

IMPLEMENTATION RESULTS OF THE NATIONAL COFFEE PRODUCT DEVELOPMENT PROJECT UP TO THE YEAR 2020 AND ORIENTATION OF PRODUCT RESEARCH AND DEVELOPMENT TO 2030

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ABSTRACT

All tasks of the national coffee product development project up to the year 2020 were implemented, except for one coffee variety that was not accredited due to requirements of the Law on Cultivation. As results, 14 technical protocols were accepted, including two technological advances, three ministerial-level ones. All protocols proved to be outstandingly effective more than 10% in production comparing to the old ones. For Robusta breeding activities, two clones *Xanh lun* and *Day* have been accredited by the Ministry of Agriculture and Rural Development for special circulation in the provinces of Dak Lak, Dak Nong, and Lam Dong. Regarding Arabica coffee, the TN9 variety has been tested for distinctness, uniformity, and stability (DUS) in Lam Dong, Kon Tum, Quang Tri and Son La provinces. Within the framework of the project, the total number of seedlings and seeds were provided to farmers and coffee growing organization in the Central Highlands region to grow/replant coffee with an estimated area of 13.000 - 15.000 hectares.

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1. INTRODUCTION

Recently, Vietnam's coffee industry has made remarkable progress in terms of yield, total area and productivity. By 2022, the country's coffee area is about 710 thousand hectares, with an average yield of more than 2.8 tons/ha, among the highest in the world [1]. Vietnam still accounts for about 14% of the global coffee market share, ranks second in green coffee export (after Brazil) and is the world's largest robusta coffee producer. In 2022, Vietnam exports about 1.8 million tons of commercial coffee to over 80 countries and territories around the world, with a turnover of about 4 billion USD. Coffee has become one of the country's important agricultural products, a key export product, creating jobs for millions of people [1].

Although highly ranked in the world in coffee production and export, the value that coffee brings back is not high. The coffee production system still has potentially unsustainable factors due to wasteful and inappropriate use of resources and inputs. Although there have been many studies on the current status of applying farming practices in coffee production, thereby providing the most reasonable solutions to improve coffee yield and quality resulting in increasing economic efficiency. However, the level of application is still limited and not synchronous. Producers are still limited in applying new advances and still practice farming based on experience, lacking of scientific basis. Besides, Vietnam's coffee quality is still low and non-uniform, especially the cup quality. There are many factors leading to this low quality such as not good varieties, nutrition, old aged plantation, diseases, harvesting, processing, etc. In addition, with the shifting economic structure towards industrialization and modernization, manual labor

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lacking will be an issue that will affect coffee production in Vietnam in the near future [2].

To solve this problem, the most important solutions to ensure efficient coffee production in Vietnam are to use new coffee varieties with high productivity and quality according to world standards. In addition, it is necessary to synchronously apply advanced farming techniques such as fertilization based on soil fertility, water saving irrigation, fertigation, and applying mechanization oriented techniques in production. At the same time, the establishment of wind-break trees, shade trees or intercropping to diversify harvested products in coffee plantations such as growing fruit trees with high economic value like durian, avocado... with appropriate density to increase income per unit area. This is also considered as a coffee farming solution to adapt to climate change, ensuring sustainable development of the coffee industry. In addition, pre-harvest measures, concentrated on uniform ripening treatment, and minimizing post-harvest losses of coffee have not been focused and fully researched. Therefore, application of these studies must synchronize the harvesting and processing process to ensure the effectiveness of technical measures [2].

In short, in order for Vietnam's coffee industry to develop more sustainably and increase added value for domestic consumption and export, the implementation of the science and technology project: "Technology for selecting and producing high-quality coffee and advanced coffee cultivation techniques with high productivity and quality" under the national product development program "Vietnamese high quality coffee" are essential. The project has been actively implemented for 3 years 2018-2020 and has had important results, contributing to sustainable coffee development in Vietnam.

2. OBJECTIVES OF NATIONAL COFFEE PRODUCTS PROGRAM

- Breeding and development of Robusta coffee varieties met with high quality criteria, grown in suitable ecological areas, and cultivated according to sustainable coffee production protocols,

resistant to most important pests and diseases, adapted to climate change, accredited and protected as key cultivars in production.

- Breeding of Arabica coffee varieties met with high quality criteria (caffeine, physic, aroma), resistant to major pests and diseases, cultivated according to sustainable coffee production protocols, accredited and protected is main cultivars in the coming time.

