

Report on the “Development of Sea transport Protocol for the Trial Shipment for the Export of Traditional Variety ‘Nendran’ to Dubai”

India is the largest producer of the banana with an annual production of 30 million tons in an area of 0.8 million hectares. Though Cavendish bananas are ruling the banana export in the world trade, traditional bananas like Nendran, Ney Poovan and Red Banana find the place in the hyper malls especially in West Asia and South East Asia markets due to the settlement of ethnic population from India. Nendran the commercial plantain variety in Kerala, Tamil Nadu and parts of Karnataka occupies 50 % of the total area in these states and maximum quantity of the fruit is sold locally. Presently the fruits are being exported through air cargo which incurs much higher expenses and the scope for sustainability and profitability of the business is getting diminished. Therefore to set a new voyage by sea to Dubai with its ‘Made in India’ farm fresh Nendran Bananas, in a first of its kind attempt, ICAR-NRCB, Trichy and APEDA, New Delhi entered into a Memorandum of Understanding (MoU) for a consultancy project “**Development of Sea Protocol for the Trial Sea Shipment of Traditional Nendran banana to Dubai**” in partnership with M/s. Fair Exports India Pvt Ltd., Kochi, on 20th April 2017.

Experts Involved:

Dr. Mrs. S. Uma, Director & Convener
Dr. K.N. Shiva – Principal Scientist (PHT-Horticulture)
Dr. R. Thangavelu- Principal Scientist (Plant Pathology)
Dr. V. Kumar – Principal Scientist (Horticulture)
Dr. P. Suresh Kumar-Senior Scientist (PHT-Horticulture)

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Rationale of the project:

With the high cost, the operational expenditure of exporting Nendran banana via sea became very high. As the demand for traditional varieties are getting sky rocketing with the introduction of good quality ethnic bananas of India to even the consumers who normally buy the Grand naine, a Cavendish banana, the need for exporting the bananas in huge volume is getting increased. Development of the Sea protocol is pre-requisite to meet this increased demand.

Detailed objectives of the consultancy project:

To provide technical advice/guidance for trial shipment of ‘Nendran’ banana for the export to Dubai from Kochi Seaport by providing technical guidance in harvesting, post-harvest handling operations, packing and cold storage.

Duration of the project:

The project was initiated with the target of to be completed within five months from the date of approval/issue. Accordingly, the project was initiated by the last week of April and culminated with the supervision and survey in the Dubai market by the end of first week of August 2017. With the time line framed, the project ended one month ahead of its schedule.

Programme of work and phasing of milestones:

Technical advice/Guidance/support for

- Visit and Identification of banana fields in Nendran growing belts based upon the crop stand and suitable maturity [NRCB & APEDA/Exporter]
- Ascertain the yield estimate [NRCB & APEDA/Exporter]
- If sufficient quantity is available, plan for Harvesting and postharvest handling, treatments, packing [NRCB & APEDA/Exporter], storage, transportation in refrigerated van to Kochi seaport by road [APEDA/Exporter]
- Kochi port to Dubai by reefer container [NRCB/APEDA/Exporter]
- After reaching the destination port i.e. Dubai, inspect the each package for its damage, decay, spoilage, any other defects/problems, etc. [APEDA/Exporter / NRCB]
- Recording the problems faced in the shipment [Exporter / NRCB]

The findings from the present consultancy work are listed in gist in this interim report.

Areas of the study:

The process of exporting quality Nendran banana to Dubai began with the identification of suitable orchards for the selection of export quality bunches. The expert team visited the Nendran fields in Valliyur (Nagarkovil), Cumbum (Theni), and Mettupalayam and Sathymangalam (Coimbatore) in Tamil Nadu and Chamaraja Nagara in Karnataka. Good quality bunches were available in all these places. The orchards in the Chamraj nagara were chosen for the exports of bananas.

