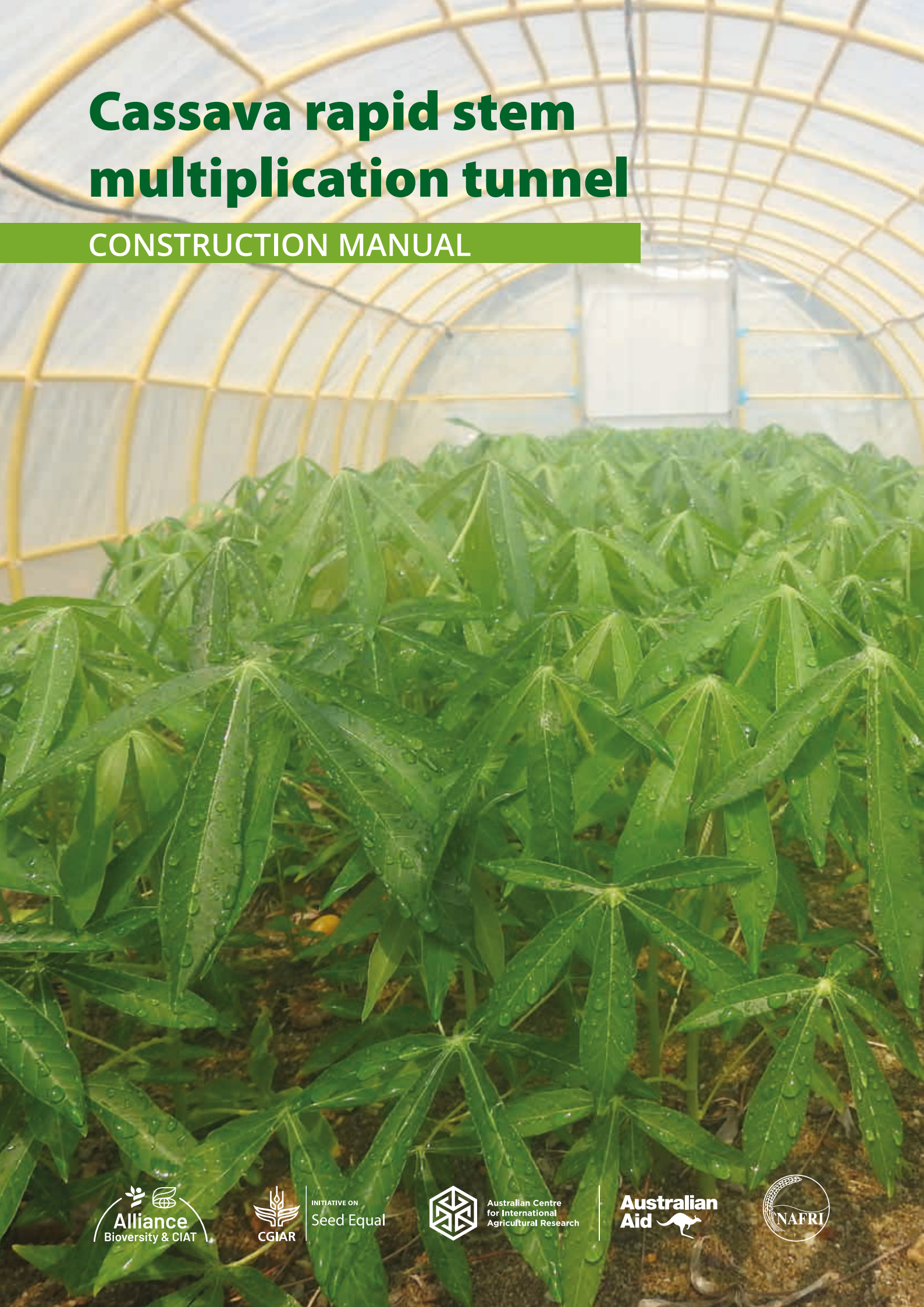
Cassava rapid stem multiplication tunnel

CONSTRUCTION MANUAL



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www.cgiar.org

Contact:

Alliance of Bioversity International and CIAT– Lao P.D.R. country office
c/o NAFRI, Dong Dok
Ban Nongviengkham, P.O. Box 783
Vientiane, Lao P.D.R.

Erik Delaquis e.delaquis@cgiar.org

Credits

Editor:

Erik Delaquis

Authors and affiliations:

Erik Delaquis, Alliance of Bioversity International and CIAT, Vientiane, Lao P.D.R.
Jonathan C. Newby, Alliance of Bioversity International and CIAT, Vientiane, Lao P.D.R.
Imran Malik, Alliance of Bioversity International and CIAT, Vientiane, Lao P.D.R.
Laothao Youabee, Alliance of Bioversity International and CIAT, Vientiane, Lao P.D.R.
Saythong Oudthachit, National Agriculture and Forestry Institute (NAFRI), Vientiane, Lao P.D.R.
Roosevelt Escobar, Alliance of Bioversity International and CIAT, Cali, Colombia

Layout and drawings:

Paul Bloxham

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Thank you, សូមអរគុណ, Gracias, ຂອບໃຈ, Cảm ơn.

Introduction

This manual will teach you how to build a rapid stem multiplication tunnel based on CIAT's experiences in Colombia and Lao PDR. These tunnels have been developed by CIAT and tested in South America and Asia, proving to be practical solutions for rapid production of clean planting materials.

