

A woman wearing a purple long-sleeved shirt, dark pants, and a straw hat with a blue band is standing in a field of tall green grass. She is pointing her right hand towards the left side of the frame. Another person is partially visible behind her, also pointing in the same direction. The background shows a line of trees and some buildings under a clear sky.

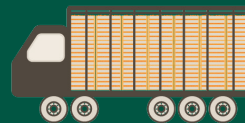
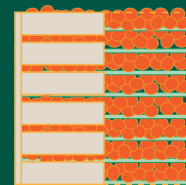
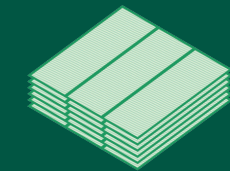
Farmers guide

Self-producing protection sheets made from leaves for tomato transport to reduce post-harvest loss & increase revenue

leafpad

Benefits

- Absorbs shock and vibration
- Prevents tomatoes from bumping into each other
- Divides weight, minimizing pressure points
- Hinders the spread of microorganisms between layers
- Allows for ventilation
- Is fully biodegradable
- Simple and cheap independent reproduction



10% reduced
quantitative loss

20% reduced
qualitative loss



10% increased revenue
at wholesale level

26% increased revenue
at market level

5.25 minutes to
produce one leafpad

Payout time of 1.5
months without reuse
and 0.5 month with reuse





Dear reader,

This guide explains the production of the leafpad. This is a transport protection sheet meant to place in between layers of tomatoes when transporting them in wooden crates. The leafpads will protect the tomatoes and minimize damages. This will maintain the quality of the tomatoes better, leading to increased revenue and less post-harvest loss.

The leafpads are made from 3 layers of banana or plantain leaves attached together, making them sturdy and reusable. The layers of banana leaves are placed over each other with the veins perpendicular to each other. This increases the strength of the sheet and prevents the sheet from ripping easily as would happen with one layer. The layers of leaves are held together by an easy-to-make glue made from natural

ingredients. This also means that the sheets are fully biodegradable and do no harm to the environment. It is a cheap, easy, environmentally friendly solution that farmers can produce and use themselves to reduce losses and increase revenue.

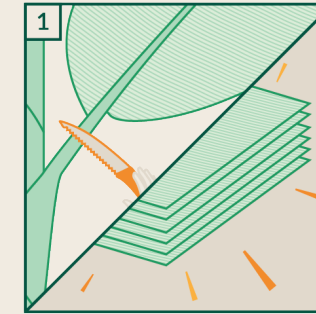
To make the sheets you first need to make a few tools such as wooden cutting stencils and drying racks. For the sheets themselves banana or plantain leaves and natural glue are required. This booklet first explains step by step how the tools and sheets can be made. At the end of the booklet the investment and effect on revenue is explained. Throughout the booklet important tips are shared, marked with an exclamation point.

Use of the leafpads

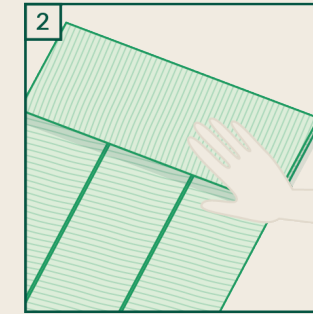
Tomatoes are fragile and suffer many damages as a result of transport such as cuts, bruises, soft spots and rotting. To protect them you can make sheets of banana leaves at your own farm for a low price. When the quality of the tomatoes is maintained this means you can increase your revenue and sell more tomatoes. How the leafpads are used is visible on the next page.

Per crate about 8 of these sheets are used to reduce post-harvest losses. Layers of leaves are placed over each other and glued. During drying of the sheets, the leaves shrink slightly, creating air pockets that give the sheets some thickness that functions as padding. The sheets absorb shock and vibration during transport as a result of bad road conditions and function as a layer between the fruits so they don't bump directly into each other. The sheet also divides weight from the layers of tomatoes above more evenly over the layers below, minimizing pressure

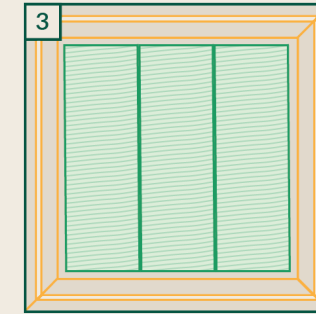
points. Lastly, it also forms a barrier that hinders the spread of microorganisms between layers, preventing fruits from decaying as a result of other rotting fruits. Next to this, the leaves have antifungal and antimicrobial properties meaning they are safe and even beneficial to use as packaging.