Criteria for the selection of orchard

- Appearance of fruits must be fresh.
- The peel colour must be green
- Physiological loss in weight must be nil.
- After ripening, the peel colour should be uniform yellow.
- The finger should be free from spots
- Pulp colour must be orange yellow
- Pulp texture must be firm
- Typical Nendran taste and flavour

Maturity indices:

For any market, the maturity index must consistently meet two requirements. It should ensure:

- Minimum acceptable eating quality
- A long storage life

In a thumb rule, for each one week bananas harvested earlier than normal harvest age, the green life increases by 3-5 days. Therefore for the export market the hands of 80 – 85 % maturity must be harvested. In other words, bunches are ready for harvesting, 80 days after initiation of shooting. For local market generally, bunches are harvested 90 days after flowering.

Table 1: Expected time to reach bunch emergence and harvest.

Stage	Plant crops
Planting to bunch emergence	6-9 months
Bunch emergence to harvest	3-4 months
Planting to harvest	10-13 months

Harvesting

Bananas were harvested by hand using a two-person team. One person cuts and the other carried the bunch away. When cutting the bunch, a shallow cross cut was made with a cane knife in the stem facing the bunch. The weight of the bunch caused the stem to bend. At this point the bunch was then lowered onto the shoulder padding of the second person and the bunch stem was cut.

Table 2: Difference between the harvested and matured Nendran banana .

Freshly harvested export fit Nendran bananas	Mature Near ripe Nendran bananas
Fingers are square, lie close together, are hard, green, clean, without insect infestation	Fingers are flabby, some turners (bananas which are approaching being "ripe to eat") present
Fruit breaks with an audible snap when broken in two	Fruit does not break with an audible snap when broken in two
Pulp temperature no higher than the external temperature	Pulp temperature higher than the external temperature
The cutting test gives rise to mucilaginous threads of juice 3 - 4 cm in length	The cutting test gives rise to no mucilaginous threads of juice
Pulp (flesh of the fruit) = color of yellow flour	Pulp = dark yellow with dark spots
Skin cannot be separated from pulp & without brown spots under skin	Skin can be separated from pulp. Small brown spots under skin

Care to be taken during harvesting

- Harvesting should always start at one end of the field moving to the other & checking for harvestable bunches.

- Avoid latex stains on the bunches.
- Minimize the damage during the movement of the plantains from point of harvesting to the packing station.
- Bunches should not be bruised while handling.
- Bunches packed boxes should not be exposed to the sun or rain.
- After dehanding, the bunches are to be placed on padded crates (bottom & side). Foam pads must be placed between each hand to protect it from rubbing.

Description of the Nendran Banana bunch

The banana spike is known as a bunch. A bunch is composed of a series of hands. The individual fruits are called fingers. The following terminology is used in this report:

1 banana	=	1 finger
5 - 6 fingers	=	1 cluster
7 - 10 fingers	=	1 hand
5 - 7 hands	=	1 bunch (90 bananas)
Average weight of the bunch	=	10-13 kg
Average weight of the finger	=	140 g

Post-harvest handling, packing & storage

De-handing: De-handing site should be close to the end of the wash tank. The bunches arrived should not be stacked on the ground. Cushioning pads could be made by using clean banana leaves or foam sheets if the dehanding to be done in the field itself. Dehanding must be done with a sharp chisel type dehanding tool, by leaving maximum crown attached to the hand. Crown should be cut evenly, otherwise it's outer finger may be detached. The knife must be very sharp to give a clean, smooth cut in a single movement. The separated hands must be spread on a clean surface to drain the latex for 10 minutes. After removal of latex, the fruits were packed in 20 kg perforated plastic crates which were foamed in the bottom and sides to avoid the abrasion and compression injury during transport. Foams were also in between hands to avoid the bruises during the handling and transport. The handling persons should use hand gloves to avoid the nail injury during de-handing, weighing and packing of the hands.

The crates loaded in the truck should be covered and it is preferable to transport the bunched during evening to avoid the hands to the high temperature. Proper air circulation should be provided to avoid the injury. Carefully packed trucks could be sent to pack house for carrying out pre-cooling and other postharvest operations.

