

# Stories of change



## Reducing post-harvest losses in mango in South Asia

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### Key messages

- Spraying hexanal (a biocompound) in mango orchards is a simple, economical and eco-friendly technology that retains the fruit on the tree for up to one month longer, enabling farmers to earn up to 15% more for their crop.
- Treatment with hexanal more than doubles mangoes' shelf life (up to 17 days at room temperature and 26 days in cold storage conditions), enabling them to reach lucrative export markets.
- A system to incorporate hexanal within mango packaging, in order to further improve its transport potential, is being developed.
- Enhanced availability of mangoes improves the nutritional security of women and children, through direct consumption and by creating income to buy nutritionally rich foods.
- There is a gender gap between men and women mango growers in farm level decision-making, including choice of crops, pest and disease management and post-harvest operations.

### Context

India is the largest producer of mango fruits (21.54 million tons) contributing 69% of global production (31.25 million tons) (Sekhar *et al.*, 2013). In Sri Lanka, mango production is approximately 90,000 tons, constituting 15% of the total fruit bowl of the country. While fruit production in South Asia is globally competitive, the region is only able to satisfy around half of its demand. One reason for this is post-harvest losses in fruits and vegetables, which, owing to poor processing and preservation facilities, can be as high as 30-35%. This represents an annual economic loss of INR 2,000 billion (Indian rupees) (US\$33 billion).

Despite several strategies being adopted to minimize post-harvest losses in India and Sri Lanka, success at the farm level is limited due to the small and marginal nature of farm holdings, inconsistent post-harvest management practices and poor infrastructure, including cold storage facilities. In attempting to address such challenges, food industries have started exploiting nanotechnology to develop smart packaging systems.

In Canada, scientists at the University of Guelph have developed a biochemical formulation -



Hexanal has been shown to substantially reduce post-harvest losses in mangoes

an artificially synthesized version of hexanal (a substance naturally produced by injured plants) which delays ripening of temperate fruits (Sharma *et al.*, 2010). Spraying even tiny quantities of hexanal on temperate fruit has been shown to substantially reduce post-harvest losses. In 2013, the Guelph team, together with partners from the Tamil Nadu Agricultural University (TNAU) in India, and the Industrial Technology Institute (ITI), Sri Lanka, successfully demonstrated this technology with a tropical fruit - South Asian mangoes.

The work has included an extensive study of the biosafety of hexanal with data clearly showing that hexanal is harmless to honey bees, natural pest enemies and earthworms. A study of how hexanal interacts with human cells, such as lung and skin cells, also found no harmful effects.

Work has since been carried out to develop packaging material containing hexanal, which can be slowly released during transportation and storage in order to maintain fruit condition. Hexanal is a highly volatile compound, but incorporating it in banana fiber pads, or 'nano-matrices', that are enclosed within packaging boxes, regulates the release of the compound, successfully preserving the fruit. MYRADA, an NGO, has helped to disseminate the new technologies, by supporting the formation of 45 mango producers groups, comprising 750

mango growers in Tamil Nadu (over 60% women) and 139 mango growers in Sri Lanka (over 20% women). Group members have been trained on post-harvest management practices and value addition, and they have now begun to adopt a number of these practices.

## Emerging outcomes

### Increasing retention of fruits in trees leads to better prices

In field tests conducted in three major mango growing areas in Tamil Nadu, spraying mangoes with a very low concentration of hexanal (0.02%) twice during the growing season was found to retain the fruit on the tree for an extra three weeks, compared to non-sprayed mangoes. Delaying the harvest enabled farmers to get a premium price in the market - nearly double what was paid three weeks earlier. This has helped to ensure nutritional security for women and children.

*“ Since the pre-harvest spray of hexanal formulation extended the shelf life of mango fruits up to three to four weeks, I can take up the spray when there is a glut in the market so as to reap the benefit of late arrivals and premium price for the produce.*

**Mr. Arun Nagarajan, President, Fruit Growers' Association**

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## Extending shelf life of fruits in storage and transport

Hexanal-sprayed mangoes have been found to have a shelf life of 13-17 days at room temperature and 21-26 days under cold storage conditions, compared to four to five and 10-12 days for untreated fruit. In Sri Lanka, a technology developed by ITI for coating mangoes with biowax has extended the shelf life up to seven and 21 days under ambient and cold conditions. Such shelf life extension will help in long distance transport and price stabilization.

Special boxes have also been designed to reduce losses during transport. The boxes are sturdy, and can be stacked without risking damage to the fruit, and this alone can reduce post-harvest losses by 10-15%. In order to further improve the storage life of fruits during transport, the project has made a pioneering attempt to develop 'nano-matrices' using banana fibers to regulate the release of hexanal. In Sri Lanka, the research team has devised a system whereby wax-coated mangoes are packed in hexanal impregnated banana-fiber paper. This has been found to extend the storage life of mangoes from just four days to 21 days, enabling long distance transport.