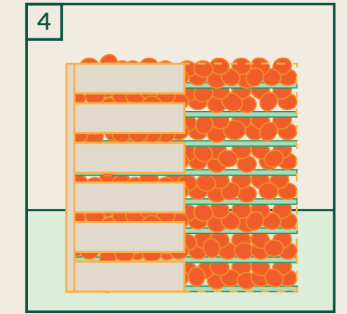
Farmer buys or harvests leaves and applies pre-treatment.



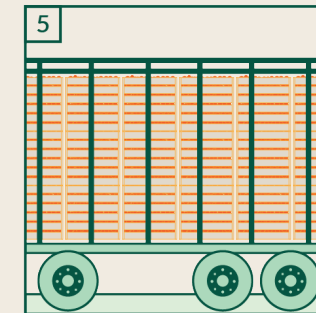
The farmer fabricates leafpads necessary for the next harvest load.



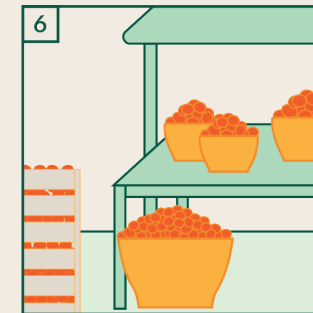
When packaging tomatoes in a crate first a sheet is placed on the bottom.



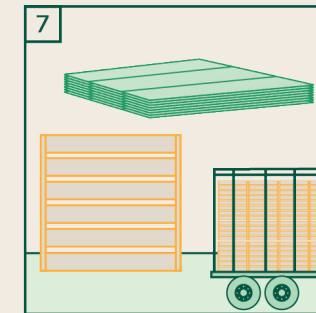
Two layers of tomatoes are placed on top with a leafpad and so on until the crate is full.



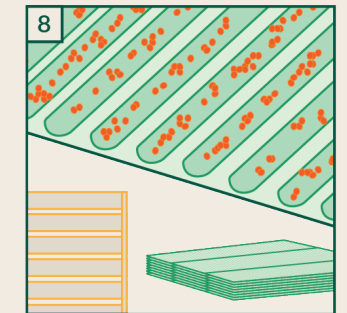
The crates are transported to the market by truck.



Crates are unpacked by market women and vegetables are sorted, displayed & sold.



Leafpads are returned to the farm with the crates through the middle women.



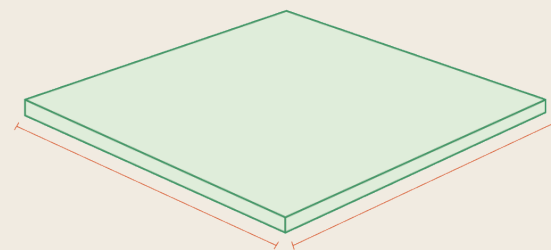
Middle women return the crates to the farm for the next harvest where the leafpads can be reused for at least 2 times.

Tools to make

The following equipment needs to be built and invested in once. It is the equipment necessary to facilitate the production of the transport protection sheets.

Stencils

One large and one small stencil are used to cut the leaves and sheets into the right sizes.

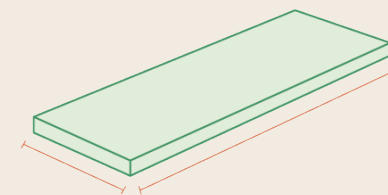


Small - 60x60 cm
Medium - 70x70 cm
Large - 80x80 cm

1x Large wooden cutting stencil

The large stencil is used to produce leafpads in the right size for the crate. For this you get a wooden plate and saw it into the right size. The size of the stencil is the same size as the crate opening. For standard crates this is:

