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Temperate fruits in the northern mountainous region: scientific results achieved and solutions for development in coming years

Manh Hai Vu[1*], Quang Dang Bui[1], Quoc Hung Nguyen[2], Van DZung Nguyen[2]

[1]Vietnam Academy of Agricultural Sciences (VAAS)
[2]Fruits and Vegetable Research Institute (FAVRI)

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Abstract:

Perennial fruit crops generally and temperate fruits in particular make an important contribution to the sustainable development of the socio-economy in the northern mountainous region of Vietnam where the living standard of local farmers - 40% of whom are minorities from 30 groups - is still low (about 70% of the average of the country as a whole), though significant assistance has been made by the government and a slowly developed socio-economy has been recorded. It is obvious that proper temperate fruit production not only benefits local growers but also protects the environment in a significant way. Recent results concerning varietal selection and cultivation technologies for temperate fruits are summarized in this paper and some of the principal solutions, including proper planning, breeding programme enhancement, the establishing of production and value chains, and the training of skillful technicians and producers that is aimed at promoting production in the future, are also proposed.

Keywords: **chilling units, northern mountainous region, temperate fruits.**

Classification number: **3.1**

The role and necessity of temperate fruit development in the northern mountainous region of Vietnam

The fourteen provinces in the northern mountainous region of Vietnam cover an area of more than 10 million hectares - 31% of the country - and have a population of 13,291,000. Forty percent of these people belong to 30 minority groups. The northern mountainous region is considered to be the most difficult one, contributing only 9.6% to GDP. The living standard of the local people is only approximately 70% if that of the country as a whole. The topography of the region is complex and is divided into various ecological sub-regions that comprise diverse biological and zoological systems. The results of recent investigations of the frontier demonstrate that 542 plant species exist in the mountainous north of which 13 species are included in the world plant red book.

In recent years, the Vietnamese government has paid great attention to investment in the mountainous regions in general, and in the northern mountainous region in particular, with the aim of socio-economic improvement and poverty eradication. Many variously prioritized national programmes have undertaken investment for the exploitation of local advantages in order to increase the efficiency of land use and to improve agro-forestry production, sustainable economic development, and to protect significant natural resources in the region, among other goals. Primary achievements relating to commodity production enhancement and improving the living standards of local people have been obtained. It is, however, obvious that these achievements are not in proportion to the capacity of the region, and the potential advantages of the mountainous north - such as the availability of vast tracts of land, a large labour force, and a diverse biology and climate - have not been adequately exploited.

Up to now, the agricultural system, including the crop structure, in this region is still a strategic problem that needs to be reconsidered and settled in a sustainable way. Apart

*Corresponding author: Email: vumanhhaivaas@gmail.com

from forestry, tea, and medicinal plants in small cultivated areas are regarded as the main crops in the region. A variety of issues that have been raised in the cultivation of other leading crops - such as the correlation of maize with soil erosion, and the viability of coffee with the appearance of frost and rubber in relation to strong winds - must be taken into account.

Perennial fruit crops and temperate fruit crops particularly are quite diverse in the region and have some advantages compared to other annual crops, especially in terms of environmental protection and the benefits. The proper development of temperate fruits can both effectively exploit the available soil and significantly improve the living standards of local farmers whose lives currently meet with difficulties.

In fact, in line with a long-standing tradition of agricultural production, some specific cultivated areas for temperate fruits have been established and developed, for example, Sa Pa (peach and plum), Bac Ha (Tam Hoa plum), Moc Chau (plum), Ngan Son (pear), Nguyen Binh (pear), Ham Yen (king mandarin), Bac Quang (king mandarin and orange), Bac Son (mandarin), Doan Hung (pumelo), and Yen Chau (mango). It is, however, obvious that production of temperate fruits in the northern mountainous region encounters many difficulties. These can be summarized as follows:

- Local cultivars that are considered the leading ones in the current production of temperate fruits in the region have mostly degenerated and are characterized by low yield and quality, while a limited quantity of promising varieties that have been introduced are cultivated on a small scale (Table 1).

