Report on research activities for

Improvement of Production in Existing Temperate Fruit Orchards and Establishment of New Orchards

Conducted from January 2010 until June 2011

in Son La and Lai Chai Province, Vietnam

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Summary

Research activities in temperate fruit (TF) cultivation in the project sites include improvement of production in existing orchards and establishment of new orchards. New varieties are trialled in sites where TF is commercially grown (Moc Chau), while both new TF species and varieties are tested in sites with no existing commercial fruit production (La Chau).

All activities for improvement of existing plum production are concentrated in Pieng Sang village (Moc Chau, Son La) and they are coordinated with value chain intervention activities. The main objectives of these activities are to: a) improve canopy management by training trees to get open vase shaped trees and pruning to optimise the number of fruits and their quality; b) improve plant nutrition and orchard floor management (application of fertilisers and mulch); c) establish IPM program, in particular area wide fruit fly control, d) optimise harvest time for best fruit quality and postharvest handling (joined activity with VC intervention). Five farmer researchers, who have orchards with young trees (4-6 years old) that are just reaching full productive age and are suitable for canopy training and severe pruning, were selected. The first pruning and addition of fertilisers done in January 2010, resulted in yield and size of plums by May-Jun 2010 that was significantly better than in other farmers' orchards. However, sugar content of plums in the experimental plots did not improve and damage from fruit fly was higher. In 2011, a lot of effort was put in area-wide fruit fly control with monitoring and weekly application of baits. Assessment in May 2011 showed that fruit fly control was successful; however the final results will not be known until the end of the season (July 2011).

New orchards were established in February 2011 after 5 months of soil preparation (September 2010 to February 2011). Trees were planted in holes of 70x70x70 cm filled with compost and manure. In Gieng Ma (Tam Duong, Lai Chau) 263 trees were planted in 5 orchards: 213 peach trees of variety DCS1, 10 peach trees of variety Tropic Beauty, 30 nectarine trees of variety Sunwright and 10 persimmon trees of variety Jiro. In Lung Su Phin (Sin Ho, Lai Chau) 178 trees were planted in 5 orchards: 128 peach trees of variety DCS1, 30 nectarine trees of variety Sunwright, 10 plum trees of variety Rubenal and 10 persimmon trees of variety Fuyu. In La Nga 252 peach trees were planted 160 of which were of variety DCS1 and 92 of variety Tropic Beauty. Trees established well and the first training is planned for July 2011.

Background

In the 1990-s the Vietnamese government put considerable effort and resources into developing fruit production in the northern highland regions. Government aims were to a) diversify and intensify agricultural production and consequently increase farmers income and reduce poverty, b) provide additional food sources and contribute to food security of local people, c) encourage permanent settlements of minority groups that still live semi-nomadic life d) create opportunities for market engagements and e) protect environment and water resources (Le Hong Son, 2003).

Government investment in development of fruit production was well supported by local Peoples Committees and farmers resulting in a 290% increase of area under fruit production from 49,000 ha to 143,000 ha in a period of just 5 years from 1996 to 2001. As could be expected when such a large scale increase in production has been achieved in a "spirit of mass movement" many important aspects of production were overlooked. Post-harvest technologies and marketing were developing at too slow space hindered by lack of sufficient and timely investment in fruit processing and storage. Sudden oversupply of fruits destabilised the supply-demand production balance in 2000-2001 and price of fruits plummeted. Price for plums dropped from 5-6000 VND to 300-1000 VND.

A survey conducted by National Institute of Agricultural Projection and Planning shows that only 20-30% of fruit trees have been planted following production protocols including land preparation, tree establishment and canopy formation, fertiliser application and plant protection (Le Hong Son, 2003). In provinces where fruit planting was centrally managed the survey shows that 70-90% of farmers applied more intensive cultivation techniques. In provinces where there was no central management, including Son La, only 25-30% farmers invested labour and other inputs into fruit production. Lai Chau province was only marginally included in intensification of fruit production in 1990s.

Plums of variety Tam Hoa were planted extensively in Pieng Sang village in the early 1990s as a part of the government sponsored intensification of fruit production, which was one of the reasons for inclusion of this village in our project. Our team interviewed and assessed production of 10 plum producers in the village from 10-12 December 2009. Results of the interviews are summarised in Table 1 and Table 2. Trees were between 4 and 18 years old. Trees in orchards were planted at different densities varying from 4x4m to 6x7m with 5x5m (400 trees/ha) been most commonly used. Size of orchards varied from 30 to 500 trees (700 m^2 to 1.25 ha). Seedlings were mainly produced by marcotting from existing trees in the area. None of the farmers interviewed practised any pruning and trees were not trained. Fifty percent of farmers never applied any fertiliser while 50% of farmers applied fertiliser at planting. Only 30% of farmers applied fertilisers after planting but application is irregular usually every 2-3 years. Only 30% of farmers ever applied any pesticide and pesticides were applied only once or twice in recent years to control aphids. Yield for mature trees varied from 40 to 100 kg per tree. Average yield per tree was 56.57kg with standard error of 9.07kg and median yield of 50kg per tree. Yield per hectare was 20.72T with standard error of 2.9T and median yield of 20 T. Small standard error and small differences between average and median values indicates uniform production between orchards. Yields are very high and it does not seem that production is declining

with age of the trees. Considering no or very low fertiliser input, results indicate that the soil is very fertile and the genetic fruiting potential of Tan Hoa plum is very high. In 2009 average gross income per hectare was 29,092,000 VND with standard error of 4,677,000 VND and median gross income of 28,000,000 VND. In comparison, gross income from maize varies from 8-24,000,000 VND per ha. Small standard error and small difference between mean and median indicates small variation in yield and price at which product was sold (from interviews we know that most farmers sold green plums for 1,200 VND/kg and highest price paid was 1,500 VND. Only one interviewed farmer sold small quantity (1T) of mature plums for 3,000 VND/kg). No observations could be made about fruit quality since the product was sold before ripening.