- Small: 60x60 cm
- Medium: 70x70 cm
- Large: 80x80 cm

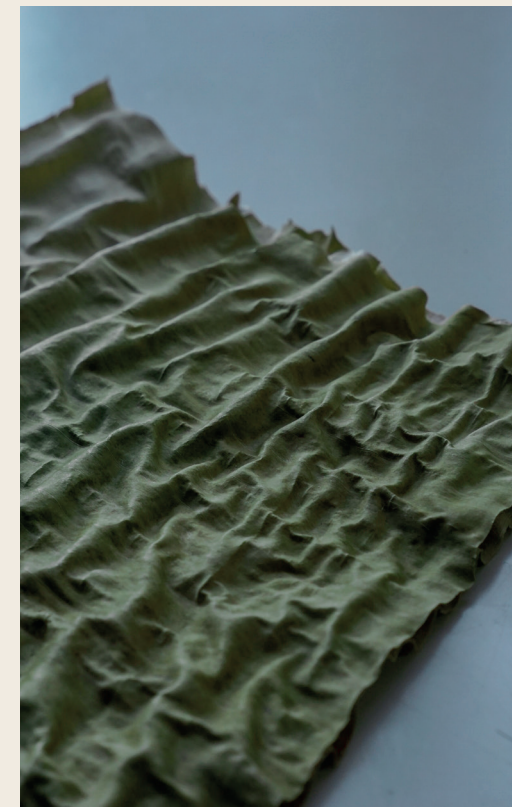


Small - 20x60 cm
Medium - 23.5x70 cm
Large - 20x80 cm

1x Small wooden cutting stencil

The small stencil is used to make cutting the leaves in the right size easy and fast. The size of the stencil is the size in which the leaf samples need to be cut for the right crate size. For this you get a wooden plate and saw it into the right size.

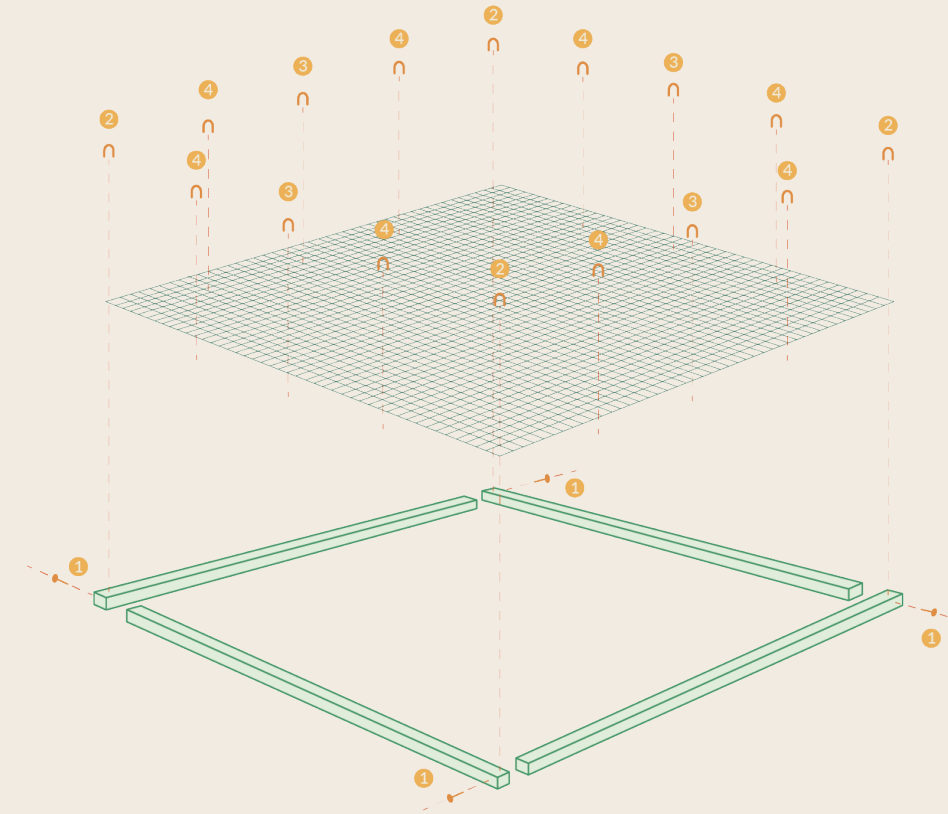
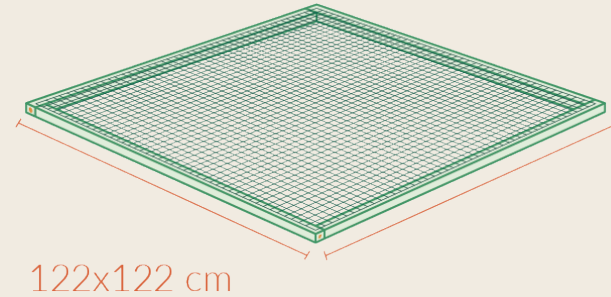
- Small crate (60x60x60 cm) - 20x60 cm
- Medium crate (70x70x70 cm) - 23.5x70 cm
- Large crate (80x80x80 cm) - 20x80 cm