- Temperate fruit development is currently not adequately planned, says, species and varieties are not selected according to ecological requirements generally and chilling demand in particular, resulting in minimal benefits earned by producers and unsustainable production.

- Cultivating technologies to be disseminated to farmers for application in temperate fruit production are in many cases not suited to the actual conditions, particularly post-harvest treatment and processing.

In addition, the lack of close links between fruit producers and traders in production and value chains has also negatively affected temperate fruit development in the region.

In order to improve temperate fruit development in the mountainous northern region and meet increasing demands for local consumption, the study on varietal programmes and advanced technologies is necessary and should be given priority.

Table 1. Main cultivars of temperate fruits recently cultivated in the northern mountainous region [1].

No	Cultivars	Main characteristics				
		Fruit weight (g)	*Yield (T/ha at 6 years old)*	*Harvest time*	*Taste of pulp*	*Fruit outside colour*
I	**Peach** [*Prunus persica* (L.) Batsch.]					
1	SunRay	60-90	4.5-6.2	Apr-May	Crisp, sweet	Pink, hairless
2	Sun Wright	60-90	3.5-5.0	Apr-May	Crisp, sweet	Pink, hairless
3	MaRaVilHa	60-90	3.5-5.0	Apr-May	Soft, sweet	Pinkish yellow
4	Flordaprince	70-100	9.6-11.0	Apr-May	Soft, sweet	Pinkish yellow
5	HaKuTo	75-110	6.8-7.0	Apr-May	Soft, sweet	Whitish green
6	ViViAn	70-100	7.0-10	Apr-May	Acidulous	Whitish green
7	DCS1	70-100	9-12.0	Apr-May	Soft, sweet	Pinkish yellow
8	D1	70-100	6.8-7.0	Apr-May	Soft, sweet	Pinkish yellow
9	Yun Nan	75-120	9.6-11.0	May-Jun	Soft, sweet	Pinkish green
10	Local peach	50-70	10-12	Jun-Jul	Soft, sour	Pinkish
II	**Persimmon** *(Diospyros kaki* L.*)*					
1	Jiro	200-350	10-15	Aug-Sept	Crisp, sweet	Yellow
2	Fuyu	200-350	10-15	Sept-Oct	Crisp, sweet	Yellow
3	Unknown	200-350	15-20	Oct-Nov	Soft, sweet	Pink
4	Quan Ba	40-90	6-12	Sept-Oct	Crisp, sweet	Yellow
5	Luc Yen	60-120	7.5-12.5	Sept-Oct	Crisp, sweet	Yellow
III	**Pear** [*Pyrus pyrifolia* (Burm. f.)]					
1	Tai Nung	200-350	10 -15	Jun-Jul	Sweetish	Yellowish green
2	Heng shan	150-300	11-15	Jun-Jul	Acrid	Brown
3	Jin hua	100-300	2.5-3.0	Jun-Jul	Sweetish	Yellowish green
4	Shi suan	200-350	7.5-8.5	Jun-Jul	Sweet, juicy	Yellow
5	No.18-19	200-350	10-15	Jun-Jul	Sweetish	Brownish yellow
6	Su li	200-350	3.5-5.5	Jun-Jul	Sweetish	Brownish yellow
7	VRQ 01	200-250	6-9	Jun-Jul	Sweetish	Brownish yellow
8	VRQ 02	200-350	7-11	Jun-Jul	Sweetish	Brownish yellow
9	VRQ 03	200-250	7-10	Jun-Jul	Sweetish	Brownish yellow
10	DL19	220-420	8.5-9.4	Jun-Jul	Sweet	Brownish yellow
11	DL20	200-360	10-15	Jun-Jul	Sweet	Brownish yellow
12	DL21	200-360	10-15	Jun-Jul	Sweetish	Brownish yellow
13	Shang khe	350-800	4.2- 5.0	Jun-Jul	Sweetish, juicy	Brownish yellow
14	Huang hua	200-350	7.5-8.5	Jun-Jul	Sweetish	Greenish yellow
15	Jin suan	180-300	3.5-5.5	Jun-Jul	Sweetish	Yellowish green
16	SaPa	180-300	8 -10	Jun-Jul	Sweetish, acrid	Green
17	Shi suan 2	200-350	7.5- 8.0	Jun-Jul	Sweetish	Yellow
18	Tai Nung 06	200-350	10 -15	Jun-Jul	Sweetish	Yellowish green
19	Bac Ha macot	30- 50	10-15	Aug-Sept	Hard, acrid	Brown
20	SaPa macot	20 - 40	9-13	Aug-Sept	Hard, acrid	Brown
21	Ha Giang pear	250-450	10- 13	Jul-Aug	Hard, acrid	Brown
22	BV1	300-550	10-15	Jun-Jul	Hard, acrid	Greenish yellow
23	BV2	210-380	10-15	Jun-Jul	Hard, acrid	Yellowish green

