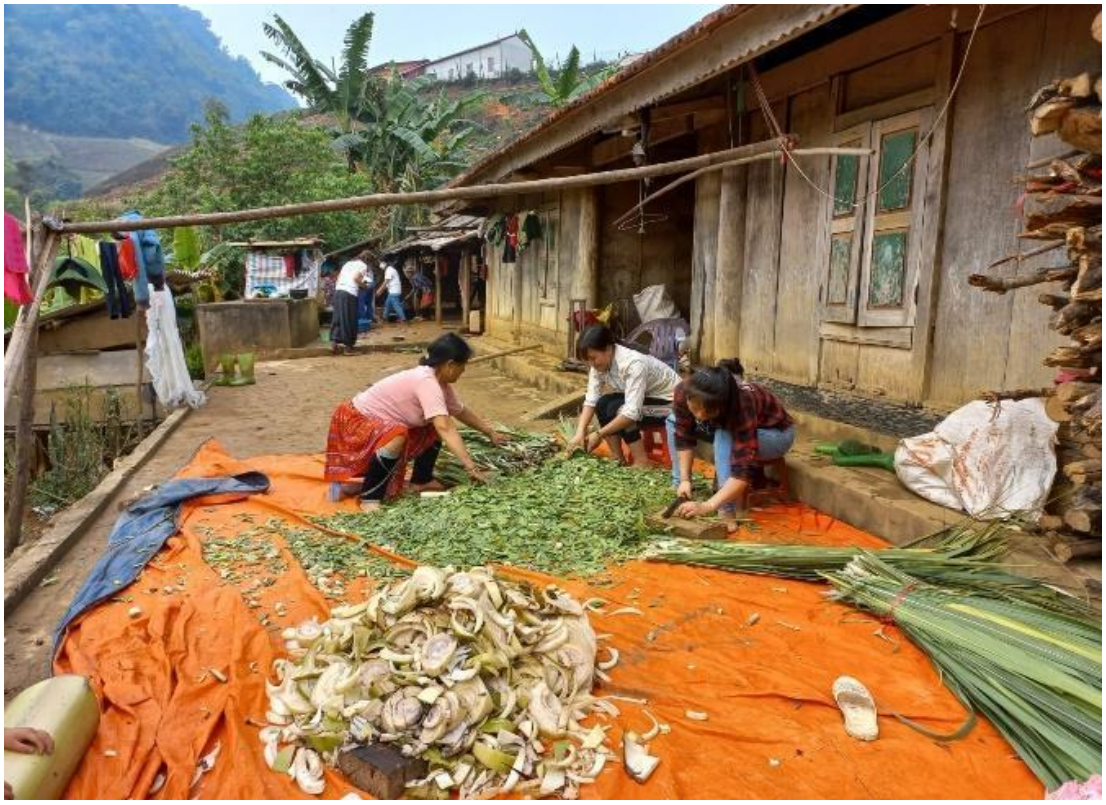
Type	Village	No. Invited			No. Participated		
		Men	Women	Total	Men	Women	Total
Type A	Mon 1	13	12	25	9	14	23
	Mon 2	12	13	25	6	17	23
Type B	Khoa	14	11	25	13	13	26
	Oi	15	10	25	14	9	23
Type C1	Xam Ta	10	10	20	9	11	20
Type C2	Buom Khoang	13	12	25	19	11	30
	Total	**77**	**68**	**155**	**70**	**75**	**145**



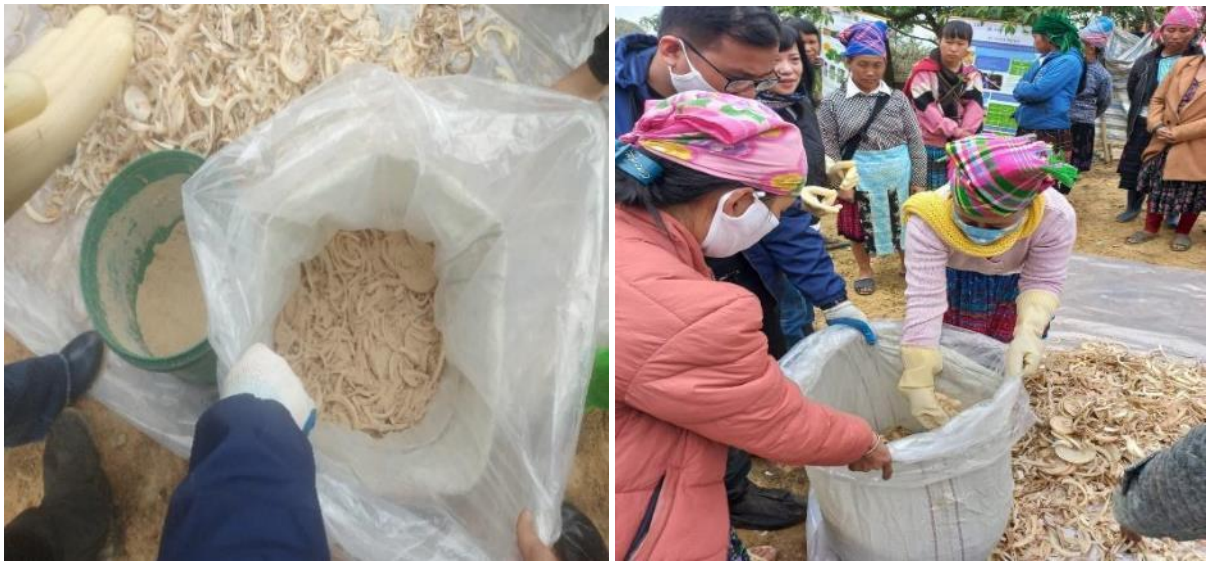
Introduction to feed techniques using posters
Photos: Trần Bích Ngọc (NIAS)



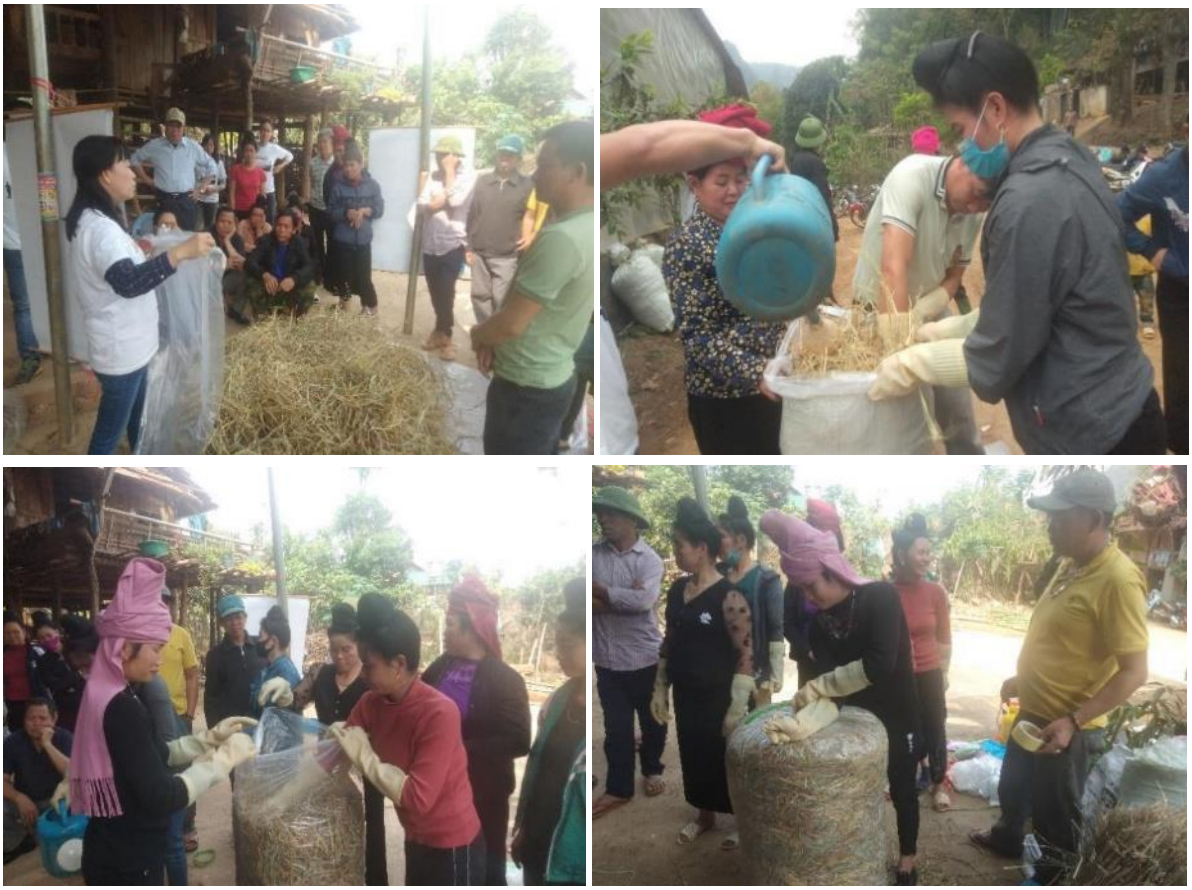
Farmers taking notes during the training
Photos: Trần Bích Ngọc (NIAS)



