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Research Article

Science and Technology as a Driver of the Lotus Value Chain: Insights from the Project on the Application of Science and Technology to Develop a Value Chain Linkage Model for the Production, Processing, and Consumption of Lotus (*Nelumbo nucifera*) in Thanh Hoa Province

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Abstract

The paper presents the results obtained during the implementation of the project "Application of science and technology to develop a value chain linkage model for the production, processing, and marketing of lotus (*Nelumbo nucifera*) in Thanh Hoa Province". During the implementation period, the project established and deployed a value chain linkage model for the production, processing, and marketing of lotus (*Nelumbo nucifera*) in Thanh Hoa Province, Nelumbo nucifera. Two lotus cultivars, Mat Bang and Tay Ho, were trial-planted and evaluated, showing good growth performance, high survival rates, and adaptability to local ecological conditions. Throughout the growth cycle, pests and diseases were minimal, with only leaf-eating caterpillars appearing at the early leaf-expansion stage; these were detected and treated promptly, preventing large-scale spread.

The project has initially formed a closed value chain from raw material production to processing and product marketing, contributing to enhancing the economic value of lotus, protecting the environment, and laying the foundation for sustainable scale-up in Thanh Hoa Province. The findings indicate that the lotus varieties and cultivation techniques applied in the project's demonstration models yielded productivity and quality 30-40% higher than local varieties and traditional cultivation practices. At the maturity stage, the diameter of floating leaves ranged from 35-40 cm, standing leaves from 60–85 cm, and plant height from 1.7–2.1 m; the seed yield reached 2.319 kg/ha, with a filled-seed rate of 79.7-86.8%.

Keywords: Growth and development; model; lotus plant; yield

Introduction

Thanh Hoa Province has a large natural area, a diverse ecosystem, and abundant water resources, creating favourable conditions for the development of concentrated lotus cultivation models in districts such as Tho Xuan, Vinh Loc, Trieu Son, and the former Yen Dinh. These areas possess natural advantages for cultivating lotus-a traditional crop with multiple uses, including flowers, seeds, rhizomes, ornamental purposes, medicinal materials, and food processing [6,7,11]. In the context of agricultural restructuring toward higher value and sustainable development, lotus stands out as a versatile crop well-suited to organic farming systems, eco-tourism, and high-value commodity production [12]. A wide range of lotus-derived products has been commercialized, such as dried lotus seeds, lotus tea, lotus essential oil, functional foods, lotus-based cosmetics, and even lotus-fibre fabric [2], [3]. In particular, value chain linkage models integrating production, processing, and consumption are being implemented in various localities to improve economic efficiency and ensure the sustainable use of local resources [11].

Globally, lotus research has mainly focused on botanical taxonomy, morphological characteristics, medicinal properties, and genetic diversity. These studies, widely published in international journals, have contributed to lotus classification, identification of population structures, and understanding the evolution of lotus germplasm, thereby providing a foundation for the establishment, utilization, and development of valuable lotus collections. Research, collection, and conservation of lotus genetic resources have recently attracted considerable global attention. At present, more than 1,500 lotus varieties are documented and preserved in China, India, Japan, Australia, and the United States [1]. China maintains approximately 600-800 varieties, and in 2002, the National Aquatic Plant Garden in Wuhan relocated and conserved 572 varieties collected from 153 districts in 18 provinces. The National Botanical Research Institute of India preserves 60 varieties, including 35 indigenous accessions collected from eight states-Bihar, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Tamil Nadu, Uttar Pradesh, and West Bengal-and three regions-Chandigarh, New Delhi, and Pondicherry-alongside 25 exotic varieties imported from Australia, Brazil, Germany, Thailand, the UK, and the US [5]. Japan maintains a rich collection of 625 ornamental varieties, while Auburn University (USA) has collected and evaluated 160 varieties from China and other countries.

