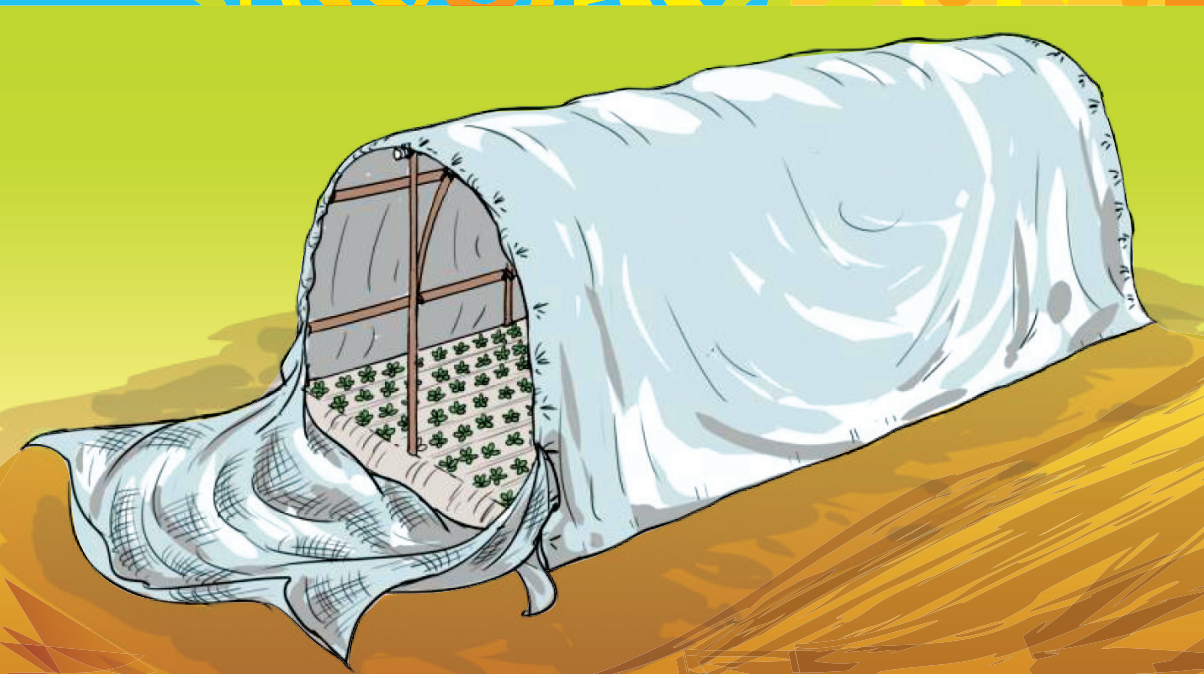

Net Tunnels to Protect Sweetpotato **Planting Material** from Disease

A Guide to Construct and Maintain Tunnels

DECEMBER 2012

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Why use a net tunnel?

One of the major yield-limiting factors in sweetpotato production is the lack of clean planting material owing to infection of sweetpotato virus disease (SPVD). Viruses are diseases spread by insects (vectors such as white flies and aphids) that build up over time in the plants, reducing yields with each season. Some sweetpotato varieties are more resistant to virus infection than others, showing less yield loss, and breeding programs in Africa focus on selecting for this very important trait. So-called susceptible varieties can disappear completely in one or two seasons in areas with high virus pressure.

At research stations, scientists use large, expensive screen houses covered with quality netting to protect disease-free planting material that comes from tissue culture labs. Recognizing the need for community-level vine multipliers themselves to have better and more affordable access to quality, disease-free ("clean") stocks of planting material, the idea of using a much smaller net tunnel with the same quality netting as a screen house emerged as a potential way to increase farmer access to quality sweetpotato planting material and lower the cost of maintaining virus-free planting material on the farm. Research conducted by the International Potato Center (CIP) and the Kenya Agriculture Research Institute (KARI) at Kakamega from 2009 to 2012 proved that the use of a properly managed net tunnel is very effective in maintaining virus-free planting material for at least 33 months. Results showed, from the second cutting onwards, a significantly higher production of vine cuttings from material from the net tunnel when compared to planting material from the equivalent area that was not under the net tunnel. Moreover, vines produced under tunnels produced much higher yields of roots than vines not protected under tunnels.