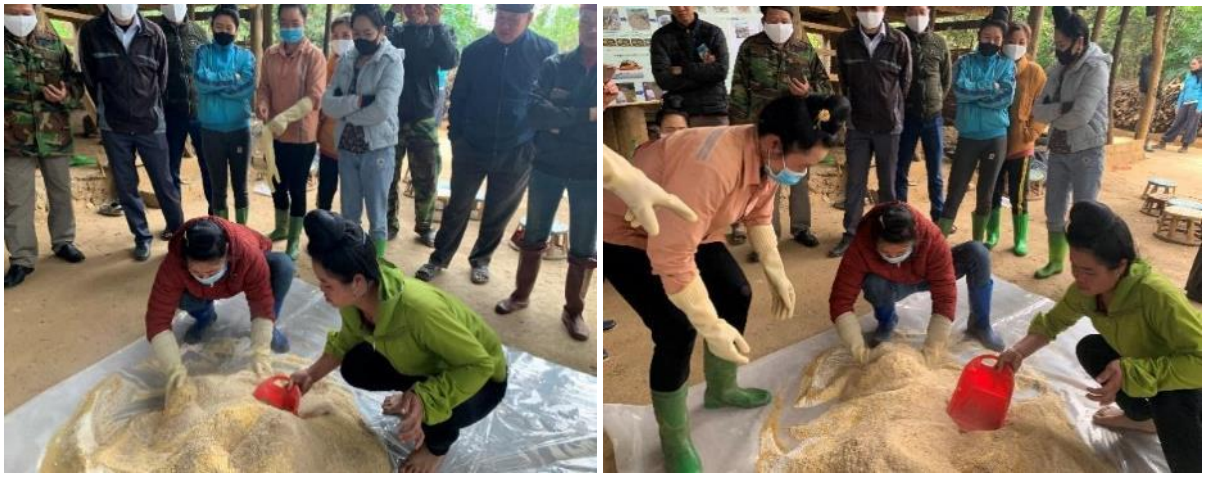
Preparing materials for silage
Photos: Trần Bích Ngọc (NIAS)

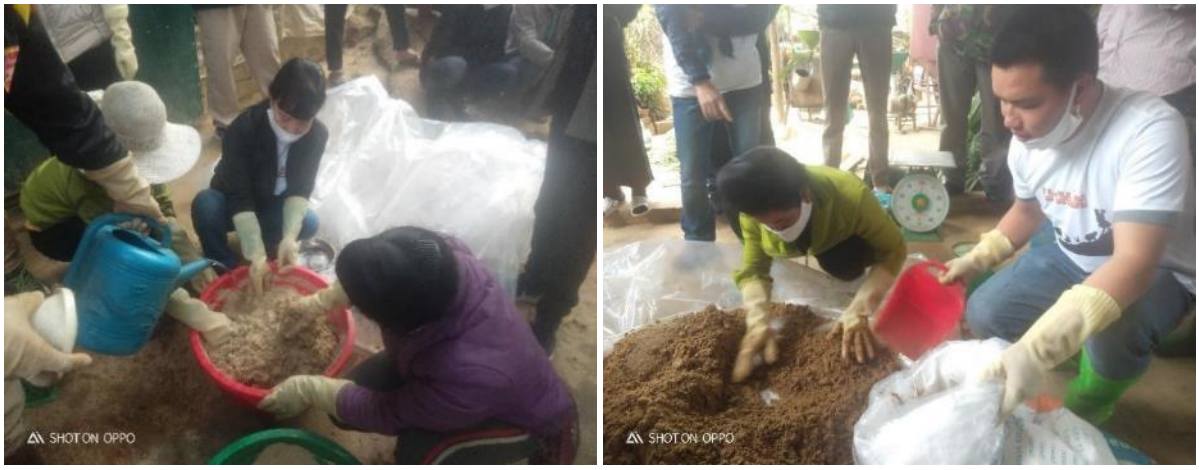


Silage preparation
Photos: Trần Bích Ngọc (NIAS)



Preparing urea-treated rice straw
Photos: Trần Bích Ngọc (NIAS)





Concentrate feed mixing and feed fermentation using probiotics
Photos: Trần Bích Ngọc (NIAS)

At the end of each day, a game was organized where participants competed in answering questions related to the training topics. This enabled the project team to note what farmers learned and highlight the key areas that farmers needed to remember and was also a way to help farmers to discuss amongst themselves and consolidate the skills learned.

A willingness survey was also conducted after the training to note the number of farmers willing to adopt the techniques covered during the training. More than 50% of farmers attending the training expressed willingness to adopt various feed technologies (Table 3).

Table 3: Number of participants willing to adopt feed techniques covered in the training

Type	Village	No. of participants	No. willing to adopt feed techniques
Type A	Mon 1	23	21
	Mon 2	23	20
Type B	Khoa	26	23
	Oi	23	17
Type C1	Xam Ta	20	10
Type C2	Buom Khoang	30	23
	Total	**145**	113

Farmers play a recall game after training
Photo: Sabine Douxchamps (ABC)

c) Follow up on uptake of feed technologies

Six months after the training while conducting monitoring of farmer-led forage trials (section 2), follow-up interviews were done with 49 farmers who were also growing introduced forages, to assess the uptake of the animal nutrition techniques from the training. Out of 49 farmers interviewed, 17 reported already applying one or more of the techniques they had learned in the training. The farmers also reported benefits from applying feed techniques such as reduction in labour and time for feed preparation. For instance, some farmers now prepare enough silage and store for a longer time as compared to before the training. Cattle prefer to eat more of the silage. Farmers preparing fermented pig feed using probiotics reported they no longer need to cook resulting in reduced fuel cost and less firewood for cooking feed.

2. *Improved forages*

a) Selection of preferred forage varieties

The proposed forage varieties included 4 grasses (Mulato II, Mombasa guinea, Green elephant and Ubon paspalum), and 3 legumes (Ubon stylo, *Arachis pintoi* and rice bean). These varieties were selected as they are high-yielding, high quality and cold-tolerant, characteristics best suited to address feed challenges in the study area. Farmers were first given an overview of proposed forages then asked to fill in a checklist to select from the proposed forage varieties that best suit their needs and farming systems (Table 4).