At the Royal Botanic Gardens, Kew (UK), conservation through seed sowing and plant division has been successfully applied [1], [4]. In Vietnam, research on the biological characteristics and genetic diversity of lotus has gained increasing attention in recent years. From 2011 to 2012, Hoang Thi Nga et al. surveyed and collected lotus (*Nelumbo nucifera* Gaertn.) genetic resources in the Red River Delta, acquiring 18 accessions from four provinces: Bac Ninh, Hai Duong, Ha Nam, and Hanoi. Preliminary descriptions and evaluations revealed notable diversity in local names and agro-biological traits [8]. From 2012 to 2013, Nguyen Thi Thuy Hang further evaluated the agro-biological traits of Tay Ho lotus-a famous Bach Diep variety with large, fragrant flowers and large white seeds used specifically for tea flavouring in Hanoi [9]. In Dong Thap, Truong Thi Nga et al. (2012) studied the agro-biological traits and habitats of several aquatic plants, including lotus, at Tram Chim National Park, Tam Nong District, highlighting its adaptation to flooded and acidic soils.

In 2007, Nguyen Phuoc Tuyen published the textbook Lotus Cultivation Techniques, which provided a comprehensive overview of the origin, distribution, utilization, and agro-biological traits of lotus across cultivation regions [10]. Currently, lotus is regarded as a medicinal plant with high potential and significant development advantages. However, in Thanh Hoa Province, production, processing, and marketing remain underdeveloped due to several constraints: small, scattered, and fragmented cultivation areas; reliance on farmers' experience rather than standardized practices; limited adoption of modern technologies; insufficient focus on market development and export promotion; absence of large-scale production–consumption linkages; and inadequate attention to product quality and food safety. Seed production, cultivation for flowers and seeds, processing, and marketing still fall short of meeting domestic and international demand for clean and safe lotus products. In response, the Thanh Hoa Agriculture Institute has launched the project "Application of Science and Technology to Develop a Value Chain Linkage Model for the Production, Processing, and Marketing of Lotus (*Nelumbo nucifera*) in Thanh Hoa Province".

The project addresses existing challenges from production to market integration, while linking with eco-tourism, enhancing the economic value of local specialty products, and applying scientific and technological advances to improve productivity, quality, and competitiveness for both domestic and export markets. It aims to increase farmers' incomes, promote local economic growth, improve community livelihoods, and reduce pressure on natural resources. This aligns with the province's agricultural and forestry development orientation under Decision No. 1747/QD-TTg dated October 13, 2015, approving the "Program to Support the Application and Transfer of Scientific and Technological Advances to Promote Socio-Economic Development in Rural, Mountainous, and Ethnic Minority Areas for the 2016–2025 Period."

Materials and Methods

Research time and sites: The project was implemented from December 2022 to November 2025 at Thanh Hoa Agricultural Institute Sao Vang, Tho Lap, Bien Thuong Communes, Thanh Hoa Province. Research subjects and technical procedures apply: The research subjects of the project are the Tay Ho and Mat Bang lotus varieties, to which the following procedures were applied:

a) Flower lotus variety (Tay Ho lotus) and technical procedures for planting and care for propagation.

b) Seed lotus variety (Mat Bang lotus) and technical procedures for planting and care for propagation.

c) Flower lotus variety (Tay Ho lotus) and technical procedures for flower production.

d) Seed lotus variety (Mat Bang lotus) and technical procedures for seed production.

e) Yield and quality of the lotus seed production–processing–consumption model under a value chain approach.

Monitoring and Data Processing Methods

Seed Production Garden Model

1 point at the intersection of the two diagonals and 4 additional points evenly located along the four sides of the lotus pond (measurement points about 1 m from the pond edge); at each point, mark a 10 m^2 plot. Measurements are taken every 7 days, starting from the appearance of floating leaves until the beginning of flowering (42 days), recording the following indicators: number of internodes, internode diameter, internode length, floating leaf diameter, number of floating leaves, and pest/disease status.

