

Apical Rooted Cuttings of Potatoes revolutionized how Generation 1 seed potatoes are produced in the Philippine highlands

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Public and Private Partners

The Apical Rooted Cutting (ARC) technology was introduced by the International Potato Center (CIP) and refined through a partnership with the Northern Philippines Root Crops Research and Training Center (NPRCRTC) of Benguet State University (BSU). ARC was used to rapidly evaluate germplasm in on-site and on-farm trials with excellent results. As a result of these trials, NPRCRTC selected an outstanding new potato cultivar named Igorota (see reference for details). To supply the farmers demand for seed, NPRCRTC launched an aggressive program of producing both the ARCs for sale to farmers as well as assisting farmers and cooperative groups to multiply the cultivar Igorota themselves to supply their own demands for seed potatoes and for neighboring farmers.

The “**Mountain Trail**” is a rugged highland topography with elevations from 1,300 to 2,400 meters above sea level. Farm size is generally less than 1.5 hectares with many small fields tilled using small rotovators and manual labor. Intensive commercial cultivation of potato and vegetables are produced here to supply large lowland cities (Fig 1).



Figure 1. Mountain trail topography and a farmer in a field of cv Igorota potatoes

1. Collaboration and institutional support for farmer seed multipliers

BSU-NPRCRTC-CIP collaborative program started in the late 1980's. The research on rapid multiplication techniques and training on seed production eventually led to the establishment of a Seed Production unit at NPRCRTC. The Seed Production unit supported the germplasm evaluation, selection, and multiplication of released varieties including Igorota. An assessment of the potato seed production program in 1999 recommended the improvement of the production system and strongly encouraged the participation of the private sector.

Institutional support by Government Agencies. During 2002-2008, the Bureau of Agricultural Research (DA-BAR) supported two seed potato projects namely; “*Improvement of Potato Seed Production Technology in the Philippines*” and “*Enhancing the Availability of Quality Potato Seeds through Community*”

Participation to Strengthen the Potato Seed System in the Cordillera". Likewise, the High Value Commercial Crops (HVCC) of the Department of Agriculture supported the *"Multi-agency Seed Potato Project"*. These initiatives improved the seed production technology, encourage active participation of the private sector, and enabled the multi-agency and multi-disciplinary teamwork in achieving a common goal.

In 2016, DA-BAR funded the project titled *"Commercialization and Promotion of Processing Igorota Potato Variety thru the Rapid Multiplication Technique in Potato Growing Areas"*. This led to an enhanced ability of farmers and their associations to multiply and produce good quality seed for commercialization.

The processing and multipurpose cv Igorota was promoted through a new rapid multiplication technique using Apical rooted cuttings (ARC). This was disseminated and adopted by nine associations from Benguet and Mt. Province. Greenhouses were constructed so that minitubers can be produced throughout the year. Diffused light seed storage with 10 tons capacity was constructed. To succeed, clean potato growing areas free of bacterial wilt and cyst nematode for seed bulking were selected.

2. Production of Quality & healthy planting material

Traditionally, quality seed potatoes were in short supply, so farmers just replanted their table potatoes for many generations allowing viruses and Bacterial wilt (*Ralstonia solanacearum*) to spread through latent infection. Late blight control by fungicidal sprays on the commonly grown cv Granola proved costly and less effective. Hence, the selection of Igorota as a moderately late blight resistant variety along with its excellent virus resistance and low reducing sugars, made it a high demand variety. NPRCRTC decided to use ARC technology as a way to rapidly produce high quality seed potatoes, which would eventually benefit the major potato producing areas in the highlands. ARC technology allowed seed tuber producers to produce large quantities of seed potato on a relatively small piece of land whether in locally constructed greenhouses or in the open field. The small size of the plots encouraged intensive crop management practices that led to better quality seed potato. This was achieved through strict field hygiene and intensive control of pests and diseases.

The BSU-NPRCRTC produced tissue cultured plants that were transplanted in the greenhouse to produce the ARC or basic minitubers that were dispersed to farmers' association for further seed bulking (Fig 2). For example in 2016, a total of 400,000 ARCs were sold to farmers which produced 118 tons of G1 seed tubers. These were planted on 47.22 hectares to produce two cycles or generation seed tubers before farmers dispersed/sell to other farmers.