Table 4: Number of households registered, and forages selected during the checklist exercise

	Mulato II	**Mombasa guinea**	**Ubon paspalum**	**Green elephant**	**Ubon stylo**	**Pinto peanut**	**Rice bean**
Type A	30	21	15	35	7	9	23
Type B	29	34	16	29	12	24	37
Type C1	15	11	3	12	7	3	6
Type C2	11	16	6	11	9	7	8
Total	**85**	**82**	**40**	**87**	**35**	**43**	**74**

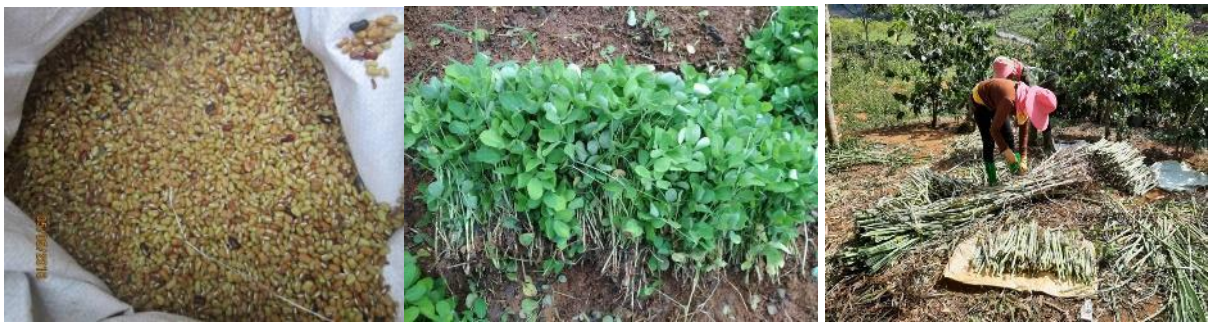
b) Farmer-led forage trials

Farmer-led field trials were set up in the 6 intervention villages with interested farmers to assess the potential of forage varieties in improving the feed basket for increased livestock productivity in the study area. In May 2021, the Livestock CRP Feeds & Forages flagship provided seeds and planting materials (seedlings and stem cuttings) (Table 5) to a total of 155 households. Field demonstrations on different ways of growing forages were conducted in each village, after which the farmers applied the same techniques in their own farms.

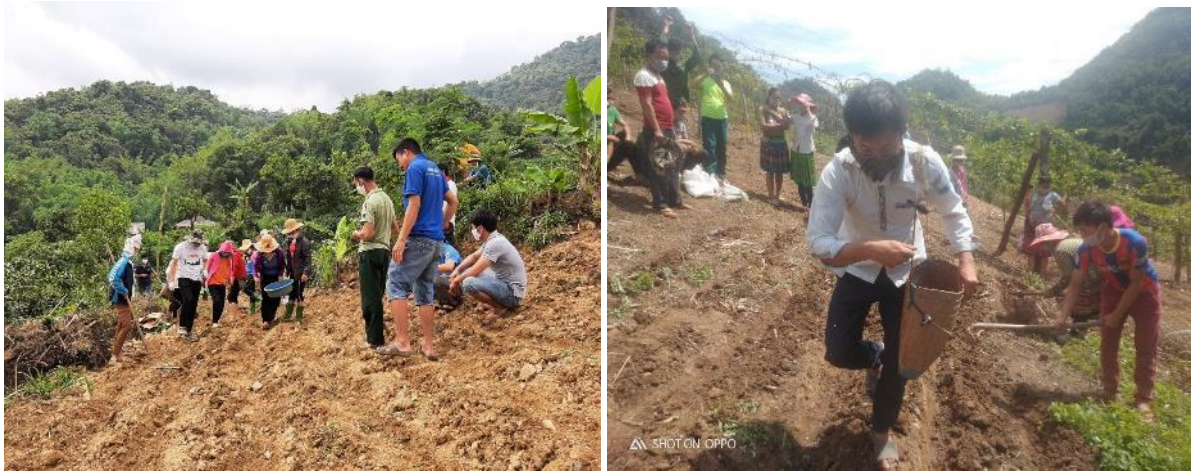
Table 5: List of forage varieties

Category	**Variety**	**Scientific name**	**Planting material provided**	**Source**
Grasses	Mulato II	*Urochloa ruziziensis* × *U. decumbens* × *U. brizantha* cv. Mulato II	Seeds	Ubon Forages Co. Ltd*
	Mombasa guinea	*Megathyrsus maximus* cv. Mombasa	Seeds	Ubon Forages Co. Ltd
	Ubon paspalum	*Paspalum atratum* cv. Ubon	Seeds	Ubon Forages Co. Ltd
	Green elephant	*Cenchrus purpureus*	Stem cuttings	NOMAFSI
Legumes	Ubon stylo	*Stylosanthes guianensis* var. *guianensis* cv. Ubon stylo	Seeds	Ubon Forages Co. Ltd
	Pinto peanut	*Arachis pintoi*	Seedlings	NOMAFSI
	Rice bean	*Vigna umbellata*	Seeds	NOMAFSI

**Seeds from Ubon Forages Co. Ltd were sourced through a local supplier – Nam Thai Co. Ltd*



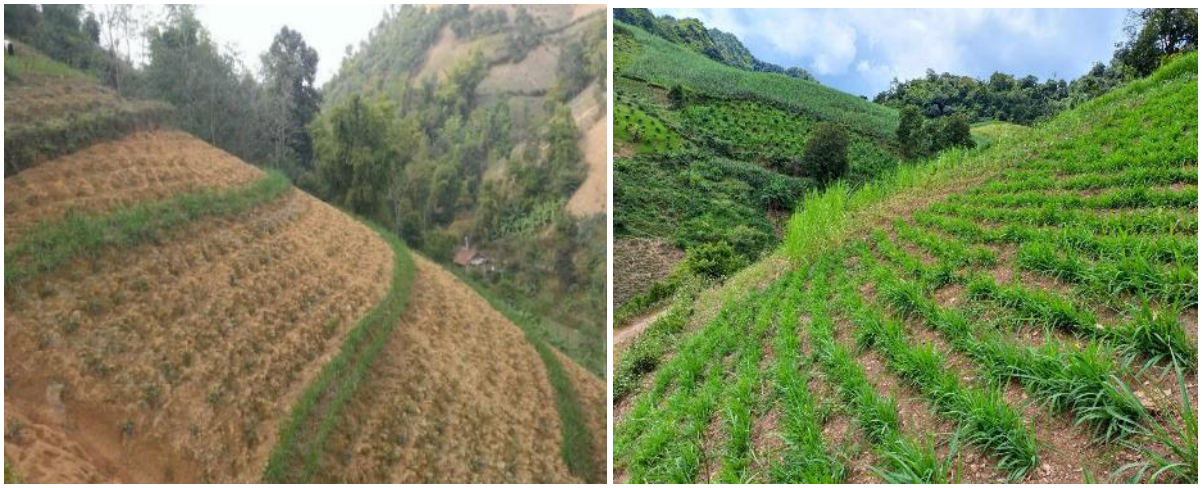
Forage seeds, seedlings (Arachis pintoi) and stem cuttings (Green elephant)
Photos: Bùi Văn Tùng, Phan Huy Chương (NOMAFSI)



Field demonstrations on planting forages
Photos: Bùi Văn Tùng, Phan Huy Chương (NOMAFSI)

Seeds of Mulato II, Mombasa guinea, Ubon paspalum and Ubon stylo were distributed and sown at the beginning of the rainy season (May). Planting materials for green elephant, pinto peanut and rice bean were distributed and sown mid-rainy season in June. Some households planted late due to shortage of rains mid-season and/or Covid-19 disruptions which caused slight delays in delivering materials and conducting on-farm demonstrations.

Various planting methods were used for selected forages depending on the system and farmers' preference. Examples include cut-and-carry mono-crop plots, grasses planted on contours, intercropping with annual or perennial crops, ground cover etc. Farmers applied varying amounts of fertilizers (NPK, urea, manure). Details on how to grow, manage and utilize the 7 forage varieties can be found in the field manual and factsheets (https://bit.ly/3CC0vHE; https://bit.ly/2ZU1dll).