This guide provides the steps for constructing a simple tunnel at the farm level and instructions on how to manage the material in the tunnel to ensure a supply of high quality foundation planting material, with little or no virus infection, for farmer planting material multipliers to use to continually renew the planting material in their sweetpotato fields.

Materials required for making the net tunnel

The suggested size of a net tunnel is:

Height of the tunnel:	1.40 meters (m) in the middle
Length:	up to 3 m
Width:	1.8 m wide at each side

Larger tunnels can be built, but this size is very stable against wind and other weather factors.

Material requirements per tunnel:

- Netting material requirements are 4 m x 3.20 m for the top and long sides; 2 m x 1.7 m for the front end; and 2 m x 1.7 m for the back end. The total amount of netting per tunnel is 19.6 m^2;
- About 30 elastic wooden sticks, each 3.6 m long with a diameter of 4 cm;
- Binding wire 5 m long; or, alternatively, sisal twine can be used, but the sisal twine has to be replaced every time you harvest the vines.

Note that the most cost-effective way to purchase netting is in rolls. We recommend the equivalent of OPTINET 50 Mesh size netting sold in Kenya. One roll can make 15 net tunnels, measuring 3 m x 100 m, or 20 net tunnels, each measuring 4 m x 100 m.

Choosing the site for the construction of the tunnel

The site selected for rapid multiplication of planting material in a net tunnel should have fertile, easy-to-work, well-drained soils and be near a perennial source of water. Avoid old sweetpotato fields as these are potential sources of diseases and pests.

Size of the plot under one tunnel

The size of the bed should be 1.8 m x 4.8 m with a plant population of 360. When soils are poor (e.g. sandy soils), plow in manure at a rate of 1 wheelbarrow load per square meter of bed space.

Steps in constructing the tunnel

STEP 1 • Construction of the tunnel frame

Use 3.6 m long elastic wooden sticks (Figure 1), bend them and push them into the ground about 20 cm deep. As shown in Figure 2, the distance between the sticks on the sides should be 50 cm. If you increase the tunnel length, reduce the distance between the sticks. Put two vertical 1.7 m wooden sticks at each end (front and back) and one 3 m long stick on the top. Then use iron wire or sisal twine to connect the end sticks and all of the bent sticks to the 3 m long central stick to increase stability.

Figure 3 shows how four additional 3-meter long sticks should be placed lengthwise on the sides and tied with iron wire at all of the joints with the bent sticks. If such long sticks are not available, two shorter sticks can be joined, but they should overlap by at least 50 cm to be able to make a strong joint.

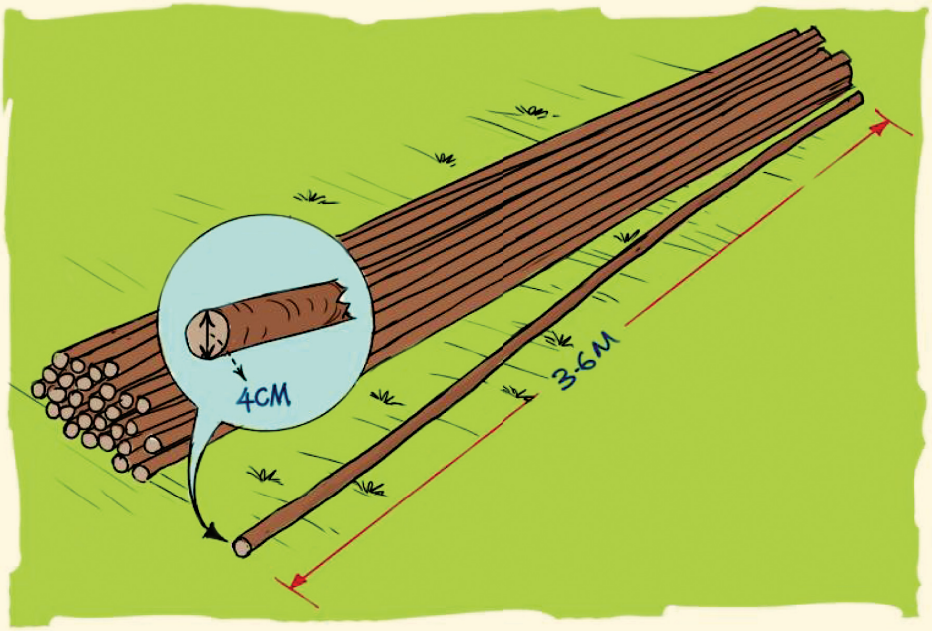

Figure 1. Choice of elastic wooden sticks.

