Australian Government
Australian Centre for International Agricultural Research

AGRONOMIC AND CAPACITY BUILDING ACTIVITIES

Project AGB/2012/078 "Developing value-chain linkages to improve smallholder cassava production system in Vietnam and Indonesia"

Northern Mountainous Agricultural and Forestry Science Institute

CIAT
Centro Internacional de Agricultura Tropical
International Centre for Tropical Agriculture

The University of Queensland
AUSTRALIA

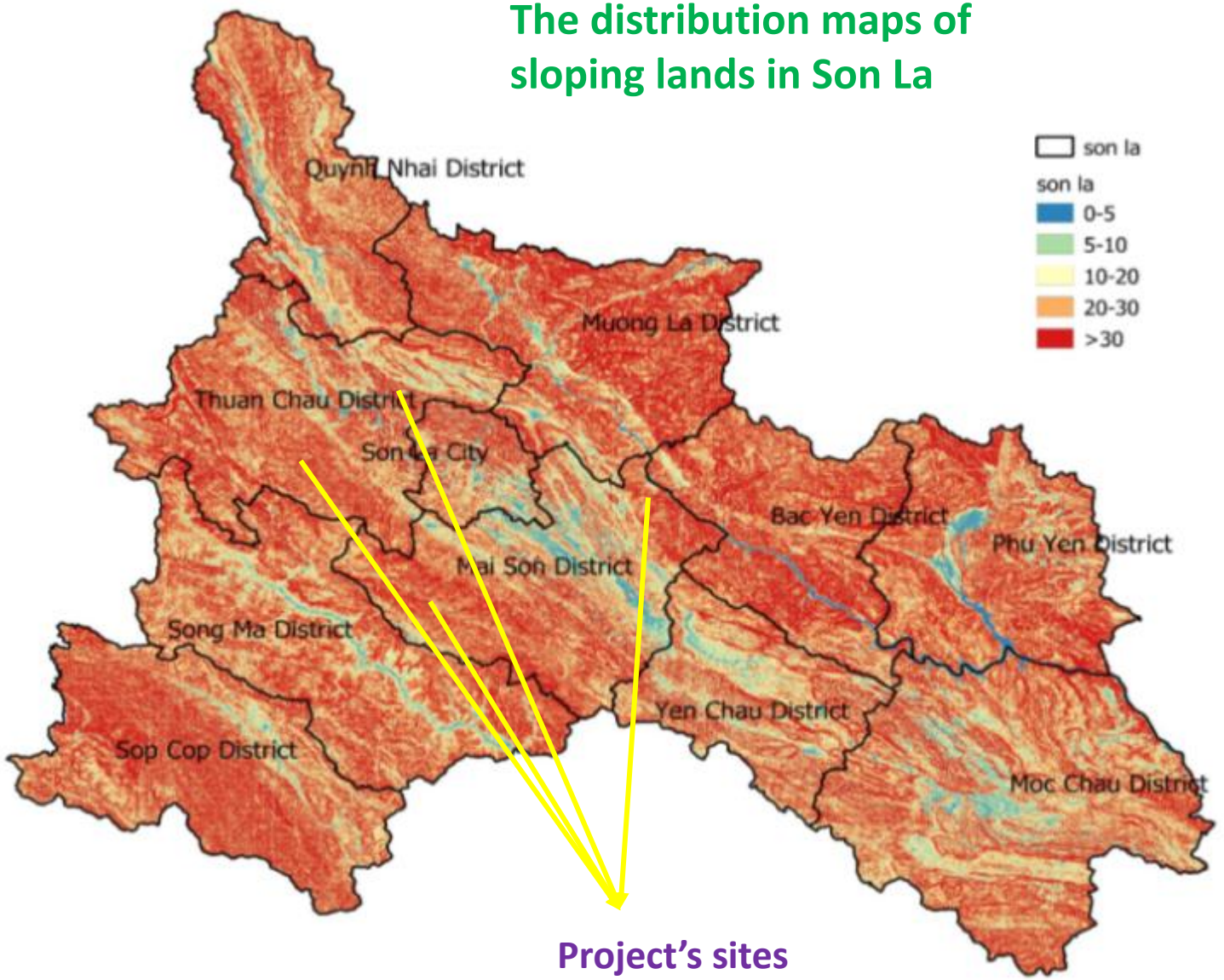
Outlines

- **Context and objectives**
- **Sites and activities**
- **Results**
  - Variety trial
  - Fertilizer trial
  - Soil management trial
  - Density trial
  - Harvest time trial
  - Capacity building & communication

CONTEXT AND OBJECTIVES

- Son La is a province in the Northern Mountainous Region of Vietnam with most cultivated lands slopping
- Cassava is one of the important cash crops in the province which is mostly cultivated in poor sloping lands, and **both the yield and economic benefits are low .**

The distribution maps of sloping lands in Son La

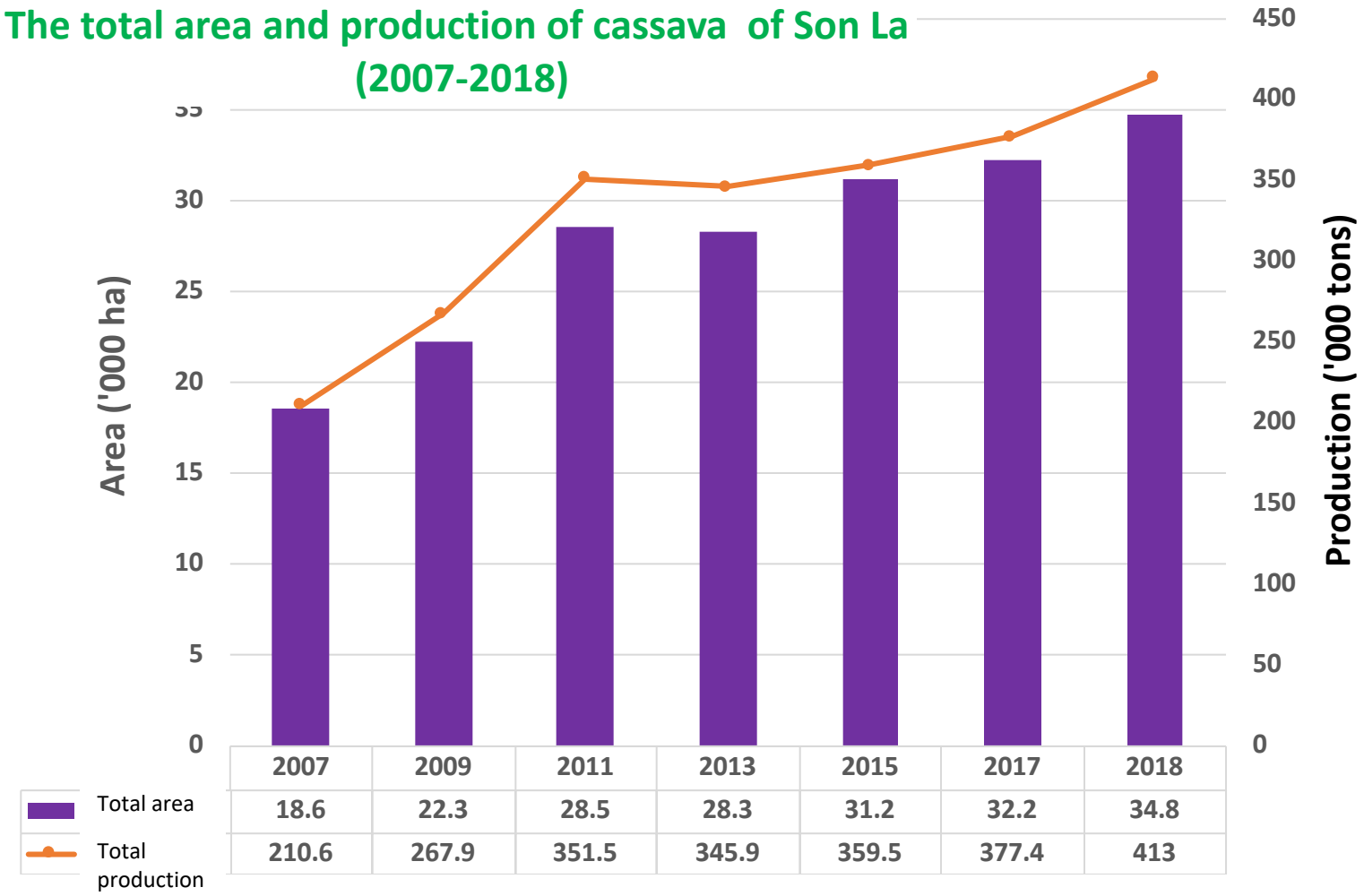


Project's sites

CONTEXT AND OBJECTIVES OF THE TRIALS (cont.)

Son La is the biggest cassava producer in the northern mountainous region of Vietnam (NMR), with the total cassava area slightly increasing annually and reach of 34,800 ha in 2018.

Nevertheless, the popular cultivation techniques remain unstable and causing serious land erosion.



