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Persian Walnut in Vietnam: A Potential Fruit Tree for Poverty Reduction

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Authors' contributions

This work was carried out in collaboration among all authors. Authors NTT, DVT, NQH, VTL, NVK, PDT, THQ, NHT, PQT, HTS, TNB, HTL, NVT, DQT, NTTP, DTD and TVD designed the study and conducted field works. Author TVD managed the literature searches, performed the statistical analysis and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Persian walnut, *Juglans regia* L., is a long-lived, wind-pollinated and deciduous tree, which produces large, woody, shelled and edible nuts. *J. regia* is one of the most economically important cultivated species for timber and nutritious nuts. Its nuts have medicinal importance for human health by high antioxidant capacity. *J. regia* has been planted in Northern Vietnam for decades. In this study, a survey was conducted in three provinces to understand current planting sites and production of planted trees. The results indicated that *J. regia* was planted personally in gardens of local people in Lai Chau, Lao Cai and Ha Giang provinces, sharing borderlines with China. The planted trees are 10-30 years old with some exceptions of up to 40-50 years old. Generally, each household owns 2-3 fruited trees with some exceptions of up to 10 trees. After planting 7 years, trees fruit annually. However, the production varies among trees. A best 20-25-year-old tree can yield 55 kg fruits/year with current market price of 1.5 US$/ 1 kg fruits. There exists high variation

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of fruit production among planted sites, as results of climate difference, and unknown source and sexual propagation seedlings. It is concluded that to establish an extensive plantation of *J. regia* for high fruit production, selecting superior genotypes from local populations should be conducted, then vegetative propagation such as grafting should be applied to produce good and uniform seedlings.

Keywords: Ethnic people; poverty reduction; production; superior genotype; vegetative propagation.

1. INTRODUCTION

The genus *Juglans* includes 21 species of long-lived, wind-pollinated and deciduous trees known as walnuts, which produce large, woody, shelled and edible nuts [1-2]. Walnuts distribute over a wide geographical range, including southern Europe, eastern Asia and the Americas [3], and display differentiation in nut characteristics. Of which, Persian walnut (*Juglans regia* L.) is the most economically important cultivated species for timber and nutritious nuts [4-5]. Its nuts have medicinal importance for human health by high antioxidant capacity [6] and ω-3 fatty acid concentration [7-8].

It is likely that prior to the Pleistocene glaciations the *J. regia* had a wide distribution in Eurasia, but during the glacial periods the distribution was contracted to refugial areas in China, the Himalayan slopes, Southern-Central Asia, the Balkans, and the Iberian and Italian peninsulas by artificial diffusion through human silvo-pastoral practices [9-11]. Ancient trade routes such as the Persian Royal Road and Silk Road enabled long-distance dispersal of *J. regia* from Iran and Trans-Caucasus to Central Asia, and from Western to Eastern China [12]. It is generally accepted that *J. regia* survived and grew spontaneously in almost completely isolated stands in its Asian native range after the Last Glacial Maximum. Despite its natural geographic isolation, *J. regia* evolved over many centuries under the influence of human management and exploitation.

In Vietnam, *J. regia* has been planted in some provinces sharing borderline with China (Fig. 1). It is indicated that cultivars were purchased from China and first planted around 100 years ago. However, information on plantations and fruit production are still limited. Therefore, this research work aims at surveying planting sites and fruit production of planted trees and discussing the potentiality of planting *Juglans regia* L. for poverty reduction in Vietnam.