Drying rack

The drying rack is used to dry leafpads between so they dry flat and quick while allowing crumpling to form air pockets. The drying rack can be stacked. This means that several layers of wire mesh racks can be stacked on top of each other instead of making two racks for every layer of leafpads drying. For example, 4 sheets can be dried between two racks, 8 can be dried between 3 racks, 12 can be dried between 4 racks and so on. If over the course of two weeks, 80 sheets are produced, 6 sides of a drying rack are necessary. Then each week two cycles of 20 sheets can be dried in the rack. Material necessary for 1 side of a drying rack:

- 4x wooden slat of 117 cm
- 1x wire mesh piece of 120 by 120 cm
- 4x nails
- 16x wood staples



To assemble the drying rack you:

1. Nail the slats together into a square frame.
2. Place the wire mesh on top of the frame and hammer the corners into place with wood staples. Make sure the wire mesh is as flat as possible.
3. Nails the sides of the wire mesh down with the remaining wood staples.

Making the leafpads

Pre-treatment of the leaf

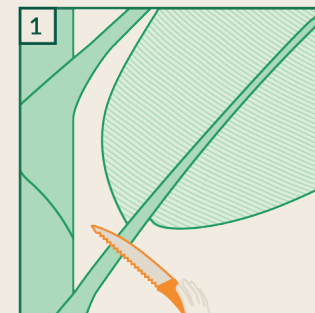
Before using the leaf, it needs a pre-treatment. This makes the leaf more flexible and makes it easier to work with the leaf. It also cleans and sterilizes the leaf, making it safe to use. The pre-treatment for one sheet takes about 3 minutes and for 8 sheets which fit one crate it takes about 25 minutes. On the page on the right the pre-treatment is explained. Depending on the size of your tomato crate you will need to cut the following amount and size of leaf pieces for one sheet:

- Small crate (60x60x60 cm) - 9 pieces of 20x60 cm = 1 to 2 leaves
- Medium crate (70x70x70 cm) - 9 pieces of 23.5x70 cm = 2 to 3 leaves
- Large crate (80x80x80 cm) - 12 pieces of 20x80 cm = 2 to 3 leaves

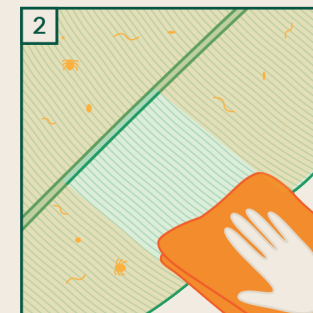
For the pre-treatment you will need:

- Plantain or banana leaves
- Sharp knife
- Cloth
- Pot with boiling water

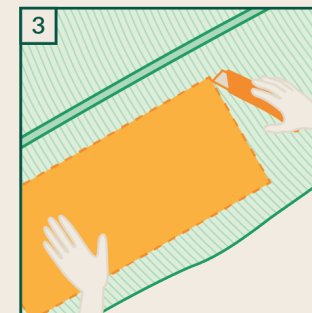
- Be careful with the leaves when they are fresh since they are prone to tearing along the vein direction.
- Leaf pieces can be rolled up while boiling, so the pot size doesn't need to match the leaf size.



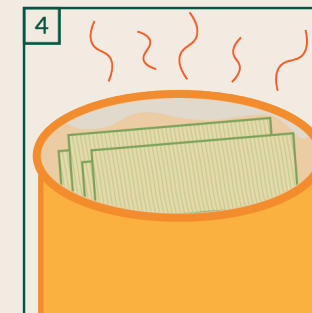
1 Cut the leaf from the plant. Ideally fully green, unripped leaves are used.



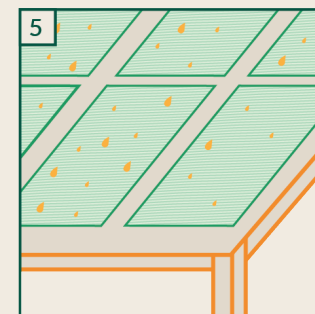
2 Clean the leaf blades to remove dirt and insects. Wipe from the midrib along the veins to avoid tearing.



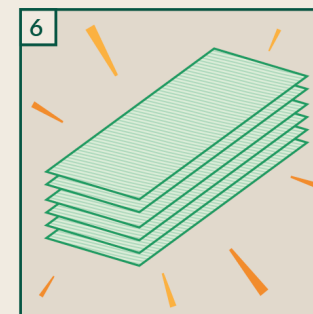
3 Cut the leaves into the desired size. Place the stencil on the leaf and cut around. Avoid yellow parts of the leaf.



