Alkathene Pipe Portable Tunnelhouse
A Low Cost Solution for Increasing Intensive Horticultural Production

by Tim Jenkins
He Whenua Whakatipu Research Team
Te Runanga o Ngai Tahu

Introduction

One of the aims of the He Whenua Whakatipu project has been to identify ways in which an increased number of livelihoods can be economically sustained on Maori owned land. In some cases there is the potential to move from extensive livestock farming to incorporating a smaller area of intensive horticulture. Tunnelhouses modify the microclimate (temperature and wind especially) to improve the range and success of intensive horticulture.

Often this land has not been developed much in the past with low or no use of lime and fertiliser. Through construction of tunnelhouses, it is possible to concentrate on small areas amending the soil with compost, fertiliser and lime with a higher likelihood of return on investment. Over time the number of tunnelhouses can be increased and spaces in between tunnelhouses utilized (taking advantage of the wind protection that the structures.

He Whenua Whakatipu and the Biological Husbandry Unit (Lincoln) have experimented with a range of tunnelhouse designs to provide low cost practical solutions for whanau who seek to gain an improved income and crop range in intensive horticultural activities.

A variety of systems utilized galvanized steel as the main structural component but a design utilizing alkathene piping has advantages of lower cost and a flexibility in wind and snow conditions that averts disastrous consequences from such weather events. The alkathene pipe structure is covered with a microclimate cloth which is dug into the soil for support. This provides an effective transformation of the microclimate within for many crops while still allowing ample ventilation. An additional cloche system inside the tunnelhouse provides an added boost for early establishment of crops and for more temperature demanding crops such as tomatoes, capsicums and eggplants in cooler regions.

Material cost for such a tunnelhouse can be within $3000 for a 24m by 5 m tunnelhouse. Options are discussed for irrigation and management.

Design

The basic design involves 8 metre lengths of alkathene pipe (63 mm diameter) which form hoops with each end placed on a Y post (this looks similar to a warratah stake but lower cost) giving a tunnelhouse width of 5 m. These hoops are the ribs of the house. There is then a backbone and two parallel side lines of galvanised pipe. Microclimate cloth is placed over the structure and dug in at four corners and along the sides leaving loose ends for doorways. Upright galvanised pipes are placed in the centre holding up each rib. Cloches can be erected inside to provide extra warmth and protection for crops that require this.

It is of prime importance to select a site that is truly safe from strong winds. Shelter is strongly recommended to protect from wind damge which may affect the shape of the house and/or tear the cloth. Snow is also damaging and there should be preparedness to remove the cloth if snow eventuates.

Requirements

Tools

Measuring Tape(s)
String Line(s)
Y post / Warratah stake Driver
Hacksaw
Ladder(s)
Cordless Drill with 22mm flat bit
Shovels and Spades

Consumables

For a tunnelhouse of 24 m by 5m, the following materials with approximate costs as at February 2008 are shown below…

Material	Units	No.	Cost	Notes
Y Posts	1.5m	22	$176	e.g. PGG Wrightsons
Alkathene Pipe	100m 63mm	1	$520	e.g. Mico Wakefield
Galvanised Pipe	6.5m 19mm	19	$680	**Threaded with collars** e.g. NZ Steel
Greenhouse Felt Cloth	Roll	1	$30	e.g. Evergreen Horticulture
Microclimate Cloth	30m by 12m	1	$370	e.g. Polynet Products
Fence batons or similar	2nd hand	13		old timber cut to around 30 cm long
Cloche Kit (optional)	Kit to fit house	1	$220	e.g. Kerilea
TOTAL MATERIALS COST			**$1996**	

Step by Step Instructions

Staking Out

Decide on the site selecting a suitable sheltered area with reasonable soil. Cultivate the area as required to eradicate weeds as much as practicable prior to erecting tunnelhouse.

Measure out the area and place four Y stakes in the correct squared positions for the four outside corners of the tunnelhouse. Measuring out can start from two corner stakes on one end (5 m apart) and squaring off a line to find the other corner positions.

With a string line along the two sides, stakes are driven in straight upright every 2 metres on each side. Drive stakes 60cm into the ground.