CONTEXT AND OBJECTIVES (cont.)

- Cassava monoculture with short harvest season
- Land with steep slopes
- Old varieties with low yield
- Traditional practice causing soil erosion
- Inappropriate fertilizers application

Problems:

1. Soil erosion and degradation
2. Low and unstable yield and income
3. Short harvest season causing difficulties in harvest, selling and processing fresh roots

Objectives:

1. Reduced soil erosion
2. Improved soil fertility
3. Increased income & economic benefit

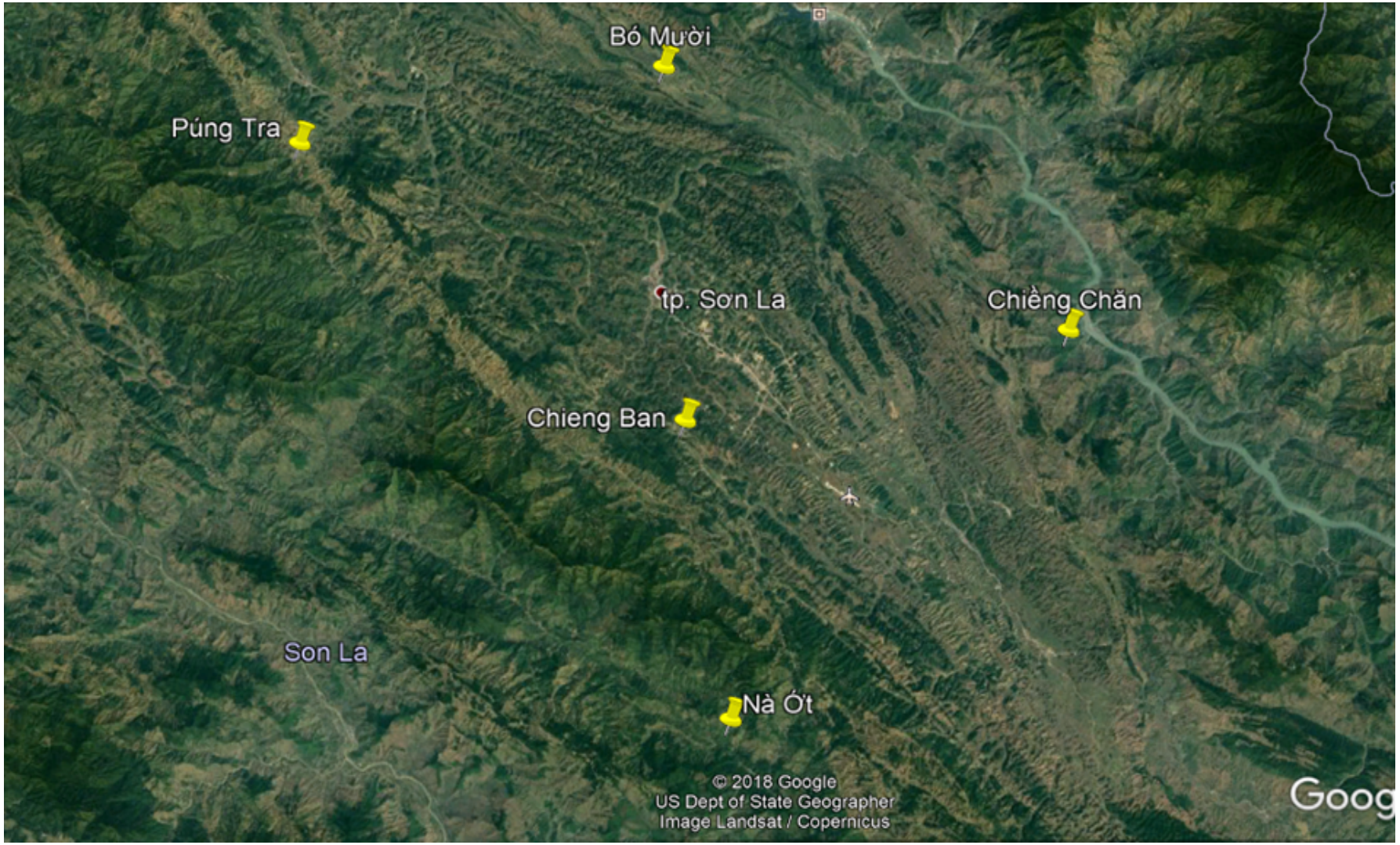
- Variety trial
- Fertilizer trial
- Soil management trial
- Planting density trial
- Harvesting time trial

TRIAL SITES

	Chiềng Chăn-Mai Sơn	Nà Ớt - Mai Son	Bó Mười - Thuận Châu	Púng Tra - Thuận Châu	Northwest center Xã Chiềng Ban – Mai Sơn
Total area (km²)	60,03	106,50	62,21	25,64	35,73
Total population	6.449	2.976	8.163	3.138	6.973
Main ethinicity	Thái, H'Mông, Kinh	Thái, Khơ Mú, Sinh Mun, H'Mông	Thái	Thái La Ha	Thái, Kinh
Total casava area (ha)	244	541	100	750	20
Main crops	Maize, casava, sugarcane	Cassava, coffee	Maize, cassava	Cassava, coffee	Coffee

In the communes where the trials were conducted, more than 70% of the total households produce cassava, with the average area ranging from 0.3 to 0.9 ha/household. Most of cassava land is sloping with serious problems of soil erosion and degradation.

GIS map of the trial sites



OBJECTIVES OF THE TRIALS

- Variety trial: To introduce new appropriate high yielding varieties for Son La
- Fertilizer trial: To identify appropriate types, levels and application methods of fertilizers for cassava in Son La
- Soil management trial: To verify and disseminate sustainable cultivation practices to reduce soil erosion for cultivation of cassava on slopes in Son La
- Density trial: To identify appropriate planning density
- Harvesting time trial: To assess the possibility to extend the harvest season of cassava in the province

1. Variety trial

- 4 New varieties: 13Sa05, BK, Rayong 9 and Sa21-12
- 2 locally popular varieties as controls: KM94 and La Tre

Notes:

- Fertilizer: Using single nitrogen, phosphorus and potassium at the level of 60N/15P/60K (equal to 130 kg urea, 213 kg superphosphate, 120 kg potassium chloride)

Basal dressing: All the amount of phosphorus and 1/3 of the total nitrogen fertilizers.

Top dressing (1^{st}) : 1/3 of total N and 1/3 of total K (45 days after sprouting)

Top dressing (2^{nd}): 1/3 of total N and 2/3 of total K (75 days after sprouting)

- Planting density: 10,000 plants/ha

2. Fertilizer trial

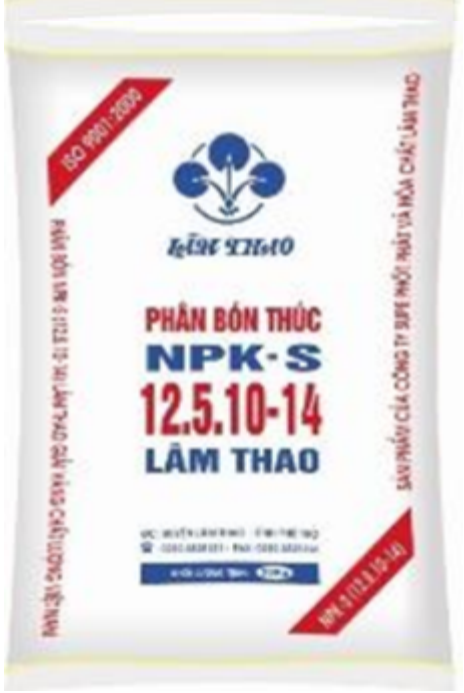
Five treatments:

- **CT1**: Without fertilizers
- **CT2:** 300kg/ha, NPK (5-10-3), all as basal (when planting)
- **CT3**: 300kg/ha, NPK (12-5-10), all as basal (when planting)
- **CT4**: 40N-10P-40K (equal to 87 kg urea, 142 kg superphosphate, 80 kg kaliclorua),
- **CT5**: 60N-15P-60K (equal to 130 kg urea, 213 kg superphosphate, 120 kg kaliclorua)

Notes; CT4 and CT5: Applied in three times (basal: all phosphorous fertilizer and 1/3 urea; The remaining urea and potassium were top dressed in 2 times, 45 days and 75 days after sprouting)
Variety: KM94 was used, density of 10,000 plants/ha

In the 1st year we included also the treatment of using DFP (deep fertilizers placement), but it appeared that DFP is not suitable in the local conditions (sloping and drought-problematic lands), and thus we no longer included this treatment in the following years.

The three most used Urea, Phosphate and Potassium fertilizers



3. Soil management trial

5 treatments:

CT1 (Control): Cassava monoculture

CT2: Cassava with black bean intercropped

CT3: Cassava with peanut intercropped

CT4: Cassava with grass hedgerows to prevent soil erosion (Guinea grass, *P. maximum*)

CT5: Cassava with strips of cassava plant residues from previous seasons

Notes:

Variety: KM 94, 10,000 plants/ha

Fertilizer: Using single N, P, K fertilizers at the level of 60N+15P+ 60K,

Basal dressing: Entire P, 1/3 N.