Summarized results of recent studies on temperate fruits in the northern mountainous region

Studies on varietal selection and breeding programmes

For years, scientific research works have focused on the evaluation of the adaptability of local and introduced temperate fruit cultivars in different locations in the northern mountainous region, from which promising ones have been

selected for further screening before being cultivated at a large scale. The results of such studies on these aspects, as conducted by variously related institutions, can be summarized as follows:

Local and introduced varieties of temperate fruits collected and tested in the conditions of northern mountains are quite diverse. Some of the promising cultivars from these collections have been evaluated in-depth and screened for large-scale production in appropriate locations.

+ For pears: 18 varieties imported from China and Taiwan in 2001 and six introduced from Taiwan in 2013 have been tested in Lao Cai, Ha Giang, Son La, Bac Kan, and Lang Son, of which the BV1, BV2, and Heng Shan cultivars/varieties, primarily, are considered to be promising [2-5]. In addition, some local cultivars/varieties, such as Trang Dinh pears and Pho Bang pears were also studied and selected as acceptable.

+ For peaches: six local cultivars - Early Yunnan, Late Yunnan, Trau, Tuyet, Tay, and Thoc - and six introduced ones, including Early Grand, Flordaprince, Tropic beauty, Sunwright, and 90-3 NW, were evaluated. Of these, the Early Yunnan and Trau cultivars were considered to have good agricultural characteristics and were selected for further screening.

+ For plums: results from studies conducted on varietal selection showed that in the collection of seven local plum cultivars and three introduced ones, two local cultivars - Com (harvested early) and Tim (harvested late) - were considered to be promising in terms of their high yield, good quality, and insect resistance, *Dacus dorsalis,* while Simca and Blackamper (introduced cultivars) would not flower because of high chilling requirement.

+ For persimmons: although many varieties of local persimmon have been traditionally cultivated in small-scale farmer orchards in the northern moutainous region, none of these has been considered as a commercial cultivar since they are all astringent and the area for the cultivation of persimmons is very limited. As regards quality, some local cultivars, such as Hac Tri, Bac Kan, and Quan Ba have been selected for further screening. In addition, some non-astringent persimmon varieties that have been introduced from outside (e.g. from Japan and Taiwan), including Fuju and Jiro, have been evaluated of their adaptability to northern moutainous conditions; however, results have also been quite limited.

Studies of cultivating technologies

Compatibility of introduced cultivars grafted onto local rootstocks:

In accordance with the idea of importing suitable varieties from outside, the study of the compatibility of introduced cultivars used as scions and local rootstock cultivars should be carefully implemented. The information that follows has been taken from the co-operative planting material exchange project involving Taiwan and Vietnam conducted by VAAS in 2013-2016 [4].

- For persimmons: when grafted on aged fruit trees, a high percentage of shoot survival, ranging from 77.5 to 100.0%, was recorded for all four introduced cultivars of persimmon. In terms of the ratio of surviving shoots, a short duration from grafting to bud emergence, and good growth of the shoots grafted, the best results were reported for Hiratanenashi and Tone Wase.

When grafted on the local rootstock cultivars Phu Tho trung persimmon and Sa Pa persimmon, a percentage of shoot survival for all four introduced varieties varying from 76.5 to 82.8% was recorded. Better results were observed for the Nishimura and Tone Wase cultivars.