4 Boil the leaf pieces in water for 1 minute. Make sure they are submerged to avoid deformation.



5 Dry the leaf and let it cool down for about 30 minutes.



6 Leaves are now ready for further processing.

Making the glue

To assemble the leafpads glue is necessary to keep the leaves attached to each other while drying, allowing air pockets to form. The glue is biodegradable and safe to the environment since it is made from natural ingredients. The recipe written here is to make glue for 8 leafpads, necessary for 1 crate of tomatoes and takes about 20 minutes. The amounts in the recipe need to be multiplied depending on how many leafpads you will make. Since the glue is made from natural ingredients it can spoil. If kept in the fridge the glue lasts at least 3 weeks. To make glue for leafpads to fit 1 crate of tomatoes you need:

- 400 milliliter of water
- 80 grams of cassava flour or starch
- 120 grams of sugar
- 16 milliliter or 1 tablespoon of vinegar
- 12 gram or 1 tablespoon of baking soda
- A pot to mix and heat the ingredients
- A whisk or mixing tool
- An airtight container to put the glue in when ready



- If vinegar and baking soda aren't available, the glue can be made without them, but it will expire faster and work slightly less good.
- Cassava flour can be coarser than cassava starch. This does not affect the glue's effectiveness.



Recipe for natural glue:

1. To make the glue mix the water and flour well in a pan and place it on a stove on medium heat.
2. When the mixture starts to warm up add the sugar. Throughout the whole process, you should keep stirring to prevent lumps.
3. When the sugar is dissolved add the vinegar and once this is stirred through add the baking soda. The mixture will foam because of the reaction between the vinegar and baking soda.
4. When the mixture starts thickening you can take it off the stove, stir until it is smooth. Transfer it the airtight container and let it cool. After that, you can use it as glue.



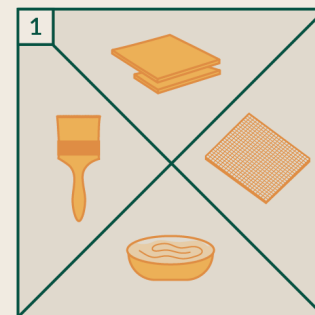
Assembling the sheets

When the tools and glue are made and the leaves are pre-treated, the leafpads can be assembled. Assembling one sheet takes about 2 minutes and for 8 leafpads, which fit one crate, it takes about 18 minutes. To make the leafpads you need:

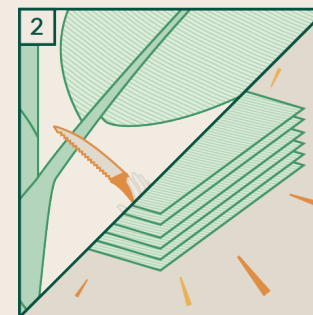
- Pre-treated plantain or banana leaves
- Natural glue
- Paint brush
- Drying rack
- Large stencil
- Small stencil
- Sharp knife

The whole process of producing the leafpads including harvesting, pre-treatment and assembling the leafpads takes 5.25 minutes per leafpad.

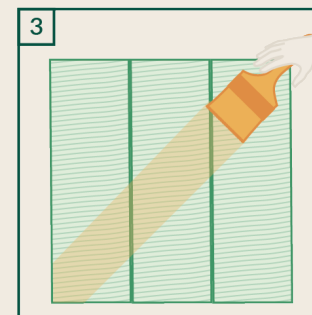
- It's important to dry the sheets between two ventilated sides of a drying rack to keep them flat; otherwise, they will curl and not work.
- Drying leafpads in the shade gives the best result, while sun drying causes more discoloration. Shade drying takes about 3 days; sun drying takes 2 days.
- A few rips in the leaf pieces are okay and work best as the middle layer of sheets. Too many rips will be less effective.



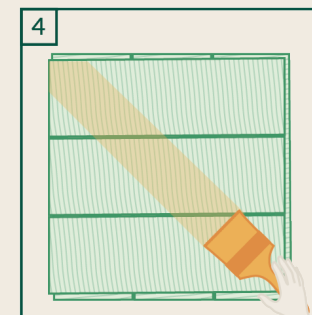
First, prepare the fixed equipment and variable components as described previously.