Yield in 2010 was much lower (most likely because biannual fruiting cycle, where year with very high yield is followed by year with low yield) and farmer did not harvest green plum but all plum were sold as ripen plums at price of 5-6000 VND resulting in good income for farmers. Few farmers including village leader claimed that income from plums was higher than income from maize in this year.

Results of profiling plum production in Pieng Sang village were surprising showing a much higher profitability than was expected from the generally held opinion that fruit plantings initiated in 1990s failed to generate significant income. This unexpectedly high level of profitability from production can be attributed to the export of immature plums to China over the last 3 years. Another contributing factor is the high productivity of Tam Hoa plums despite virtually no inputs. However reliance of production on only one market is highly risky and development of alternatives markets for Tan Hoa plum is necessary for sustainable production.

The results of the diagnostic study undertaken from August to December 2009 as part of this project and previous literature have tended to emphasise the negative aspects of Tam Hoa plums. For example the following observations were made by Philippe Cao-Van and Nguyen Minh Chau (1999). The three main cultivars of Japanese plum grown in Vietnam are Tam Hoa, Hau and Duong and they all have the following disadvantages:

- Lack of a long harvest period, which leads to a serious oversupply to local markets, and a sudden drop in prices immediately after that harvest in June
- Small sized fruit (average fruit size is 20-30mm)
- They have very poor keeping quality

However, Tan Hoa plums have a number of very positive characteristics that should not be overlooked. The robust nature of this variety is very well suited to farmers that have no technical knowledge of fruit production, low funds for investments in inputs and have a subsistence lifestyle. Farmers growing Tan Hoa plums are an excellent starting point for our project because they are good candidates to be “farmer researchers” and have potential to develop more sophisticated aspects of fruit production. Tan Hoa plums can provide a basic income stream while other opportunities for income through fruit production are investigated and developed. Other opportunities for our project include the development of higher value processed products from Tan Hoa plums, such as dried fruit, jams or plum brandy. The introduction of growing techniques will allow production of better quality and higher sugar content plums for the fresh market and processing. Skills developed in fruit tree cultivation can then be used to introduce other varieties of

temperate fruits (plums, peaches and persimmons) which produce more sought after fruit for the fresh market, but require much higher levels of technical skills.

Fig1: 10 year old Tam Hoa plum trees in their natural shape which bore 100 kg fruit per tree in 2009

Fig2: Intercropping of tea and plum demonstrating the exploratory nature of the Pieng Sang farmers

References

Le Duc Khanh and Ha Minh Trung. (2006) Ky thuat trong cay an qua on doi (man, hong, dao). Nha xuat ban giao thong van tai, pp. 104.

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Philippe Cao-Van and Nguyen Minh Chau (1999) Deciduous fruit production in Vietnam In: Papademetriou, MK and Herath, EM (eds.) Deciduous fruit production in Asia and the Pacific, FAO Bangkok 1999 p.91-96.

Table 1: Descriptive statistic of production data for Tam Hoa plum in Pieng San village

Production indicator	units	Statistical indicator	Productive trees (> 5 years old)	Young trees (4 years old)	Maize
Yield/tree	kg	Average (±SE)	56.57 (9.07)	29,06 (6.78)	n/a
		Median	50.00	30.86	n/a
Yield/ha	T	Average (±SE)	20.72 (2.90)	13.58 (4.81)	4-6
		Median	20.00	13.7	n/a
Income/ha	‘000 VND	Average (±SE)	29,092 (4,677)	22,065 (9,340)	8-24,000
		Median	28,000	19,672	n/a

Table 2: Profile of plum production in Pieng Sang village

Name of farmer	Number of trees	Age of trees	Grid	Area	Pruning	Fertiliser	Pesticide	Yield/ tree	Yield/ area	Gross income per area	Yield/ha	Gross income/ ha
Tang Van Dan	60	6	4x5	2500 Intcrop Tea (1200 plum)	no	Manure at planting NPK 2x in 6 years	no	40	2000 green 400 mature	2,400 1,200 8,400 (tea)	20,000 (plum area only)	30,000 (plum only) 48,000
Ly Duc Duong	70	4	6x7	3000 Intcrop tea	no	NPK 0.5kg tree at planting	no	25.71	1800	2,160 5,880	6,000	7,192 (plum only) 26,773
Ly Thy Xuan	300 200	4 18	5x5 5x5	7500 5000	no no	NPK 2kg/tree at planting and last year no	no no	11.67 30	3500 6000	4,200 7200	4,550 12,000	5,586 14,400
Trieu Van Song	35	4	4x5	700	no	no	no	42.86	1500	2.250	21,435	32,152
Tang Van Phong	80 20	5 7	6x5	3000	no	no	1x in last 2 years	40	4000	6,000	13,200	19,800
Trieu Thi Huong	30	7	5x5	750	no	no	1x dimethoat (Bi58)	66	2000	3,000	26,667	40,000
Ban Van Senh	60	10	6x5	1800	no	Manure at planting NPK 1.5kg/tree every 2 years	Bi-58 as needed	100	6000	9,000	33,333	50,000
Dang Van Chien	70	4	4x4	1120	no	At planting NPK 0.7 kg	no	36	2500	3,250	22,325	43,333
Dang Van Senh	100	12	5x6	3000	no	no	no	50	5000	6,500	16,500	21,450
Dan Van Truong	100	16	5x6	3000	no	no	no	70	7000	8,400	23,333	28,000