Minitubers are also harvested from the mother plants at the end of the apical cutting phase. Generally, the minituber sizes varies from <3 to 8 grams.

Minitubers upto 3 g are sold at US\$0.06 per piece while sizes of >3g are sold at US\$ 0.10 to 0.16 per piece. The demand for these minitubers, regardless of the size are in high demand by the farmers who are able to grow even the smallest size successfully.

Inspection and certification are being done by National Seed Quality Control Services (NSQCS)-Bureau of Plant Industry (BPI). Seed inspectors monitor mother plants at monthly intervals and do minituber sampling at harvest. Virus indexing is done quarterly. Only pathogen free-plants are maintained at the tissue culture laboratory and in the greenhouse.



Figure 2. Apical rooted cuttings (ARC) in plastic bags with 80 pieces at NPRCRTC ready for sale to farmers at US\$2.00/ 80 ARCs

An application for certification is submitted upon planting the ARC in the selected farmers fields. Plants in the field are being monitored twice during the vegetative growth and at harvest. A certificate of Inspection/seed classification is issued by NSQCS after analysis.

3. Farm management and cropping techniques by farmer seed multipliers

Formerly, only BPI-Cordillera Administrative Region (CAR) produces seed potatoes as there was no other farmer or agency that was accredited to be seed producers. With the large scale adoption of the ARC technology and the popularity of Igorota made it possible for NPRCRTC and trained farmers such as the 3 mentioned here and many others to be accredited seed potato growers (Fig 3 and 4).



Figures 3 and 4. Farm level greenhouses with mother plants for ARC production

Nelio Compelio. He is a trained seed potato farmer and together with his son produces their own seed tubers and supplies it to their customers (farmers) through contract growing. He buys tissue cultured plants from BSU-NPRCRTC and establishes them as mother plants for ARC production. He does basic seed production in his 150^{sqm} greenhouse built on the flat roof top of his house which prevents intruders from entering and allows strict sanitation practices. He claims that producing your own planting materials is cheaper and ensures better quality seed tubers compared to buying imported seed of the cv Granola. He has established himself as an excellent source of ARCs and his customers keeps coming back because they see the advantage of producing seed tubers from ARC.

Mrs. Susan Bokilis. She produces and sell ARC in her 500^{sqm} greenhouse. ARC are being used either for sale to other farmers or she plants them in her own farm. She employs two (2) regular farm workers and part time students during peak seasons. She testifies that ARC techniques are an excellent user-friendly business for women.

Mr. and Mrs. Leonardo Antonio. The couple was recently accredited as seed potato growers. They own about 500^{sqm} greenhouse and 3 hectares disease-free farm. This area is isolated from other potato farms that makes it suitable for seed potato production. The farm has wider terraces topography from 300 to 1000 sqm, unlike most of the potato field terraces which measures from 50 to 200 sqm each. They sourced their tissue cultured plants from BSU-NPRCRTC and multiply them through ARC in their greenhouse and field. Certified seed tubers are sold to other farmers in Benquet province.

4 & 5. Seed storage and Marketing.

Diffused light storage (DLS) that was introduced by CIP is still the most popular and convenient method being used by farmer seed multipliers (Fig. 5). Farmers are now aware that seed tubers stored in 2 layers in diffused light give strong multiple sprouted tubers. The seed multipliers store only the seed they need for their potato production. All orders for generation 1 seed are immediately sold to the customers who ordered them after the harvest.



Figure 5. Sprouting seed potatoes nicely stored in a Diffuse Light Storage

6. Creating added value

BSU-NPRCRTC along with her cooperators continue to champion the ARC technology. With a cultivar with good virus resistance like Igorota, farmers can now keep their own seed supply for at least 5 cycles of replanting prior to getting a new supply of minitubers or generation 1 field grown certified seed. With good management, farmers can obtain up to 40 t/hectares (Fig. 6). Overall average yields have increased to around 20t/ha. The ARC technology has dramatically improved both sustainable and profitable potato production. The role of government agencies in supporting the BSU-NPRCRTC and other agencies in doing the certification work continues to help the potato farmers in the Philippine highlands.



Figure 6. Harvesting cv Igorota with a measured yield of 40 t/ha with Field Generation 2 seed potatoes

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