- For peaches: when grafted on the local rootstock cultivars Thoc peach and Son La peach, good results were observed for all four introduced peach cultivars. The shoot survival ratio was 80% or more and no significant difference was recorded between cultivars and locations. For the grafting on seedlings, the rootstock cultivars mentioned above were used and the percentage of grafted shoot survival obtained was 84.5 to 88.7%. It is clear that all of the four introduced cultivars have good compatibility with the local rootstock. Tropic beauty gave the best results and A 2-2-39 ranked second, a bit better than Flodared and B115.

- For pears: when grafted on aged trees of the Tai Nung pear cultivar that had been budded from local rootstock seedlings, good compatibility indicated by high ratio of shoot survival was recorded for all of the introduced varieties. The best results were observed for the Mi Xue and Heng Shan cultivars (more than 95%) compared to the others (about 93% of shoots survived). For grafting on seedlings, the same situation was reported, with the good compatibility of the introduced varieties with the local ones Big fruit Macoc and Small fruit Macoc indicated by the high percentage of grafted shoot survival observed in both implementing locations, Moc Chau and Sa Pa (94.5% and more than 80%, respectively).

In other studies [6], the same results were obtained. Tran Thanh Toan, PPRI concluded that the local Thoc peach cultivar could be used as rootstock for introduced ones because of good compatibility and fast growth; while Ha Quang Thuong NORMAFI has stated that the local persimmon cultivar, Trung Lap Thach, is regarded as good rootstock cultivar for grafting with a range of scion varieties, both local and introduced ones.

Growth and productivity of grafted shoots of introduced cultivars:

Apart from the compatibility of scion-roostock cultivars, the growth of introduced varieties was also evaluated according to the health of the grafted shoots, as indicated

by two principal criteria: the diameter, measured at a site close to grafting point, and its length. The datas presented in Table 2 can be summarized as demonstrating that all the varieties introduced from Taiwan showed relatively good growth and that no significant difference in the growth of the same cultivars tested in various locations was recorded.

Table 2. Diameter (D) and length (L) of grafted shoots of introduced cultivars in different locations (cm) [4].