Improvement of production in existing plum orchards in Pieng Sang village, Moc Chau, Son La

Introduction

Participatory approach to research is an overarching principle in our project and the objectives set for activities in Pieng Sang were derived from a series of discussions with the farming community in August and December 2009. At our final meeting with the community before the start of research activities on 12 December 2009, a group of 5 farmer researchers that had been involved in research over the previous 18 months were selected. The elected leader of the group is Mr Dang Van Chien, and members of the group are Mr Trien Van Song (village leader), Mr Tang Van Dan, Mr Ly Duc Duong and Mrs Ly Thi Xuan. In a later stage of the project, these farmers will have a major role in dissemination of developed technologies into the community. All members of the group have actively participated in designing and implementing the experiment with a high level of support from extension officer Mr Luong Trung Hai. All activities in 2010 and 2011 are concentrated in one large experiment conducted in five orchards, each orchard belonging to one of the five farmer researchers. Selected orchards consist of young trees (4-6 years old) just reaching full productive age, suitable for canopy training and severe pruning. The progress and the initial results of this experiment are presented in this report.

Objectives

The objectives of the experiment are:

- Improve canopy management by
    - Training trees to get open vase shaped trees
    - Pruning to optimise number of fruit and quality
- Improve plant nutrition and orchard floor management
- Establish IPM program
- Optimise harvest time for best fruit quality and postharvest handling for
    - Fresh fruit market
    - Plum brandy production
- Develop model for up scaling

Experimental design

The experiment has been designed as a random block design with each of five orchards being a block. Within each block, three treatments were randomly assigned to the group of ten trees, except for the control that was assigned to five trees. This makes a total of 25 trees per orchard (block) and 125 trees for the whole experiment.

The following treatments were applied:

1. Pruning + mulch + fertilisers (T1)
2. Pruning + mulch (T2)
3. Control (no pruning, no mulch and no fertilisers) (T3)

Monitoring of pests and diseases was conducted in all treatments and appropriate pesticides were sprayed as necessary in all treatments including control.
Major activities in the orchards implemented in the period January 2010-May 2011 by the farmer researcher group are presented in Table 3.

Soil analysis and plant nutrition

Soil samples were taken in March 2010 and soil analysis was done in April 2010 at UQ-Soil laboratory in St Lucia. Samples were taken from three locations 500-1000 m apart in distinctly different areas of the village.

- Location 1: Mr Dang Van Chien orchard
- Location 2: Mr Trien Van Song and Mrs Ly Thi Xuan orchards
- Location 3: Mr Tang Van Dan and Mr Ly Duc Duong orchards

Three soil samples were taken from each location:

- Sample 1 at the depth of 5-15 cm
- Sample 2 at the depth of 25-35 cm
- Sample 3 at the depth of 55-65 cm.

Samples were taken from a hole dug to the depth of approximately 80 cm using a trowel. Three sub-samples were taken from each site (= three holes per site). About 0.5 kg of soil was taken for each sample. Soil samples were labelled and air-dried in a sheltered place.

Results of the soil analysis (Table 4) showed that soil characteristics at Location 1 are very different from soil characteristics at Locations 2 and 3, which are in turn similar. Soil at Location 1 is neutral to slightly alkaline, heavier with high cation exchange capacity (CEC). It has higher levels of macro- and micro-elements but they are more tightly bound to clay particles than at Locations 2 and 3 so equal or even less nutrients may be accessible to plum trees.
Soil at Location 2 and 3 is slightly acid with low CEC and soil at Location 2 is very low in potassium. Boron levels are too low for normal development of plums at both locations. To address these deficiencies lime (500 g/tree) and boron foliar fertiliser were used.
Overall it can be concluded that soil at all locations is suitable for plum production and the level of nutrients is surprisingly high given that farmers do not use fertilisers and have cultivated the soil for a long time.
Fertilisers were added 4 times in the reporting period. For the first fertiliser application in January 2010 the amount of nutrient applied was estimated following the recommendation of Khanh and Trung. (2006) (Table 5) but after the soil analysis amount of fertilisers were adjusted (Table 6).