This manual will start by explaining what the tunnels can do and why they are important. After that, a step-by-step guide to tunnel construction will provide pictures and links to videos that you can use to build your own tunnels. A second manual will provide instructions for managing the tunnels to produce planting material effectively.

Rapid multiplication

There are three major reasons to use cassava rapid multiplication tunnels: 1) to consistently produce large volumes of planting materials, 2) to rapidly scale up new varieties, and 3) to support a breeding or seed certification program. Traditional stem multiplication involves harvesting mature stems from cassava plants, storing them until the beginning of the rainy season, planting ~15cm cuttings in a field, and waiting 8-12 months to harvest. This means that it takes 1 year to complete 1 multiplication cycle. Different varieties have different numbers of stems, in Asia usually 1-3 stems per plant. Depending on other factors like the height and nutrition of the plant and the density of nodes, it is normal to get 5 good cuttings per stem. This means that in one year, the multiplication ratio of cassava in the traditional system may only be about 1:10.

Cassava rapid multiplication tunnels allow you to speed up this process greatly. They do this in several ways. First, sprouting cassava plants in the tunnels uses much smaller cuttings than in the field, so you can get more cuttings from a single stem. In addition, the tunnel system can use young, green parts of the stem that are normally thrown away in the traditional method. The cuttings are also planted lying down to make all of the buds sprout. So instead of 1:10, you can achieve a multiplication ratio as high as 1:40 or 1:60. Secondly, by spouting stems in the tunnel you can shorten the length of the stem multiplication cycle. Instead of 1 cycle per year with the traditional system, you can achieve 5–6 tunnel cycles in one year..

These 2 differences allow the tunnel system to produce a much higher volume of plantlets in a given time than the traditional method. In addition, the tunnels are closed environments, allowing you to control pests and disease during multiplication.

Pests and diseases of cassava

One of the major advantages of using tunnels is reducing infection from pests and diseases to produce disease free planting stems. This is important because many dangerous cassava diseases, like cassava witches broom (CWB) and cassava mosaic disease (CMD), are caused by pathogens that live inside the stem, and can be spread through infected planting materials. Both of these diseases are also believed to be spread through the bite of small flying insects. CMD and CWB are important diseases in Asia, causing considerable yield losses to farmers. Because there is no cure for either disease, producing clean planting materials is a very important way to fight the spread.

Rapid multiplication tunnels allow you to ensure that materials remain disease-free by controlling the starter materials to go into the tunnels, preventing insects from infecting them during multiplication, and closely monitoring the health of the plants during the process.

Plants with typical leaf symptoms of cassava mosaic disease.

Plants showing symptoms of cassava witches broom disease including proliferation of small leaves (left) and browning of vascular tissues (right).

Tunnel design

Tunnels are big enough for an adult to stand up inside, and are designed to be built with materials that are easily available in many hardware and agriculture supply shops. It is best to keep the tunnels the same size they are in this manual. If you want to produce more cassava seedlings, build multiple tunnels instead of making larger ones. This makes it easier to manage, more flexible, and more effective for handling any accidental pest or disease outbreaks.

Selecting a location

The first thing to be considered when building a tunnel is the location. You will need to irrigate the mini-cuttings in the grow bed and the young plants, so there must be a source of water nearby. If you plan to use automatic sprinklers or fans, you will need to make sure that there is an available source of electricity.

Because cassava stems are big and heavy to transport compared to rice or maize seed, the location should be close to where you plan to use or sell the stems you produce. However, the location should also be far enough from other cassava plantations to reduce the risk from whiteflies and other insects that can introduce disease. General advice is to maintain 10 –15km distance from large cassava production areas with major disease problems for tunnel-based stem production activities. Sometimes this is not practical or possible, but the important thing is to be aware of the issue and to keep this advice in mind when choosing your location – if possible locate your tunnels next to crops or land uses other than cassava.

Tunnel Construction

Materials

A list of all the materials you will need is provided in an appendix at the end of this document. If there some materials you cannot find in your area, substitutions can be made with what you can get.

Clean river sand X 3m^3

Coarse gravel X 9m^3

Large cement blocks X 100

Wooden board
70 cm / 25 cm

Wooden baton
5 CM / 10 cm + 4 cm / 8 cm

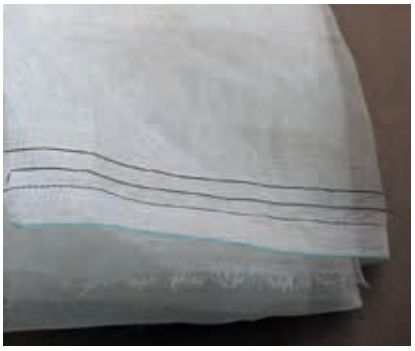
Heat resistant oil based paint
X 5 Litres + thinner

Carpentry nails
5 cm X 2 boxes

Aluminium door frame

Galvanized steel rod
2 cm Ø

Regular plastic 2 m X 20 m for grow bed, 25 m for side benches



Plastic whitefly mesh (size '50 – 0.27 x 0.79 mm) X 5m²

UV resistant greenhouse plastic 15 m X 8 –10 m, minimum 6 mil thickness

Flexible PVC pipe – 2 cm/¾" Ø, 30 X 6 m + 2.5 cm/1" Ø, 45 X 6 m

Flexible PVC pipe connectors 2 cm/¾" Ø X 50 + 2.5 cm/1" Ø X 50

PVC pipe T connectors 2 cm /¾" Ø X 50

PVC pipe elbow connectors 2 cm/¾" Ø X 50

Plastic cable ties 25 cm X 100

Irrigation pipe Irrigation pipe (9m X 3) with mister or microsprinklers (X 50)

Preparing the land

The land used for tunnel construction should be flat, and you should remove large stones, branches, and other obstructions. This is to make sure the edges of the tunnel can maintain contact with the ground all the way around the structure. Weeds and grasses should also be removed from the site.