Top dressing 1st: 1/3 N, 1/3 K (45 days after sprouting)

Top dressing 2nd 1/3N, 2/3 K (75 days after sprouting)

In the 1st year we included also the treatment of intercropping with mungbean. However, almost all mungbean plants died shortly after germination, and as mentioned by local farmers they have never succeeded in production of mungbean in the region. Thus, we omitted this treatment afterward.

4. Planting density trial

4 planting densities were assessed:

- M1 (0.8m X 0.6m, 20,800 plants/ha)
- M2 (0.8m X 0.8m, 15,600 plants/ha)
- M3 (0.8m X 1.0m, 12,500 plants/ha)
- M4 (1.0m X 1.0m, 10,000 plants/ha)

Notes:

- **Variety used:** KM94,
- **Fertilizer used:** Separated N, P, K with the level of 60N+15P+ 60K,

  Basal dressing: Entire P, 1/3 N.

  Top dressing 1st: 1/3 N, 1/3 K (45 days after sprouting)

  Top dressing 2nd: 1/3N, 2/3 K (75 days after sprouting)

5. Harvesting time trial

10 harvest times :

CT1 (in season1): December (2018)		**CT6:**	June (2019)
CT2 (in season 2): January (2019)		**CT7:**	July (2019)
CT3 (in season 3): March (2019)		**CT8:**	August (2019)
CT4:	April (2019)	**CT9:**	September (2019
CT5:	May (2019)	**CT10:**	November (2019)

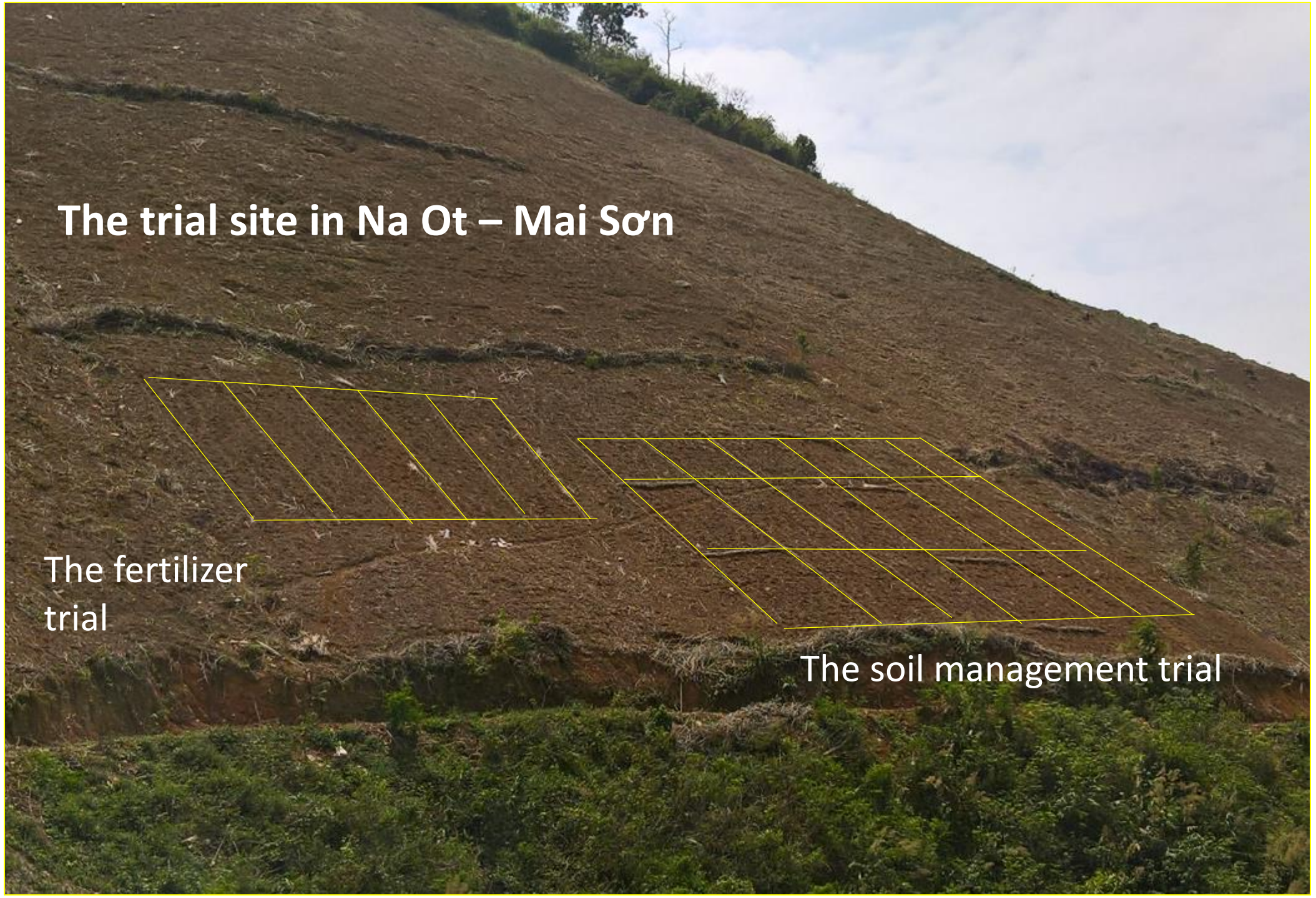
Notes:

Planting date: 15/4/2018

Varieties used: KM 94, La Tre

Planting density: 1m x 1m (10,000 plants/ha)

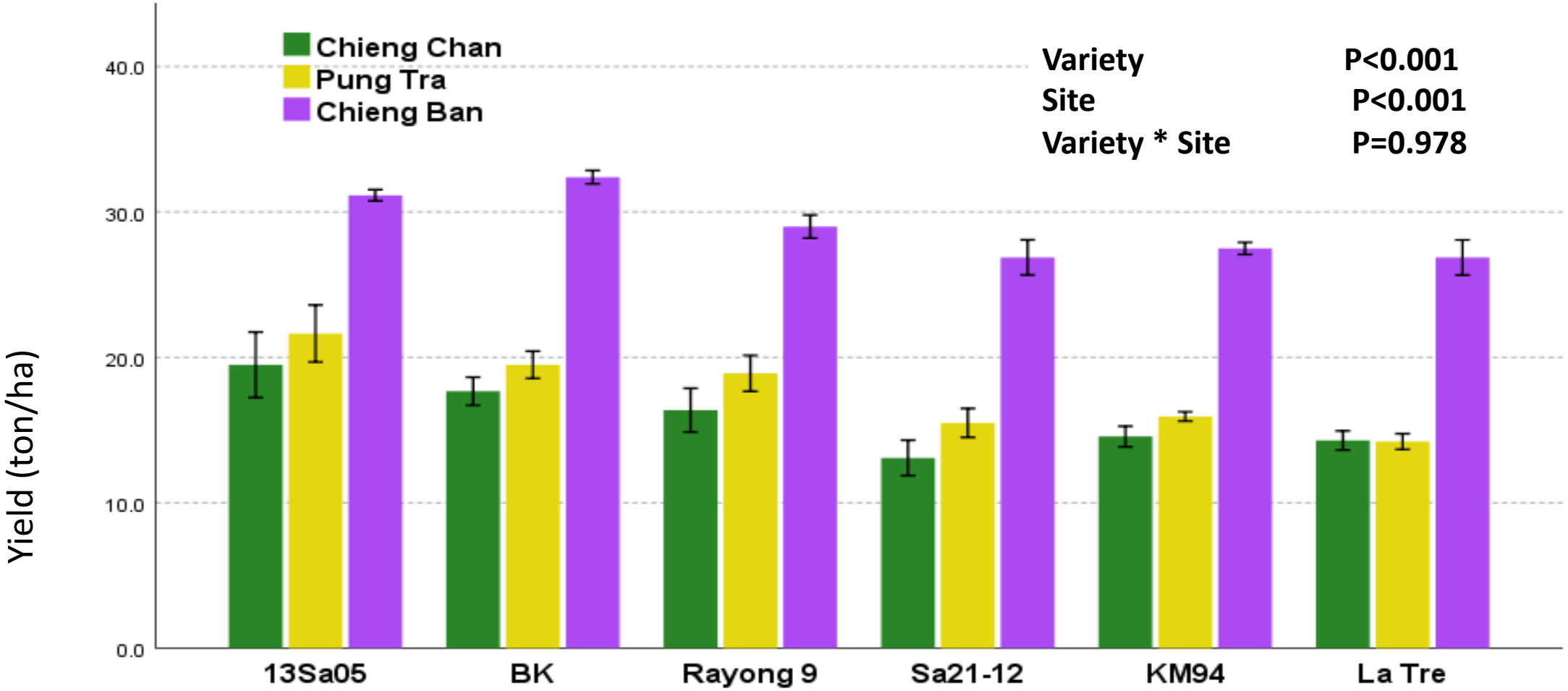
Fertilizers used: Single N, P, K (60N+15P+ 60K); Basal: All P and 1/3 N; Top dressing (1st): 1/3 N, 1/3 K (45 days after sprouting); Top dressing (2nd): 1/3N, 2/3 K (75 days after sprouting)