Table3: Calendar of plum development phases and activities in the experimental orchard

Month	Developing phase	Activity in experimental treatment pruning + fertiliser
January/2010	Dormancy Budburst	1. Fertilisers applied: Manure 5-10 kg/tree Phu My Urea (46 %) 300 g/tree Lam Thao phosphate (16 %) 400 g/tree Belarus potassium (60%) 150 g/tree 2. Pruning 3. Mulching 4 Winter spraying Copper oxchloride, DC-Tron oil
February	Flowering	1. Pest monitoring 2. End of flowering usually spray for aphid Control (cypermethrin)
March	Fruit development	1. Pest monitoring, 2. Fruit fly traps (Metyl Eogenol) 3. Spray cypermethrin and mancozeb
April	Fruit development	1. Pest monitoring, 2. Fruit fly traps (Metyl Eogenol 3. Spray cypermethrin and mancozeb
May	Fruit maturing and beginning of harvest	Low population of Oriental fruit fly recorded in fruit fly traps but high fruit damage-most likely damage was not caused by Oriental fruit fly but by other fruit fly species not attracted by Metyl Eogenol
June	Post harvest production and storage of nutrients for start of next growing season	1. Summer pruning 2. Fertilisers applied: Phu My Urea (46 %) 100 g/tree Lam Thao phosphate (16 %) 100 g/tree Belarus potassium (60%) 150 g/tree
July-August	Post harvest production and storage of nutrients for start of next growing season Defoliation if not enough nutrients are provided.	Regular monitoring for rust and shot hole disease Applications of mancozeb
September	Formation of flower buds	1. Fertilisers applied: Phu My Urea (46 %) 100 g/tree Lam Thao phosphate (16 %) 100 g/tree Belarus potassium (60%) 150 g/tree
November-December	Dormancy	None
January/2010	Dormancy Budburst	1. Fertilisers applied: Manure 5-10 kg/tree Dolomite 500 g/tree (except Mr Chien) Phu My Urea (46 %) 250 g/tree Lam Thao phosphate (16 %) 140 g/tree Belarus potassium (60%) 240 g/tree 2. Pruning 3. Mulching 4 Winter spraying Copper oxchloride, DC-Tron oil
February	Flowering	1. Pest monitoring 2. End of flowering usually spray for aphid Control (cypermethrin)
March	Fruit development	1. Pest monitoring, 2. Fruit fly traps (protein bait) and regular area wide spray (protein + fipronil) 3. Spray cypermethrin and mancozeb
April	Fruit development	1. Pest monitoring, 2. Fruit fly traps (protein bait) and regular area wide spray (protein + fipronil) 3. Spray cypermethrin and mancozeb
May	Fruit maturing and beginning of harvest	Late ripening. No significant fruit fly damage.

Table 4: Results of soil analysis from samples taken in Pieng Sang in March 2010

Site	Sample	pH	EC	OC	TN	C:N ratio	Col P	Ca	K	Mg	Na	CEC	SO_4-S	B	Cu	Fe	Mn	Zn
			dS/m	Wt %	Wt %		mg/kg	cmol+/kg	cmol+/kg	cmol+/kg	cmol+/kg	cmol+/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
DVC Loc1	5-15	7.37	0.08	2.65	0.22	11.87	56.50	8.43	0.42	4.68	0.01	13.54	21.10	0.49	2.91	39.97	35.83	2.21
DVC Loc1	25-35	6.88	0.13	1.97	0.15	12.77	50.44	6.78	0.29	4.09	0.01	11.17	49.59	0.58	2.65	26.37	42.42	1.64
DVC Loc1	55-65	7.25	0.13	0.58	0.08	6.95	25.47	6.96	0.32	3.73	0.02	11.02	12.06	0.67	1.41	15.65	31.64	0.72
TVS Loc2	5-15	4.97	0.06	2.02	0.22	9.10	44.84	2.79	0.25	0.87	0.02	3.93	16.75	0.24	2.62	49.09	91.23	1.88
TVS Loc2	25-35	4.76	0.02	1.54	0.19	8.31	31.13	2.09	0.79	0.79	0.04	3.71	29.44	0.28	1.58	24.62	58.11	0.56
TVS Loc2	55-65	5.10	0.03	0.92	0.13	7.05	20.36	1.98	0.18	0.71	0.02	2.89	24.45	0.21	0.24	7.75	5.26	0.09
TVD Loc3	5-15	5.06	0.04	2.62	0.25	10.34	60.07	3.28	0.55	0.84	0.01	4.68	17.95	0.20	2.23	53.84	119.88	2.20
TVD Loc3	25-35	4.91	0.03	1.57	0.16	9.79	33.54	1.59	0.17	0.36	0.03	2.14	25.38	0.23	1.94	32.31	81.39	0.72
TVD Loc3	55-65	5.60	0.02	0.76	0.10	7.90	19.88	1.09	0.10	0.19	0.05	1.43	20.91	0.17	0.60	18.75	37.98	0.15
Recommended levels		**5-7.5**	**<0.15**	**> 2**	**n/a**	**8-14**	**60-100**	**> 5**	**> 0.5**	**> 1.6**	**< 1**	**< 10**	**> 5**	**> 0.5**	**> 0.5**	**>20**	**> 5**	**> 1.2**

Farmer researchers: Location 1: DVC=Dang Van Chien, Location 2: TVS=Trieu Van Song, Location 3: TVD=Tang Van Dan

Table 5: Amount of fertilizers applied in January 2010 before soil analysis in Pieng Sang following Khanh and Trung. (2006).