Commercial Lotus Cultivation Model

Monitor 5 points per model following a diagonal pattern. At each point, mark a 10 m^2 plot to track each harvest and measure the evaluation indicators.

Evaluation Parameters for the Commercial Lotus Cultivation Model

Quantitative traits are evaluated using standard measurement and counting methods commonly applied in plant physiology research. Each trait is measured or observed on individual plants (depending on the trait), and the mean value is recorded.

The parameters include: Plant height (cm): Measure the height of the petiole from the mud surface to the point where the petiole meets the leaf blade at the mature stage. Leaf diameter (cm): Measure the widest distance across the leaf blade. Fully bloomed flower diameter (cm): Measure the flower diameter between 8:00–10:00 a.m. on the second day after blooming. Flower bud length (cm): Measure the length between 8:00–10:00 a.m. when the flower has not yet bloomed. Yield and Yield Components: Yield components for seed production: Number of seed pods per 10 m^2, number of seeds per pod, number of filled seeds per pod, percentage of filled seeds per pod (%), weight of 100 seeds (g), seed yield per 10 m^2 (kg/10 m^2). Yield components for flower production (Theoretical Flower Yield – TFY): Theoretical yield (TY) (kg/ha) is calculated according to the formula:

$$Yield\left(kg/ha\right)=\frac{Number\ of\ \ seedpod/10m^2\times Number\ of\ \ fill\ seed/seedpod\times 100seeds\ weight\left(kg\right)\times 10.000m^3}{100\times 10m^2}$$

The theoretical flower yield (TFY, flowers/ha) is calculated using the formula:

$$Yeild\ (\ flower\ /\ ha)=\frac{Number\ of\ \ flower\ /10m^2\times 10.000m^2}{10m^2}$$

Monitoring and evaluating pest and disease incidence: The monitoring and evaluation of pests and diseases are conducted following the National Technical Regulation on Plant Pest Surveillance – QCVN 01-38:2010/BNNPTNT. Occurrence Degree (OD) of pests is determined as follows:

$$OD=\frac{Number\ of\ \ plants\ infested\ by\ a\ given\ pest}{Total\ number\ of\ \ plants\ serveyed}\times 100$$

Where OD (Occurrence Degree) represents the prevalence level of a pest in the surveyed population.

Method for Assessing Pest Occurrence Degree.

Symbol	Degree of Popularity	Frequency
+	Very race	< 10%
++	Race	10 - 25%
+++	Common	25- 50%

Results and Discussion

Technology Transfer and Adoption of Technical Procedures

Five technical procedures were transferred between the Plant Resources Centre and the Thanh Hoa Agriculture Institute:

a) Technical procedure for lotus propagation.

b) Technical procedure for Tay Ho lotus cultivation.

c) Technical procedure for Mat Bang lotus cultivation.

d) Technical procedure for production and processing of dried lotus seeds.

e) Technical procedure for production and processing of ready-to-eat seasoned lotus seeds.

The transfer process was carried out in compliance with the technology transfer contract. After receiving the transferred procedures, the implementing unit has been actively preparing infrastructure and facilities to carry out activities according to the trained procedures.

Results of Model Implementation

Establishment Model for Lotus Propagation

The lotus cultivation model was implemented by planting two varieties simultaneously on a total area of 1,000 m^2, including 300 m^2 of Tay Ho lotus (for flower lotus) and 700 m^2 of Mat Bang lotus (for seed lotus) at the Thanh Hoa Agriculture Institute by (Tables 1-3). Evaluation of the growth and development potential of the Mat Bang lotus cultivation model. After 14 days of observation, the

number of nodes of the Mat Bang lotus variety increased rapidly from 1 to 3 internodes. The internode length at the week of the first appearance of floating leaves was only 6.1 cm, but after 7 days of observation it reached 16.91 cm, and by day 14 it reached 33.94 cm. The internode diameter developed strongly, ranging from 0.22 to 0.71 cm. The floating leaf diameter showed very rapid growth, from 13.39 to 36.29 cm by day 14. The number of floating leaves increased from 1 to 3 leaves (Table 1). Based on the above data, the number of internodes increased rapidly from 1 to 3 nodes on the Tay Ho lotus variety.