The trial site in Na Ot – Mai Sơn
The fertilizer trial
The soil management trial

Land management trial in Pung Tra

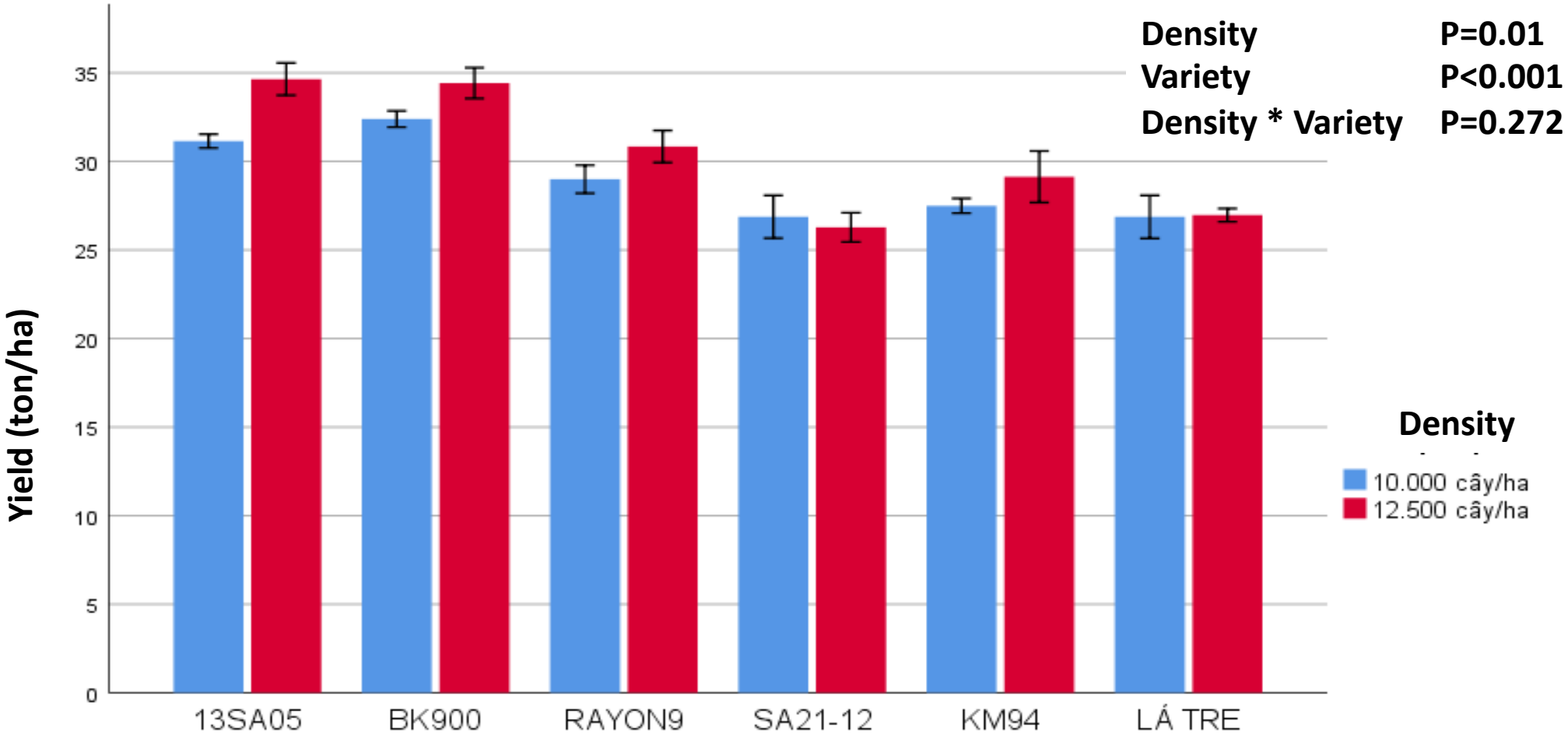
RESULTS
OF THE VARIETY TRIAL

The yield of the cassava varieties in different sites



2 new varieties **13Sa05** and **BK** grew well, their yields ranged from 18-32 tons/ha (depending on the conditions - slope, soil fertility…), 14-76% higher than the yields of the 2 control varieties (locally popular KM94 and La tre)

Fresh root yield of varieties in Chieng Ban site at 2 planting densities



2 varieties 13Sa05 and BK performed good growth and gave high yield compared to other varieties, at both planting densities 10,000 plants/ha and 12,500 plants/ha.

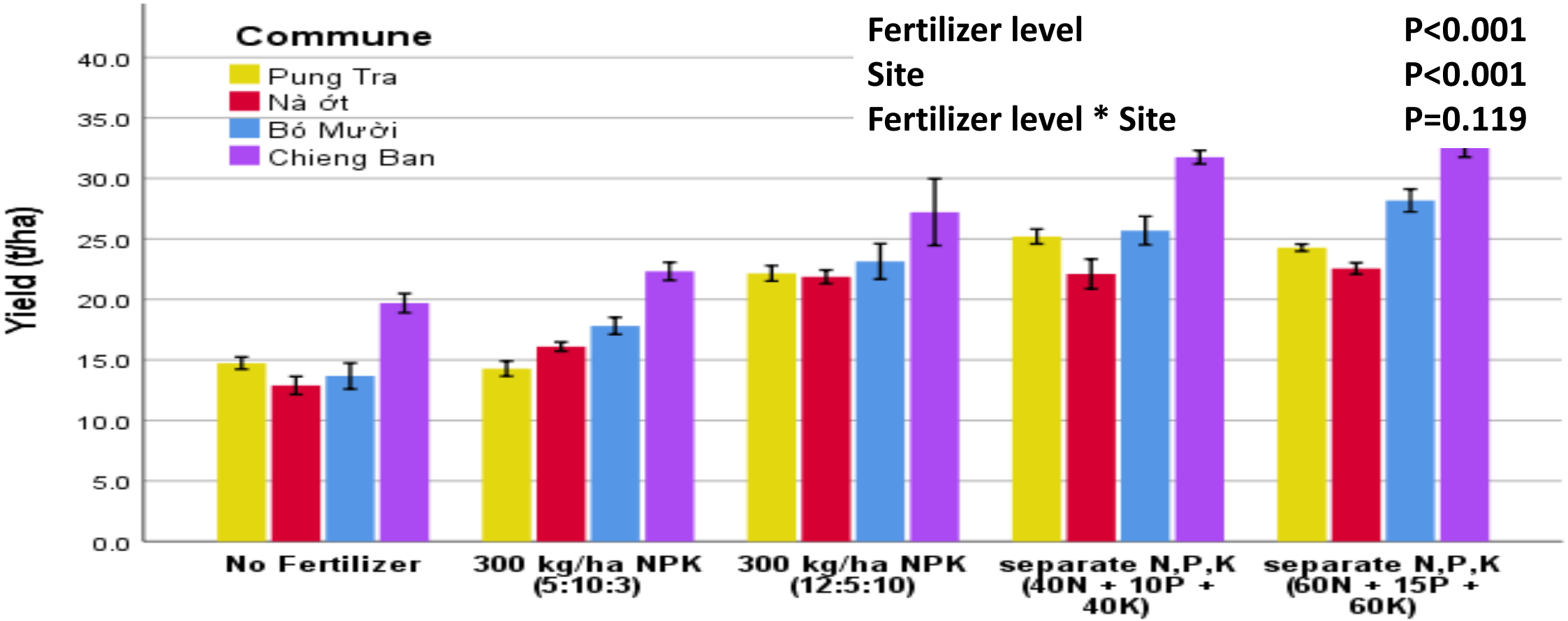
Table 1: Starch content (%) of the varieties

Variety	Pung Tra (28/11/2018)	Chieng Chan (23/1/2018)
KM94	30.0	28.2
13SA05	30.0	29.8
RAYON9	27.7	28.0
LÁ TRE	30.0	30.0
BK	28.7	30.0
SA21-12	30.0	29.7

All the varieties had high starch content which is suitable for producing starch.