Forage grass grown on contours
Photos: Bùi Văn Tùng, Phan Huy Chương (NOMAFSI)

Trial monitoring was conducted by project staff with the support of local stakeholders. The Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI) was the main local partner leading trial setup and monitoring. Data collection (germination rate, height, biomass yield [fresh matter (FM)]and farmer preferences, dislikes, and challenges) was done on selected farms in each village - > 3-5 farms per crop per village.

c) Results

Area planted

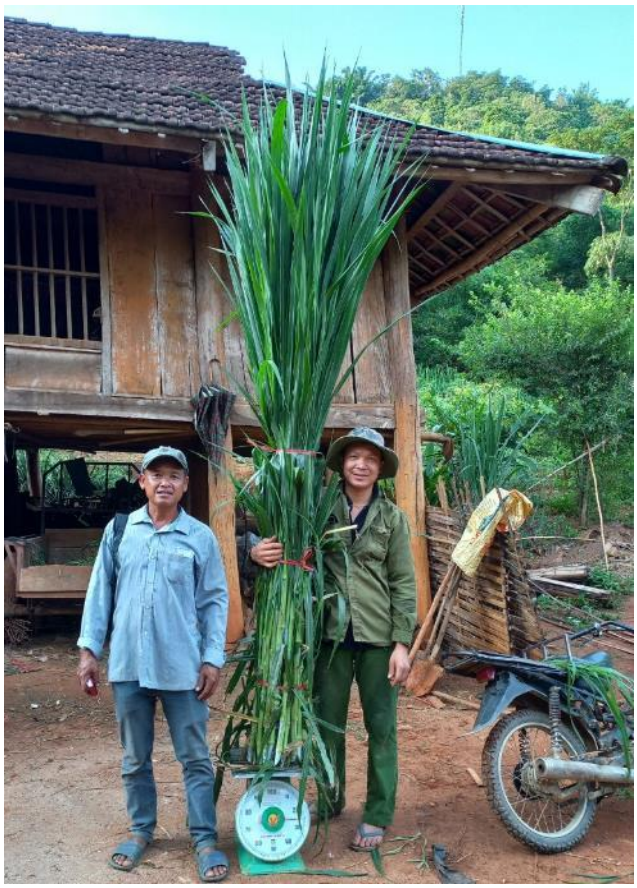
Approximately 25 ha were planted with improved forages across the 6 intervention villages (Table 6). This is a significant increase in area grown with forages in all the 4 farming system types. Type A villages reported an average increase in area from 0.01 ha to 0.06 ha per household, Type B – from 0.01 to 0.04 ha, Type C households– from 0.02 ha to 0.06 ha.

Table 6: Area (ha) planted with forages in each village

	Mombasa guinea	**Mulato II**	**Ubon paspalum**	**Green elephant**	**Ubon stylo**	**Pinto peanut**	**Rice bean**	**Total**
Type A	0.81	1.19	0.53	0.98	0.32	0.26	2.04	**6.13**
Type B	2.09	1.91	0.39	0.51	0.5	0.47	4.61	**10.48**
Type C1	0.37	0.44	0.03	0.28	0.08	0.01	0.45	**1.66**
Type C2	1.09	0.72	0.12	0.29	0.53	0.37	3.23	**6.35**
Total	**4.36**	**4.26**	**1.07**	**2.06**	**1.43**	**1.11**	**10.33**	**24.62**

Green elephant

Green elephant grass showed a high germination rate of >81% across all farming system types except in Type C1 with 79% (Table 7). Average yield ranged from 33.8 – 82.1 tonnes FM/ha with Type A and C2 recording the highest biomass of > 82 ton/ha after the second harvest while Type C1 reported the lowest yield as farmers did not apply any fertilizer. All farmers showed high preference (100%) and expressed interest to continue growing this variety as it is high yielding, grows fast, has soft leaves and stem and is liked by cattle and buffalo. However, when harvested too early or fed in large quantities, green elephant grass contains a lot of water which can cause bloating and diarrhea in cattle.



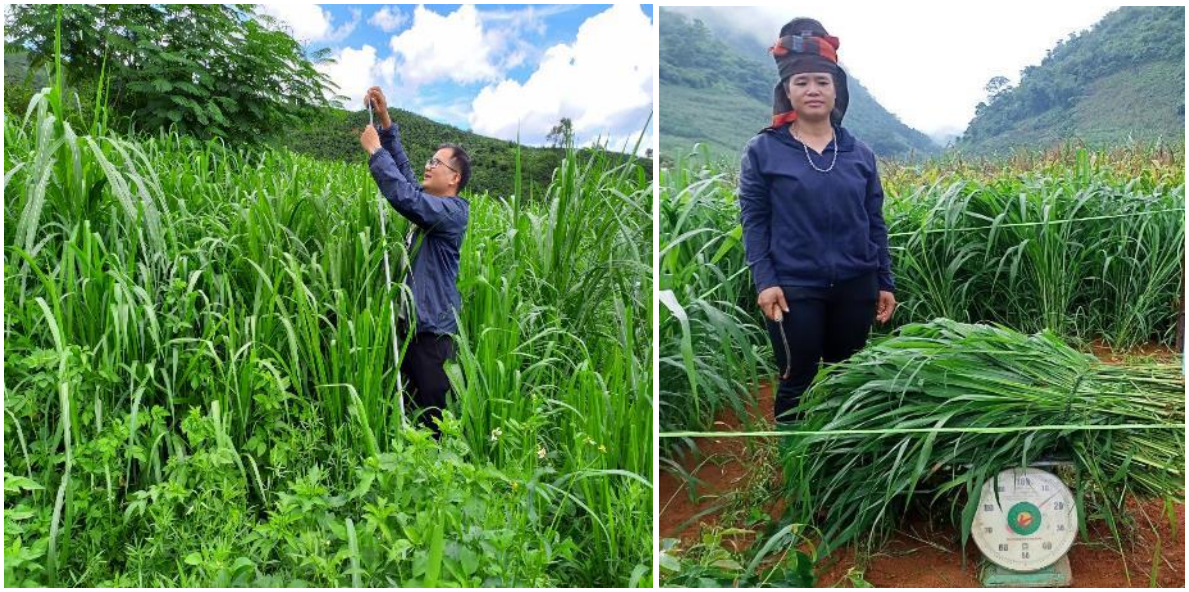
Green elephant grass
Photos: Bùi Văn Tùng, Phan Huy Chương (NOMAFSI)

Table 7: Parameters measured on the farmer-led trials

Forage variety	Typology	Yield 1st cut (tons/ha)	Yield 2nd cut (tons/ha)	Total yield (tons/ha)	Plant height 1st cut (cm)	Plant height 2nd cut (cm)	Germination rate (%)	High preference (%)	Medium preference (%)	Low preference (%)
Green elephant	**Type A**	45.4	37.5	83.0	232.7	214.5	87	100	0	0
	Type B	41.9	34.4	76.3	235.3	211.7	86	100	0	0
	Type C1	33.8	0.0	33.8	191.0	-	79	100	0	0
	Type C2	52.9	29.2	82.1	225.0	200.7	95	100	0	0
Mombasa guinea	**Type A**	30.8	27.9	58.7	152.8	144.0	71	19	75	6
	Type B	26.0	22.4	48.4	163.7	138.7	79	73	19	8
	Type C1	11.8	0.0	11.8	116.7	-	75	40	20	40
	Type C2	29.4	17.8	47.2	137.1	107.6	84	100	0	0
Mulato II	**Type A**	26.8	20.9	47.7	134.4	118.0	76	17	35	48
	Type B	23.3	19.1	42.4	124.4	128.2	86	38	42	21
	Type C1	12.1	0.0	12.1	84.8	-	74	67	0	33
	Type C2	26.0	15.9	41.9	102.8	60.0	80	67	0	33
Ubon paspalum	**Type A**	34.5	25.8	60.3	138.3	130.7	86	60	30	10
	Type B	25.9	16.3	42.3	128.8	105.3	66	30	70	0
	Type C1	10.6	0.0	10.6	78.5	-	63	0	50	50
	Type C2	36.1	30.0	66.1	121.0	104.0	75	25	75	0
Ubon stylo	**Type A**	11.0	5.6	13.8	90.3	66.5	70	0	67	33
	Type B	18.3	8.2	26.4	68.8	51.4	63	0	50	50
	Type C1	10.5	0.0	10.5	73.7	-	84	0	33	67
	Type C2	10.6	4.3	14.9	59.0	49.5	80	20	80	0
Rice bean	**Type A**	10.1	-	10.1	-	-	90	50	50	0
	Type B	12.4	-	12.4	-	-	92	32	36	32
	Type C1	13.8	-	13.8	-	-	100	50	50	0
	Type C2	8.1	-	8.1	-	-	82	0	67	33
Pinto peanut	**Type A**	2.7	-	2.7	-	-	65	0	67	33
	Type B	2.8	-	2.8	-	-	63	50	14	36
	Type C1	4.0	-	4.0	-	-	56	0	40	60
	Type C2	2.0	-	2.0	-	-	57	0	67	33