Table 1: Growth dynamics of Mat Bang lotus after planting

N0	Traits	Time of first appearance of floating leaves (days)		
		0*	7	14
1	Number of internodes	1.00	2.43	3.00
2	Internode length (cm)	6.10	16.91	33.94
3	Internode diameter (cm)	0.22	0.51	0.71
4	Floating leaf diameter (cm)	13.39	28.29	36.29
5	Number of floating leaf's	1,00	1.67	2.60

Note: * Time of first appearance of floating leaves.

Table 2: Growth dynamics of Tay Ho lotus after planting

N0	Traits	Time of first appearance of floating leaves (days)		
		0*	7	14
1	Number of internodes	1.00	2.77	3.33
2	Internode length (cm)	6.77	21.88	39.97
3	Internode diameter (cm)	0.35	0.75	1.13
4	Floating leaf diameter (cm)	15.69	28.67	40.67
5	Number of floating leaf's	1.00	2.07	3.33

Note: * Time of first appearance of floating leaves

Table 3: Pest and disease infestation levels on lotus varieties in the propagation model.

Varieties	Leaf-eating pests	Thrips	Mealybugs	Anthracnose	Stem rot	Leaf blight
Mat Bang lotus	++	+	+	+	+	+
Tay Ho lotus	++	+	+	+	+	+

The internode length increased from 6.77 to 39.97 cm, showing slightly stronger growth compared to the Mat Bang variety. The internode diameter also developed significantly, ranging from 0.35 to 1.13 cm. The floating leaf diameter exhibited very rapid growth, from 15.69 to 40.67 cm by day 14. The number of floating leaves increased from 1 to 3 leaves (Table 2). Evaluation of pest and disease infestation levels. Overall, the growth dynamics of the Mat Bang and Tay Ho lotus varieties show good growth and development. During the growth process, no signs of pest or disease infestation were observed on the lotus plant. During the implementation of the seed production model, the project team organized the production of five batches of seedlings (rhizome seedlings) for two varieties. The total output of standard seedlings (rhizome seedlings) ready for field transplanting in 2024 reached 50,000 seedlings, including 12,500 seedlings of the Tay Ho lotus (flower lotus variety) and 37,500 seedlings of the Mat Bang lotus (seed lotus variety). The project management team produced enough lotus seedlings to hand over to households participating in the decentralized commercial cultivation model for both flower and seed production.

In 2025, 7,000 seedlings of Mat Bang lotus (seed lotus variety) were produced for an expanded cultivation model in Sao Vang commune, Thanh Hoa province. Seedling Standards: Seedlings (rhizome seedlings) must have 2 to 3 floating leaves (coin leaf), with roots evenly distributed around the rhizome. The floating leaves should spread on the water surface with a diameter of 30–50 cm. Seedlings must be uniform, with stems and leaves intact, not crushed or damaged.

Establishment of a Concentrated Commercial Lotus Cultivation Model for Flower and Seed Production

The concentrated commercial lotus cultivation model scale 09 hectares (including 07 hectares for commercial seed lotus cultivation – Mat Bang lotus, and 02 hectares for commercial flower lotus cultivation – Tay Ho lotus) at Tho Lam commune, Tho Xuan district (now Sao Vang commune), Thanh Hoa province. Implementation approach: To ensure the effective implementation of the project, the local authorities and the project's lead unit applied appropriate selection criteria to choose households to participate. Evaluation of the growth and development capacity of the model. The data in (Table 4) show that plant height increased from 19.62 cm cm at the

week when floating leaves first appeared, growing rapidly between day 14 and day 42, from 59.76 cm to 148.86 cm. Petiole diameter increased from 0.23 cm at the time of floating leaf emergence to 0.76 cm by day 21, then rose sharply to 1.24 cm by day 42. Leaf diameter developed from 33.90 cm on day 14 to 71.07 cm on day 42. The data in (Table 5) show that plant height increased from 24.70 cm at the time of floating leaf emergence to 93.01 cm by day 21, then rose sharply to 173.12 cm by day 42.