N^0	Fertiliser type	Amount of fertilizers applied g/kg
1	Phu My Urea (46 %)	300
2	Lam Thao phosphate (16 %)	400
3	Belarus potassium (60%)	150

Table 6: Amount of fertilisers applied after soil analysis in Pieng Sang in the period June-January 2010/11

N^0	Fertilizer type	Gram/tree/year g/kg	After harvest g/kg	Mid Autumn g/kg	End of winter g/kg
1	Phu My Urea (46 %)	450	100	100	250
2	Lam Thao phosphate (16 %)	340	100	100	140
3	Belarus potassium (60%)	540	150	150	240

Plant protection

Farmers generally use very little or no pesticides and the few who did mainly targeted aphids. Fruit fly is a major pest but farmers do not apply any control measures except for the practice of very early harvest of unripe plums at the time when fruit fly damage is still low. In 2010 monitoring of fruit fly populations using fruit fly traps with methyl eogenon as a lure proved ineffective. There were only 2-3 flies recorded per trap and 30- 60% of fruits were damaged by fruit flies. The most likely reason for the discrepancy between low numbers of trapped flies and high fruit damage is that the lure used is primarily attractive to Oriental fruit flies and fruit was damaged by another (not identified) species.

This year (2011) the control of fruit flies was organised not just in experimental orchards but in the whole village and over 2000 trees were sprayed with protein bait (Ento-Pro) mixed with fipronil. Sprays started on April the 1st and have been regularly applied at 7 day-intervals until harvest.

Preventative sprays of mancozeb were applied against diseases and a few cypermethrin sprays were applied against aphids (Table 4).

Assessments of fruit quality and quantity

Assessment of fruit quality included:

- Soluble solids using refractometer
- Firmness using penetrometer
- Size graded by weight: small fruits <20 g, medium fruits 20-30 g and large fruits >30g

Yield was measured per tree.
Assessments were done between 8 and 12 May 2010, 110 days after flowering.

Results from 2010 harvest

Data from 2010 harvest were analysed using mixed model of analysis of variance (SPSS v17) and results are presented in Table 7 and Figures 3, 4, 5 and 6.

There were significant differences in yield ($F_{2, 8}$= 7.634, p=0,014) and size of the fruits ($F_{2, 7}$= 21.403, p=0,001) between treatments. The treatments pruning +fertilisers and pruning only had significantly higher yield and larger fruit than farmer practice (no pruning and no fertilisers). There were no significant differences between the treatments pruning + fertiliser and pruning only.

There were significant differences in firmness of fruit between treatments ($F_{2, 7}$= 6.430, p=0,026) but not in amount of soluble solids (dominantly sugars) ($F_{2, 7}$= 0.670, p=0,542). Fruits in treatments pruning +fertilisers and pruning only were significantly softer that in farmer practice. There were no significant differences between treatments pruning + fertiliser and pruning only.

Table 7: Yield, percentage of soluble solids, firmness and size of plums from 2010 harvest

TREATMENT	**Yield (kg/tree)[1]**	**Ryan's Q-test***	**fruits > 30g (%)**	**Ryan's Q-test***	**Firmness (kg/cm^2)**	**Ryan's Q-test***	**Soluble solids (^{o}Brix)**	**F-test***
Pruning + fertilisers	11.86* (3.15)	**a****	49.02* (5.75)	**a****	7.64* (0.24)	**a****	11.24* (0.34)	**a****
Pruning only	8.10 (2.49)	**a**	40.64 (5.13)	**a**	7.59 (0.36)	**a**	11.13 (0.40)	**a**
Farmer practice (no pruning and no fertiliser)	2.06 (0.36)	**b**	3.38 (1.78)	**b**	9.48 (0.53)	**b**	10.90 (0.24)	**a**

* Values are the mean numbers from five orchards (n=5). Standard errors of mean are given in parentheses.
**Treatments with the same letter do not differ significantly from each other.
[1]Data were ln(x+1) transformed prior to analysis. Untransformed data are shown.

Discussion of 2010 harvest

Plums were harvested premature to prevent further damage from fruit flies and to capitalise on high demand for early plums. Fruit fly damage at the time of harvest reached 30-60% of total fruit depending on the orchard, which was unacceptably high, resulting in an intensive preventative fruit fly baiting programme implemented in 2011.

Results indicate that pruning contributed more to the increase in yield, fruit size and reduced firmness of fruit at harvest than addition of fertilisers with non-significant difference between trees that are only pruned and trees that are pruned and fertilised being recorded for all mentioned parameters. This is not surprising considering that soil analysis showed just a slight deficiency of nutrients (Table 4) at the time.

Pruning and fertilisers did not increase "sweetness" of the fruit which is a major desired attribute determined by the consumers, but fruits were not thinned, and that together with climatic conditions in Pieng Sang may be the main contributing factors for the non-significant difference in sugar content between farmer practice and experimental treatments. Farmers claimed that fruit from experimental trees were ripening slower but our results shows that there were no differences in ripening levels of plums from farmer practice trees and experimental trees. On the contrary significantly lower firmness of fruits from experimental trees indicates that both experimental treatments may have positive stimulative effects on fruit ripening.