Washing: The boxes should be unloaded carefully and should not be exposed to sun or rain after unloading to avoid the physiological loss in weight and possible infection by microorganisms. Crown was removed after careful inspection if necessary before placing the fruits in wash tank. As soon the hands are drained from latex they are placed in the wash tank to remove the dirt & latex which exudes from the cut surface of the crown. There should be flow of

water through the tank to avoid accumulation of dirt & fungi spores, which may infect the crown of hand. The hands were trimmed in to the cluster of fingers if necessary. All the damaged, undesirable size and shape fruits were removed using knife.

Use of chlorine: The second tank was filled with water containing alum (hydrated potassium aluminium sulfate with the formula $KAl(SO_4)_2 \cdot 12H_2O$) (@1.0 gm / lit or sodium hypochlorite (100 ppm) as the surfactant to remove the latex & destroy microorganisms. The clusters were kept in this tank for 3-4 min for effective removal of dirt. Normally, the flow of the water should be from the de-handing end of the tank, so that the hands of plantains move along to the far end where workers select & grade them prior to fungicide application. Before keeping the alum treated fruits in the third tank which contains fungicides, the fruit skin was gently rubbed with foam having soap solution to remove the tough strains from the fruit skin and to give the glossy appearance to the surface of the fruit. After rubbing with soap solution, clean water was used to remove the soap before transferring them to the third tank.

Fungicide treatment*: The most effective postharvest control of crown rot is provided by treatment with benzimidazole group of fungicides. Thibendazole is available in the form of wettable powder & emulsifiable concentrates & benomyl as a wettable powder. Bavistin @ 1.5 g/lit for 3-5 minutes was used for arresting the fungal growth.

**It is to be noted that fungicide application is made after the hands of fruit have been washed, but they must first be drained of excess water. Especially when dipping is in small amounts of fungicide suspension, otherwise water adhering to the skin of fruit may dilute the fungicide below its effective concentration.*

Air Drying: Once the hands are removed from the third tank which has fungicides, the hands are to be air dried by placing the hands in the cushioned drying tables through air drying. High capacity fans should be mounted on the wall or at the top to provide air for the faster removal of water from the skin. The hands should not be wiped by the foam or soft cloth in order to facilitate the faster drying. The fungicides will be removed if the hands are dried by wiping the moisture out from the produce. Natural air drying should be given to remove the moisture from the skin.

Packaging: The air dried hands are weighed and packed in the 100 gauge polypropylene bags which was lined in the 5 ply fiberboard boxes holding an average weight of 10.5 to 12 kg to avoid the moisture loss. Roughly 6 hands per box was arranged to get the desirable weight. The hands were packed in a regular pattern in the box in such a way that the hands of fruit did not move & damage each other when the box is handled. Two pouches of $KMnO_4$, an ethylene absorbent were placed in opposite corner of the boxes to control the ethylene release and to enhance the shelf life. The air was removed from the polyethylene bag using vacuum. The polyethylene lining should be tightly adhered to the fruit skin without leaving any space to avoid the air build up and water condensation during transit.

Pre-cooling/ cold storage: The packed boxes were stacked and loaded in the pre-cooling room to bring down the temperature of the fruit. The RH of 85-90% with the temperature of 13.5°C was maintained in the room. Pulp thermometer, hygrometer, and room thermometer was used to check the temperature in the fruit and in the storage environment. Because many of the containers refrigeration units are designed only to maintain cool temperatures, not for the rapid removal of field heat the produce should reach the desirable temperature in the cold storage