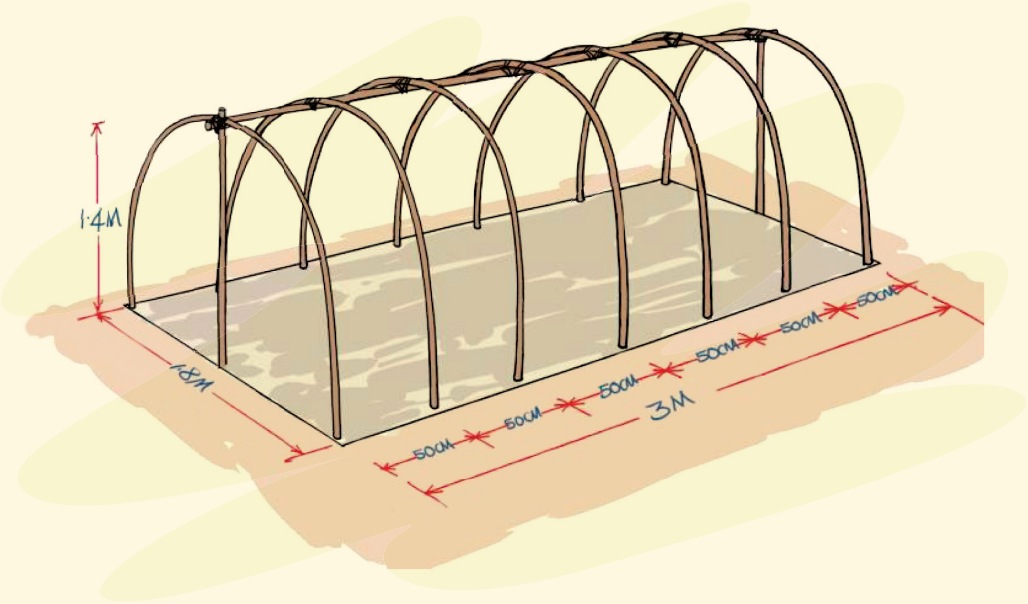

Figure 2. Putting up the structure using the elastic wooden sticks.

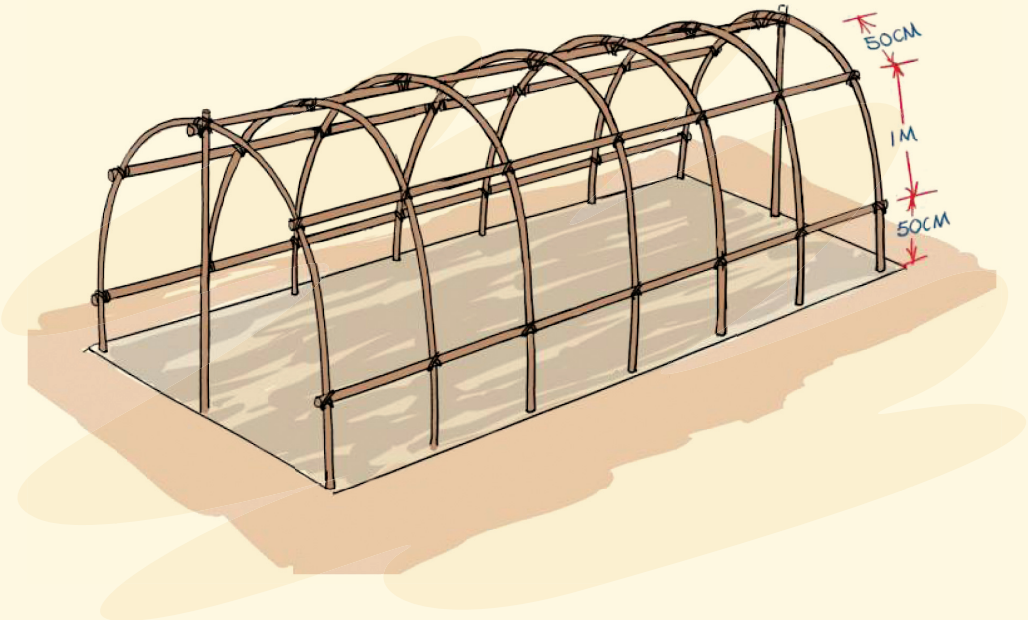

Figure 3. Improving the stability of the structure by reinforcing with more sticks.