Pick an area that does not get flooded during heavy rains. The tunnels are designed to operate in full sunlight – it is not necessary to look for shade. Visit the site and think about other hazards: are there tree branches that could fall on the tunnels, or risk of landslides? Is it located in an unsecure or unsupervised area where thieves, animals, or curious kids are likely to enter? Before beginning construction, make sure you are satisfied with the location and land preparation.

Starting on your flat, clean area, make a thick layer of gravel on the ground. Go at least one meter beyond the edge of the structures. This will make the 'floor' for your tunnel and keep the area clean and free of mud and contaminants.

Use string to frame the area

To plan the dimensions for the tunnel, it's useful to use a wooden frame and strings to frame the footprint. This will help you to make sure that your lines are straight and that the area you are planning to use is big enough. You can make marks or tie small ribbons on the string to measure the distances where you will place the cinderblocks.

Placing the blocks

You will be making 6 rows of blocks, which will hold up two side benches and the grow bed in the middle.

Notice that the grow bed is shorter. This leaves room for the entrance where the door will open.

Bench materials

The benches can be made from different materials like wood, bamboo, or plastic sheeting. The important thing is that they are strong, flat, and can can withstand the weight of the gravel, sand, and water, as well as the high humidity and temperature in the tunnels.

Staining the wood

To make the wooden boards more resistant to the high humidity, they must be stained with paint. This helps to prevent them from rotting or being attacked by termites. You should use an oil-based, heat-resistant paint. This can be diluted with paint thinner following the directions on the can.

Materials for side benches

The planks for the benches will constantly have water falling on them. To make them last even longer, they should be wrapped in plastic sheeting.

Cover each plank with plastic and secure it using your stapler.

The assembled benches with plastic-wrapped planks look like this. The long planks are resting on shorter batons of wood going across the blocks.

These boards are strong, dry, protected from rotting and termites, and will last for a long time.

Middle grow bed frame construction

The middle grow bed will hold the gravel, water, and wet sand for the cassava stems to sprout in, so it requires a strong and deep frame. This will be made out of painted wood nailed securely together.

Assembling the middle grow bed

NOTE: We want excess water to drain down to one end of the grow bed, where we can insert drain holes to allow it to flow out. To do this, use a level and **make sure that one end of the grow bed is at least 10cm higher than the other.** If this is not the case, remove some of the gravel and soil underneath the blocks on on end. If this is not done, we risk having water pool in one area and not drain out – this can lead to growth of algae, bacteria, and fungi that can cause rot.

The wooden frame rests on the cinderblocks, making a stable structure that is strong, durable, and will not attract termites.

Adjust the placement of the cinderblocks so that the grow bed rests properly in place. In this picture, the cinderblock needs to be moved a little bit to the right.

Preparing the grow bed for the gravel

To complete the grow bed, it needs to be covered with another layer of plastic, creating a water-tight compartment like a bathtub or swimming pool. This should use a single, unjoined piece of plastic with no holes in it. You canuse greenhouse plastic, or any other strong, durable waterproof type.

Adding gravel

Before putting the gravel in the grow bed, rinse it with water to remove impurities. Slowly and carefully fill the bottom of the grow bed with gravel.

The spaces between the gravel will allow water to drain out, making sure that the plants don't get drowned. Be gentle, filling the grow bed gradually and making sure the plastic is not being folded or bunched. The grow bed should be approximately half filled with gravel.

Adding the cloth layer

After making sure that the gravel is evenly spread out and level, place the cloth over the gravel. The cloth we use is called geotextile fabric. It is commonly used in road construction and will allow water to pass through, but will prevent the sand from falling down into the spaces between the gravel. The result is a top layer of sand with good drainage.

The color of the cloth is not important, but manufacturers often use colors to separate different grades. Please ask the manufacturer for more information.

Adding sand

Fill the remaining half of the trough with your clean sand. Make sure the sand is spread out evenly, and settled into the corners, but there is no need to pack it down hard – it will settle over time. You can add more sand later if necessary. Just like the gravel, smooth the sand out to be flat and even.

Completed grow bed

Now we have a strong grow bed with a plastic lining, layer of gravel, layer of cloth, and layer of sand. This will be a perfect place to sprout cassava stems. Now it's time to work on the outer frame.

Making the base for the frame

To build the tunnel frame, we first use galvanized metal poles to make a strong foundation in the ground. Hammer the poles into the ground using a rubber mallet or wooden club.

The poles should be hammered in until about 50cm is left protuding from the ground. The PVC pipes will slide over the end of the poles, giving the frame a strong and resistant shape.

Making the ribs of the frame

There are 2 common PVC types available in most hardware and supply stores: the yellow type, which is thinner and more flexible electrical conduit, and the blue type, which is thicker, more rigid irrigation pipe.