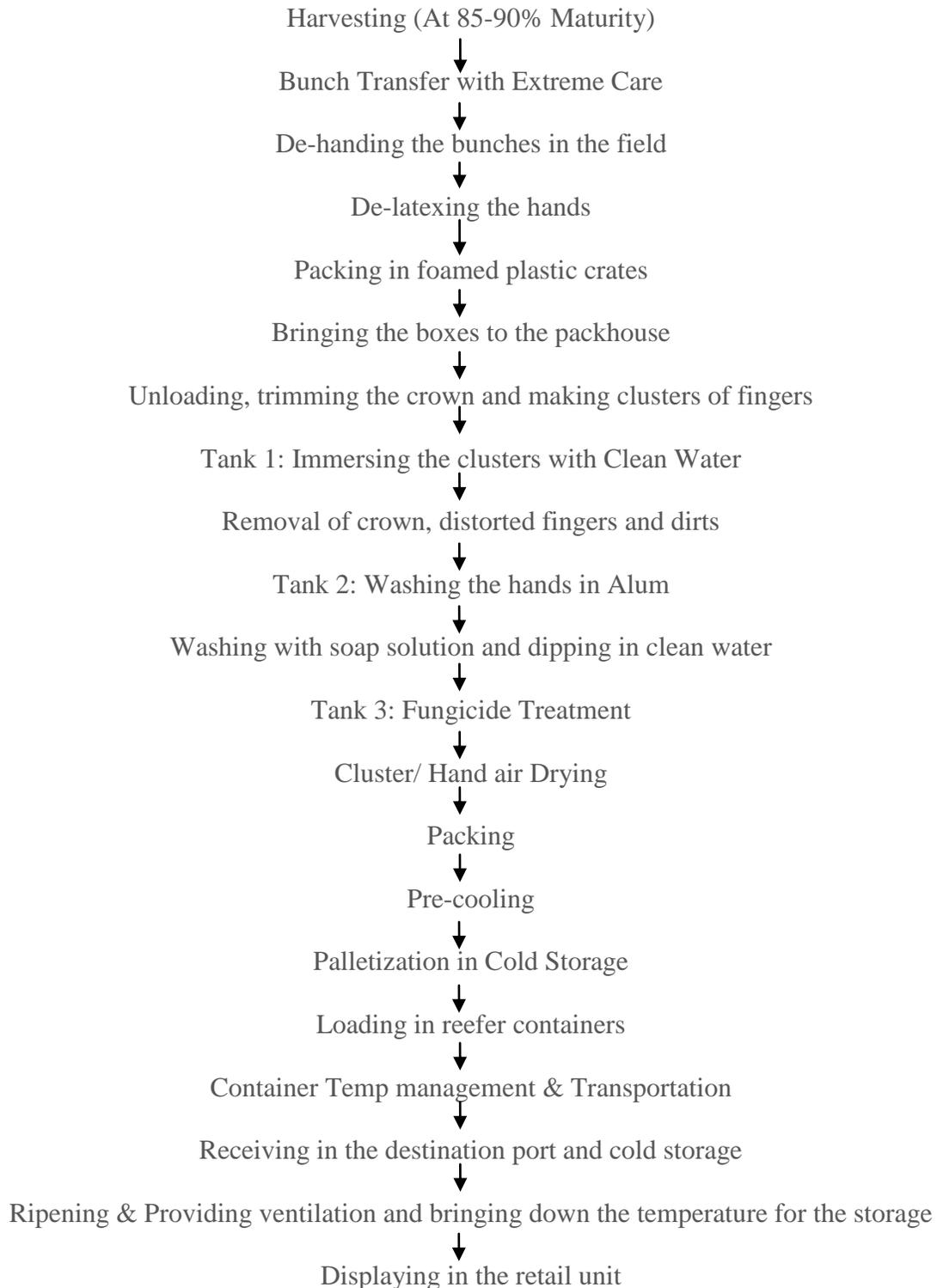
itself. Stacking boxes of fruit in ships holds or containers must be done by ensuring of adequate ventilation to all boxes..

Transport: The plantain boxes are directly loaded on to pallets at the pack houses & the pallets were loaded on to refrigerated containers (reefers), which are 20' or 40' insulated containers. For the trial shipment 40' insulated reefer container was used. The containers are transported by sea to the Dubai port and then by road directly to the ripening chamber and cold storage room. Fruits were shipped under refrigeration to prevent the initiation of ripening before they arrive at their destination. Storage temperature 13°C & Humidity 90-95 % was maintained during Voyage.