STEP 2 • Sourcing and preparing the sweetpotato cuttings

Source your cuttings from mother plants that have been tested and are known to be virus-free. The most likely source will be the research station. Note that on each vine you will see bumps. These are called nodes, and each node can generate roots. To get the most cuttings possible, cut up each vine into pieces that are two to three nodes in length (Figure 4). Note that different varieties have different distances between their nodes.

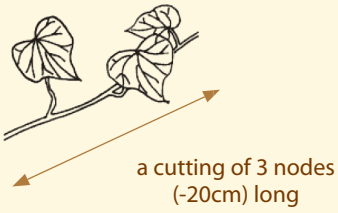

Figure 4. Cutting showing leaves emerging from each node.

STEP 3 • Planting inside the tunnel

Within a row, leave 10 centimeters (cm) between each plant (Figure 5). If using three-node cuttings, two nodes should go under the soil. If you plan to cut every 80 days, leave 15 cm between the rows. Then you will have 12 rows, 30 plants per row (plant population total of 360). If you plan to cut less frequently, you can leave 20 cm between the rows and have 9 rows with 30 plants per row (plant population total of 270).

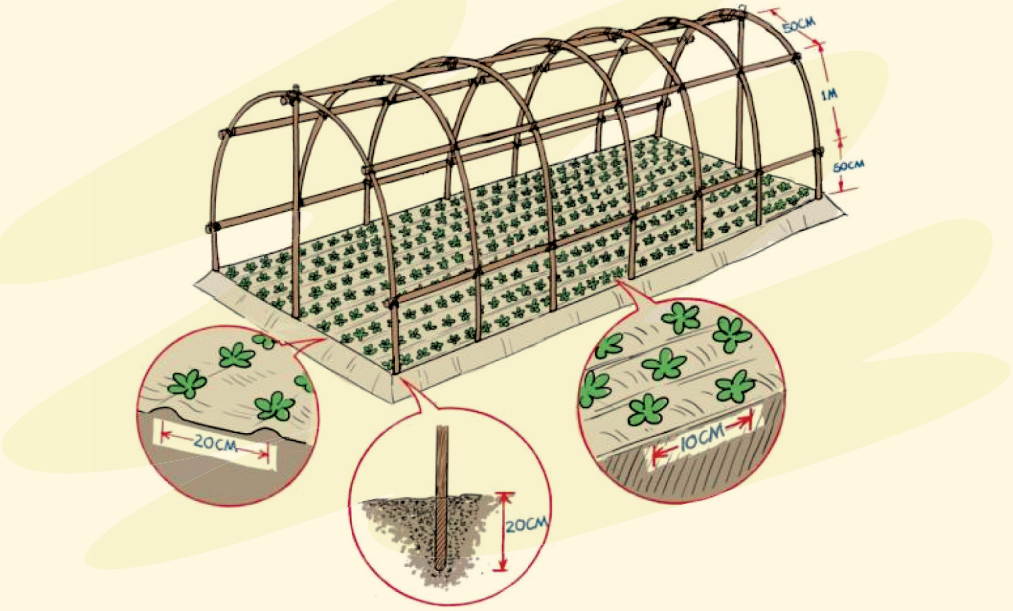

Figure 5. Planting inside the tunnel.

STEP 4 • Covering the tunnel with the quality netting

Put the netting on top of the tunnel frame (Figure 6) and fix it to the structure with iron wire (Figure 7). Cut the netting so that there is an extra 20 cm extension of the netting beyond that which reaches the ground on all sides. Leave at least a 10 cm allowance of extra netting at the front and back to connect with front and back cover. Fix the net pieces at the front and back onto the netting on the top and the frame itself. On each side, where the net tunnel touches the earth, place a pole along the length of the respective side and then cover it with 20 cms of soil, to make it stormproof (Figure 8).