Persimmon			Peach			Pear		
Cultivar	*D*	*L*	*Cultivar*	*D*	*L*	*Cultivar*	*D*	*L*
Bac Ha, Lao Cai								
Hiratone Nashi	0.34	29.6	B115			Mixue	2.23	94.5
Tone Wase	0.30	28.6	Flordared			Heng shan	2.16	90.5
NishimuraWase	0.39	31.7	Tropic Beauty			Ming Fu	2.01	88.2
Mackawa Jiro	0.41	33.5	A2-2-29			Jin xian	1.56	76.2
						Zhi Zi	1.73	82.2
						GaoQiang	1.85	87.9
Sa Pa, Lao Cai								
Hiratone Nashi	0.30	25.3	B115	4.45	140.2	Mixue	4.25	148.2
Tone Wase	0.30	24.1	Flordared	3.97	136.5	Heng shan	3.97	139.5
NishimuraWase	0.32	22.9	Tropic Beauty	4.93	148.6	Ming Fu	3.83	132.6
Mackawa Jiro	0.36	25.7	A2-2-29	4.82	152.5	Jin xian	3.47	118.5
						Zhi Zi	3.54	123.7
						GaoQiang	3.67	130.6
Dong Van, Ha Giang								
Hiratone Nashi	0.31	31.6	B115	4.23	143.6	Mixue	4.04	144.5
Tone Wase	0.30	29.6	Flordared	3.84	137.2	Heng shan	3.66	135.3
NishimuraWase	0.33	34.7	Tropic Beauty	4.71	146.1	Ming Fu	3.52	130.2
Mackawa Jiro	0.35	36.5	A2-2-29	4.56	155.4	Jin xian	3.28	115.6
						Zhi Zi	3.15	121.8
						GaoQiang	3.35	128.1
Ngan Son, Bac Kan								
Hiratone Nashi	0.34	28.5	B115	4.03	99.8	Mixue		
Tone Wase	0.34	27.1	Flordared	3.89	10.2	Heng shan		
NishimuraWase	0.36	25.8	Tropic Beauty	4.23	10.2	Ming Fu		
Mackawa Jiro	0.41	28.9	A2-2-29	4.41	9.6	Jin xian		
						Zhi Zi		
						GaoQiang		
Trang Dinh, Lang Son								
Hiratone Nashi	0.38	33.3	B115	3.98	93.4	Mixue	2.70	94.5
Tone Wase	0.34	32.2	Flordared	4.02	104.3	Heng shan	-	-
NishimuraWase	0.44	35.7	Tropic Beauty	4.11	101.2	Ming Fu	-	-
Mackawa Jiro	-	-	A2-2-29	4.27	98.7	Jin xian	2.02	83.3
						Zhi Zi	-	-
						GaoQiang	2.27	86.3
Moc Chau, Son La								
Hiratone Nashi	0.28	38.3	B115	3.98	63.13	Mixue	4.04	74.8
Tone Wase	0.29	35.1	Flordared	4.02	57.25	Heng shan	3.66	76.6
NishimuraWase	0.30	29.6	Tropic Beauty	4.11	5.5	Ming Fu	3.52	43.7
Mackawa Jiro	0.27	30.3	A2-2-29	4.27	6.63	Jin xian	3.28	34.6
						Zhi Zi	3.15	57.9
						GaoQiang	3.35	78.9
Don Duong, Lam Đong								
Hiratone Nashi	2.98	68.6	B115			Mixue		
Tone Wase	2.60	38.2	Flordared			Heng shan		
NishimuraWase	2.37	55.6	Tropic Beauty			Ming Fu		
Mackawa Jiro	2.98	-	A2-2-29			Jin xian		
						Zhi Zi		
						GaoQiang		

The yields (kg/tree) of the introduced cultivars presented in Table 3 were the means of the same cultivars grafted on 4-6 year old trees grown in two crops in different locations.

It should also be mentioned that the yield and quality of the perennial fruits, including persimmon, peach, and pear, should significantly improve with 10 to 12 years of further growth.

Table 3. Yields and fruit characteristics of introduced cultivars [4].

Cultivars	Yields (kg/tree)		Fruit characteristics (means)			
	Min	*Max*	*Diameter (cm)*	*Length (cm)*	*Weight (g)*	*Brix (%)*
Persimmon						
Hiratanenashi	12.8	19.3	6.1	6.5	128.0	19.3
Tone Wase	11.7	16.1	6.6	5.3	142.7	16.1
Nishimura Wase	14.7	20.2	5.8	4.6	94.6	20.2
Mackawa Jiro	15.6	21.3	7.2	4.6	254.7	21.3
Peach						
B115	6.6	8,4	5.2	4.7	71.3	11.8
Flodared	6.0	7.0	6.0	4.5	82.1	9.7
Tropic beauty	6.9	8.9	4.8	4.6	68.3	9.2
A2-2-39	6.6	8.9	5.7	5.3	91.2	11.5
Pear						
Mixue	6.2	10.2	8.1	7.4	295.2	13.2
Heng Shan	3.5	5.8	6.3	5.5	263.7	12.1
Ming Fu	-	-	-	-	-	-
Jin Xian	4.5	6.5	6.6	5.8	145.3	11.3
Zhi Zi	5.7	8.7	6.3	5.2	130.7	10.4
Gao Qiang	4.3	5.3	6.8	5.8	164.3	11.2

Based on the abovementioned criteria relating to the productivity and quality of the cultivars studied, general considerations can be summarized as follows: i) almost all the cultivars introduced from Taiwan, except Ming Fu (pear), can flower and fruit in the first and second year after top worked on aged fruit trees; and ii) of all the cultivars studied, Mackawa Jiro (persimmon), B115 and A2-2-39 (peach), and Mi Xue and Heng Shan (pear) can be considered the promising ones.

