# Virus-fighting tomatoes

**Validated RNRRS Output.**

Three new varieties of tomato that are resistant to Tomato leaf curl virus (ToLCV) are boosting Indian farmers' profits up to ten times over and are capturing much commercial interest. Previously, the disease could cause farmers to lose their whole crop, and infection spread rapidly, as the virus is carried by whiteflies. Now, the new varieties 'Sankranthi', 'Nandi' and 'Vybhav' give very high yields and don't need to be sprayed with insecticide. Sixteen seed companies have already used the new varieties to produce hybrid tomatoes—which are being grown by an estimated 55,000 farmers in southern India alone. Seed of the three varieties has reached more than 14 institutes in 13 different countries, and there is continuing global demand, which is being met mainly through the World Vegetable Center.

Project Ref: **CPP33:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **Natural Resources Institute (NRI), UK**
Source: **Crop Protection Programme**

**Document Contents:**



**Research into Use**
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**Geographical regions included:**

**Africa, Asia, Bangladesh, Europe, India, North America, South America,**

**Target Audiences for this content:**

**Crop farmers,**

## Description

***CPP33***

***A. Description of the research output(s)***

*1. Working title of output or cluster of outputs.*
*In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.*

**Tomato leaf curl virus disease and whitefly, *Bemisia tabaci*, management**

*2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.*

a) RNRRS Programme: Majority of funding from the Crop Protection Programme
b) DFID Competitive Research Facility
c) EC INCO-DEV: International cooperation with developing countries

*3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.*

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*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced?* ***(max. 400 words)****. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

**Tomato leaf curl virus** (ToLCV) and its **whitefly vector, *Bemisia tabaci*** (Genn.), are two of the most serious constraints to **tomato** production in India and many other tropical and sub-tropical countries throughout the world. ToLCV causes a severe **disease** in susceptible tomato varieties, particularly when infection occurs at an early stage of seedling development. Small populations of the vector can spread the virus rapidly, often leading to 100% yield loss. In response to the demand for a solution to this problem, earlier phases of this project developed and tested various new technologies and alternative management practices to insecticides, which were used intensively by farmers to target the whitefly vector. In response to farmer feedback, project activities focussed eventually on the development, through farmer-participatory breeding, of three **ToLCV-resistant open pollinated** (OP) tomato varieties. These were named, ***Sankranthi***, ***Nandi*** and ***Vybhav***. They are high yielding and highly resistant to ToLCV. The three varieties received official notification by the **Indian Central Seed Committee**, early in 2004. They were then **released officially** as agricultural varieties for use in the whole of India by the variety names being published in The Gazette of India on May 31, 2004.

*5. What is the type of output(s) being described here?*
*Please tick one or more of the following options.*

| ***Product*** | ***Technology*** | ***Service*** | ***Process or Methodology*** | ***Policy*** | ***Other Please specify*** |
|---|---|---|---|---|---|
| X | X | | | | |

*6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment*

The main commodity is **vegetables** and specifically **tomatoes**.

*7. What production system(s) does/could the output(s) focus upon?*
*Please tick one or more of the following options.* *Leave blank if not applicable*

| ***Semi-Arid*** | ***High potential*** | ***Hillsides*** | ***Forest-Agriculture*** | ***Peri-urban*** | ***Land water*** | ***Tropical moist forest*** | ***Cross-cutting*** |
|---|---|---|---|---|---|---|---|
| X | X | X | | X | | | |

*8. What farming system(s) does the output(s) focus upon?*
*Please tick one or more of the following options (see Annex B for definitions).*
*Leave blank if not applicable*

| ***Smallholder rainfed humid*** | ***Irrigated*** | ***Wetland rice based*** | ***Smallholder rainfed highland*** | ***Smallholder rainfed dry/cold*** | ***Dualistic*** | ***Coastal artisanal fishing*** |
|---|---|---|---|---|---|---|
| X | X | X | | | X | |

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)?* ***(max. 300 words)****.*

*Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.*

| | | | |
|---|---|---|---|
| IPM promotion through improved training manuals | R8417/R8341 | Dr H Dobson | NRI |
| Linking demand with supply of agricultural information | R8429/R8281 | Dr B Pound | NRI |
| Management systems for export horticulture | R8271/R8431 | Dr A Graffham | NRI |
| Solar dried fruit and vegetables<br>*Producing solar dried fruit & vegetables for micro and small-scale rural enterprise development. 1. Assessing opportunities for a fruit drying business. 2. Dryer construction. 3. Processing aspects. 4.Business profitability* | R5539 | Dr J Orchard | NRI |

## Validation

***B. Validation of the research output(s)***

*10. **How** were the output(s) validated and **who** validated them?*

*Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation **(max. 500 words)**.*

The outputs have undergone a prolonged period of rigorous validation by various groups. The three tomato leaf curl virus disease (ToLCVD)-resistant tomato varieties, TLB111, TLB130, and TLB182, subsequently named ***Sankranthi***, ***Nandi*** and ***Vybhav***, were evaluated extensively in on-station and participatory on-farm trials in Karnataka. The on-farm trials were managed by the University of Agricultural Sciences, Bangalore, (UASB) extension service to provide an independent assessment of their performance. The yield of the varieties was high in spite of extremely high disease pressure and, due to the resistance being present in the young seedlings, they did not require netting protection at this stage or insecticide sprays, which reduced farmers' costs.

In particular, data on the horticultural acceptability of the tomato lines to farmers was used to feedback into the variety selection and breeding programme. This resulted in the production of tomato varieties that have characteristics desired by tomato farmers and consumers.

Data on the three varieties were presented at the Joint Meeting of the Zonal Research Extension Advisory Council (ZREAC) and Zonal Research Extension Formulation Committee (ZREFC) for the different zones in Karnataka State, where technical Officers and breeders from the State Departments of Agriculture, Horticulture and farmers representatives were present. Data for two field seasons were considered acceptable, which then allowed the varieties to be released successfully. Following consultation with the Central Seed Committee, official notification took place by the variety names being published in The Gazette of India on May 31, 2004. This means that these are notified agricultural varieties for use in the whole of India. As part of this process, the National Bureau of Plant Genetic Resources, New Delhi, conserved the varieties' seed. The data are also published in the following scientific article: Muniyappa, V., Padmaja, A.S., Venkatesh, H.M., Sharma, A., Chandrasekhar, S., Kulkarni, R.S., Hanson, P.M., Chen, J.T., Green, S.K. & Colvin, J. (2002) Tomato Leaf Curl Virus Resistant Lines TLB 111, TLB 130 and TLB 182. *HortSci.*, 37, 603-606.

Demonstration field days were held at the UASB and successful negotiations took place with commercial vegetable seed producers. This resulted in ten of them taking up the rights, on a non-exclusive basis, to multiply and distribute the varieties and/or use them as parental material to develop ToLCVD-resistant hybrids.

Through cooperation with the commercial seed companies, data on the performance of the tomato varieties in different Indian States were obtained (see also question 11).

Impact assessment data were also collected with regard to the economic, social, health and environmental benefits to Indian farmers who are growing the project's varieties. The data showed that these farmers could obtain up to 10 times the profits achieved by growing an existing ToLCVD-susceptible OP variety and that they used the extra income for improved nutrition, children's education and health.

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

In June 2001, at the end of the second phase, a workshop was held at the UASB, which was attended by approximately 500 participants who included tomato farmers, extension workers, private-seed company representatives and both government and university research scientists. There was agreement that these outputs were unique and could make a major contribution to managing the ToLCVD problem.

The farmers that attended the meeting can be considered to be in the Semi-arid, High Potential, Hillsides and Peri-urban production systems that supply both local fresh vegetable markets as well as exporting them to the major cities through middle-men.

From 1999-2002, with funds from R7257, the tomato varieties were grown in Gujarat, northwest India. The performance of the three varieties varied from tolerant to highly resistant and it is presumed that this is due to the presence of different ToLCV species in this area.