Figure 3: Estimated yield per tree at the early ripening stage approximately 110 days after flowering

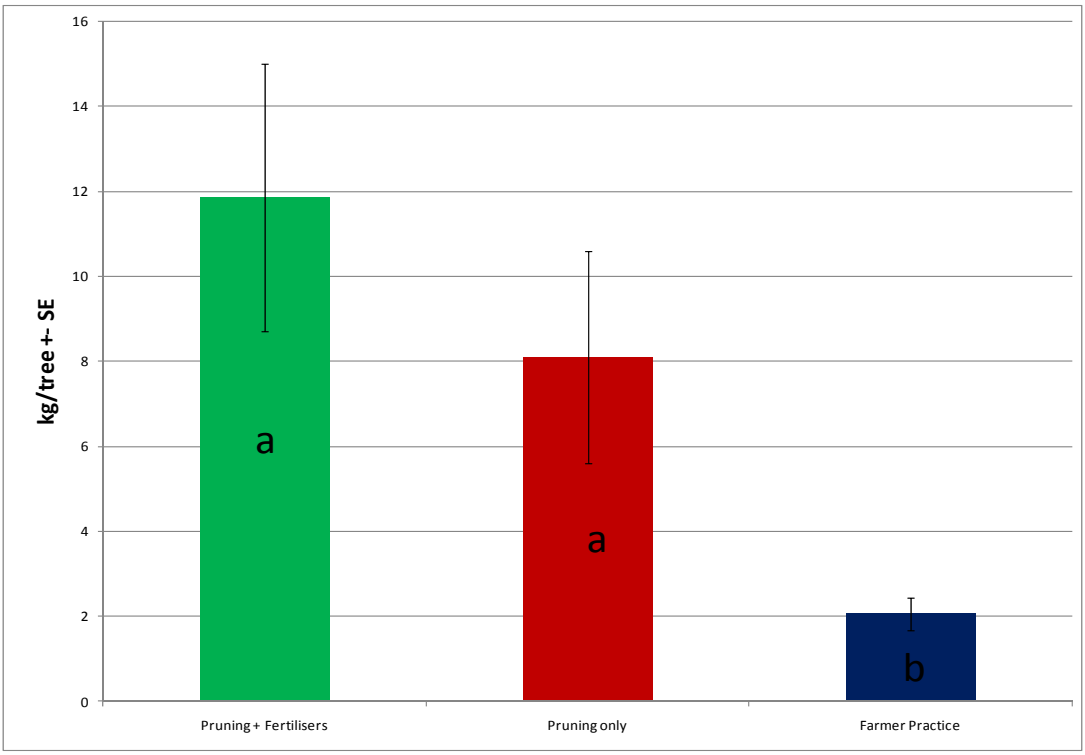


Figure 4: Percentage of large fruits with weight over 30 g

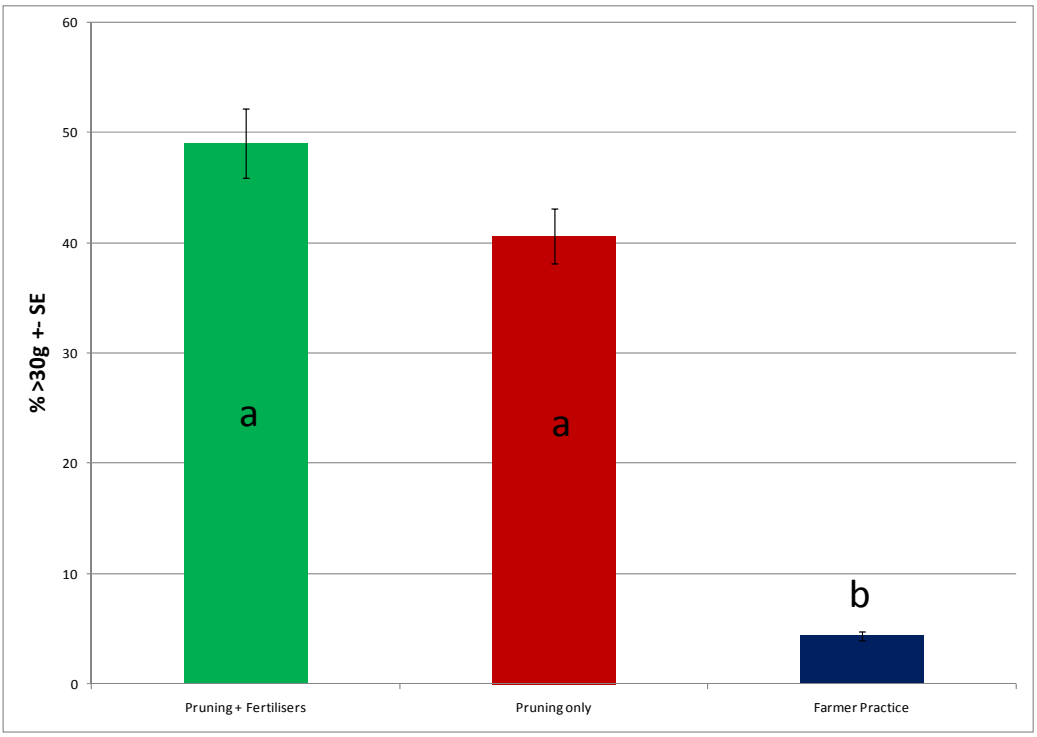


Figure 5: Firmness at the time of harvest 110 days after flowering

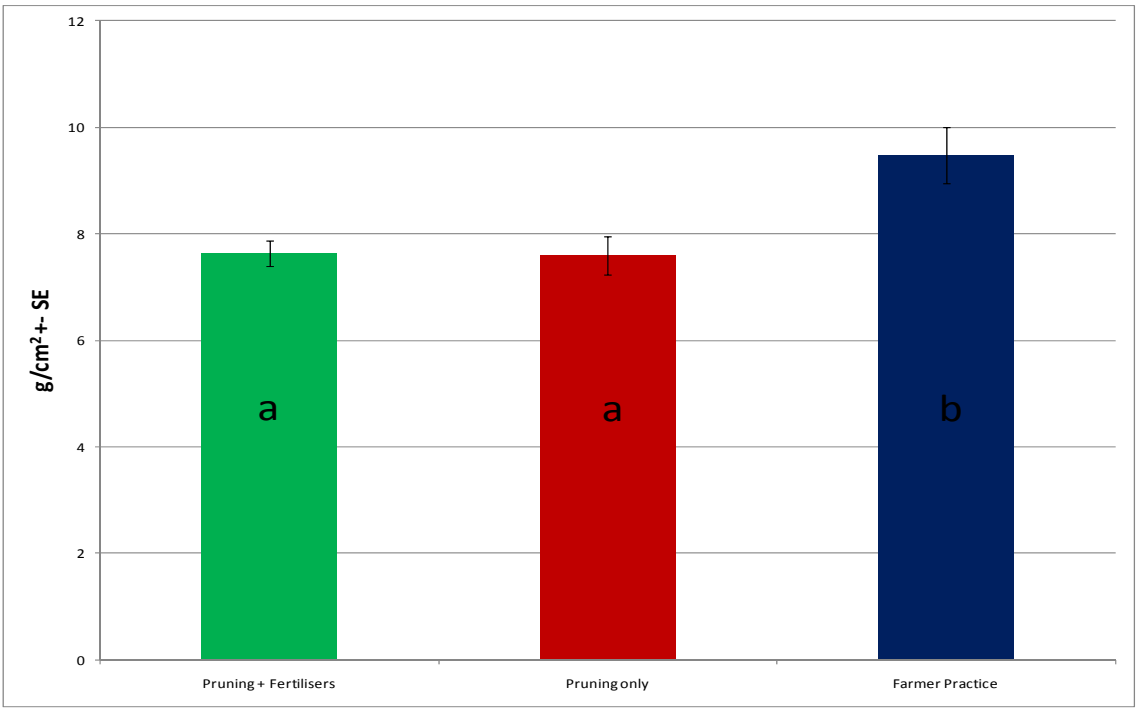
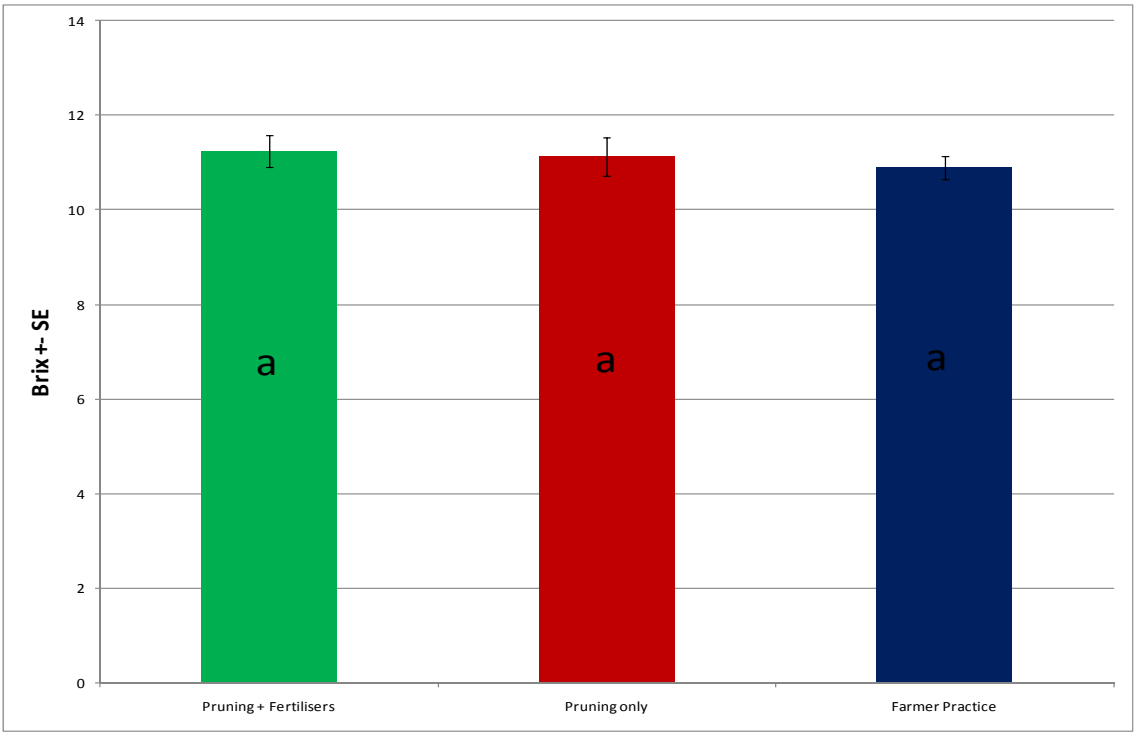


Figure 6: Concentration of soluble solids at the time of harvest 110 days after flowering



Evaluation of temperate fruit varieties and cultivation methods in Lai Chau and Moc Chau

Objectives

A major objective of project activities in Lai Chau is to introduce temperate fruit (TF) species and varieties suited for a cooler climate than in most other parts of Vietnam. These introduced species/varieties should give producers a market advantage because they cannot be successfully grown in other warmer parts of Vietnam or if they can be grown then they are just marginally suited to the climate in that area. Hence, production in Lai Chau should give higher yield of higher quality products than in other areas.