Table 4: Growth dynamics of Mat Bang lotus after planting.

N0	Traits	Time of first appearance of floating leaves (days)						
		0*	7	14	21	28	35	42
1	Plant height (cm)	19.62	39.65	59.76	80.83	105.85	130.86	148.86
2	Petiole diameter (cm)	0.23	0.37	0.55	0.76	0.98	1.13	1.24
3	Leaf diameter (cm)	13.97	24.34	33.90	45.78	54.55	63.98	71.07

Note: * Time of first appearance of floating leaves

Table 5: Growth dynamics of Tay Ho lotus after planting.

N0	Traits	Time of first appearance of floating leaves (days)						
		0*	7	14	21	28	35	42
1	Plant height (cm)	24.70	47.95	69.98	93.01	117.97	148.07	173.12
2	Petiole diameter (cm)	0.29	0.46	0.70	0.90	1.07	1.28	1.46
3	Leaf diameter (cm)	16.39	26.00	36.11	48.14	67.61	76.11	82.61

Note: * Time of first appearance of floating leaves

Petiole diameter increased from 0.29 cm at the week of floating leaf emergence to 1.07 cm by day 28, and further to 1.46 cm by day 42. Leaf diameter developed from 26.00 cm on day 7 to 82.61 cm on day 42. Yield indicators and yield components (Figure 1). The yield of lotus plants is determined by several factors, including the number of seed pods per square meter, the number of viable seeds per pod, and the average weight of 100 seeds. For lotus growers pursuing economic benefits, the density of flowers and pods is particularly important, as it reflects the crop's yield potential as well as the profit achievable in a growing season. Results from (Table 6) show that the average number of pods per 10 m^2 ranges from 28 to 31 pods; the number of viable seeds per pod varies from 31 to 34; the percentage of viable seeds per pod ranges from 79.7% to 86.8%; and the weight of 100 seeds ranges from 0.23 to 0.25 kg. Consequently, the theoretical yield is estimated at 2,185–2,408 kg/ha. For professional lotus growers, seed yield is the primary objective.

Figure 1: Model of intensive commercial lotus cultivation for flower production at Tho Lam commune, Tho Xuan district (now Sao Vang commune), Thanh Hoa province, 2025.

From the above monitoring (Table 7), it can be seen that the number of flowers per 10 m^2 ranges from 11 to 12 flowers; the bloom diameter in the monitored stages averages between 16.45 cm and 18.28 cm; the bud length ranges from 12.47 cm to 14.03 cm, with an average of 13.44 cm across all monitoring periods. The theoretical average yield is 11,910 flowers per hectare. Assessment of Pest and Disease Infestation Level (Figure 2). During the growth and development of the Mat Bang lotus variety and the Tay Ho lotus variety, pests and diseases occurred very rarely. Leaf-eating caterpillars were observed only at the time when

the first aerial leaves appeared; however, they were promptly monitored and controlled at an early stage to prevent large-scale spread. Monitoring pest and disease incidence plays a crucial role in managing and maintaining crop health, while also helping to protect the environment and enhance production efficiency.

Figure 2: Model of intensive commercial lotus cultivation for flower and seed production at Tho Lam commune, Tho Xuan district (now Sao Vang commune), Thanh Hoa province, 2025.

Table 6: Yield and yield components of Mat Bang lotus variety.