Mombasa guinea

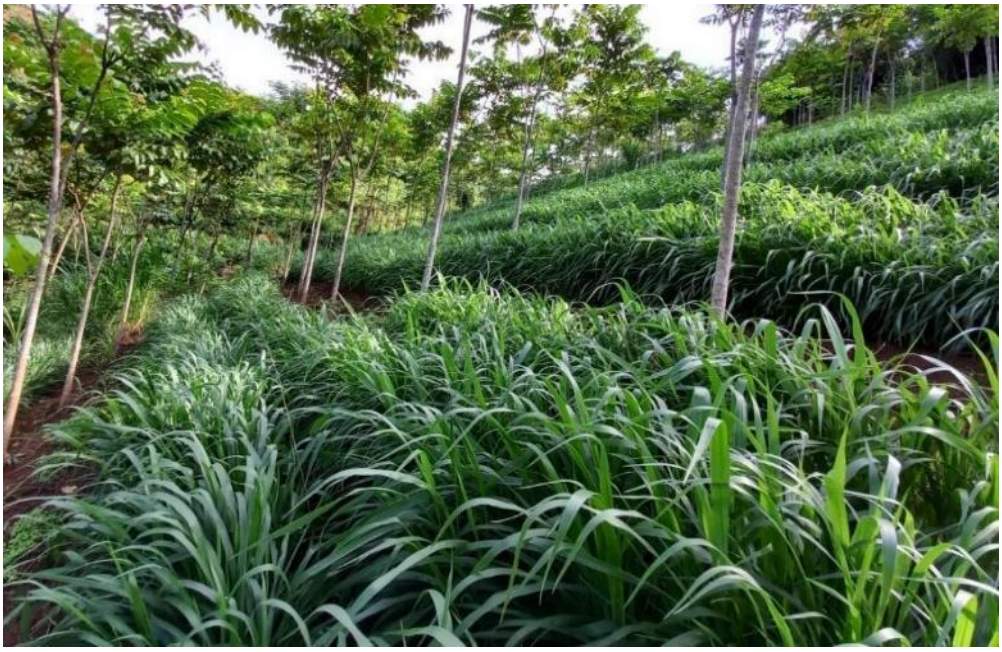
Germination rate ranged from 71-84% and was highest in Type C2 (84%) and lowest in Type A villages (71%) as it temporarily stopped raining after sowing. There were also issues with poor sowing and land preparation techniques and some seedlings eaten by chickens especially in unfenced plots. Biomass yield was lowest in Type C1 (11.8t FM/ha). Highest preference for Mombasa guinea was reported in C2 village because of high rate of germination and growth, and liked by cattle when fed in moderate quantities.



Mombasa guinea
Photos: Bùi Văn Tùng & Phan Huy Chương (NOMAFSI)

Mulato II

Similar to green elephant grass, Mulato II also showed a germination rate of 74-86% in all system types except in Types A and C1 due to poor land preparation and sowing methods, high temperatures and also seedlings damage by chickens. Average yield after the second harvest was 41.9-51.1t FM/ha except for C1 (12.8t FM/ha). Highest preference for this variety was reported in Type C households. However, 48% of Type A households reported low preference for Mulato II due to low germination and yield in some farms as compared to green elephant, hairy leaves and not liked by cattle and buffalo were further factors contributing to low preference.



Mulato II
Photo: Bùi Văn Tùng & Phan Huy Chương (NOMAFSI)

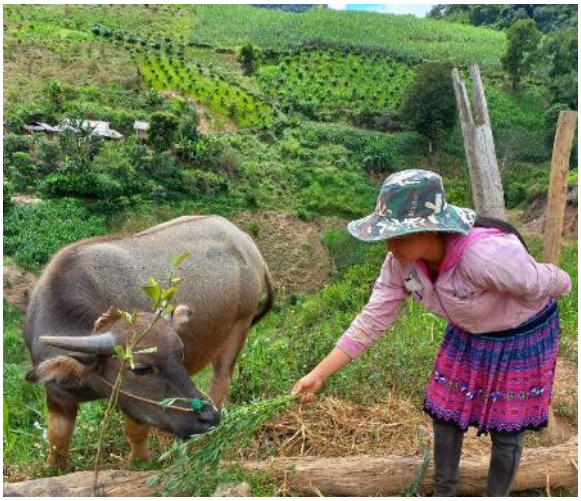
Ubon paspalum

Ubon paspalum recorded a high germination rate in Type A households (86%) and lowest in Type C1 and B (63-66%) attributed to poor land preparation and sowing methods, high temperatures and also seedlings damage by chicken. Type C1 also recorded the lowest yield of only 10.6t FM/ha. Most households reported high to medium preference while 50% of C1 had low preference for this variety. High preference was attributed to soft leaves and stem and liked by cattle when fed in moderate quantities. However, as with other grasses, cutting young Ubon paspalum and feeding large quantities caused digestion-related problems such as bloating and diarrhea in cattle.

Ubon paspalum
Photo: Bùi Văn Tùng & Phan Huy Chương (NOMAFSI)

Ubon stylo

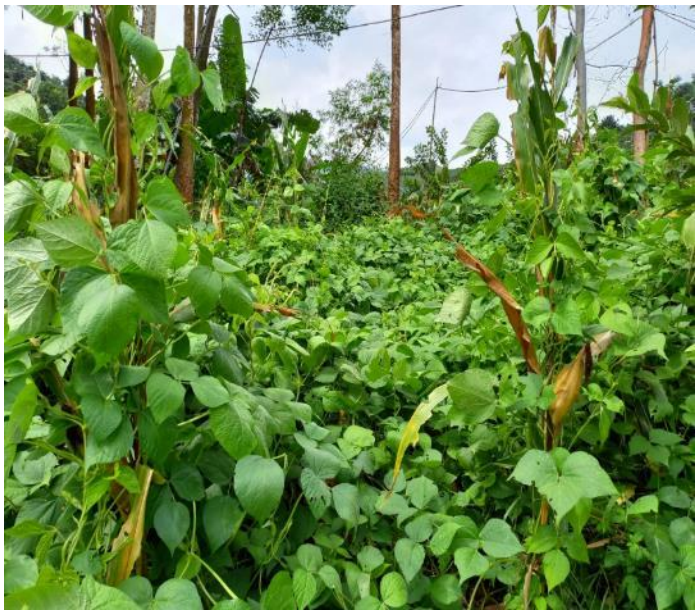
Stylo germinated well in Type C farms (80-84%), however the highest yield was reported in Type B after 2 harvests (26.4t FM/ha). Preference for Ubon stylo was medium to low as farmers complained about low yield, difficulties to manage, tough stem and not liked by cattle and goats even when fed in moderate quantities.

Ubon stylo
Photos: Bùi Văn Tùng & Phan Huy Chương (NOMAFSI)

Rice bean

Rice bean had the highest germination rate out of the 7 varieties ranging from 82-100% with Type C1 reporting 100% germination of sown seeds. As rice bean was planted later in the rainy season, low yields were reported at the time of sampling with only 1 harvest. Most farmers reported high to medium preference and intend to continue growing rice bean because it is a multipurpose -purpose crop (seeds can be used as food, biomass as feed, and because of additional benefits of improving soil health) and has a high germination rate. One constraint reported is the slow regrowth after the first harvest.