Another equally important objective of TF activities in both Moc Chau and Lai Chau is to develop cultivation methods suited to farmers inexperienced in fruit production with low education and low investment capacity.

Establishment of new orchards

Establishment of orchards in February 2011 followed long consultation process with farmers, local government and extension services that started in April 2010. All farmer researchers who have participated in planting new orchards on their land showed a lot of initiative in the consultation process and the suggestion to grow mainly peaches in all orchards at all locations came from farmers. Selection of specific varieties of peaches was done following recommendations of Dr Khanh. Also on Dr Khanh's advice Sunwright nectarine, Rubenal plum and persimmons were included in some of the orchards. Details on the numbers of trees, species and varieties in each orchard are presented in Tables 8a, 8b and 8c.

Table 8a: Numbers of trees, species and varieties planted in five new orchards in Lùng Sử Phìn, Tả Ngảo, Sìn Hồ, Lai Châu

Orchard number	Farmers' names	Total number of trees	Peach ĐCS1	Nectarine Sunwright	Plum Rubenal	Persimmon Fuyu
1	Thào A Giao 1	43	23	10	10	
2	Thào A Giao 2	31	21			10
3	Giàng Chứ Sinh 1	23	23			
4	Giàng Chứ Sinh 2	55	35	20		
5	Mùa A Chá	26	26			
	Total	**178**	**128**	**30**	**10**	**10**

Table 8b: Numbers of trees, species and varieties planted in five new orchards in Giang Ma, xã Giang Ma, Tam đương, Lai Châu

Orchard number	Farmers' names	Total number of trees	Peach ĐCS1	Peach Tropic beauty	Nectarine Sunwright	Persimmon Jiro
1	Giàng Páo Giang	46	36		10	
2	Giàng A Vang	55	55			
3	Giàng A Giao	76	46	10	10	10
4	Ma Khoa Giàng	56	46		10	
5	Tần A Tải	30	30			
	Total	**263**	**213**	**10**	**30**	**10**

Table 8c: Numbers of trees, species and varieties planted in five new orchards in La Nga- Mường Sang-Mộc Châu-Sơn La

Orchard number	Farmers' names	Total number of trees	Peach ĐCS1	Peach Tropic beauty
1	Lò Văn Ến	56	36	20
2	Lò Văn E	65	45	20
3	Vũ Văn Khang	45	30	15
4	Nguyễn Văn Tuấn	50	28	22
5	Đinh Công Sún	36	21	15
	Total	**252**	**160**	**92**

Planting of the new orchards

The approach adopted for orchard establishment was similar to the method used by CIRAD where deep rooting was stimulated by depositing large amounts of organic and mineral fertilizers deep in the soil. Soil preparation started in September 2010 when deep holes 70 by 70 by 70 cm were dug on a 4.5 by 5 m grid, and organic material such as weeds, green twigs from shrubs and about 10 kg manure were added to each hole. This material was left to compost until February when mineral fertiliser was added and the soil, which had been originally removed from the holes, put back on top of the mineral and organic fertilizer. Seedlings were then planted into the original soil in the top of the holes. Establishment rates were very good with less than 5% needing to be replaced. At the beginning of May, young trees were 0.5-0.7 m high and had 3-5 branches 0.15 to 0.5 m long. Most farmers will sow legumes as intercrop (see Table 9)

Table 9: Chosen intercropped plants in the project's orchards

Farmers' names	**Village**	**Chosen intercrop plants**	**Area (m^2)**	**Sowing schedule**
Lò văn Ến	La Ngà	Peanuts	1200	Sowed
		soybeans	1200	Not sowed yet
Hạnh	La Ngà	Peanuts	2500	7/5/2011
Đinh Công Sún	La Ngà	White egg-plants	2500	4/2011
Giàng Chứ Sinh	Lùng Sử Phìn	Nothing		
Thào A Giao	Lùng Sử Phìn	Vegetable	1000	4/2011
Thào A Lồng	Lùng Sử Phìn	Soybeans	600	4/2011
Mùa A Chá	Lùng Sử Phìn	Pumkin	1200	4/2011
Tẩn A Tải	Giang Ma	Maize	1200	4/2011
		Soybean	1200	7/2011
Giàng Páo Giang	Giang Ma	Pumpkin	1200	4/2011
		Peanuts	1200	7/2011
Giàng A Vàng	Giang Ma	Peanuts, soybeans	1200	4/2011
Mà Khoa Giàng	Giang Ma	Soybeans		7/2011
Giàng A Giao	Giang Ma	Soybeans	100	4/2011