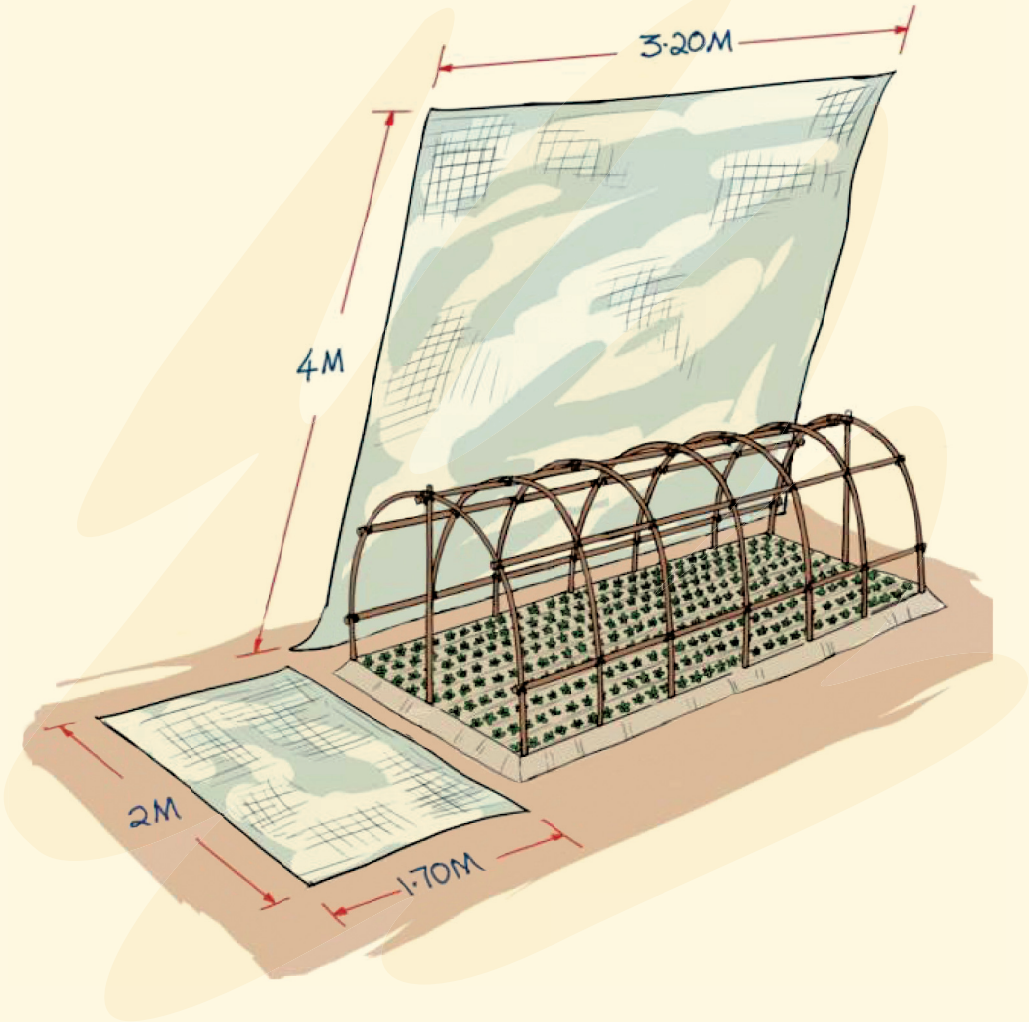

Figure 6. Covering the tunnel with the quality netting.