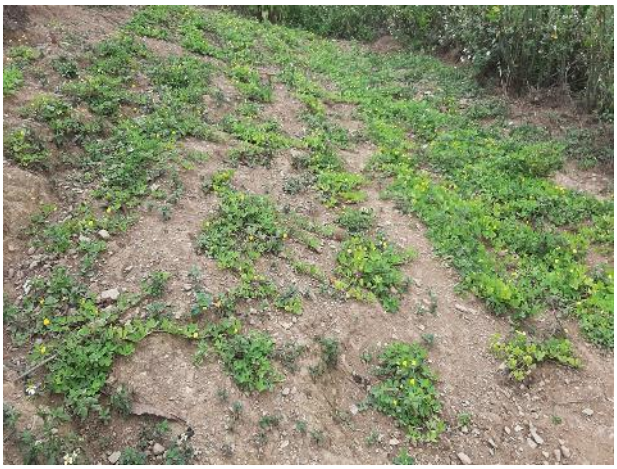
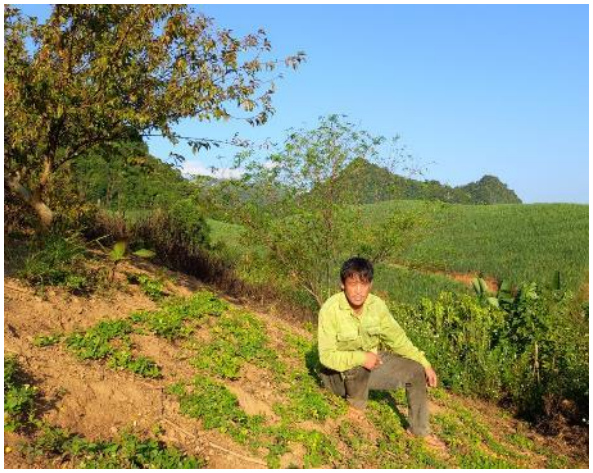


Rice bean intercropped with maize
Photo: Bùi Văn Tùng & Phan Huy Chương (NOMAFSI)

Pinto peanut

Of all the 7 forage varieties, Pinto Peanut had the lowest germination rate (57-65%), lowest yield (2-4t FM/ha) and lowest preference particularly in Type C1 (60%) due to low germination and yield, and slow growth. Surprisingly, Pinto peanut was expected to have a higher uptake and preference in C1 (extensive system) as it is best utilized as a ground cover under trees and tolerant to acidic soils

predominant in this area. However, the farmers who showed high preference for pinto peanut reported benefits of adopting this variety as they could feed it to pigs, chicken, and cattle, and for ornamental use because of its beautiful blossom.

Pinto peanut grown as ground cover
Photos: Bùi Văn Tùng & Phan Huy Chương (NOMAFSI)

d) Forage utilization and benefits of improved forages

- Forages are mainly fed for cattle and buffalo. Moreover, there is a small number of farmers who fed the promoted varieties to pigs and poultry (chicken, local goose and ducks). In this case, forages were often chopped and mixed with rice bran or maize meal.
- There was an increase in the number of forage varieties grown by farmers who previously relied on local Napier grass and to a lesser extent – Guinea grass, in addition to food-feed crops such banana, maize etc.
- Increased amount of feed available for livestock was reported and animals had enough to eat.
- Cut-and-carry systems helped to increase the availability of forages near the farms and family house, especially during rainy days when grazing is difficult.
- Increased transition to intensive systems, from grazing to stall feeding especially in Type A households.
- Growing forages reduced the cost and time of collecting native grasses from paddy fields and forests and prevented harvesting grass contaminants such as herbicides. Farmers had more time for other on-farm and off-farm activities.
- Increasing the availability of forages resulted in few farmers expanding their herd size.

IV. Farmers' perceptions

1. Photovoice stories

In the frame of Li-chăn project, the photovoice method was used as a participatory monitoring and evaluation tool to document change stories from farmers' perspectives (Wang & Burris 1997). Farmers gave their own reflections on livestock development including the benefits of growing improved forages, feed preparation and preservation for improved nutrition and productivity of livestock. These stories were featured in a virtual exhibition - *Livestock Development in Vietnam from Artists' and Farmers' Perspectives* - developed in collaboration with the Vietnam Fine Arts Museum (https://bit.ly/3BylpGr). Farmers shared stories on benefits of applying different methods of feed processing and preservation such as increased availability of feed, high preference of silage by cattle, increased weight gain of pigs fed with fermented feed. They also reported increased forage yields from selected varieties and availability of livestock feed, preference of their animals to different forages, challenges encountered when introducing new varieties to their animals, and plans to increase adoption of these forages. Below are some stories on adoption of animal nutrition techniques and improved forages.

"Lò Văn Thương has five buffaloes. When fresh sugarcane tops are not available, he uses fermented tops to feed his cattle.
Since 2016 and 2017, farmers in Mờn village have been fermenting grass and sugarcane tops to make fodder. Following these pioneers, I also ferment grass for the dry season, when there is a shortage of fodder. Previously, I did not add anything except sugarcane tops. Learning from the training by the Li-chăn project, I know that mixing rice bran helps fermentation, and sealing the bags protects the air-free silage from mold or rotting. My cattle prefer fermented grass."

Narrator and photographer: Lường Văn Yêu (Thai ethnicity, 46 years old)
Person in the photo: Lò Văn Thương (Thai ethnicity)

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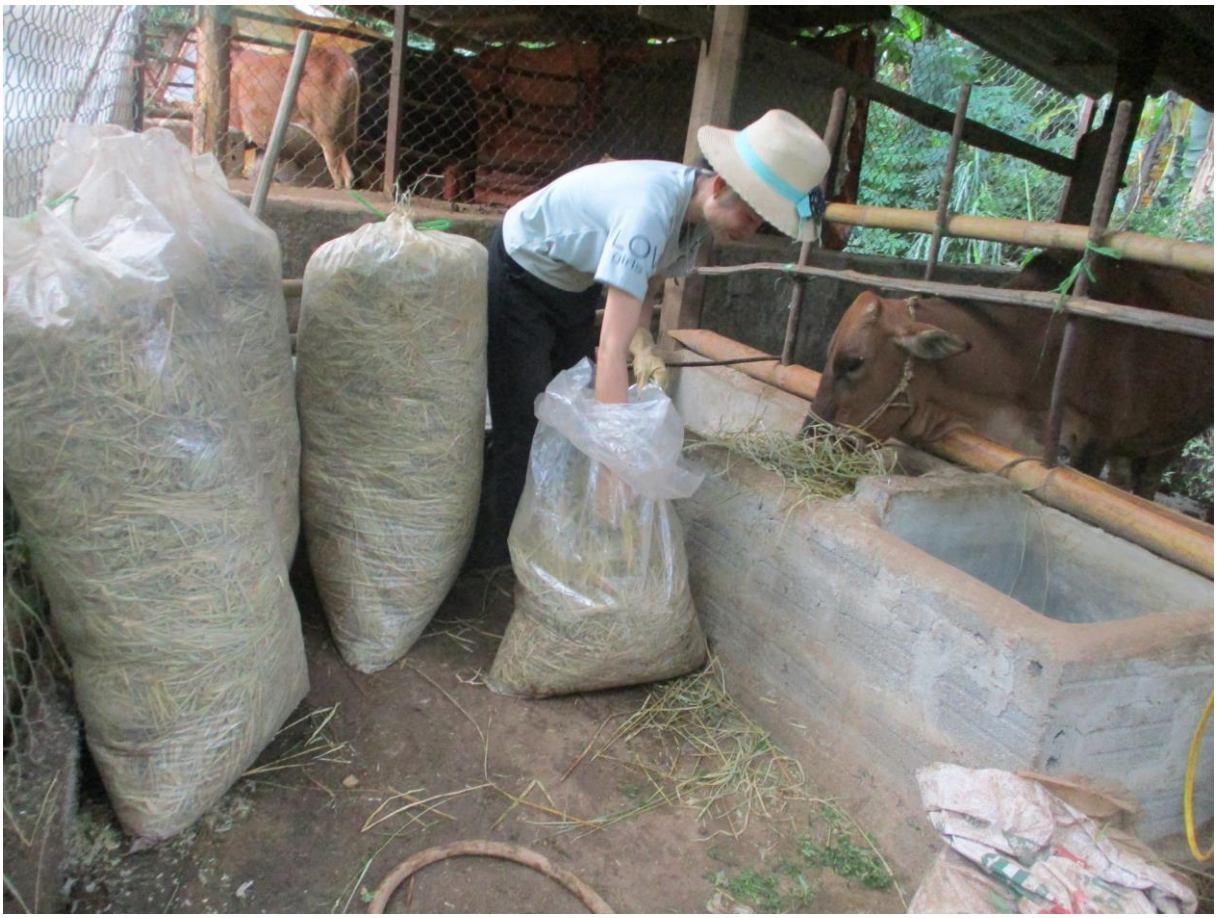

“This is the straw I treated with urea to feed my cows. Before joining Li-chăn project’s training, I did not know about mixing straw with urea and used only straw. Being fed with straw treated with urea, the cows look beautiful and their coats are soft. They consume more straw than before because the straw is softer.”