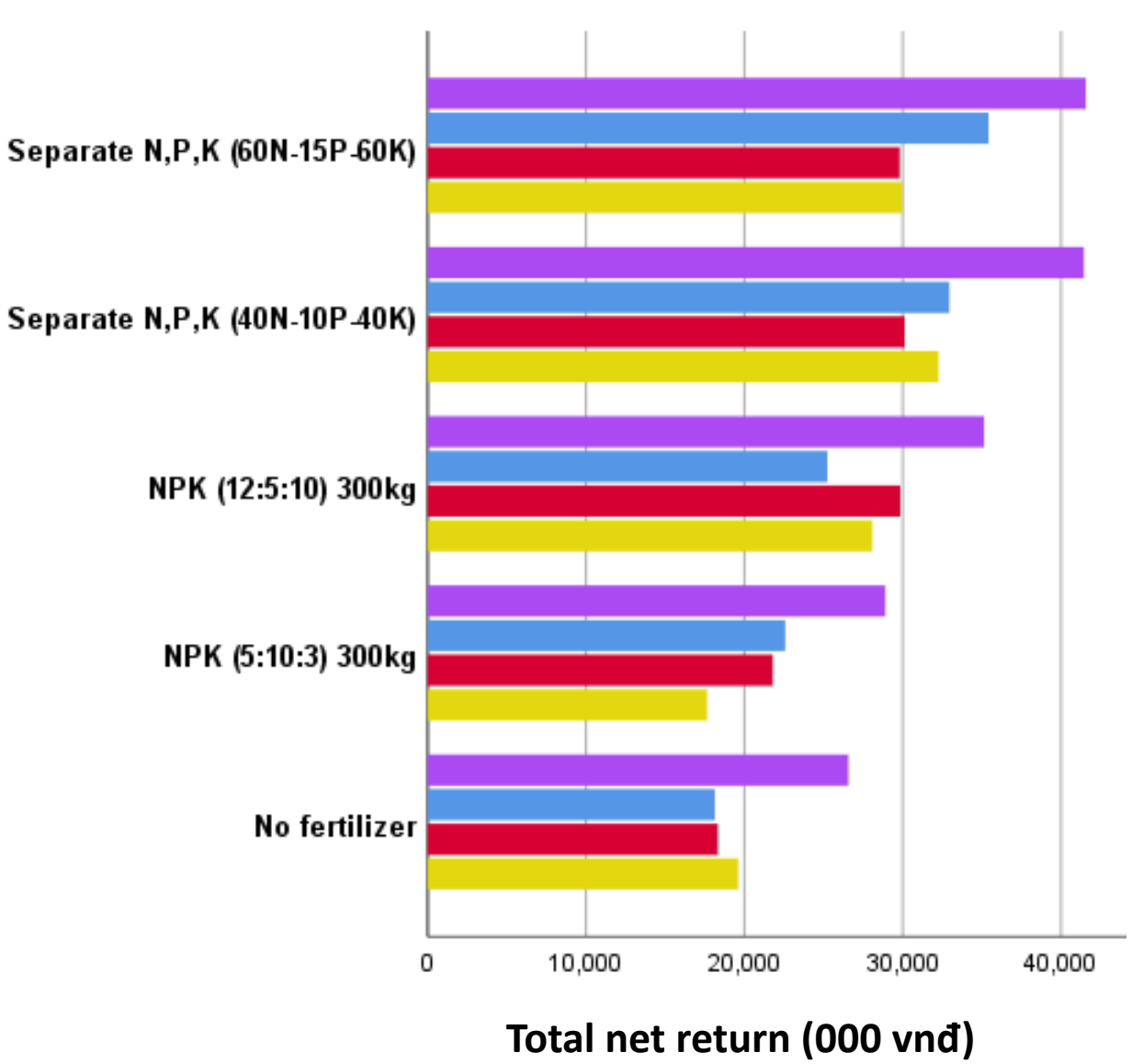
RESULTS
OF THE FERTILISER TRIAL

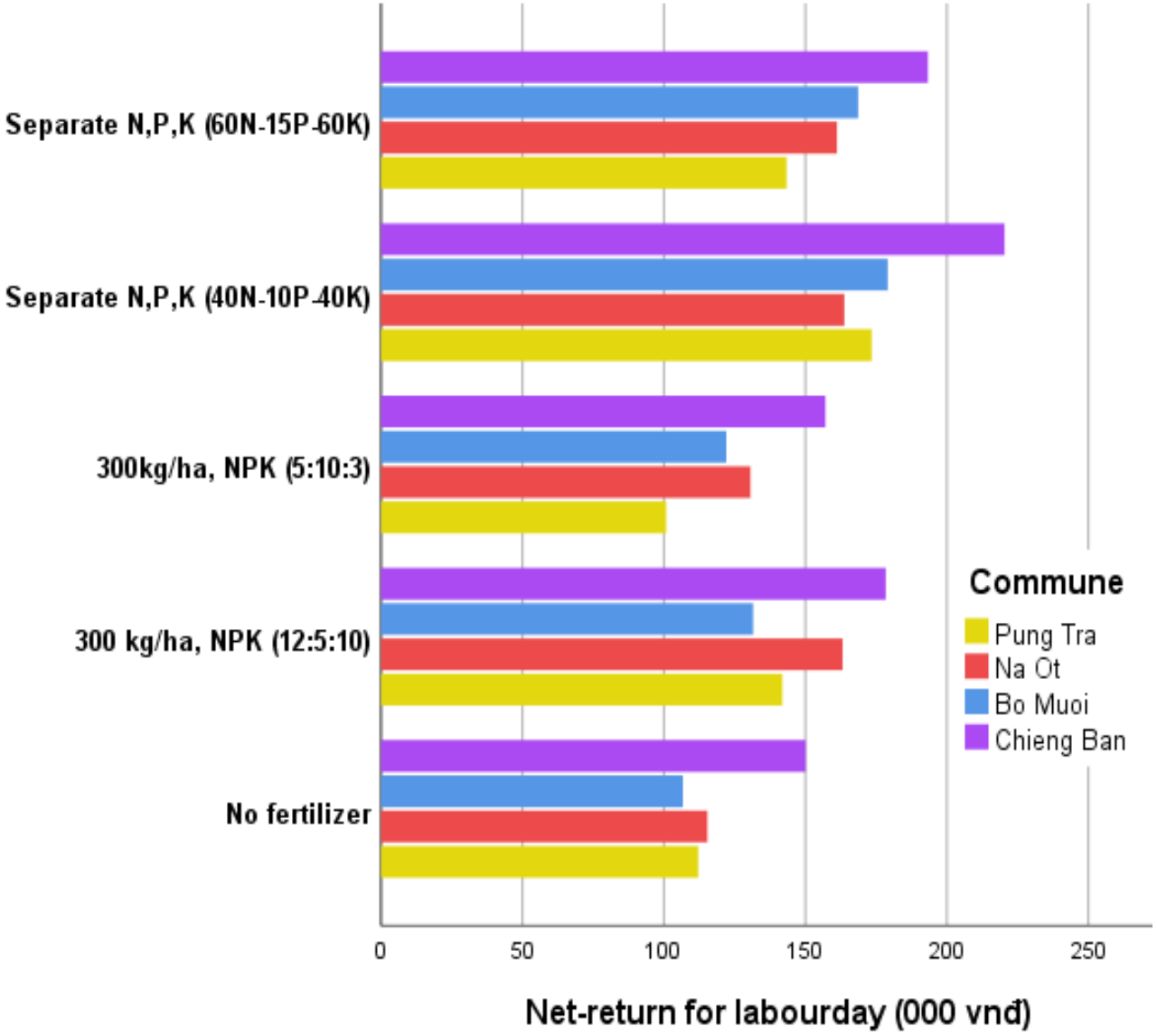
Fresh root yield of KM94, the fertilizer trial



With the same amount spent for purchasing fertilizers, using single N, P, K fertilizers gave higher yield than using mixed NPK fertilizers. The level of 40N-10P-40K gave highest return per working day, while the level of 60N-15P-60K gave highest yield and total return.