For the ribs, we need 6m long pipe sections. Because it needs to be flexible, you should use the yellow, flexible electrical conduit pipe. This comes in either 6m or 3m lengths. Use one 6m or join two 3m lengths of PVC using a straight couple, and slide the ends of the PVC pipe over the galvanized metal poles, creating a natural arch shape.

This will hold in place on its own, without any need for joints or glue between the metal and plastic (glue joints between different types of materials are often weak).

Securing the ribs together

Use PVC going lengthwise to join all the arches together. For this you can use either the yellow electrical conduit, or the blue irrigation PVC. The blue irrigation PVC is stronger, but also heavier and a bit more expensive. There will be 17 of these pipes in total – 7 on the top and 5 on each side, including one laying along the ground on each side. Use 2 plastic zip ties in an X shape to secure the pipes together **at all points** where the PVC crosses each other.

The completed frame should look like this (see the technical drawings at the end of this manual for exact dimensions).

Note the PVC elbows at the ends of the pipes to keep them in place.

Closing the tunnel ends

Using metal poles and more PVC lengths, create a door frame on the end for access. Use 2 metal poles for the sides of the door frame, and connect the cross braces to the pipes on the side using T and elbow joints.

The door can be made of PVC or aluminum frame. You can either use a pre-made door frame or make one yourself from the aluminum strip. After making the shape, cover the door with the fine mesh and secure it to the frame all the way around.

This will allow some ventilation while keeping out insects. It is usually a good idea to add a simple door handle and either hinges or strong straps to attach it to the door frame. Whiteflies that transmit some cassava diseases are very small (<1mm), so the mesh needs to be very fine.

Covering the tunnel with plastic

Because the sun makes normal plastics become brittle, for all external parts of the tunnel we use UV-resistant plastic designed for greenhouse construction.

Pull the plastic sheet over the entire structure, leaving a length on either side of the tunnel, and shovel gravel over the edges of the plastic to hold it down.

The gravel will weight the plastic, giving it tension over the frame and allowing you to keep a good seal from the exterior without cutting or gluing the plastic (which weakens it). Make sure to cover the edges surrounding the door frame, leaving no holes.

The finished tunnel structure

The finished structure has space for sprouting cassava stems in the sand, keeping seedlings on the side benches, and can keep pests and diseases from entering.

A properly built tunnel can last several years, even under harsh tropical weather.

Irrigation

Water is important for keeping the sand moist, and for maintaining high air humidity inside the tunnel.

To maintain humidity, misting sprinklers or microsprinklers should be used (not drippers). The exact arrangement of sprinklers will depend on your setting – access to water supply, water pressure, and other factors. It is important to use clean water to consider water quality and avoid the use of wastewater.

When clean water sources are not readily available, it may be necessary to consider using a pump and filter system to irrigate with clean water.

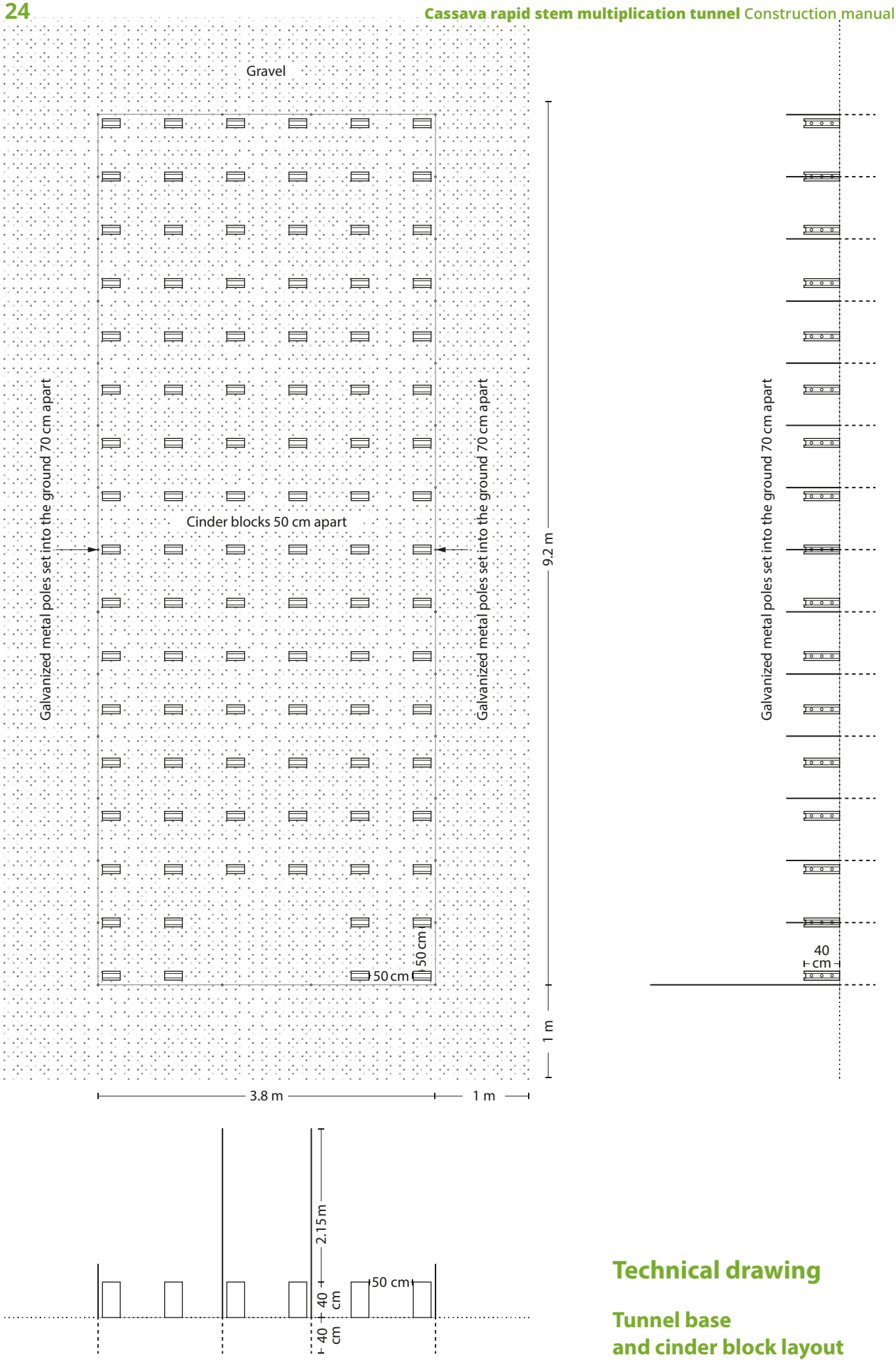
We have found the arrangement pictured to work well – irrigation tubing with one row of sprinklers over each grow bed and side benches. The sprinklers are punched into the tubing at 50cm intervals. This is then connected to a ball valve above the door to allow the sprinklers to be turned off or on manually.