- Development of synchronous packages of coffee production techniques covered from seedling use to harvesting with orientation of mechanization and GAP/BAP application to improve economic efficiency, sustainable production, and high-quality product production for domestic consumption and export.

- Development of advanced seedling and seed production protocols, creating high quality, disease-free coffee seedlings to provide for new planting and re-cultivation of coffee.

- Building of production models, demonstration models applying advanced technical protocols from seedling to cultivation and harvesting in order to transfer new technologies to production.

3. MAIN ACCOMPLISHMENTS

3.1. Research on breeding of high-quality Robusta coffee varieties for concentrated coffee growing regions in the Central Highlands

3.1.1. Selection, breeding and evaluation of starting materials

- Six high-quality Robusta clones have been selected from hybrid progenies including: L2H24C10, L2H36C1, L3H20C7, L4H6C10, L4H15C8 and L4H18C6. These clones have good growth characteristics, the average yield is 2.6 kg beans/tree. In the harvest season, the average cherries/dry beans ratio was 4.5, the weight of 100 beans was 20.4 g, the average bean rate on screen 16 was 89.5%, and especially the cup quality was, in accordance with the standard SCA scores, from 80.0 to 82.5 points, these clones have not shown leaf rust disease in the field [3].

- Nine drought tolerance Robusta clones have been selected from hybrid progenies: CH18C5,

CH18C16, CH20C10, CH20C22, CH38C20, CH41C17, CH41C26, CH43C4, CH43C8. These clones were completely wilted after 41 - 46 days of watering, clearly longer from the control variety with 31 - 33 days. The average yield was 1.73 kg of green beans/tree. In the harvest season, the average cherries/dry beans ratio was 4.5, the weight of 100 beans was 19.0 - 22.4 g, and the average bean rate on screen 16 was 90.2%. No leaf rust disease was observed in the field [3].

3.1.2. Selection of new coffee varieties

a) Prospective clones (from variety evaluation and comparison experiments):

Eight promising clones have been selected including: Lam H17C19, Quy H27C10, Duc H10C4, Long H8C2, TTGL H4C8 and Hoi H6C23, L4H15c2, L1H36C9. These clones have shown SCA standards score of cup quality >80 points, the average yield of the established crop is >3.0 tons of beans/ha, the weight of 100 beans of all clones is over 20.0 g, the rate of beans on screen 16 is >85%.

b) New Robusta coffee cultivars

Two Robusta cultivars of *Xanh lun* and *Day* have been selected with wide adaptability in the trial areas. The yield was >3.8 tons of green beans/ha in the first established season. the average yield shown in production was >4.5 tons of green beans/ha. The above 2 clones have SCA standards scores of cup quality from 80.0 to 82.5 points. The weight of 100 beans is from 22.5 to 27.8 g, the rate of beans on screen 16 >95%. These two clones *Xanh lun* and *Day* have been accredited exceptionally by the Ministry of Agriculture and Rural development for the provinces of Dak Lak, Dak Nong and Lam Dong according to Decisions No. 74/QD-TT-CCN and Decision No. 75/QD-TT-CCN dated April 20. 2021 [3].

3.1.3. New breed models

Thirty hectares of new Robusta coffee varieties have been established in 5 provinces of the Central Highlands. These new varieties can grow and adapt widely in the growing areas with an average yield of 3.20 tons of green beans/ha in the first harvest season, while the control clone

TR11 reached only 2.48 tons of green beans/ha [3].

3.2. Research on breeding of high-quality Arabica coffee for production in the main growing regions

3.2.1. Evaluation, creation of starting materials and varieties comparison

- Five new arabica coffee materials originated from Lam Dong including: Duy1, Viet1, Viet2, Duy2 and Nghia have been collected. These materials give yield from 5.0 to 5.5 kg of cherries/tree, average weight of 100 beans is 16.8 g, ratio of beans on screen 16 ranges from 79.9 to 82.3%. The cup quality scores of these ones ranged from 79 to 81 points (SCA standards). In Lam Dong conditions, those materials have shown completely uninfected with leaf rust.

- Regarding other starting materials grown in Buon Ma Thuot, they have an average yield of 2.3 first harvests over 2.2 tons of beans/ha, weight of 100 beans is >17 g, the ratio of beans on screen 16 is about 80%, the cup quality score is >75, their rust resistance levels are from high to very high.