From 2003-2005, with the cooperation of the commercial seed companies that had purchased breeder seed of the tomato varieties, data on the performance of the tomato varieties in different Indian States were obtained. The geographic areas included northern India (Himachal Pradesh) and Nagpur (central India). Nine of the companies returned information on crop performance and stated that the tomatoes did not show any ToLCVD symptoms, whereas the susceptible control varieties were all infected.

From 2003-2005, the tomato varieties and additional genotypes were taken to Bangladesh and Tamil Nadu as part of an EC-funded project on "Improved sustainability of smallholder peri-urban vegetable production in South Asia". Researchers at Bangladesh Agricultural Research Institute (BARI) and Tamil Nadu Agricultural University (TNAU) selected the best performing genotypes, which included **Sankranthi**, **Nandi** and **Vybhav.** They have multiplied the seed with the intention of releasing the varieties to farmers in the near future.

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## Current Situation

***C. Current situation***

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words**).*

Previous project work adopted three strategies for disseminating the varieties and creating developmental impact. Between 2003-2005, on a global scale, seed has been made available through AVRDC and it has been distributed to more than 14 institutes in thirteen different countries (Brazil, Egypt, France, P.R. China, Taiwan, Vietnam, Hong Kong, Japan, South Africa, USA, Turkey, Germany, Thailand). Funds were not available, however, to follow up how the varieties are being used, although this could from an impact assessment exercise in any future RIU activity.

The second strategy involved making breeder seed available to Indian seed companies. The varieties were purchased by 16 commercial seed companies who have already produced ToLCV-resistant hybrids and are also in the process of using them to create new ToLCV-resistant hybrid tomatoes. The categories of farmer benefiting from these technologies include those in the Semi-arid, High Potential, Hillsides and Peri-urban production systems.

The third strategy was aimed at the poorest tomato growers, who prefer to grow OP-varieties and cannot usually afford the expensive inputs involved in hybrid tomato production. In order to ensure both that this category of farmer continued to benefit from the project's outputs and the sustainability of the project's impact in India, a 'revolving fund' was set up by the National Seed Project of the University of Agricultural Sciences, where receipts from seed sales through various outlets are used to produce replacement seed that, in turn, will be sold.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

The outputs are currently being used both intensively and extensively throughout India. Breeder seed has now been purchased by 16 commercial Indian seed companies. Seed has also been distributed through the NGO, Gram Vikas Samstha (GVS), Madanapalli, as well as the Agricultural Technology Information Center (ATIC), Hebbal, the National Seed Project (NSP), GKVK, and Krishi Vigyan Kendra (KVK), Kandli, Karnataka State.

As mentioned in Q11, researchers at Bangladesh Agricultural Research Institute (BARI) have multiplied the seed with the intention of releasing the varieties to farmers in the near future.

By the end of the project in January 2006, the following institutes and organisations had received the seed of the three varieties: Institute of Vegetables, Zhejiang Academy of Agricultural Sciences, Zhejiang Province, P.R. of China; Farmer Seed & Agricultural Co. Ltd., Taiwan; Green Co. Ltd., Ho chi minh city, Vietnam; Horticulture Department Faculty of Agriculture, Kafr El-Sheikh, Egypt; Clover Seed Co., Little Hong Kong Village, Hong Kong; Shimizu, Suginami – ku, Tokyo, Japan; Starke Ayres, Cape town, South Africa; Seminis Vegetable Seeds, Woodland CA, USA; May Seed Company, Samanli Mah, Bursa, Turkey; Centre de Recherche de La Costiere, France; Department of Vegetable Crop Production, Lentzealle 75, Berlin, Germany; Asian Regional Center Bangkok, Thailand; Sakata Seed Sudamerica, Braganca paulista, SP Brazil. There is continuing global demand, which is being met mainly through AVRDC.