Hoops Up

The alkathene roll needs to be gradually unraveled to achieve 8 m lengths that do not have too much kink in them. Hacksaw off the 8 m lengths. Place one end of a length over one warratah stake and with assistance place the other end over the other warratah with someone pushing from the other side to help the hoop be more vertical over the second stake.

Linking the Hoops

Drill holes through the alkathene pipe to allow for galvanised pipes to go through. On each end hoop only drill the inside side of the hoop and leave the outside side closed to hold the pipe. Holes are in the very centre of the hoop and just above the height of the warratah stakes (so approximately 1 m high on each side. This will allow lengths of pipe to be slipped through and threaded together. Cut (hacksaw) the last pipe to size to allow all hoops to be connected and still be 2 m apart at each junction. Felt tape is used to keep the hoops in position with the steel pipes once the positions are confirmed. The felt surface to this tape helps prevent rubbing damage to the microclimate cloth.

Trench Digging

Dug in sides of the cloth will provide structural strength and anchorage for the tunnelhouse. Dig trenches approx 30 cm deep along both sides and for at least 1 m from each corner on both ends. Leave soil close by to make it easy to fill in after the cloth is put in place.

Cover Up

Unroll the microclimate cloth on one side of the tunnelhouse and at least two people hold a corner and drag it over the hoops. It can help to have one or more extra people assisting getting the cloth over the middle hoops (perhaps with ladder assistance. Even the cloth up and ensure that there is at least three metres extra length from the hoop at one end. This will be the anchor end. Dig in this end ensuring the cloth remains square. Digging in involves putting in one quarter of the soil over the cloth with the end of the cloth left protruding from the other side of the trench. This protruding cloth can be picked up to tighten the cloth and adjust the squareness as required. When satisfied that the cloth is in a correct position and pleating of the ends of the cloth helps maintain a squareness, then the remainder of the soil can be filled in.

Dig in 2 m up both sides from this end and then pull the cloth reasonably tight from the other end of the house and dig in that end and 2m up both sides keeping the cloth tight and square. Then fill in the rest if the sides again pulling the protruding cloth as required to keep the cloth square and reasonably tight.

Uprights

Further holes are drilled near the backbone of each rib but this time the holes are straight up from the bottom and do not go through the top of the pipes. This is to accommodate the upright poles (galvanised pipes) that will help the house have structural strength and greater tightness of cloth. The upright poles will be on a base of old fence batons or similar wood. Cut this wood to around 30 cm lengths and drill holes partway into the centre to house the base of the poles.

The remaining galvanised pipes can be cut to the correct height for uprights. A suitable height might be 2.6 m to allow the pipes to go into the holes and then be lifted upright and placed into the prepared pieces of wood which will preferably be dug into the ground a little for extra stability.

Cloche Up

Cloches can be erected according to manufacturers recommendations. We have used 1 m wide cloches and had four rows with three 0.33 m gaps between cloches for access. A better design we have found is to have the two centre cloches together to allow for two wider (50cm) rows for better access.

Cloche film can be down when required for extra warmth and up to allow for access for weeding, harvesting etc as well as to improve ventilation and prevent overheating.

Photos showing a 50 m alkathene pipe house with cloches and the sheltered selected site for it.

Spinach Production in Tunnelhouses

For local market supply and where labour is available for the intensive growing process, spinach is a useful starting crop and potentially a good money earner. On this page there are useful pointers for fitting spinach growing into a tunnelhouse setting. Particular advantages of spinach include the fast growing cycle so weeds are less likely to get out of hand. A full protocol of organic spinach production (as well as 26 other crops) was also developed by He Whenua Whakatipu in conjunction with the Biological Husbandry Unit with support from the Sustainable Farming Fund. The spinach protocol follows this page.

LIME AND FERTILISER
Aim for soil pH of 6.2 to 6.6, using dolomite lime preferably
Utilise plenty of compost – preferably at least 20 tonne per hectare for first crop and two more 10 tonne per hectare applications during the year.

PLANTING
Plant seed with planet Junior. (Different types of spinach for each season).
Drill width 100mm apart.
Seek advice on seed cultivars from Fruitfed Supplies, Hornby (Lawson Sheppard).
Summertime: seedlings up in 5/6 days. Harvest in 4 weeks.
Winter: seedlings up in 8/9 days. Harvest in 9 weeks.