- Two promising arabica coffee hybrids THA1 x Sr and Sr x THA1 have been selected. These two hybrids have good growth ability; the average yield of the first two harvests is 3.03 and 2.82 tons of beans/ha, 23.2% and 19.7% more comparing to their parent varieties; weight of 100 beans is >17 g; ratio of beans on screen 16 >85%; the cup quality score is 78 points, and they are highly resistant to leaf rust disease.

- Nine outstanding individuals in the F2 generation have been selected including: H32C5, H32C24, H32C29, H32C30, H32C42, H45C122, H45C126, H33C54, H37C86. The yield in the first established year of individuals is from 3.8 to 5.4 kg of cherries/tree, corresponding to the equivalent yield of 2.99 to 4.41 tons of beans/ha [2].

3.2.2. Trial of 03 F1 arabica coffee clones (TN6, TN7, TN9) and the pure line TH1 in suitable ecological regions

- At three trial sites in Lam Dong, Quang Tri, Son La, varieties TN6, TN7 and TN9 grew and

developed quite well; the yield in the harvest season is over 2 tons of beans/ha, in the stable established period, it reaches more than 3 tons of green beans/ha. The weight of 100 beans of TN varieties reached more than 17 g; the percentage of beans on screen 16 is >80%; the cup quality scores of these varieties in Lam Dong reached from 81.50 to 82.75 points, in Quang Tri from 78.50 to 82.25 points, in Son La from 79.50 to 82.50 points. Of which, the TN9 variety in all 3 regions reached over 82 points. In all three regions, TN varieties are highly resistant to leaf rust. Among these three varieties, the TN9 has been tested for distinctiveness, uniformity, and stability (DUS); controlled trial according to basic standards and approved by the scientific committee (decision No. 68/QD-VNLT (SPQG) dated 30/11/2020) and certified by the Department of Agriculture and Rural Development of Lam Dong, Kon Tum, Quang Tri and Son La provinces.

- Regarding the pure line TH1, in 3 trial locations, it grew and developed quite well, yielded from 2.26 to 2.50 in the established year; the average weight of 100 beans is 17.2 g, the percentage of beans on screen 16 ranges from 78.9 - 80.2%; The cup quality scores of TH1 variety in the regions ranged from 82.00 to 84.75 points according to SCA standards. In all 3 areas, this TH1 has shown a light leaf rust infection with the disease index <1% [2].

3.2.3. Building a new breed model applying appropriate farming methods

- Thirty hectares of new arabica coffee varieties have been established in 3 provinces of Kon Tum, Quang Tri and Son La. At the sites where the model is built, these new varieties have shown good growth and wide adaptability. Two hectares of planting model in 2018 in Quang Tri at the established stage give a yield of >3 tons of beans/ha. The average yield of 3 crops was from 2.60 to 2.90 tons of beans/ha, increasing from 22.1% to 36.2% compared to the control. while 28 hectares of planting model in 2019 give the yield 1.66 to 2.19 tons of beans/ha; especially, the TN9 variety in all 3 regions reached over 3 tons of

beans/ha, increased from 40.6% to 43.3% compared to the control variety Catimor.

- Economic efficiency of the varieties compared with the control depends on each variety in different growing regions. In Kon Tum, profit from TN varieties varies from 92.5 to 107.2 million VND, increased from 23.8 to 38.5 million VND compared to the control variety. In Quang Tri, the profit of TN varieties ranged from 89.6 to 102.6 million VND, increased from 33.9 to 46.9 million VND compared to the control. In Son La, the profit of TN varieties was from 94.0 to 107.4 million VND, increased from 34.2 to 47.6 million VND compared to the control Catimor. In all 3 regions, the highest rate of increase in profit compared to the control was the TN9 variety with 56.0 to 84.2%, followed by the TN7 variety from 45.7 to 75.3%, the TN6 variety at 34, 6 to 61.0% and only TH1 profit growth rate decreased from 4.0 to 14.0% [2].