Narrator and photographer: Quàng Thị Thuấn (Thai ethnicity, 31 years old), and Quàng Thị Nương (Thai ethnicity, 12 years old)
Person in the photo: Quàng Thị Thuấn (Thai ethnicity, 31 years old)

“I am feeding pigs with fermented banana stems mixed with a little bran. Previously, I did not feed them with the mixture of banana stems and bran, and the pigs were skinny. Since I joined the Li-chăn (project’s) training, the pigs have grown rapidly and healthily as I feed them with the mixed bran.”

Narrator: Quàng Thị Thuấn (Thai ethnicity, 31 years old)
Photographer: Quàng Thị Nương (Thai ethnicity, 12 years old)
Person in the picture: Quàng Thị Thuấn (Thai ethnicity, 31 years old)

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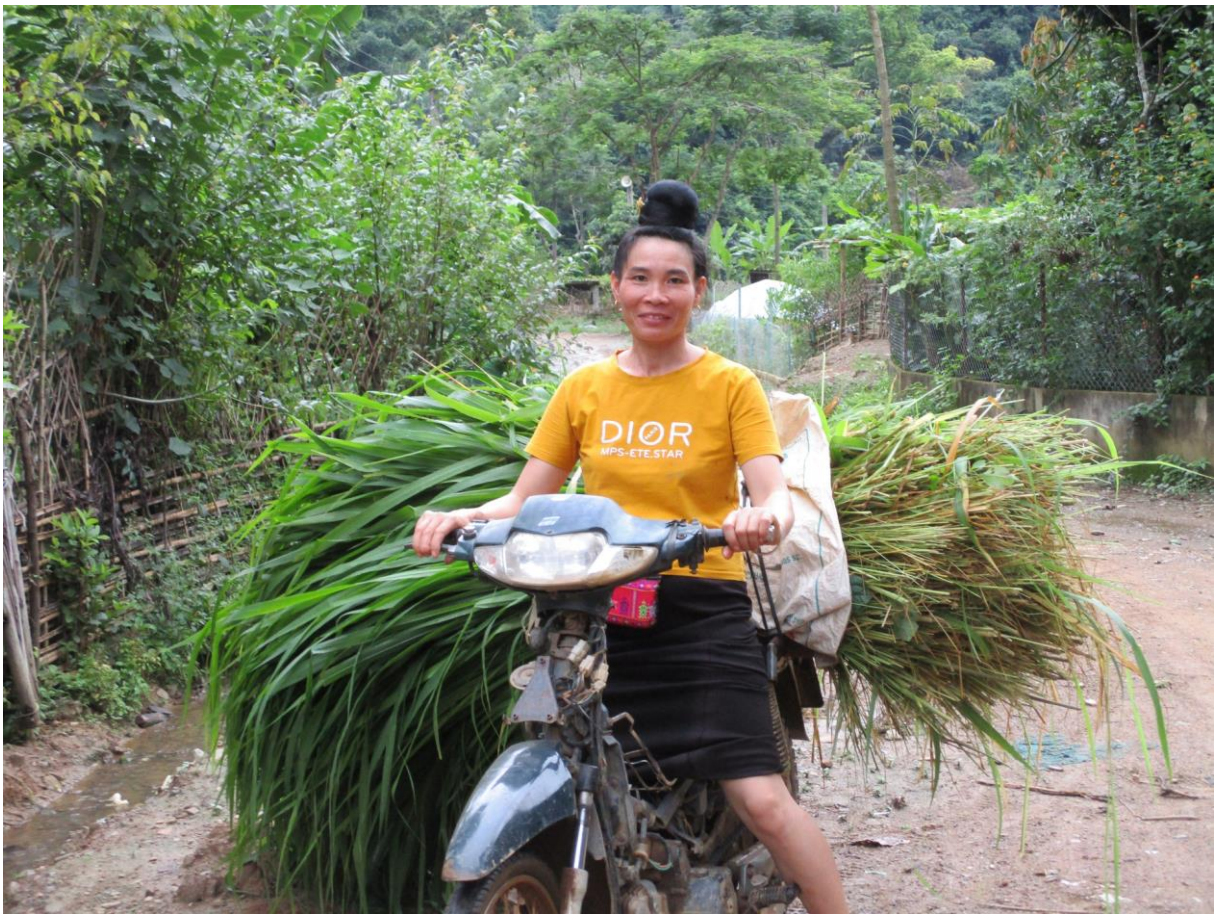


“My wife is going to cut grass in our field about 100 metres from home. It often takes her about 30 minutes. This is Guinea grass provided by the (Li-chăn) project for trial planting. In addition to rice bean, we grow three varieties of grass: Mombasa guinea, green elephant and Mulato II. We have harvested 17 kilograms of Mombasa Guinea grass, 15 kilograms of Mulato II grass and 35 kilograms of green elephant grass on an area of four-square metres. Rice bean is planted to harvest its foliage for feeding the cows. The productivity is satisfactory. Currently, these varieties are suitable for the soil, but I don't know if they are drought tolerant during the dry season. The chopped rice bean and green elephant grass are accepted by the cattle. The stem of Mombasa guinea grass is too hard for them, but they can eat the leaves.
I’m planning to plant more green elephant and Mombasa guinea grass next year because they are tall and easy to harvest.”

Narrator and photographer: Lường Văn Dũng (Thai ethnicity)
Person in the photo: Lường Thị Liến (Thai ethnicity)

livestockpanorama.ilri.org/en/livestock-development-farmers-perspective/ff23-story-dung

"Dụ is weeding the green elephant grass field of the Li-chăn project. The field is about 1,000 square metres, growing green elephant grass at the foot of the hill and Mombasa Guinea grass at the top. I have decided to raise more cows and build a shed. So, I want to try and find out which grass variety is better before scaling up so that I have enough fodder for my cattle.
Currently, I have three cows and one buffalo. I have enough grass because I have sugarcane leaves in the dry season. However, there will be a shortage of fodder if I expand the herd. In Chiềng Lương commune, we run out of fodder in April and May because there is no longer a supply of sugarcane leaves. From June to October, the fodder supply is sufficient as elephant grass is available. From November, sugarcane tops are used to feed the cattle again."

Narrator and photographer: Lý A Trống (Hmong, 43 years old)
Person in the photo: Sồng Thị Dụ, wife of Trống (Hmong)

livestockpanorama.ilri.org/en/livestock-development-farmers-perspective/ff18-story-trong

"After planting green elephant grass two months ago, many households have harvested the grass to feed their cattle. Lêng collected 20 kilograms of grass. This grass is very productive. It is less hairy but tall. This variety is soft and the whole plant can easily be chopped. The traditional variety of elephant grass has hard stems and hairy leaves. Only the upper half of its stem is chopped. Farmers are in favour of this variety and keep asking for seeds all the time.
The harvested green elephant grass contains a lot of water, causing diarrhea in cattle if they consume too much. If grass is mixed with straw or dried for feeding on the following day, diarrhea can be avoided."

Narrator and photographer: Lường Văn Yêu (Thai ethnicity, 46 years old)
Person in the photo: Hà Thị Lêng (Thai ethnicity)

livestockpanorama.ilri.org/en/livestock-development-farmers-perspective/ff9-story-yeu

2. Technical feedback from farmers

- Provide more seeds and planting materials for new, improved forages to be tested by farmers. Farmers who did not register for some varieties would like to expand the area for forages and test these varieties.
- Organize follow-up technical trainings on feed processing, feed mixing, preservation of feed for winter, cultivation of forages.

- Provide technical advice on crop production to achieve high biomass yield such as irrigation methods, support with inputs such as fertilizers, equipment e.g., chopping machines to reduce labour and time spent on feed processing.
- Support access to credit facilities or capital for farmers to increase and expand investments in livestock production.

V. Challenges for implementation

Language barrier: The study area is mainly occupied by ethnic minorities (Thai and Hmong) and some farmers do not understand Kinh language (Vietnamese) nor English. This can pose a challenge when conducting trainings and usually requires the help of a translator.

Accessibility: Some villages are difficult to access especially during the rainy season e.g. Xam Ta, Buom Khoang, and sometimes Oi village.

Covid-19 pandemic: Travel restrictions limited follow-ups to guide farmers on forage management and utilization. However, forage factsheets were developed and adapted to address issues raised by farmers such as appropriate cutting time, feed mix and use.