The net return of KM94, fertilizer trial





RESULTS
OF SOIL MANAGEMENT TRIAL

Fresh root yield of KM94, soil management trial

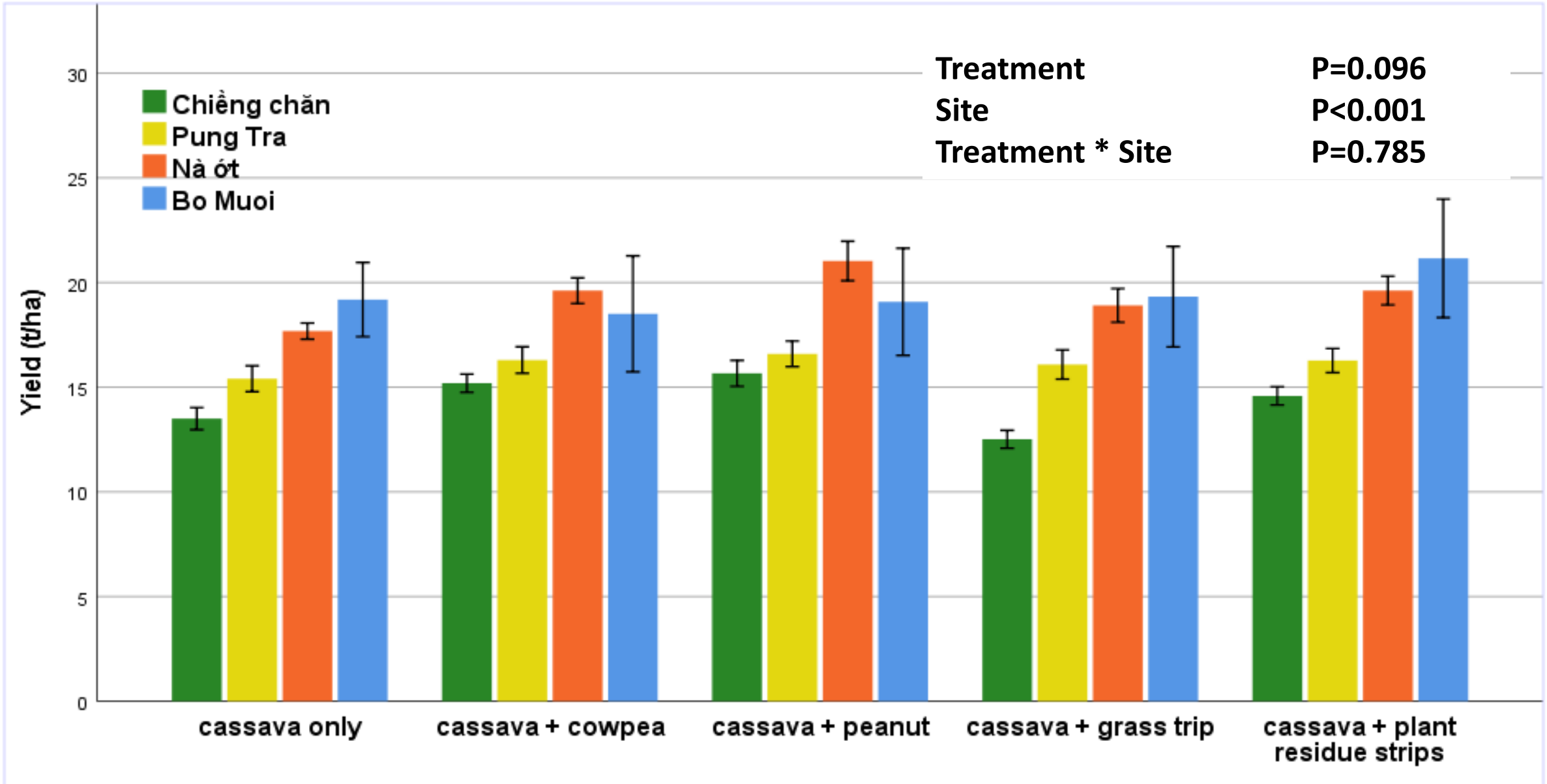
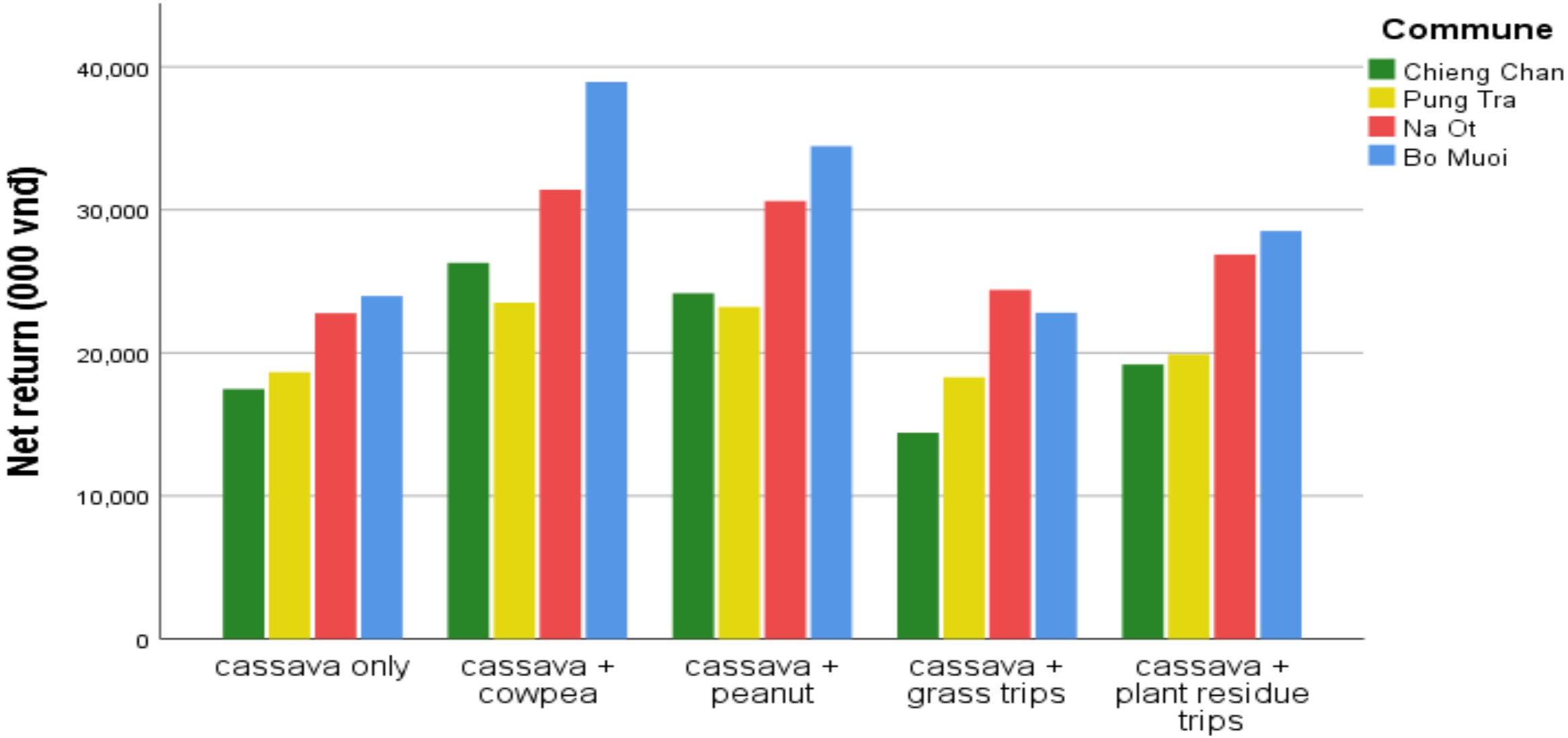


Table 2: Yield and biomass of the intercrops

Site	Black bean		Peanut		Grass hedgerows
	Yield (kg/ha)	Biomass (ton/ha)	Yield(kg/ha)	Biomass (ton/ha)	Biomass (ton/ha)
Chieng chan	128.75	1.11	220.83	1.47	5.02
Na Ot	372.00	1.63	613.33	1.63	7.50
Pung Tra	124.80	1.02	256.00	0.91	4.29
Bo Muoi	661.11	2.00	1,327.78	2.04	4.53

Total net return, soil management practices



Main points regarding soil management practices:

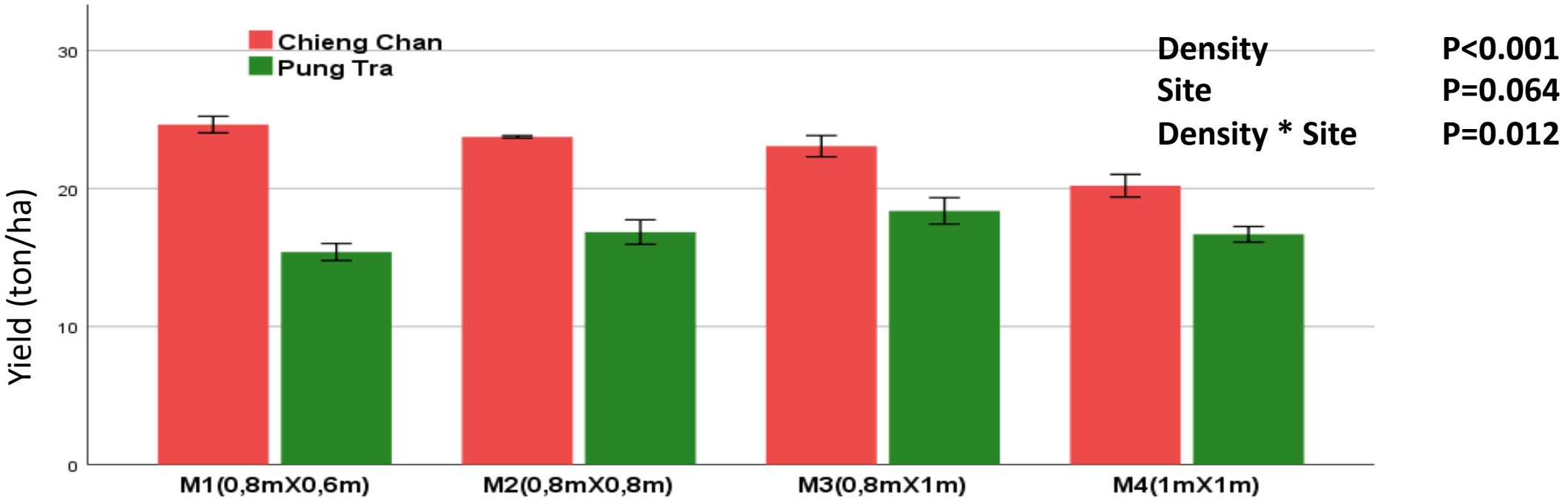
- All the practices trialed (intercropping with legumes; grass hedgerows; plant residual strips) did not affect the fresh root yield of cassava.
- Plant residue strips (using the previous seasons' cassava stems) could prevent some soil erosion, while it is also easily for farmers to applied and does not require extra financial investment.
- Intercropping with **cowpea or peanut** produced additional income source, and also gave the highest total net return and net return per working day. Intercrops also help improve soil quality (biomass and N-fixation). However, this practice required more financial & labor inputs, and also brought additional difficulties for crop management, especially in term of pest control.
- Grass hedgerows could also reduced soil erosion and gave some grass harvest for feeding cattle. However, it affected cassava yield and was laborious in term of management and harvest of grass.
- The impact of practice to prevent soil from being washed off away could only be clearly observed when the field is not too steeply sloping.