3.3. Research and develop synchronous technical packages for coffee to increase the added value of coffee and to serve for domestic consumption and export

3.3.1. Research and perfectionate technical protocols of replanting coffee on the basis of applying integrated solutions focused on mechanization and BAP

- The technical protocol of integrated coffee replanting with mechanization orientation was accredited as a technical advance by the MARD in May 2021. While applying this technical protocol, the production efficiency increased markedly because of increased productivity, decreased water for irrigation and fertilizer uses and saving cost for coffee plantation care and harvesting. Comparing to control, irrigation efficiency increased by over 25%; dissolved fertilizer application through the irrigation system has saved 20 - 40% of fertilizer amount. Coffee planted with high density has significantly increased yield, increasing by more than 50%. Economic efficiency increased by over 90%, equivalent to an increase of over 50 million VND/ha compared to current production [4].

3.3.2. Research to perfectionate the technical protocol of sustainable coffee intensive farming with BAP orientation, pre-harvest and post-harvest processing and improvement of synchronous harvesting equipment to improve production efficiency, reduce costs and post-harvest losses

- The BAP-oriented sustainable intensive farming protocol was evaluated and accepted in December 2020. While applying this protocol, the use of controlled slow-release fertilizers allowed to save about 15% of fertilizer; the use of soluble fertilizer has saved 20% of fertilizer; the quality of green coffee when applying the protocol has been significantly improved compared to mass production. Slow-release fertilizer application has significantly increased yield (increasing by 12.86% for Robusta coffee, increasing by 17.95 - 19.07% for arabica coffee. Economic efficiency of soluble fertilizer application is quite high, more than 10% compared to current production.

- The protocol of pre-harvest and post-harvest processing for coffee has been evaluated and accepted in March 2020. While applying this protocol, the use of ethephon with a concentration of 300 ppm (0.3 liters/tree) spraying at the time of fruit ripening rate of 15 - 20% gave best results. After 20 days of spraying, the percentage of ripe berries was 90.6% (control 54.4%) but the leaf drop rate was 21.95% higher than that of the control 8.45%. It allowed only one picking time that reduced the cost by 32.6% compared to the current harvesting method. It also made the process of mechanized farming and harvesting more convenient. Also, the use of yeast *Saccharomyces cerevisiae* (1 g/kg coffee berries) and *pectinase* enzyme (0.1 g/kg coffee berries) resulted in the best quality of green coffee and cup coffee (cupping score: 72 compared with 58 of the control). It reduced postharvest losses by 4.6%. Moreover, when applying improved coffee harvesting equipment, combined with a mechanized coffee replanting protocol, it saved 34.05% of the cost compared to manual harvesting [4].

3.3.3. Research on building intercropping technical protocol for coffee with BAP orientation

- The protocol of intercropping coffee with increasing production efficiency and adapting to climate change was evaluated and accepted in December 2020. The use rational fertilization for agronomic and economic efficiency showed better results than those of the current production (increasing by 6.5 - 8.1%, corresponding to an increase of 7.6 - 24 million VND/ha). The appropriate amount of irrigation water for first flowering for the intercropping coffee plantation by the method of direct irrigation and mini-sprinkler irrigation has also been determined respectively to be 400 liters/tree and 350 liters/tree [6].

3.3.4. Building 4 models of applying synchronous technical package for sustainable farming BAP orientation (2 models of arabica coffee, 2 models of Robusta coffee, scale: 10 ha/model)

- Four demonstration models (10 hectares/model) using newly accredited coffee varieties with high yield and quality applying a synchronous technical package for sustainable farming towards BAP in the Central Highlands and Northwest region. The coffee model in Dak Nong showed an increase of economic efficiency by over 14% and productivity by over 11% compared to current mass production while the one in Dak Lak increases the economic efficiency by over 10% and productivity by over 15%. The arabica coffee model in Dak Lak increased economic efficiency by over 13% and productivity by over 14% compared to mass production while in Son La, increases of 10% for economic efficiency and productivity were recorded [2, 3, 5].

3.4. Producing new high-quality seeds and seedlings for new planting and replanting of coffee in key concentrated regions

3.4.1. Improvement of cultivation and production technical protocols for new high-quality coffee seeds and seedlings

Synthetic improvement of technical measures in this project allowed to build four technical protocols: Cultivation of garden producing hybrid seeds and that of garden of the leading coffee clones; protocol of producing, harvesting,

processing, and preserving coffee seeds; and protocol of producing disease-free and high-quality coffee seedlings. These protocols are accredited by the MARD according to Decision No. 73/QD-TT-CCN dated April 20/2021; moreover, the technological protocol of breeding high-quality coffee by *invitro* methods was accredited according to Decision No. 96/QD-TT-CCN dated May 7, 2021. These protocols are widely applied in production practice, contributing to improving the quality of coffee seeds and seedlings, providing farmers to replant coffee in the main growing areas [6].