Forage utilization and adoption of feed technologies:

- Farmers reported low preference for forage legumes due to low germination, slow growth, tendency to be outcompeted by weeds, low biomass yield and low palatability when fed to animals.
- Forages harvested when too young and fed in large quantities to animals caused digestive complications as young leaves and stems contain high water content. When left in the field for long periods before harvesting, the leaves and stem became too hard for the animals to eat. Farmers also complained that Mulato II having hairy leaves and stems caused discomfort during cutting.
- Despite being trained on feed processing techniques such as chopping and feed mixing, almost all farmers tended to feed their cattle with one forage variety at a time. This led to livestock not quickly getting used to eating these new and improved forages.
- Some techniques such as silage preparation are labour intensive requiring several steps and materials e.g., nylon bags, basins, and collecting forages and crop residues. If farmers do not apply the recommended rate and proportion of raw materials, the silage quickly goes sour and cannot be stored for a long period.

VI. Conclusions and recommendations

1. Forage management and utilization

Highest preference was reported for 3 grass varieties (Green elephant, Mombasa guinea and Ubon paspalum) due to their high germination rate, high biomass productivity and good palatability. Moderate preference was expressed for forage legumes (Ubon stylo, rice bean, *Arachis pintoi*) and Mulato II. Overall, farmers expressed willingness to expand land area to grow more improved forages. Preliminary results reported high biomass yields and increased feed availability for livestock. However, it is still early in the project to evaluate the impact of interventions on livestock productivity, labour savings and changes to household income. Continued monitoring and evaluation of promoted feed interventions should be done to assess impact on socio-economic and productivity indicators.

Forage management approaches such as appropriate cutting time, not harvesting too early or late can ensure animals get high quality feed. There is a need to find a balance between animal health, forage biomass and quality. Fencing forage plots can protect seeds and seedlings from being destroyed by wandering animals such as poultry. Inputs such as application of fertilizers are important to increase biomass yield especially for areas with poor soils.

Adoption of high yielding, high quality forages and feed techniques can improve livestock production for smallholder livestock farmers in NW Highlands, who mainly rely on low quality forages and crop residues. To increase forage area, small-scale farmers can multiply planting materials, harvest seeds from legumes (e.g., rice bean, stylo) or use vegetative cuttings for grasses and Arachis pintoi. These planting materials can also be shared with or sold to other interested farmers. As winter feed shortage is the main feed-related challenge in this area, monitoring the on-going forage trials and adoption of feed techniques in the upcoming winter season will inform appropriate changes to the feeding strategy.

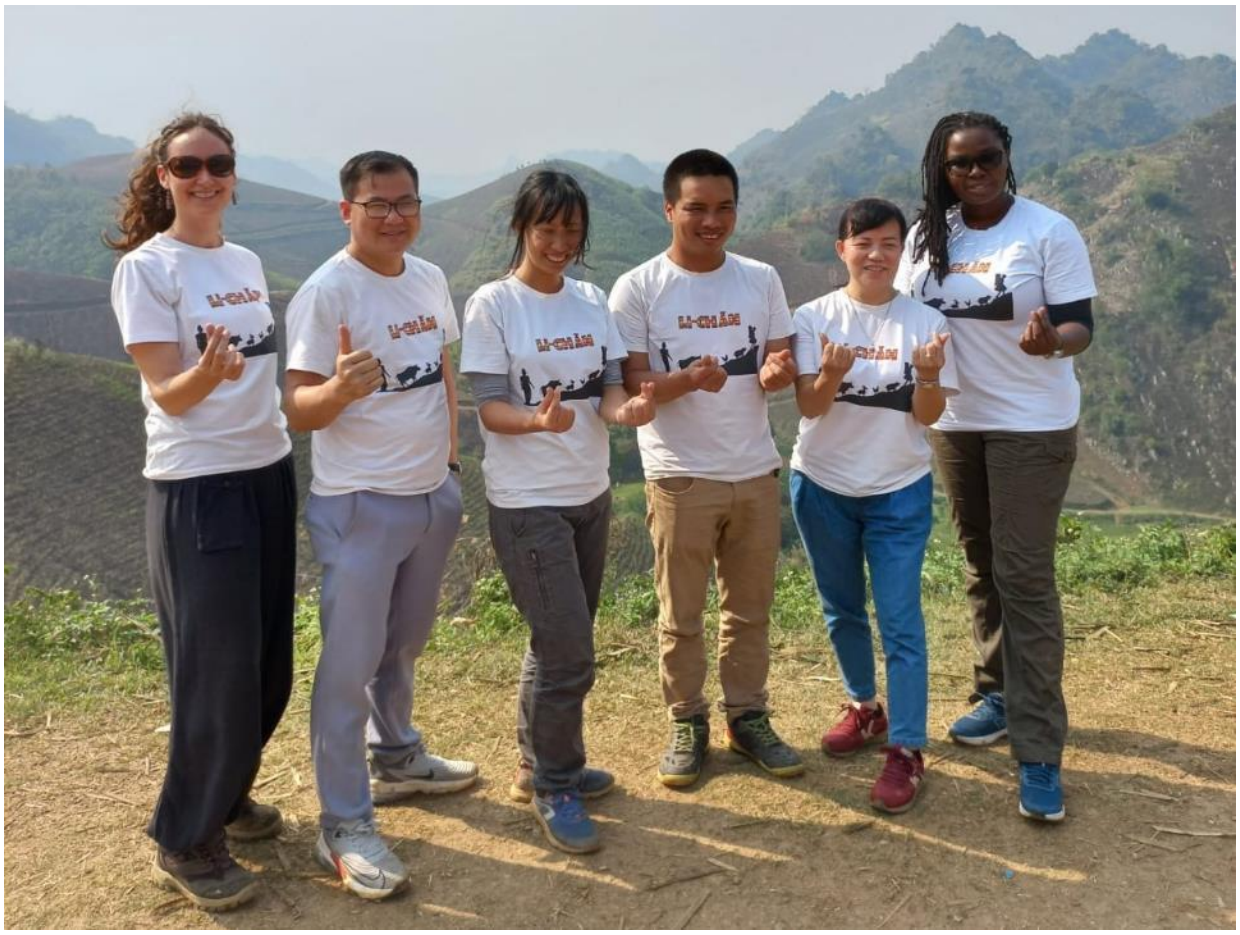
2. Technical approach

Hands-on trainings and on-farm practical demonstrations for farmers on forage management and utilization, feed processing and preservation is crucial for optimum use of forages to achieve improved animal nutrition. Maintaining a gender balance during flagship activities also saw more female farmers actively participating in practical trainings.

3. Future scaling

A seed system network analysis in Northwest Highlands of Vietnam reported government agencies and traders as the main sources of forage planting materials while dissemination is primarily from farmer to farmer especially in beef-oriented systems (Leyte *et al*., 2021). In this study, seeds and planting materials were sourced from local seed traders and government institutions multiplying and disseminating planting materials. Local authorities, village chiefs and commune vets provided support to project activities in different ways such as distributing planting materials to farmers, organizing farmer trainings and practical demonstrations, preparing training materials and helping the technical team with trial monitoring. Local authorities also supported the technical team with getting permits

to enable travelling to the intervention villages. Local authorities also supported with ensuring inclusion and access to ethnic minorities in remote areas as well as equal participation of men and women, wherever possible, in the study interventions. As seed exchange is dominated by formal actors/traders whereas transfer of vegetatively propagated materials is mainly through farmers, these actors can play a key role in developing efficient forage seed systems, capacity building and knowledge exchange to improve technical skills as a driver for scaling (Leyte *et al*., 2021). Engaging local authorities, such as People's Committee at provincial, district and commune levels, Sub-Department of Animal Health, Animal Husbandry & Aquaculture (Sub-DAH), can ensure successful implementation, sustainability of feed interventions, and essential for future scaling.



Feeds & Forages Vietnam technical team. From left: Sabine Douxchamps (ABC), Bùi Văn Tùng (NOMAFSI), Mai Thanh Tú (ILRI/ABC), Phay Huy Chương (NOMAFSI), Trần Bích Ngọc (NIAS), Mary Atieno (ABC)
Photo: Mary Atieno (ABC)

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