## Increased adoption of technology and income of women farmers

Through training, group meetings and field level interactions, the adoption of good agricultural and farm management practices by the mango growers has increased by 22%. Post-harvest losses of mango at the field level have come down by 10% (700-900 kg/ha) through the adoption of appropriate harvesting and post-harvest practices, including use of suitable harvesting tools, and techniques of fruit collection, cleaning, grading, sorting, packaging and transport. Reduction of post-harvest losses has resulted in the greater availability of quality fruits in the market, thereby generating an additional income of INR 5,600 (US\$92) per hectare per year.

*“ I feel proud that I have convinced my husband to consider my decisions related to post-harvest management and marketing after associating with the mango producers group.”*

**Mrs. Dhanalakshmi, Mango Producers' Group, Moramadugu, Krishnagiri, Tamil Nadu**

Collective marketing of mangoes through the mango producer groups, rather than contractors, has enabled women to increase

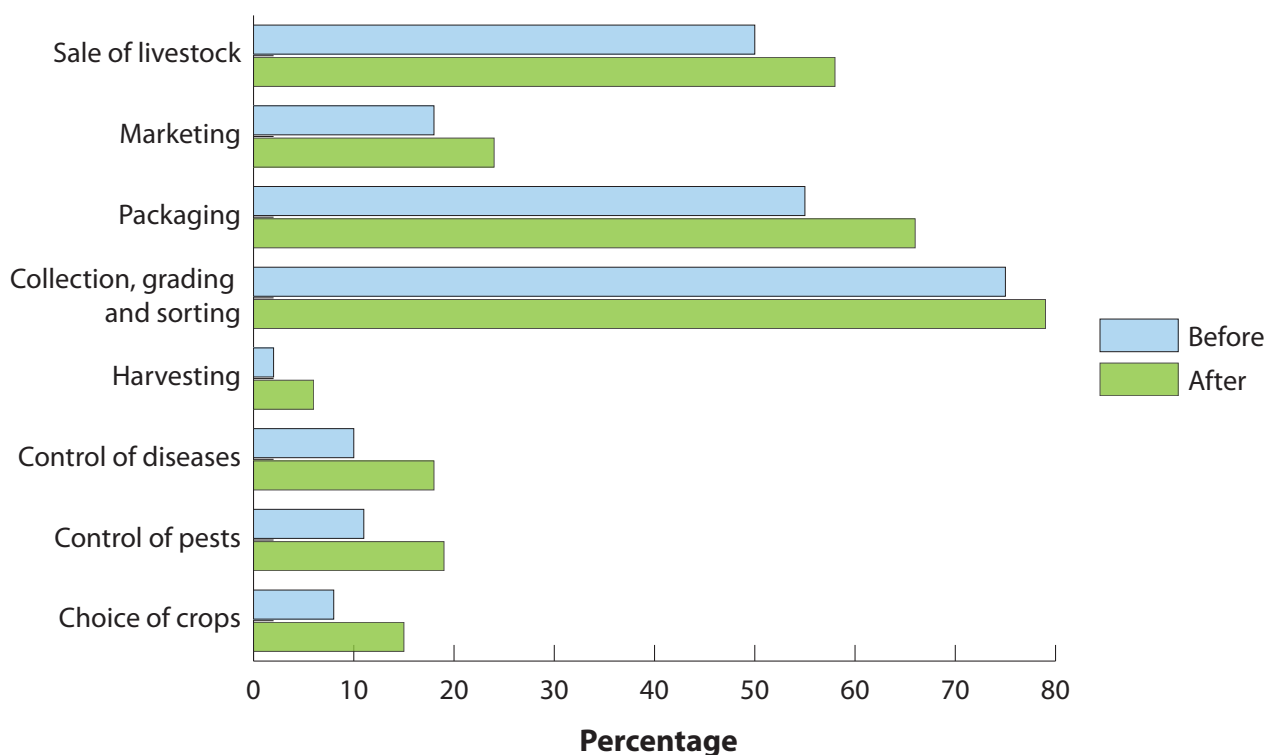


Figure 1: Level of women participation in farm decision-making



their income by 7-10% in the three research sites in Tamil Nadu. Additionally, hands-on training on value-added products, such as mango-based pickles and sweets, has also helped women enhance household income by 10%. This money is being used for education and health expenses as well as buying more nutritious food such as green vegetables. The participation of female group members in the overall management of farm-related decisions, such as production, harvesting, grading and packaging has also been enhanced by 7% (Figure 1).



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Farmers are adopting good post-harvest practices after attending training and group meetings

## Conclusion

Applying better pre- and post-harvest management practices in their mango orchards has considerably reduced losses for mango farmers with smallholdings, while enhancing the availability of fruit and nutritional security. Despite the fact that hexanal formulation was found to be effective, its storage life is very short (6-8 hours). Therefore, there is a need to study the storability of the product and find ways of producing a 'ready to use' formulation. Since hexanal is a volatile compound, incorporating it within packaging material may facilitate regulated release and help to reduce fruit losses during storage and transport, which will need to be investigated extensively during the scale up project, in order for the technology to be commercialized. With the support of this project, women were able to participate more actively in production and post-production management decisions.

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