IRRIGATION
One line down the middle suspended from midrib.
Sprinklers 3 metres apart, covering 6 metre width or 2.5 m apart covering 5 m width.
Water morning only, before 9am (to reduce disease potential especially downy mildew
(Soil type will determine how long.) Moderately heavy silt loam is watered for around ¾ hour.

HARVEST
Cut plants 1.5cm below ground.
Place in sleeves & soak in cool water.
Harvest when approx. 10inches high. Harvest plants before 9am to retain colour and crispness. Use crates (W47) and should fit in short of crate height so leaves don't get damaged.

SELLING
Market price in winter around $4.00, Summer $2.00 – higher prices may be achieved through direct selling if appropriate

Spinach (*Spinacia oleracea*)
Organic Crop Protocol developed by He Whenua Whakatipu in Association with Biological Husbandry Unit, Lincoln

Spinach General Background and Basic Agronomy

Spinach is a fast growing green vegetable with the leaves and stalks being eaten. In market gardening, plants are generally pulled as a bunch with the roots and outer leaves trimmed.

Spring sown crops (summer spinach) are generally sown from September to November and autumn sown crops (winter spinach) from March to May. Different varieties can be sourced to suit the different sowing times – refer to your seed merchant for current hybrid and open pollinated cultivars.

Precision sowing is at 3.5 to 4.5 kg/ha and conventional drills at 10 to 11 kg/ha of seed.

The crop is very perishable. It is advised that harvested plants be cooled straight away e.g. with cold water if a cool store is not handy. The crop will store for 14 days at 0^{o}C (95-100% relative humidity).

Recommended rotation span is to not grow spinach on the same plot more often than one in three or four years.

A major issue with spinach can be bolting. Actions to take against bolting include growing in cooler temperatures (>25^{o}C is a concern), irrigating well (taking into account the shallowness of rooting), reducing the seeding rate (density), varietal selection in hot conditions.

Soil and Fertiliser

Prefers medium to rich loam soils. Optimal pH around 6.2 to 6.6 with a desire for good calcium levels (calcium deficiency sometimes seen as yellowing and dying off of leaf tips – termed 'tipburn'). Liming is recommended to maintain the soil pH at around 6.2 to 6.4 (above this level, there may be some issue with the uptake of metal trace elements like iron, manganese, copper and zinc).

Spinach is fast at growing and has shallow roots meaning they benefit from highly available levels of nutrients.

Around 25 days prior to anticipated harvest, it can be beneficial to apply a biofertiliser with the aim of improving the yield and green appearance of the crop. A liquid fertiliser including fish or some other nitrogen source can be especially helpful.

Intercropping Potential

Spinach can be grown as a fast maturing crop in between rows of slower to mature crops such as European brassicas.

Spinach Weed Management

Control perennial and grassy weeds prior to cropping and manage annual weeds through false seed bed technique. Interrow cultivation is likely to be important before the spinach canopy is sufficient to smother weeds. Intrarow weeding is more difficult but could be achieved by interrow cultivation being designed to leave some soil on the row to smother weeds. Some hand weeding may make harvesting easier but the main concentration should be on the false seed bed technique to reduce the issue. With any weeding operation, control while the weed seedlings are still small (e.g. three or four true leaves) is importance for speed and effectiveness of weed removal.

False Seed Bed Technique

The false seedbed technique is to cultivate a seedbed as if for planting and then allow a flush of weeds to occur (if necessary irrigating to bring on the weed flush). The weeds are then controlled by undercutter bar or thermal weeding avoiding disturbing the soil to trigger deeper weed seeds. This should be repeated once or twice if weed burden is high or if a high level of seed exhibiting dormancy is expected (e.g. mature fathen that had been ploughed in several years ago and the area has been once more ploughed).

Some extra tips for false seed beds are…

Control of weeds is ideally done when weeds are very small (less than four true leaves) as regrowth after thermal weeding or light cultivation is not an issue.

Established perennial weeds should be controlled before going into the false seed bed method.

Grassy weeds are more able to regrow from thermal weeding or undercutter bar work

Spinach Pest Management

The pests of spinach include aphids and leaf miner.