Irrigation management

Sprinklers can work automatically using a programmable timer box connected to valves or a pump, or can be switched on and off manually. Many agricultural supply shops sell sprinkler control systems. Manual watering with a hose can be done before sprinklers are available, but this method may not be able to maintain the humidity in the air effectively, so sprinklers are the best solution.

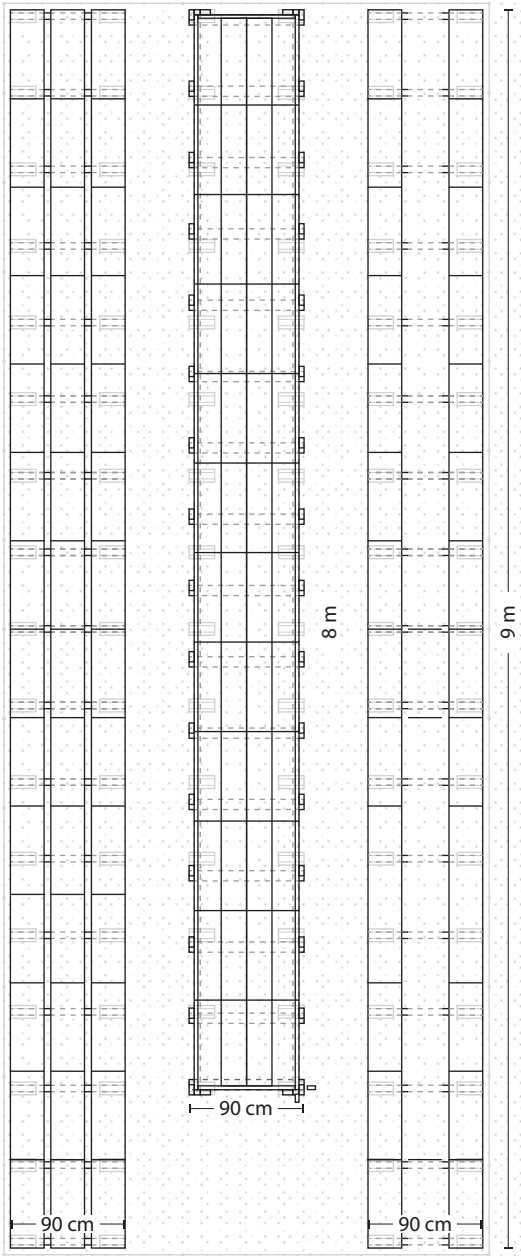
Management of the tunnel system

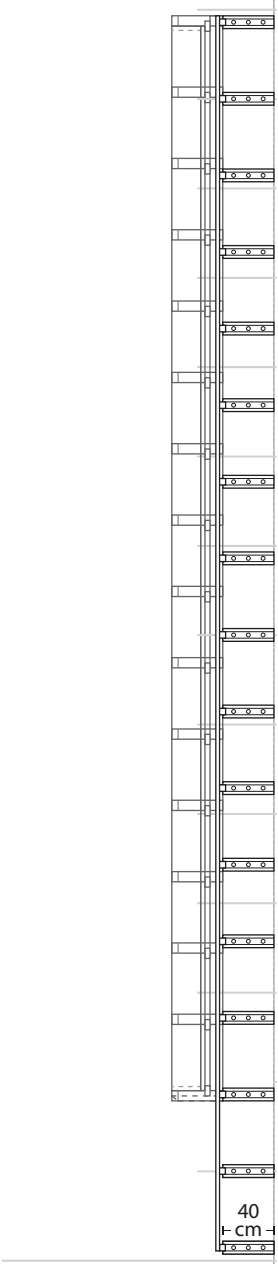
Management of the tunnels to produce cassava seedlings will be covered in the next manual, entitled 'Cassava rapid stem multiplication tunnel: Operations manual'.