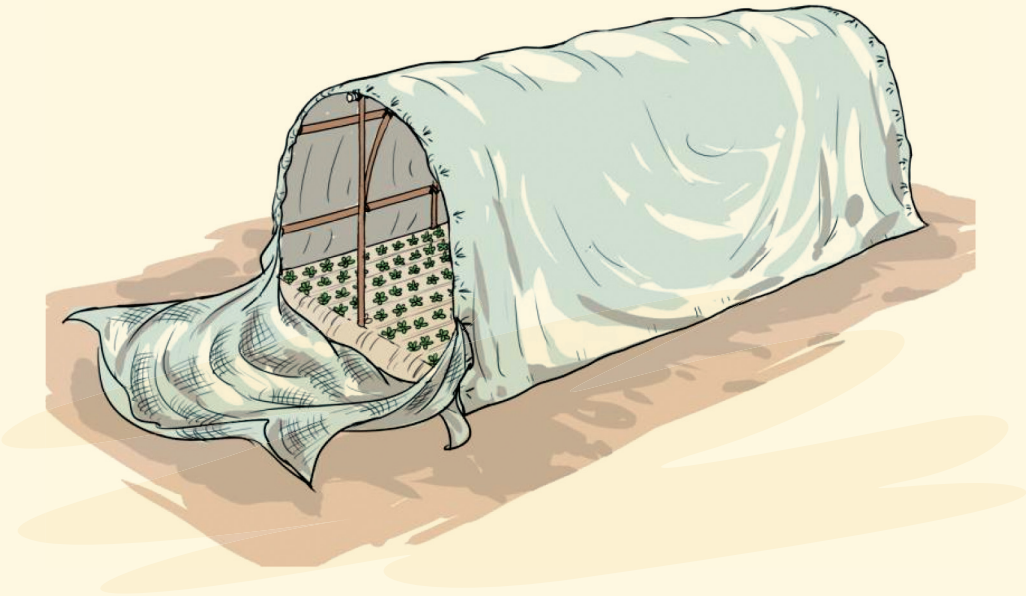

Figure 7. Using iron wire, seal the front and back netting pieces onto the frame .

Figure 8. Left picture shows the construction of the net tunnel, including placing the supporting poles before adding the soil cover to make it stormproof. Right picture shows a completely sealed net tunnel.

Care / cultural management practices of the tunnel beds

An integrated control strategy for effective insect management includes:

a) Preparing tunnel beds where the soil has been worked to be fine, without lumps;

b) Applying and incorporating mature farmyard manure or compost into the tunnel bed before planting, at a rate of 30 kg or 45 liters for the size of the net tunnel;

c) Removing weeds around the tunnels, since weeds serve as hosts for the insects;

d) Irrigating twice a day (early morning and late afternoon) with a watering can without opening the tunnel--pour from the top through the net. Note that watering is not necessary when it is raining. You want to avoid waterlogged conditions caused by excessive watering;

e) Using mulching material to control weeds by spreading dried grass before planting on the prepared beds;

f) Ensuring that the beds do not become dry, especially during the first five days after planting;

g) Labeling each bed with the name of the variety and date of planting; and

h) Ensuring that farm animals, such as goats and pigs, do not have access to the nursery.

Harvesting of cuttings from the tunnel

Depending on the growing conditions, harvesting can be done about 80 to 100 days from the time of planting or last cutting. Be careful when opening the netting, so as not to damage it. Cut apical (top) portions of vines (25-30 cm long), at least 10 cm above the soil level, leaving some nodes on the remaining stems. These remaining stems will grow again. If NPK fertilizer is available, after each harvest of vine cuttings apply N:P:K (e.g. 17:17:17) fertilizer at a rate of 200 grams per net tunnel (which is equivalent to 1 level teacupful of fertilizer). To apply, make a 2 cm deep furrow between the lines by using a stick, and apply the fertilizer evenly in the furrows. After the fertilizer application, cover the furrows with soil.

After harvesting, spray the tunnel with an insecticide (against aphids and white-flies) before covering again. You can apply insecticides based on organophosphorus, synthetic or natural pyrethroid active ingredients at the recommended rates on the package; for example, the Duduthrin brand is a 1.75 EC synthetic pyrethroid, that you would apply at a rate of 10g/20l of water using a spray pack or hand sprayer.

What are the economic benefits of using the tunnel?

Our results indicate that the benefits of using insect-proof netting attached to a simple tunnel far outweigh its cost. In 2011 in Kenya, the cost of one net tunnel (to build and maintain it), as described in this guide, was about $120 (US dollars). To determine the benefits of the tunnel, we calculated the total number of vine cuttings produced from the tunnel and the yield of sweetpotato roots from three different varieties planted with the planting material from the tunnels. Then the total production was multiplied by the value of sweetpotato roots in dollars. This resulted in an average benefit of $839 (Table 1) obtained by using the insect-proofed net tunnel, combining the accumulated effect of higher yields per unit area of planting material and root yields when using healthy vines from the net tunnel compared to vines not protected by the net tunnel.

Table 1. Dollar value of sweetpotato roots from vines derived from 6 cuttings (over 33 months) from vines in net tunnels compared to vines outside the tunnels

Variety	Exposed	Net Tunnel	Difference
Kemb 37	1054	2070	1016
SPK 004	924	1853	929
Zapallo	266	839	572
Average	748	1587	839

Note that among these three varieties, Zapallo is considered to be more virus susceptible than the other two.

Healthy vines lead to healthy harvests and healthy profits for farmers

Figure 9. Women harvesting vines inside the tunnel.

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