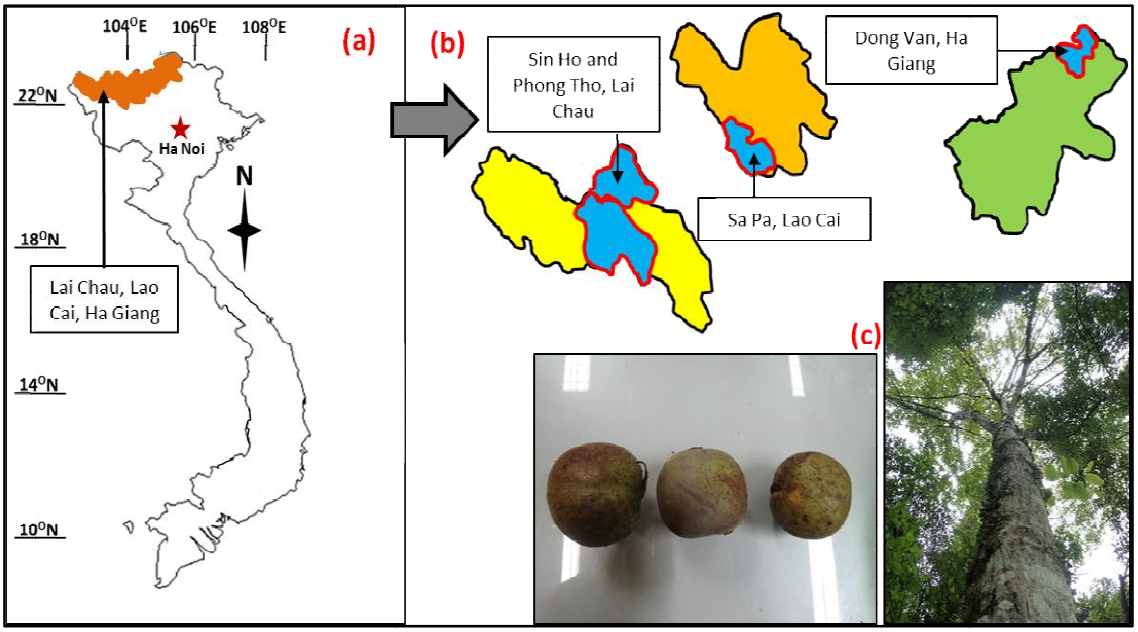

Fig. 1. Map of Vietnam (a), maps (non-scale) of survey provinces and districts (b), and Persian walnut tree and fruits (c)

2. METHODS

2.1 Research Sites

Previous researches [13-14] indicated that *Juglans regia* L. grows in the Northern provinces of Vietnam (Fig. 1), sharing borderlines with China. Therefore, in this study three provinces including Lai Chau, Lao Cai, and Ha Giang were selected for field surveys. Interviewing responsible persons belonging Provincial Department of Forest Development indicated some districts which have the highest number of *J. regia* populations owned by numerous households. Therefore, four districts were selected for the field survey, including Sin Ho and Phong Tho (Lai Chau), Sa Pa (Lao Cai), and Dong Van (Ha Giang). Further interviewing responsible persons in districts indicated some communes with *J. regia* populations, which were selected for data collection. Survey included 17 communes in Sin Ho and Phong Tho districts, 6 communes in Sa Pa district, and 16 communes in Dong Van district.

2.2 Survey Method

Interviewing householders was used in this study. With the guide of communal authorities, surveying team passed through all households owing *J. regia* populations to gather information including (1) number of *J. regia* trees, (2) planted years if available, fruit production in the past three years of top production trees, (4) selling price and market location (e.g., at home, local market, outside market), and (5) others (e.g., tending *J. regia* trees, diseases)

2.3 Statistical Analysis

First, a number of households and number of top production *J. regia* trees in each commune were generated. Fruit production (kg/year) was calculated for each commune based on three consecutive year records. Then, the average production (kg/tree/year) was generated. Univariate analysis of variance (ANOVA) and post-hoc tests were used to evaluate the effects of planting sites (provinces) on fruit production. SAS 9.2 was employed for statistical analysis.

3. RESULTS

In all survey communes of the four study districts, there was a high variation of annual fruit production among planted trees. Only around 10% of top production trees were recorded and mentioned for their productions.