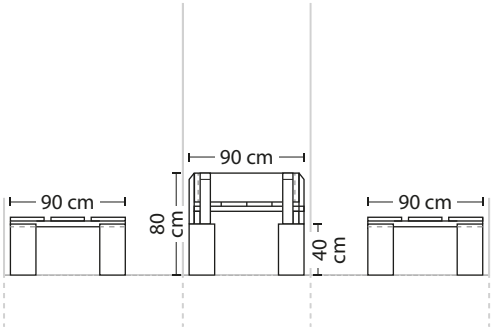


Technical drawing

Tunnel base and cinder block layout

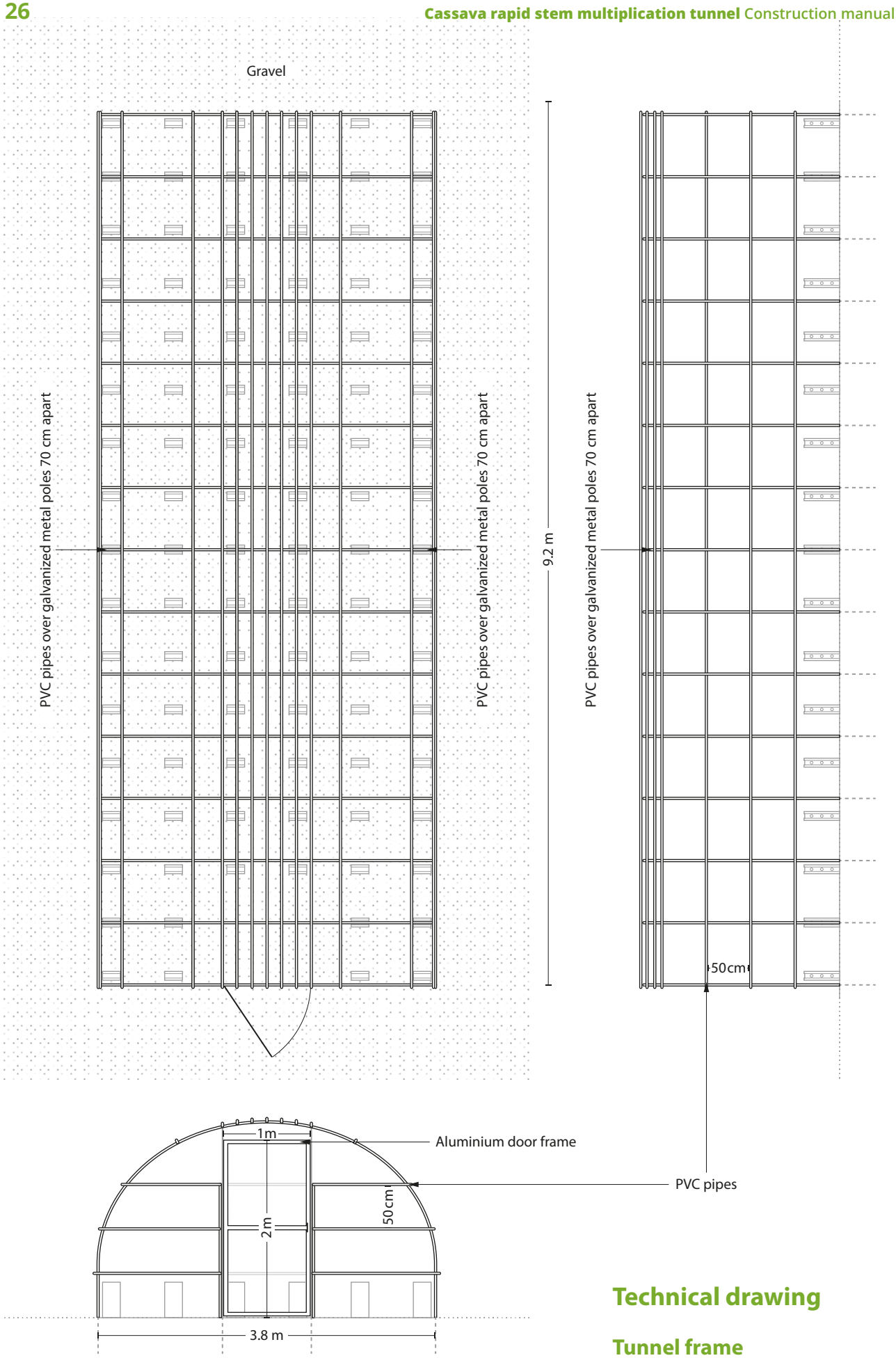






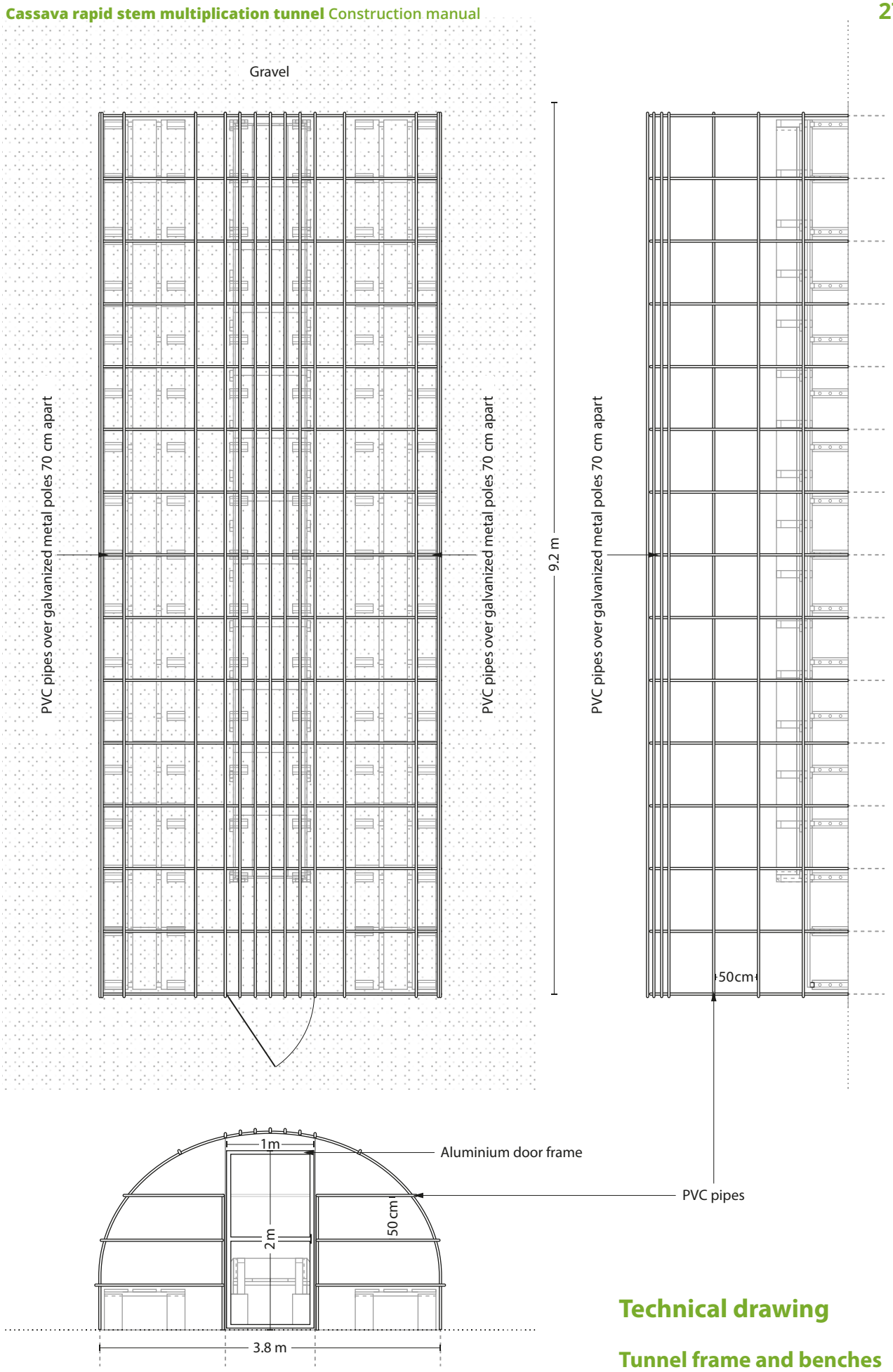
Technical drawing

Tunnel grow bed and benches



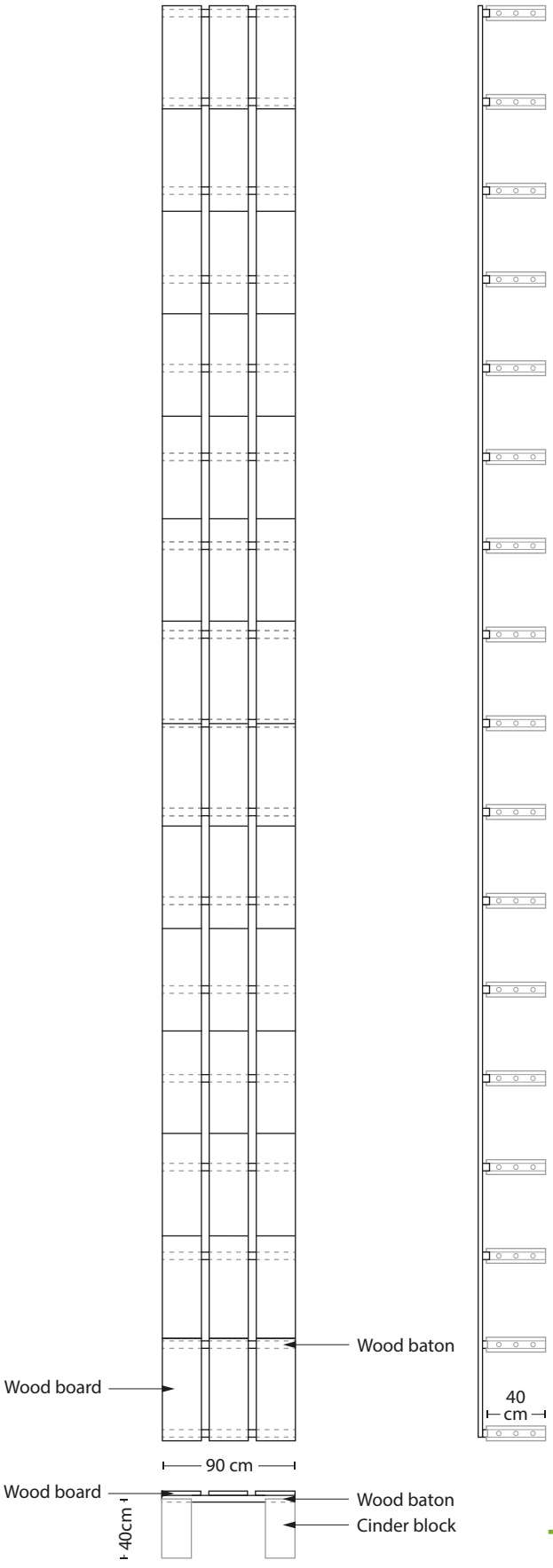
Technical drawing