Aphids

Also see general information on aphid management.

Floating row covers are effective in keeping out the pest. And generally there should be an encouragement of beneficial flowering plants to increase levels of natural enemies of the aphids. Flowers include phacelia for feeding hoverflies and buckwheat for general natural enemy improvement.

Leaf Miner

Leaf miner causes characteristic squiggly lines as the internal tissue of the spinach and many other plants is eaten out. There are many types of leaf miner, most being quite specific to a small number of species. Some are caterpillars, others are tiny grubs, but they all arise from eggs laid inside the leaf by flying adults. Severely

affected plants include some of the Asian brassicas, the related rocket and also spinach.

Where leaf miner requires control, older more affected leaves can be trimmed off or, in many vegetables, simply cut back to the base to allow fresh unblemished growth. Affected clippings should be composted well or buried more than 25 cm deep to prevent the pests burrowing to the surface and flying off to cause more strife.

Neem products can be highly effective and don't have too much effect on the leaf miners' natural enemies (tiny wasps that lay their eggs in the miners).

A floating row cover can also be used to exclude the flying adults.

Spinach Disease Management
The main diseases of issue in spinach are downy mildew, damping off and sclerotinia.

Downy Mildew (*Peronospora farinosa*)

This is a foliage blight that starts off as a white turning to grey downy growth on both sides of the leaves. It is favoured by warm or cool (not hot) humid conditions. The disease organism requires a film of water to germinate so try to irrigate the soil only if practical (otherwise water in mornings to allow the water to dry off leaves quickly). If using tunnelhouses, ensure these are well ventilated e.g. use mesh (frost cloth etc) rather than plastic film. Overly dense plantings are more prone to the disease.

Bordeaux mixture is effective against downy mildew and can be used on a restricted input basis (spray at 7-10 day intervals from first sign of the disease being an issue) but the prime means of control are growing the crop well and employing the practices mentioned above to limit the potential for prolonged films of water on the foliage.

Damping Off (mostly *Pythium rostratum*)

Microscopic animals normally described as fungi by plant pathologists are responsible for this disease. Damping off caused by *Pythium* spp. and *Phytophthora* spp. kills young seedlings and can also parasitise the roots of larger plants. Seedlings die when very young or in some cases will die of 'wirestem' whereby the seedling stem is rotted in a position just above the soil and the plant usually dies. The damping off diseases are more a problem of stressed seedlings, poor drainage/excess moisture, excess available nitrogen or slow growth of seedlings (e.g. with seed planted in too cold a soil). The optimal time for emergence of spinach seedlings is six days from sowing.

A biologically active soil and good germination conditions are the most effective way of controlling damping off. Pythium is more likely where unrotted organic material exists, ensure any manures and crop residues are well decomposed. More interventional measures may be required where a known problem exists including permitted fungicides (e.g. sulphur) or plant (e.g. chamomile – see below) and compost extracts as a seed treatment.

One of the main factors increasing soilborne diseases is high soil moisture (e.g. poor drainage). Wet soils promote the spread and propagation of soilborne diseases. Poor

aeration in wet soils can also stress plant roots increasing their susceptibility to the disease. If transplanting, special attention should be paid to good drainage and aeration in potting media and seedling containers should be clean and the propagation house kept clean to reduce damping off potential.

Chamomile Spray or Tea: Soak several handfuls of chamomile flowers (either the perennial or annual varieties can be used) in a bowl of cold water for 3 or 4 days. Strain then spray or water. Used on young seedlings, the spray will help prevent damping off.

Sclerotinia – cottony rot (*Sclerotinia sclerotiorum*)

Sclerotinia is a common fungal disease of vegetables. In spinach the symptoms are the development of soft "cottony" white growth of fungal mycelium around the base of the spinach bunch and on the leaves where they contact the soil. The characteristic black resting bodies of the disease, sclerotia, are eventually formed within the mycelium. The disease can result in the wilting and even death of plants (and whole patches of plants).

Avoid planting spinach in poor draining conditions as this will favour the development of the disease.

See general information on *Sclerotinia* management. Crop rotation and soil health are the most important methods of avoiding this disease.