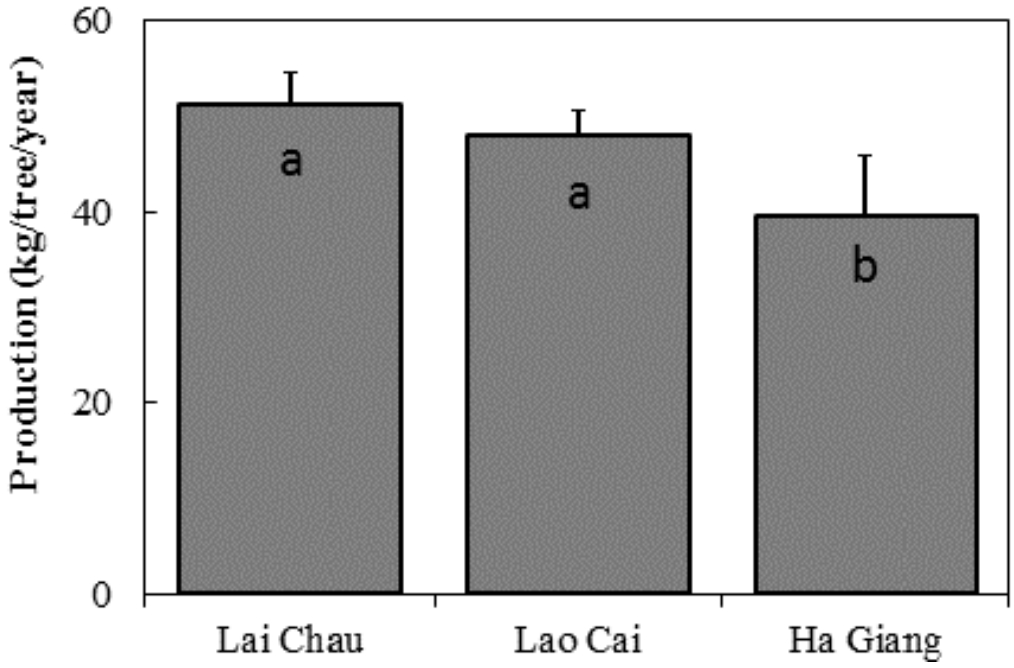

Fig. 2. Comparison of fruit production among three provinces, Vietnam
Bars indicate +SE. Different letters [a, b] indicate significant difference of means at p =0.1

Table 1. Walnut population and production in 17 communes in Sin Ho and Phong Tho districts, Lai Chau province, Vietnam

No	Commune	Number of households	Number of trees	Fruit production (kg/year)	Average production (kg/tree/year)
1	Lang Mo	2	3	235	78.3
2	Ta Phin	13	21	1,598	76.1
3	Ta Ngao	9	9	590	65.5
4	Chan Nua	8	9	505	56.1
5	Nam Ma	8	12	673	56.1
6	Nam Cha	14	16	875	54.7
7	Tung Qua Lin	4	5	262	52.4
8	Tua Sin Chai	11	13	659	50.7
9	Pa Tan	6	6	301	50.2
10	Nam Cuoi	4	7	348	49.7
11	Nam Han	10	15	729	48.6
12	Nam Tam	5	7	325	46.4
13	Dao San	13	17	717	42.2
14	Phang So Lin	4	4	165	41.3
15	Sin Ho Town	2	2	75	37.5
16	Xa De Phin	3	3	105	35.0
17	Pa Vay Su	10	13	405	31.2
Total		**126**	**162**	**8,567**	**51.3**

Ages of survey trees ranged 25-30 years old

Table 2. Walnut population and production in 6 communes in Sa Pa district, Lao Cai province, Vietnam

No	Commune	Number of households	Number of trees	Fruit production (kg/year)	Average production (kg/tree/year)
1	Ta Phin	5	8	451	56.3
2	Sa Pa town	11	15	832	55.4
3	Sa Pa	9	11	501	45.5
4	San Sa Ho	8	9	397	44.1
5	Hau Thao	6	7	304	43.4
6	Lao Chai	7	10	432	43.2
Total		**46**	**60**	**2,917**	**48.0**

Ages of survey trees ranged 20-25 years old

Table 3. Walnut population and production in 16 communes in Dong Van district, Ha Giang province, Vietnam

No	Commune	Number of households	Number of trees	Fruit production (kg/year)	Average production (kg/tree/year)
1	Pho La	16	16	1,596	99.8
2	Ta Lung	17	19	1,764	92.8
3	Van Chai	8	12	675	56.3
4	Thai Phin Tung	41	58	2,916	50.3
5	Pho Cao	9	11	523	47.5
6	Sung La	37	49	1,589	32.4
7	Dong Van town	6	6	193	32.2
8	Sang Tung	55	80	2,465	30.8
9	Pho Bang town	10	12	356	29.7
10	Lung Tao	49	63	1,796	28.5
11	Sinh Lung	44	50	1,389	27.8
12	Ho Quang Phin	9	9	238	26.4
13	Ta Phin	43	38	887	23.3
14	Sa Phin	46	55	1,187	21.6
15	Ma Le	29	31	625	20.2
16	Lung Cu	61	80	1,189	14.9
Total		**480**	**589**	**19,388**	**39.7**

Ages of survey trees ranged 10-20 years old

In Sin Ho and Phong Tho districts, Lai Chau province, most of the trees are 25-30 years old. There was a high variation in production among survey communes (Table 1). It was 78.3 kg/tree/year in Ta Phin commune, reducing to 50.2 kg/tree/year in Pa Tan commune and to 31.2 kg/tree/year in Pa Vay Su commune. Average production in Lai Chau province was 51.3 kg/tree/year.

In Sa Pa district, Lao Cai province, most trees are 20-25 years old. There was less variation in production among survey communes (Table 2). It was 56.3 kg/tree/year in Ta Phin commune, reducing to 45.5 kg/tree/year in Sa Pa commune and to 43.2 kg/tree/year in Lao Chai commune. Average production in Sa Pa district, Lao Cai province was 48.0 kg/tree/year.

Ages of trees in Dong Van district, Ha Giang province are younger than other survey provinces, which are 10-20 years old. There was a remarkable variation of fruit production among survey communes (Table 3). Pho La commune had the highest production of 99.8 kg/tree/year. The middle production (30.8 kg/tree/year) belonged to Sang Tung commune. While the lowest production (14.9 kg/tree/year) belonged to Lung Cu commune.