Tunnel frame



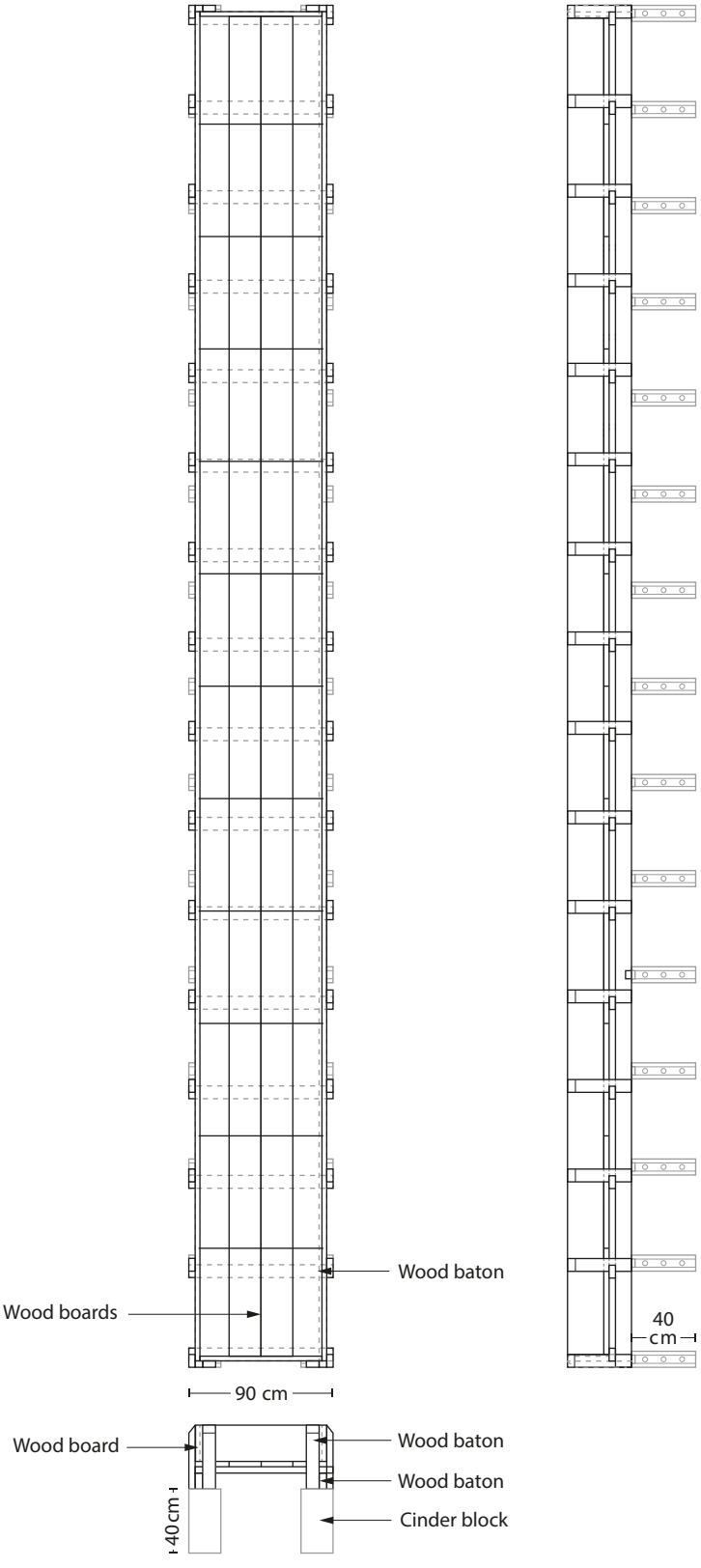
Technical drawing

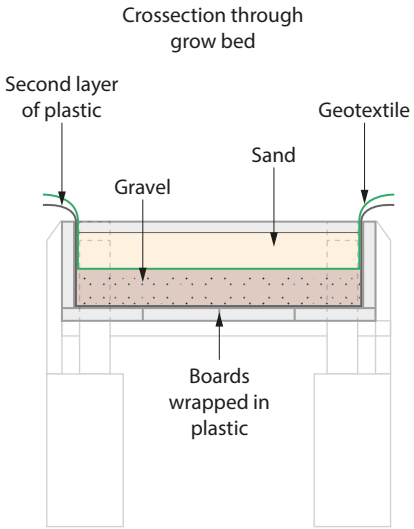
Tunnel frame and benches



Technical drawing

Side bench





Technical drawing

Grow bed

Video resources

Most videos are available in several languages. Please scan the QR code with your smartphone or tablet with your device's camera or scanner app to watch the videos and find out more.

CIAT Asia cassava YouTube channel: check here for all videos and languages.

The Cassava rapid stem multiplication tunnel: Operations manual is available here:

https://cgspace.cgiar.org/handle/10568/129795