Plant residue strips prevent soil washed off way.

Grass hedgerows prevent soil from being washed off away

RESULTS OF THE PLANTING DENSITY TRIAL

Fresh root yield of KM94, different planting densities



- For KM94, the most appropriate planting density was 12,500 plants/ha (1 m x 0.8 m). This density gave the highest total net profit and net return per working day.
- For lands with steep slopes and has been used for monoculture of cassava for many years like in Pung Tra experimental block, the yield of cassava was significantly improved when planting density increased from 10,000 plants/ha to 12,500 plants/ha. But, the yield decreased when the density further increased to 15,600 or 20,800 plants/ha.
- For lands with not steep slopes like in Chieng Chan experimental block, increasing planting density from 12,500 to 15,600 or 20,800 plants/ha did not change the yield, but reduced the net return due to increase in the input & labor cost.

Table 3: Economic return of KM94, planting density trial in Pung Tra

	M1	M2	M3	M4
Total income (000 vnd/ha	23,920	26,050	29,750	25,990
Total input cost (000 vnd/ha)	5,108	4,588	4,278	4,028
Total labor (persondays/ha)	191	187	191	183
Net profit (000 vnd/ha)	18,812	21,462	25,472	21,962
Profit per working day (000 vnd)	98.49	114.77	**133.36**	120.01
Profit per each VND invested (vnd)	3.68	4.68	5.95	5.45

M1: 0.8m X 0.6m, (20,800 plant/ha), **M2** : 0.8m X 0.8m, (15,600 plant/ha);

M3 : 0.8m X 1.0m, (12,500 plant/ha); **M4 :** 1.0m X 1.0m (10,000 plant/ha)

Table 4: Economic return of KM94, planting density trial in Chieng Chan

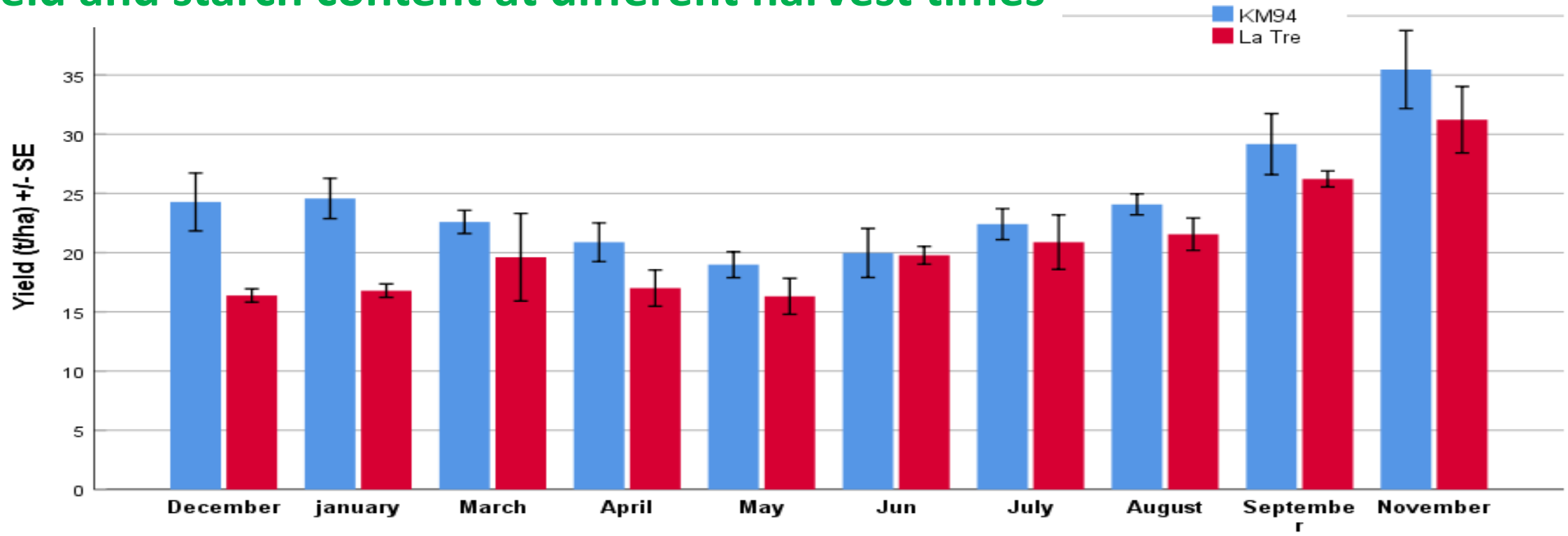
	M1	M2	M3	M4
Total income (000 vnd/ha)	36,953	35,625	34,609	30,312
Total input (000vnd/ha)	5,108	4,588	4,278	4,028
Total labor (persondays/ha)	216	205	200	190
Total net profit (000 vnd/ha)	31,845	31,037	30,331	26,284
Net profit per person day (000 vnd)	147.43	151.40	**151.66**	138.34
Profit per each VND invested (vnd)	6.23	6.76	7.09	6.53

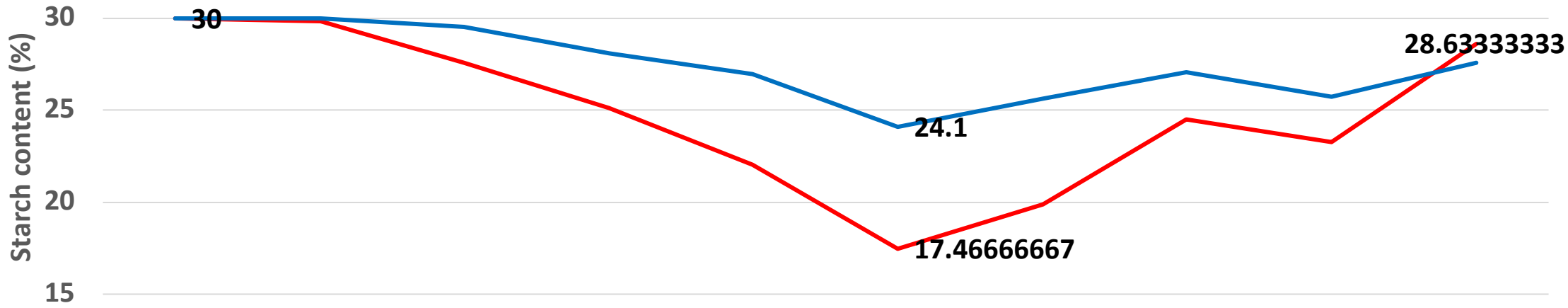
M1: 0.8m X 0.6m, (20,800 plants/ha),**M2** : 0.8m X 0.8m, (15,600 plants/ha);

M3 : 0.8m X 1.0m, (12,500 plants/ha); **M4 :** 1.0m X 1.0m (10,000 plants/ha)