Ripening: At destination port, depending upon the demand, the fruits were ripened by keeping the boxes in the ripening chamber where the temperature was maintained around 25°C & Relative Humidity at 90-95 %. Ethylene gas was applied at 100-150 ppm for 24 hours. After 24 hours ventilation should be done to remove the ethylene from the ripening chamber. Once the fruits were ripened uniformly, the treated fruits can be hold in the ventilated chamber at 13-14 °C temperature & 85 % RH to extend the yellow life of the fruits.

Feedback from the Consumer: The consignment received through the trial shipment has received great attention from the consumer. Blemish free availability of Nendran enthused the banana lover to buy more fruits even with the premium prices. Contrastingly, through this venture, good quality fruits will be available to the consumer in affordable and cheaper rate in the days ahead with the success of this APEDA sponsored, ICAR-NRCB technology supported trial shipment.

Flow chart for the harvest & postharvest handling of Nendran Banana for the export



Annexure - II

Requirements for Banana export (10 tons)

S.No	Particulars	Specification	Quantity (nos)
1	Fibre tank	1000 lit rectangular	3
2	Slanting trays	Aluminium trays of 5x1.5 ft	3
3	Pedestal fan	High capacity	3
4	Weighing Balance		3
5	Plastic crates	58x39x31 cm	150
6	U type; 5 ply CFB boxes-bottom 3 ply- top	13-14 kg, 8% ventilation, 600 g bottom tare 450 g top lid, folding telescope carton	1000
7	Polythene bags	100 gauge, transparent	1500-2000
8	Foam sheets thick	6 mm thick black foam as a liner in plastic crate	
9	Foam Sheets Thin	2 mm thick White foam: insert in hands; ventilated foams as a separate between cluster/hands	
10	Yellow sponge		Required numbers
11	Vacuum sealer / Air remover	Eureka/Forbes	2
12	Treatment chemicals like sodium hypochlorite, Benomyl/ carbendazim		15 kg each
13	Ethylene absorber	2 per bag	2000 sockets
14	Rubber bands		
15	Colour tags		
16	Stickers		
17	Scissors		
18	Finger remover		10 nos
19	Hand Callipers		2 nos
20	Shoulder Padding materials		Enough quantity
21	Cold storage unit	10 tons	3 nos
22	Reefer van	20-40 MT capacity	One

Annexure - III

Nendran Banana specifications and packaging

Per pack:

- 6 big hands
- No. of fingers : 48-55 per box
- 11-12 kg / box

- Harvest age from planting: 10-11 weeks
- Vacuum packed in 0.001 mic. Plastic bag
- 2 stickers per hand
- Boxed in U-type export quality carton
- Pre cooling and cold storage: 13.5 C and 80-85% RH
- 1540 boxes per refrigerated 40” high-cube van
- Non palletized/ palletized
- Ripening at 18-24 °C, ethylene exposure: 100 ppm for 24 hrs
- Ventilation and cold storage



MoU signed with the APEDA for the Development of Sea Shipment Protocol for Nendran



Dr. S. Uma, Director, ICAR-NRCB & Mr. R. Ravindra, Dy. General Manager, APEDA at the pack house facility of Fair Exports Pvt Ltd



Banana stuffed Reefer container ready for voyage



Post Harvest handling and packing under the supervision of the ICAR-NRCB Scientists



Team of scientists and officials with the refrigerated reefer container ready for voyage



ICAR-NRCB scientists and the Fair Exports officials with the banana consignment at LuLu facility, Dubai



Nendran Banana sailed from the Cochin Port, India and received after 12 days at the Dubai Port



ICAR-NRCB Scientists (Drs. R. Thangavelu and K.N. Shiva) with Mr. M.A. Salim, Director and officials of LuLu Group International with the ripened Nendran bananas at Dubai



Ripened Nendran Banana in display at LuLu Hyper Mall, Dubai