Number of lotus seedpod harvests	Number of seed-pod/10m^2	Number of seed per seedpod	Number fill seed per seedpod	Rate of fill seed per seedpod (%)	100 seeds weight (kg)	Theoretical Seed Yield (kg/ha)
1	28.0	39.4	33.75	85.7	0.23	2,185
2	30.0	39.4	34.2	86.8	0.23	2,408
3	31.0	38.0	32.4	84.4	0.23	2,325
4	30.6	39.0	31.4	79.7	0.25	2,382
5	29.8	39.0	31.6	81.4	0.24	2,289
6	28.8	39.0	32.8	85.0	0.24	2,302
7	30.04	38.9	32.48	83.5	0.24	2,341
Total	208.24	272.70	228.63	586.50	1.66	16,232
Everage	29.75	38.95	32.66	83.79	0.24	2.319

Table 7: Yield and yield components of Tay Ho lotus variety.

Number of lotus seedpod harvests	Number of flower/10m^2	Flower diameter (cm)	Bud length/ (cm)	Theoretical Flower Yield (flower per ha)
1	12	16.74	12.47	12,200
2	12	17.54	13.23	11,800
3	12	18.11	13.30	12,000
4	12	18.28	13.62	12,200
5	11	18.28	13.62	12,200
6	12	17.81	13.19	11,600
7	12	17.02	13.52	12,000

8	11	17.09	13.15	11,400
9	12	16.45	13.79	11,600
10	12	16.76	13.92	11,800
11	12	17.03	14.03	12,200
Total	130.00	191.11	147.84	131,000
Everage	11.82	17.37	13.44	11,910

Table 8: Pest and disease infestation level on lotus in the model.

Varieties	Leaf-eating pests	Thrips	Mealybugs	Anthracnose	Stem rot	Leaf blight
Mat Bang lotus	++	+	+	+	+	+
Tay Ho lotus	++	+	+	+	+	+

Results of model implementation: As of the present time, the concentrated commercial lotus cultivation model for flower and seed production model has harvested 27,173 flowers and produced 16.3 tons of fresh seeds. These results demonstrate that the selected varieties and cultivation techniques applied in the project's models have produced yields and quality levels 30-40% higher than those obtained from local varieties and traditional cultivation practices. Comparative analysis between the actual yields obtained from the models and the theoretical yields of the evaluated lotus varieties indicates that Tay Ho lotus (primarily cultivated for flowers) and Mat Bang lotus (primarily cultivated for seeds) exhibit vigorous growth, stable development, and exceptionally high yields. Both varieties are considered highly promising for large-scale production and sustainable exploitation in the locality.

Establishment of a Decentralized Commercial Lotus Cultivation Model (Flowers and Seeds)

The decentralized commercial lotus cultivation model scale 20 ha (5 ha for flower production using Tay Ho lotus; 15 ha for seed production using Mat Bang lotus) at Thuan Minh Commune, Tho Xuan District (now Tho Lap Commune) and Vinh Hung Commune, Vinh Loc District (now Bien Thuong Commune), Thanh Hoa Province. Results to date: Flower production: 52,884 flowers and Seed production: 35.4 tons of fresh seeds

In the decentralized model, seed material was supplied from the seed production model under the project, ensuring high-quality stock with yields significantly higher than local varieties. However, due to small, scattered planting areas and inconsistent adoption of cultivation techniques among farmers, yields were lower than those in the centralized commercial production model.

Establishment of a Lotus Seed Processing and Consumption Model Ensuring Food Safety and Hygiene

Renovated and upgraded the processing workshop, installed cold storage facilities, a steam supply system, and production machinery and equipment. Implemented production, processing, and marketing of lotus seeds with the following outputs: Dried lotus seeds: Processing capacity: 5 tons/year; Actual output: 8.88 tons (per project), meeting food safety and hygiene standards. Ready-to-eat seasoned lotus seeds: Processing capacity: 2 tons/year; Actual output: 3 tons (per project), meeting food safety and hygiene standards.