3.4.2. High quality planting materials supply

This project has produced seeds and seedlings to supply to growers from 2018-2020 as follow: 5,238 kg of TRS1 seeds; 200,013 grafted coffee trees with TR14 and TRR15 varieties; 2,805,405 coffee trees with TRS1 varieties; 200,230 real coffee and tea plants like THA1; 2,737,000 scalloped coffee plants like TRS1 and 23,490 coffee trees with green beans by tissue culture method like TR4 and TR11. Seedlings and seeds have been produced to provide coffee farmers and coffee growers in the Central Highlands to new/replant coffee with an estimated area of 13,000 - 15,000 ha [5].

3.4.3. Sustainable farming model building

Sustainable farming models using new high-quality coffee varieties have been built in many localities with a total scale of 30 hectares (20 hectares of Robusta coffee with 2 varieties of TR14, TR15 (late ripening) and 10 hectares of arabica coffee with the variety THA1). In all models, these new varieties have shown the ability to grow and adapt widely in the growing areas [5].

4. SHORTCOMINGS, GAPS IN SCIENTIFIC AND TECHNOLOGICAL RESEARCH AND LESSONS LEARNED

- All tasks are fully implemented following the project proposal. However, due to the requirements of the Law on Cultivation, 01 variety of arabica coffee could not been accredited for circulation. Moreover, even 02 varieties of Robusta coffee have been accredited for circulation but this

is an exceptional accreditation, and the application scope is narrow in only 03 provinces.

- A total of 14 technical protocols have been evaluated and accredited, including 02 technical advances, 03 ministerial-level protocols. These protocols were all proven to be effective in production. However, it is still necessary to continue to monitor and research to perfectionate a few techniques in the protocols to achieve higher efficiency such as pruning to shape, increasing the rate of mechanization in harvesting, etc.

5. PRODUCT RESEARCH AND DEVELOPMENT ORIENTATIONS TO THE YEAR 2030

- Better cup quality coffee varieties with drought tolerance and uniform ripening traits: to have better coffee quality as national product, breeding research should be prioritized and continued based on starting materials and promising clones inherited from previous period research results. At the same time, varieties with drought tolerance and uniform ripening characteristics can be an important solution to cope with challenges that will face coffee production in the near future.

- From previous period, high quality varieties have been accredited, it is necessary to encourage the expansion of these new varieties in specialized farming areas. At the same time, it is necessary to continue to research and evaluate the interaction between the growing area (climate, soil) with the specific traits of these varieties (yield, quality, drought tolerance), combining sustainable farming methods appropriate to the region to have basis for determining the structure of high-quality varieties for each cultivation area, meeting the demand for specialty coffee production in each specific region.

- We should continue to research and perfectionate the design and manufacture of equipment that can harvest, clean and sort coffee with automatic, highly synchronous mechanization in farming to further improve the efficiency of the protocol and to create high-quality green coffee products.

- We should coordinate with coffee production, processing, and export enterprises in transferring high-quality coffee varieties and applying new technical packages to improve coffee quality, promote deep processing in order to improve coffee quality and to diversify products towards high quality, meeting the objectives of the National Coffee Product Program.

REFERENCES

1. Department of Production. (2023). Preliminary report on cultivation production for the 2023 summer-autumn cultivation; Implementing production plan for the 2023 - 2024 winter-spring season in the South Central coast, Southeast and the Central Highlands regions, Conference proceedings, 25p.

2. Dao Huu Hien (2021). Improvement of cultivation and production technical protocols for new high-quality coffee seeds and seedlings. Final

report, WASI, 109 p.

3. Dinh Thi Tieu Oanh (2021). Research on breeding of high-quality Robusta coffee varieties for concentrated coffee growing regions in the Central Highlands. Final report, WASI, 209p.

4. Nguyen Thi Thanh Mai (2022). Research on breeding of high-quality Arabica coffee for production in the main growing regions. Final report, WASI, 171p.

5. Phan Viet Ha (2019). Technology for selecting and producing high-quality coffee varieties and advanced coffee cultivation techniques to achieve high productivity and quality. Research proposal, WASI, 106p.

6. Phan Viet Ha (2021). Research and develop synchronous technical packages for coffee to increase the added value of coffee and to serve for domestic consumption and export. Final report, WASI, 333p.