Training and pruning technologies:

In the past, local farmers cultivated temperate fruits without training or pruning, resulting in low quality products. This is the reason that these techniques have received great attention in recent research. Tables 4 and 5 below provide some examples that prove their impact on the growth and productivity of temperate fruits grown in northern mountainous region.

Table 4. Effects of training and pruning on the growth of pears [1].

Location	Treatment	Tree age	Trunk diameter (cm)	Canopy diameter (m)	Tree height (m)
Sa Pa, Lao Cai	T1	3	6.02	1.56	1.96
	T2	3	6.86	2.23	2.18
	T3	3	5.17	1.14	2.10
Dong Van, Ha Giang	T1	3	5.54	1.26	1.66
	T2	3	6.32	2.11	1.82
	T3	3	4.96	1.04	1.76
Sin Ho, Lai Chau	T1	3	5.32	1.12	1.52
	T2	3	6.17	2.04	1.72
	T3	3	4.82	0.98	1.67

T1: palmate training with three prunings per year; T2: open vase training with three prunings per year combined with bending; T3: (control) natural canopy without pruning.

Table 5. Effects of training and pruning on the productivity of pears [1].

Locations	Treatment	Tree age	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit quantity/ tree	Yield (kg/ tree)
Sa Pa, Lao Cai	T1	3	7.02	6.77	319.3	22.5	9.65
	T2	3	7.16	6.97	322.5	40.7	14.70
	T3	3	6.84	6.61	303.7	11.9	3.64
Dong Van, Ha Giang	T1	3	6.96	6.65	300.3	16.7	8.51
	T2	3	7.10	6.91	321.5	33,6	13.40
	T3	3	6.76	6.56	313.4	7.5	2.35
Sin Ho, Lai Chau	T1	3	7.05	6.69	311.3	17.6	7.28
	T2	3	7.03	6.87	318.5	31.1	12.50
	T3	3	6.78	6.58	303.7	8.2	2.50
$LSD_{0.05}$							3.1
CV (%)							10.8

Soil moisture management in temperate fruit orchards:

Water resources used for irrigation are one of main constraints for agricultural production, including for fruit crops. Technologies that save water and limit soil evaporation have, therefore, received significant attention. In the case of perennial crops, intercropping and mulching are considered effective and feasible (Tables 6 and 7). The examples in the tables (one for pears and one for persimmons) demonstrate the impact of these techniques on temperate fruit growth and productivity.

Table 6. Effects of mulching and intercropping on the yield of pears [1].

Location	Treatment	Tree age	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit quantity/ tree	Yield (kg/ tree)
Sa Pa, Lao Cai	T1	3	7.22	6.95	327.5	51.3	16.8
	T2	3	7.04	6.87	320.3	48.4	15.2
	T3	3	6.87	6.65	307.6	40.9	12.6
Dong Van, Ha Giang	T1	3	7.15	6.87	327.5	47.4	15.5
	T2	3	6.96	6.78	320.3	43.2	13.1
	T3	3	6.81	6.59	307.6	35.9	11.0
Sin Ho, Lai Chau	T1	3	7.09	6.85	327.5	45.6	14.9
	T2	3	6.95	6.76	320.3	41.3	13.2
	T3	3	6.75	6.57	307.6	32.1	9.9
$LSD_{0.05}$							1.2
CV(%)							5.6

Table 7. Effects of watering method, intercropping, and mulching on the yield of persimmons [5].