Average production was statistically significant different among three survey provinces (Fig. 2), which was highest in Lai Chau (51.3 kg/tree/year), reducing to Lao Cai (48.0 kg/tree/year), and the lowest production belonged to Ha Giang (39.7 kg/tree/year).

4. DISCUSSION

It is indicated that most planted trees were from seeds/sexual propagation. Therefore, genetic variation among trees led to a different fruit production. After planting 6-8 years trees started fruiting and fruit production became stable after three years of fruiting [13]. Therefore, all survey trees were stable fruiting at the time of the survey. The sizes of *J. regia* tree are stable after planting 12-13 years, indicating no significant change of crown diameter which is considered as main part for fruiting. There is a high variation of fruit production among trees, survey communes, districts, and provinces (Tables 1, 2, and 3). The difference in fruit production results from (1) different tree ages, (2) different variables planted, and (3) differences of climates and edaphic conditions. Therefore, the difference of fruit production among trees in a commune and provinces in the present study results mainly from genetic variation among planted trees. Selecting plus trees of high fruit production and applying vegetative propagation (e.g., grafting) in each province should be conducted to have superior genotypes for high production and quality plantations.

It is noted that survey areas are residential places of ethnic people, who are living under national standard and classified as poor communities, and their lives are manly depending on forest resources. Therefore, growing long-lived fruit trees (e.g., *J. regia*) seems to be the best solution for poverty reduction and sustainable development [15-16]. The current market price is 1.5 US$/ 1 kg fruits. A 20-25-year-old tree of *J. regia* can yield average 45-55 kg fruits annually. If a household owns 20 fruited trees, annual income from nuts of *J. regia* could be at least 1,500 US$. Such a high income can sustain their minimal daily food requirement. In fact, there are several households who own 10-15 fruited trees. However, fruited trees with high production >20 kg fruits/year are low as a maximum of 3-4 trees. Therefore, income from nuts of *J. regia* is still low. Such low production resulted from growing unknown sources of different variables and stock plants from seeds/ sexual propagation other than from vegetative propagation of superior genotypes [17]. In addition, after planting trees are not tended properly (e.g., no fertilizing, no crown forming). If good genotypes are used and trees are tended properly, the plantation will yield much higher production than 45-55 kg fruits/tree/year (Table 1, 2, and 3).

Most trees were planted scattered in gardens of local people personally with a maximum of 10-15 trees/household. Pure plantations of *J. regia* are not recorded in the study site. After planting, trees are not tended and/or fertilized. Until recently, there have been no national programs on growing *J. regia*. No tending techniques were applied, leading to low production. The current local market price is 1.5 US$/ 1 kg fruits. However, there is no insurance on market stability if seed production increases. Intensive growing in large scale may meet the difficulty in future marketing. Therefore, detail study on the future demand of walnut nuts in local communities and in Vietnam should be conducted for the further recommendation on enlarging plantation [13]. At the meantime, selecting superior genotypes from local populations in the study sites should be

conducted. Then, techniques for vegetative propagation such as grafting must be improved for practical application [18]. Culture and society aspects of local ethnic people must be carefully considered if ones plan to establish intensive plantations in the study sites. Small scale plantation as planting in gardens and surrounding-house lands with a limited number of trees (e.g., 20-30) seems to be best suitable for ethnic communities in the study sites. However, technique guideline should be carefully conducted and transferred to each household on planting and tending to ensure high fruit production. For better enlarging plantation to ethnic people, supporting seedlings of superior genotypes, fertilizer and techniques should be conducted freely. In addition, local communities should support products-marketing to ensure a higher price and a stable market for sustainable development.

5. CONCLUSION

Nuts of *Juglans regia* L. are valuable for human health and widely marketed locally with the current price of 1.5 US$/1 kg fruits. Therefore, *J. regia* could be considered as potential forest trees for poverty reduction to ethnic communities in Northern Vietnam. After planting 6-8 years, trees start fruiting. At the ages of 20-25 years old, a tree of *J. regia* can yield 44-55 kg fruits annually. However, there is a high variation of fruit production among sites and planted trees as results of planting unknown and sexual propagation seedlings, and most planted trees were not tended properly.

It is recommended that to establish intensive, high production plantation of *J. regia* in Northern Vietnam selecting superior genotypes from available local populations should be conducted and vegetative propagation such as grafting should be applied to produce best and uniform seedlings. In addition, seedlings from superior genotypes should be distributed freely to local people for growing in their gardens and surrounding-house lands. It could be the best way contributing to poverty reduction and sustainable development in local communities.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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