*14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading **(max 250 words).***

The outputs are currently being used both intensively and extensively throughout India and will also begin to be utilised in Bangladesh. Since their recent release, over 17 kg of seed of the varieties has been sold. In addition to this, the 16 seed companies have started to release their ToLCV-resistant hybrids, which use one of the varieties, usually ***Vybhav***, as one of the parental lines. Sasya seeds have released the currently 'ruling' ToLCV-resistant hybrid, Mrythyanjaya and ECL-agrotech have released Ajay and Sonali. A conservative estimate made in 2005 was that, hybrids developed from our varieties, will be grown by more than 55,000 South Indian farmers (Dr Anand, Namdhari Seeds, pers. comm.) by the end of 2006. The use of our technology, therefore, was adopted quickly and is

continuing to expand rapidly.

We currently have a small amount of funding for dissemination and promotion activities, provided by the Tropical Whitefly IPM project. In May 2007, we are planning to hold a 'show-case' field day at Namdhari Seeds farm, Karnataka, where companies will exhibit their ToLCV-resistant hybrids and we will also show ***Sankranthi***, ***Nandi*** and ***Vybhav*** and provide a demonstration of other IPM techniques. At present, we have received indications that about 80 hybrids will be on show. The companies are contributing approx £60.00 per hybrid entry to help cover the cost of the field day, which clearly demonstrates their commitment to their products and the successful uptake of the project's outputs.

*15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success?* ***(max 350 words).***

The Crop Protection Programme, which funded the majority of the work, had the consistent and clear criterion that there needed to be strong evidence of a 'demand' for the technology that we developed. This ensured that the 'voice' of farmers was heard at a very early stage of the work. The farmers stated very clearly that there was a great need for tomato varieties that had resistance to ToLCV, as these did not exist at that time.

Towards the end of the CPP, there was a funding phase that was concerned with dissemination and promotion. This allowed the stakeholders, who had developed the outputs, to direct their efforts at facilitating and bridging the often huge gap between product development and adoption. This process involved creating links with the private sector and changing policy within the Agricultural State University. This allowed the University, for the first time, to promote actively the three varieties by releasing TV, radio and press articles, which in turn generated considerable interest in private sector seed companies throughout India. The university then allowed, again for the first time, breeder seed of the three varieties to be sold to any private seed company that wanted them. The promotion phase of the project also allowed capacity strengthening to occur in the National Seed project (NSP). This involved project staff working with the NSP to set up a 'revolving' fund, which enables the sustainable production of seeds for the three varieties to meet the demand of the poorest farmers. Seed from this source is sold to farmers through the Agricultural Technology and Information Center. This will continue to occur for the foreseeable future, without any additional external funding.

The key factor in the successful adoption of the technology was a clear understanding of the obstacles that might prevent the successful uptake of the outputs and a strong commitment by the project staff to overcome them. If the success of this project is to be repeated elsewhere, the importance of identifying and involving key people with the appropriate leadership skills, local knowledge and commitment to generating developmental impact cannot be overstated.

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## Environmental Impact

***H. Environmental impact***

*24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)?* ***(max 300 words)***

*This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate evidence can be provided in the form of an annex.*

Where ToLCV-resistant tomato varieties are not available, farmers try to protect their crop by spraying insecticides very intensively with consequent detrimental effects on their health and the environment (Nagaraju *et al*., 2002, see Q20). The validation field trials carried out for the tomato varieties were conducted without the application of any insecticides. These varieties, therefore, can be grown with a greatly reduced number of insecticide sprays, with consequent benefits to farmers' and consumers' health, the environment and profitability of the crop.

*25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)?* ***(max 100 words)***

No, we are not aware of any.

*26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience?* ***(max 200 words)***

If the climate changes involve the region in question getting wetter or experiencing less extreme temperatures, then the outputs could still be grown and the resilience of the farmers to cope with these changes would be increased. If, however, the changes resulted in temperature extremes and drought becoming more frequent, these constraints could conceivably make the growing of ToLCV-resistant tomatoes inappropriate. In general, however, the intense pressure to generate more produce from less land, water and other resources has contributed to the dramatically increased frequency of vector-borne virus epidemics. The outputs offer a solution to one of these problems and therefore should increase the resilience of the poor who adopt them.

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