Location	Treatment	Fruit weight (g)	Fruit quantities/ tree	Yield (kg/tree)		% compared to control
				Calculated	*Harvested*	
Hac Tri	I	83.40a	278.50a	23.20b	20.97b	100.00
	II	90.74a	304.11a	27.60a	24.99a	119.18
	III	87.89a	297.05a	26.08ab	24.19a	115.36
	IV	89.82a	298.91a	26.79ab	24.80a	118.29
	$LSD_{0.05}$	*6.92*	*36.32*	*3.27*	*2.33*	-
	CV%	*3.9*	*5.9*	*6.3*	*4.9*	-
Quan Ba	I	33.14a	799.88b	26.49b	24.65b	100.00
	II	35.04a	861.20ab	30.18a	27.92a	113.27
	III	34.52a	848.32ab	29.24a	27.04a	109.69
	IV	34.99a	881.00a	30.83a	27.62a	112.04
	$LSD_{0.05}$	*2.93*	*65.74*	*2.72*	*2.13*	-
	CV%	*4.3*	*3.9*	*4.7*	*4.0*	-
Dien Bien	I	134.23b	191.21a	25.73b	23.60b	100.00
	II	143.66a	199.49a	28.66a	26.52a	112.36
	III	141.40ab	199.16a	28.13a	26.14a	110.77
	IV	143.01ab	198.71a	28.40a	26.25a	111.21
	$LSD_{0.05}$	*9.36*	*18.39*	*2.27*	*1.98*	-
	CV%	*3.3*	*4.7*	*4.1*	*3.9*	-

Notes: the values followed by different letters in the same columns indicate that the differences are significant at 5% probability. I (control): no irrigation, no mulching; II: irrigated at fixed stages: when flower buds emerged, 2-3 weeks after fruit setting, 2-4 weeks before harvest (40 litres/tree/one time); III: mulched with straw, dry leaves of 1.5 cm thickness; IV: intercropped with legume crops.

Scientific solutions to promote future temperate fruit development

In order to sustainably develop temperate fruits in the northern mountainous region, the following key issues should be taken into account:

+ Determining species and good varieties to be grown properly and effectively in various locations in the northern mountains, with attention paid to chilling requirements (Table 8).

+ Completing and developing suitable techniques for multiplication (both seedlings and TOP grafting) to be applied to leading cultivars of temperate fruits cultivated in the northern mountainous region.

+ Completing and developing advanced cultivation technologies that suit local conditions and the biological characteristics of varieties grown to meet increasing consumer demand. The bending technique should accordingly be considered and introduced into production [7].

+ Establishing small- and medium-scale pilot demonstrations of temperate fruit production to link scientists, producers, managers, and trader by means of production and value chains.

+ Training skilled technicians and local famers in advanced technologies for temperate fruit cultivation.

Table 8. Temperate fruits planned commercially in different locations in the northern mountainous regions.
CU: chilling unit.

No.	Location	Altitude (m)	Mean temp. of coldest month		CU	Species to be grown
			Max.	*Min.*		
1	Sa Pa, Lao Cai	1,580	12	6	616	Peach, pear, plum, persimmon
2	Bac Ha, Lao Cai	930	17	8	322	Peach, pear, plum, persimmon
3	Sin Ho, Lai Chau	1,530	14	6	522	Peach, pear, plum, persimmon
4	Tam Duong, Lai Chau	960	18	9	256	Peach, pear, plum, persimmon
5	Moc Chau, Son La	970	17	9	281	Peach, pear, plum, persimmon
6	Pha Din, Dien Bien	1,380	16	9	316	Peach, pear, plum, persimmon
7	Mu Cang Chai, Yen Bai	960	20	9	278	Peach, pear, plum
8	Dong Van, Ha Giang	1,480	17	7	568	Peach, pear, plum
9	Trung Khanh, Cao Bang	520	18	9	291	Peach, pear, plum, persimmon
10	Nguyen Binh, Cao Bang	490	19	10	237	Peach, pear, plum, persimmon
11	Ngan Sơn, Bac Kan	520	18	9	244	Peach, pear, persimmon
12	Bac Son, Lang Son	390	18	10	218	Pear

Conclusions

1. Temperate fruits in general and pears, peaches, plums, and persimmons in particular can be properly cultivated in the northern mountainous regions of Vietnam where land availability and climatic conditions are considered favourable for their requirements. It is worth mentioning that temperate fruits play an important role both in improving the living standards of local people in environmental protection.

2. The results of various studies indicate that suitable varieties of temperate fruits and cultivating technologies have been selected for application in large-scale production.

3. Accordingly, in order to develop temperate fruits in the northern mountains, the combination of good varieties and advanced techniques should be taken into account and applied appropriately.

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