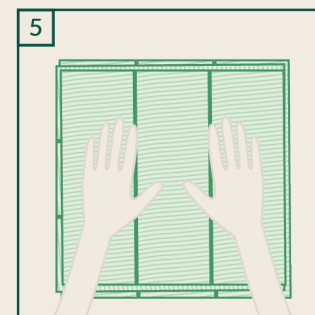
After pre-treatment of the leaves, you are left with leaf pieces that are ready for use.



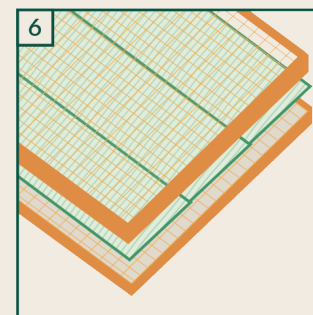
Place three leaf pieces on the large stencil and apply glue. Apply an even, not too thick layer of glue for the best result.



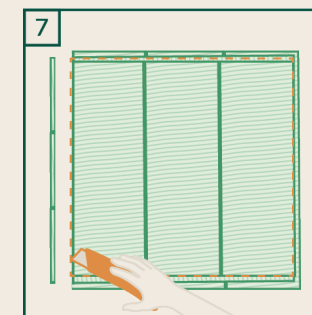
Place the second layer of 3 leaf pieces on top with the veins perpendicular to the first layer and apply glue again.



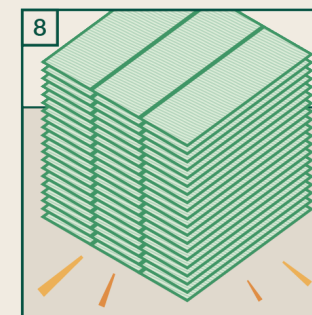
Place the last layer of 3 leaf pieces on top, again with a perpendicular vein direction and press together well.



The leafpad can be transferred to a drying rack. Continue until the drying rack is full and leave to dry for 3 days.



Once dried, leafpads can be cut to size if necessary with the help of the large wooden stencil and a knife.



The leafpads are done and can be stored in a stack. A new round of production can start.

Investment & revenue

To give an impression of the effect of the transport sheets the investment, revenue and payout time are calculated. The following numbers are calculated with available data for the tomato farmer with an average amount of land of 4.15 acres. This means that the numbers should be taken with caution and are an estimation rather than a fact. Especially the expected increase in revenue and the payout time heavily depend on farm size, the quality of the tomatoes, the length of transport, the weather conditions and the crate size & material.

Investment

The production of the sheets requires an initial investment in the form of fixed costs for the production of the stencils and the drying rack. Tools that are excluded from the fixed costs and are expected to be available in the household are a knife, a cloth, a pot for boiling water and a mixing tool. On the right the investment is visualized if 20 sheets are dried at a time, which means 6 sides of a drying rack are necessary. The cost for 1 side of a drying rack is 103.5 cedi.

Next to this, the production of the sheets requires an investment per sheet in the form of variable costs. This includes the costs of the glue and leaves. The assumption is made that the leaves can be obtained for free at your own or neighboring farms.

Component	Cost GH¢
Stacked drying rack with 6 sides	621.14
Large leaf cutting stencil for full leafpad	16.00
Small leaf cutting stencil for leaf pieces	4.80
Paintbrush	20.00
Total initial investment	641.94

Component	Cost GH¢
160 banana or plantain leaves	0.00
50 milliliter of glue	0.82
Total investment per leafpad	0.82
Total investment 80 leafpads	65.60



Revenue

From a simulated transport test that is compared to post-harvest loss data in the context and comparison studies it is expected that the solution will reduce the overall total loss in weight of tomatoes can be reduced by 10% and that the amount of damages can be reduced by 20%. With the available data it is calculated that this could mean a 12% increase in revenue for over the year for the farmer at wholesale level. For the effect at market level, the results are about a 26% increase in revenue. Of course this is an estimation and not guaranteed. These calculations take into account that less tomatoes fit in one crate when using the leafpads, which is about 2.3% less.

The sheets can be reused if they are transported back to the farm along with the crates, getting the most value out of them. This means you can start making profit faster than when they are not reused. If the payout time (moment when profit is made) is calculated for the average farmer it lies around one and a half months if the sheets are not reused and around half a month when they are reused. The exact payout time is different for every farmer and need to be calculated based on profit of the farmer.



Before (left) and after (right) picture of the leafpad used during a transport test



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