RESULTS OF THE HARVESTING TIME TRIAL

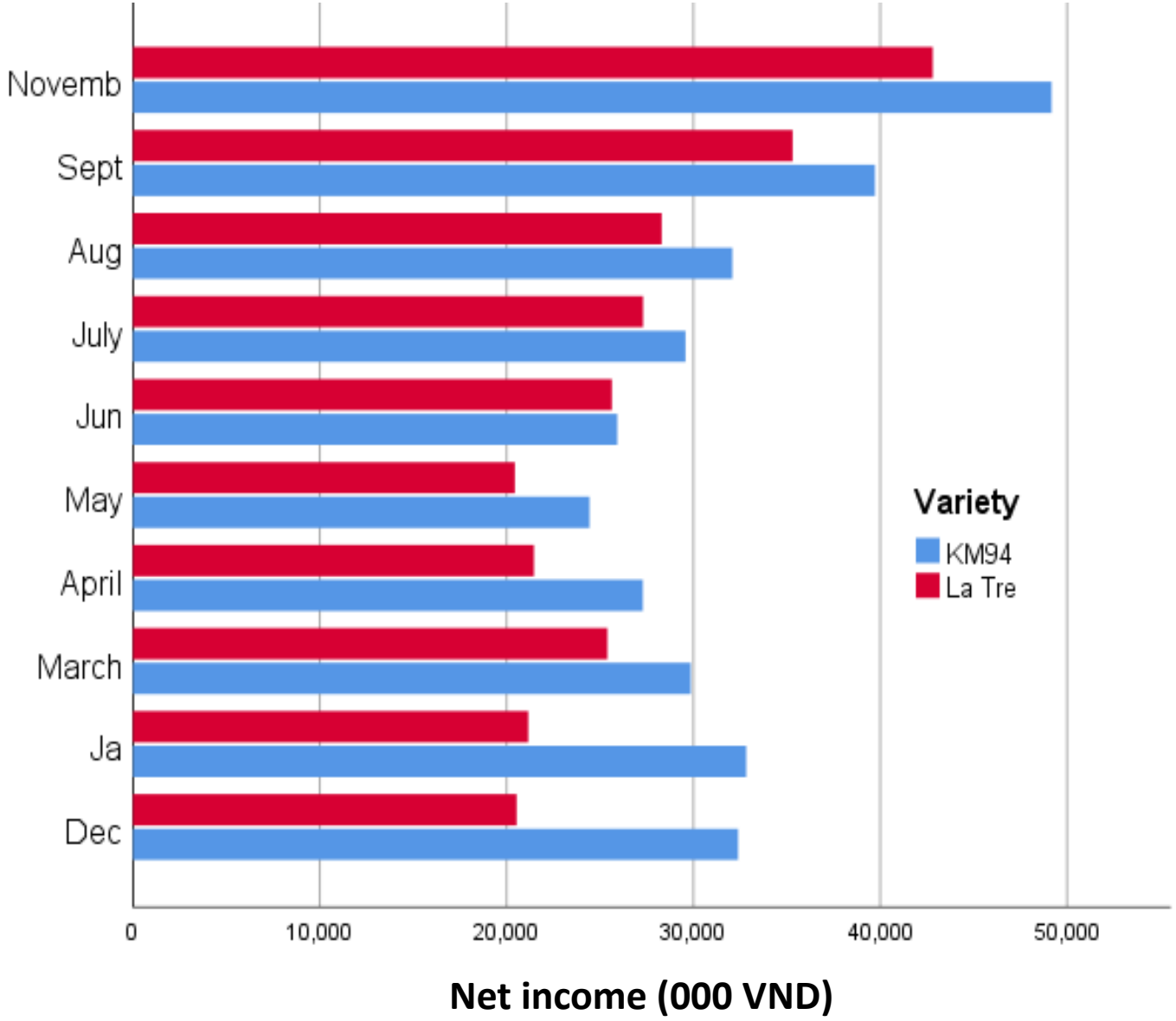
Yield and starch content at different harvest times





- Regarding starch content:
  - Roots of KM94 harvested at anytime (from December to November next year) have starch content high (over 24%), enough for the factories to use for processing (they need over 22%).
  - For the variety La Tre, roots harvested during May – July have starch content lower than 22%, and thus not suitable for the starch factories to buy for processing.

Net return, harvesting time trial

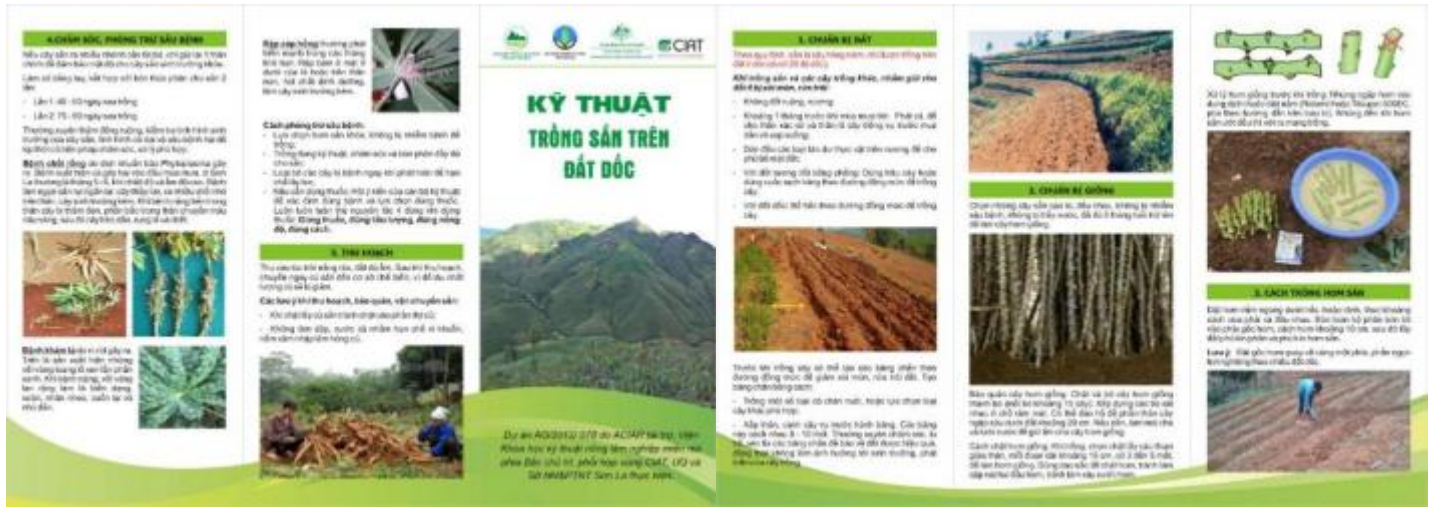


Harvesting 20 months after sprouting gave higher net return.

Especially with variety La Tre, harvesting 20 months after planting gave 2fold-higher net income compared to that harvested after 1-year.

Training and communication materials produced

Training manual



Flyers

Posters

Flyers

MAJOR RESULTS OF TRAINING AND COMUNICATION ACTIVITIES

Training courses focusing on 4 following topics were conducted using Farmer Field School (FFS) method for farmers and local extension officers:

1. Techniques for planting and managing cassava on sloping lands
2. Techniques for applying fertilizers and for controlling weeds
3. Techniques for controlling pest and diseases
4. Techniques of harvesting and postharvest treatment of fresh roots; techniques for storing cassava seed stocks.

Producing and distributing communication and extension documents:

- The training manual on “Sustainable cultivation of cassava on sloping lands” for extension officers and champion farmers to use.
- Publishing and distributing flyers and posters “Planting techniques for cassava on slopes” and “Application of fertilizers for cassava on slopes”. The fliers are for farmers to use, the posters are to put in the community houses.

Field days to trial sites

Introduction of a simple tools for harvesting cassava roots

CONCLUSIONS

- Regarding varieties: 2 new varieties **13Sa05** and **BK** grew well and gave higher yield. They are suitable for scaling up in Son La.
- Regarding fertilizers: Using single fertilizers (containing only N or P or K) at suitable rates gave higher economic benefits compared to using mixed NPK fertilizers. For sloping lands in Sơn La, the level of 40N/10P/40K (equal to *87 kg urea + 142 kg superphosphate + 80 kg potassium chloride*) gave highest net return per working day, while the level of 60N/15P/60K (equal to *130 urea, 213 kg superphosphate + 120 kg potassium chloride*) gave highest fresh root yield and total net return. Applying fertilizers at 3 times (1 basal dressing and 2 top dressing times) brought higher impacts.

CONCLUSIONS (cont.)

- Regarding planting density: For KM94, the density of 12.500 plants/ha (with the distance of 1 m x 0.8 m) was the most suitable for the common conditions in Son La.
- Regarding land conservation practices: Intercropping with cowpea or peanut increased both the yield and economic return due to the additional income from the intercrops. Plant residue strips could protect some soil from erosion without requiring additional financial investment. Grass hedgerows also had soil protection impacts and could give grass harvest for feeding cattle.
- The barriers to adoption of soil conservation practices: The requirements of extra labor and input cost; additional difficulties in management of crops and controlling pest and diseases (especially with intercrops); difficulties in harvesting and transporting grass from the field to house to feed cattle. On the other hand, soil protection impacts could only clearly observed when lands not too steeply sloping.

CONCLUSIONS (cont.)

Regarding extending the harvest season:

- The starch content of KM 94 roots was always higher than 24% no matter what harvesting time was during the year, and this is appropriate for processing starch.
- Variety La Tre could be harvested after 2 year, as then it gave higher economic return. However, this variety's fresh roots harvested during May – July had starch content lower than 22% (could be as low as 17%), not suitable for starch processing.

Participants in the implementation of activities

1. Northern Mountainous Agriculture and Forestry Science Institute (NOMAFSI)
2. Root Crop Research and Development Centre, Field Crops Research Institute (FCRI)
3. The International Center for Tropical Agriculture (CIAT)
4. The University of Queensland (UQ)
5. Provincial Department of Agriculture and Rural development of Son La, District Departments of Agriculture of Thuan Chau and Mai Son districts
6. Son La Cassava Starch Factory (under FOCOCEV Coop.)
7. Extension officers, farmers and village leaders at the trial sites


Thank you!