Training

The technology transfer unit-Plant Resources Centre has successfully transferred five technical procedures to the project and trained ten technicians who were certified upon completion of the training course, including the following procedures:

a) Technical procedure for lotus propagation (Certificate issued).

b) Technical procedure for cultivation of the Mat Bang lotus variety (Certificate issued).

c) Technical procedure for cultivation of the Tay Ho lotus variety (Certificate issued).

d) Technical procedure for the production and processing of dried lotus seeds (Certificate issued).

e) Technical procedure for the production and processing of ready-to-eat seasoned lotus seeds (Certificate issued).

A total of 10 technicians were trained and fully mastered the technical procedures transferred Figure 3.

Farmer training workshops

The project organized training sessions on the technical procedures for propagating and cultivating Tay Ho and Mat Bang lotus varieties for 300 participants. Six training classes were conducted, each with 50 participants, at the project's model implementation sites Figure 4.

a. Harvesting and sorting lotus pods

b. Cleaning the seeds
(after separating the lotus seeds from the lotus pods)

c. Assessment and evaluation of the lotus seed processing model

d. Dried lotus seed

Figure 3: Model for lotus seed processing at Thanh Hoa Institute of Agriculture, 2025.

Figure 4: Training program for farmers at Thuan Minh Commune, Tho Xuan District (now Tho Lap Commune) and Vinh Hung Commune, Vinh Loc District (now Bien Thuong Commune), Thanh Hoa Province, 2024-2025.

Conclusion

The Project has Successfully Accomplished its Initial Objectives, Including

1. The project has successfully received the transfer of five technical procedures from the technology support unit – Plant Resources centre, including: (1) Lotus propagation techniques; (2) Cultivation techniques for Tay Ho lotus; (3) Cultivation techniques for Mat Bang lotus; (4) Production and processing techniques for dried lotus seeds; and (5) Production and processing techniques for ready-to-eat seasoned lotus seeds.

2. Development of project models:

a) Lotus seedling production model for both ornamental flowers and seed harvesting: Accepted on 8 May 2024, with a scale of 1,000 m^2 (300 m^2 of Tay Ho lotus for flowers, 700 m^2 of Mat Bang lotus for seeds). A total of 44,500 seedlings (rhizomes) of seed lotus and 12,500 seedlings of flower lotus meeting nursery standards were produced.

b) Concentrated commercial cultivation model for flowers and seeds: Implemented on 9 ha in Dang Lau villages, Tho Lam Commune, Tho Xuan District, Thanh Hoa Province (now Sao Vang Commune). To date, 27,173 flowers and 16.3 tons of fresh lotus seeds have been harvested to supply the production, processing, and marketing model.

c) Dispersed commercial cultivation model for flowers and seeds: Implemented across the approved 20 ha. To date, 52,884 flowers and 35.4 tons of fresh lotus seeds have been harvested for processing and consumption.

d) Production, processing, and marketing model: Annual production capacity reached 5 tons of dried lotus seeds and 2 tons of ready-to-eat seasoned lotus seeds, meeting food safety standards.

3. Ten technicians received comprehensive training in the project's technical processes, enabling them to participate in model development and provide guidance to local farmers.

4. Six training courses on cultivation techniques for Tay Ho lotus (flower type) and Mat Bang lotus (seed type) were organized, each with 50 participants over three days, totalling 300 participants in Tho Xuan and Vinh Loc districts, Thanh Hoa Province. The training provided essential knowledge on lotus cultivation, including fertilizer application, variety selection, care, harvesting, and post-harvest preservation, thereby improving productivity, quality, and economic efficiency, and contributing to sustainable rural agricultural development.

The implementation of this project by the Thanh Hoa Agriculture Institute represents a practical and timely approach aligned with the orientation toward sustainable, green agriculture. Scaling up the model will not only enhance agricultural economic value but also conserve valuable lotus varieties and harness local potential. Policy, technical, and investment support will be key to expanding the model in the future. The project team is committed to providing favourable conditions in terms of land and infrastructure, encouraging local communities to expand the model, adopting advanced techniques, seeking market opportunities, and building a regional lotus brand.

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Conflict of Interest

The authors affirm that they have no conflict of interest.

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