Season Extension Structures

Guide 14 · Foundations Reference

Version 2026.05 · Revised 2026-05-16

Cold Frames · Low Tunnels · Hoop Houses · High Tunnels

Contents

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About this guide

A well-built season-extension structure is the single highest-leverage investment a Dragoons grower can make. The published frost-free window for Cochise County base elevation is roughly April 5 through October 25 — about 200 days. That is enough season for most warm-season crops on paper, but it is not enough season to overwinter a year-old Rocoto, to push spring greens into early March, to harvest peppers in November, to keep a fig tree alive through a 15 °F February night, or to grow lettuce through a Cochise July. Every one of those requires a structure.

The good news: the Dragoons climate is unusually friendly to passive solar season extension. Winter nights are cold, but **winter days are bright, dry, and sunny**. A south-facing cold frame routinely hits 75 °F inside on a clear January noon while the outside air sits at 38 °F. A hoop house with 110 gallons of water in painted drums coasts through a 20 °F night with a 12 °F internal lift. The same climate that punishes a bare seedling in February rewards a passive solar structure all winter long.

The structures in this guide form a ladder, and most growers climb it in order:

1. **Cold frame** — the entry-level project. 4×8 ft, built in a weekend, costs $50–150, protects 30 sq ft. Hardens off transplants in March, holds salad greens through January, gives you the first taste of "extended season" with one weekend's work.
2. **Low tunnel** — hoops and row cover over an existing bed. $30–80 per 10 ft, protects 30–50 sq ft per run. Frost protection for fall brassicas, late-season greens, overwintering kale.
3. **Hoop house (single-bow tunnel)** — 12×24 ft, ~290 sq ft, walk-in scale. $400–800 DIY or $1,200–2,500 kit. Overwinters peppers, runs cool-season greens commercially, starts warm-season transplants 6 weeks early.
4. **High tunnel** — 20×48 or 30×96 ft, NRCS-cost-share scale. $3,500–12,000 with up to 75% cost-share if you qualify for EQIP. This is the leap from "protected bed" to "protected growing space."
5. **Shade structure / lath house** — the inverse problem. 30–50 % shade cloth over a frame; lettuce and brassicas through summer; pepper bloom-set cooling.

This guide is organized to support all three readers. **The first-timer** building a first cold frame should read chapters 1, 2, 3, 5, and the Project A build plan in chapter 17. **The returning practitioner** scaling from a cold frame to a hoop house should focus on chapters 4, 7, 9, 11, and Project C. **The expert planning an NRCS high tunnel** should read chapters 8, 13, 14, and the cost-benefit math in chapter 16.

> **The three rules of season extension in the Dragoons.** First: **ventilation matters more than heating.** Almost every Dragoons grower who loses crops in a structure loses them to overheating on a sunny February afternoon, not to

cold on a January night. Plan vents before plastic. Second: **orient the long axis east-west.** A south-facing long wall captures 30–40 % more winter sun than a north-south oriented tunnel and pays back the orientation choice every January day. Third: **the 200 sq ft permit threshold.** Cochise County does not require a building permit for an agricultural structure under 200 sq ft. A 12×16 hoop house is under that; a 12×24 is over it. Plan accordingly.

1 · What problem are you solving?

Decision framing · matching structure to goal

The right structure depends on what you are trying to do. Many first-time builders pick a structure based on appearance or budget — the cheapest hoop house at the home store — and only after construction discover the structure does not match their goal. Start from the goal and work backward.

1.1 The five season-extension goals

Goal	What you actually want	Smallest structure that does it
Protect from frost (one-off cold snap)	A 28–32 °F night not killing tonight's bloom or salad	Row cover thrown over the bed
Stretch the spring season	Plant 4–6 weeks earlier than the open-field calendar	Cold frame, low tunnel
Stretch the fall season	Harvest 4–6 weeks past first frost	Low tunnel, hoop house
Overwinter tender crops	Keep peppers, citrus, figs alive through January	Hoop house with thermal mass
Summer heat protection	Lettuce and brassicas alive through June–August	30–50 % shade cloth on a frame
Wind protection (April–May gusts)	Stop transplants from being shredded	Any of the above; lath house works well

The decision is not "what structure should I build?" — it is "what season do I want to add?" If the answer is "I want salad through January," a 4×8 cold frame against the south wall of the house will do it for $100. If the answer is "I want a perennial Rocoto in year 5," you need a walk-in hoop house with thermal mass. If the answer is "I want lettuce in July," you need shade cloth, not heat retention.

1.2 The decision matrix

If your goal is…	Budget $50–150	Budget $200–500	Budget $500–2,500
Spring head-start	Cold frame	Low tunnel system (multiple beds)	Hoop house
Fall extension	Row cover stash	Low tunnel	Hoop house
Overwinter peppers / citrus	(not feasible)	Cold frame with lights	Hoop house with thermal mass

If your goal is…	Budget $50–150	Budget $200–500	Budget $500–2,500
Stone-fruit frost protection	Frost-cloth stash (Guide 9 §5.2)	Frost ring + lights per tree	(not the right tool)
Summer lettuce	Shade-cloth tarp	Lath house, small	Lath house, walk-in
Wind protection only	Burlap windbreak	Permanent fence + mesh	(overbuilt for goal)
Production-scale season extension	(not feasible)	(not feasible)	NRCS high tunnel

LOCAL TIP

The Dragoons-specific bias: build wider, not taller, for your first structure. A 4×8 cold frame is more useful in this climate than a 2×4 cold frame, because there is no shortage of winter sun — there is a shortage of *area protected from winter wind*. The same dollar spent on width returns more growing area than the same dollar spent on insulation. Save the insulation for the rare 15 °F nights; spend the everyday dollars on volume.

1.3 Bed types — what's underneath the cover

A protected structure is only half the system; the bed inside determines drainage, root run, water demand, and how easily you can rotate crops between protected and open ground. Pick by your specific site conditions, water access, and mobility needs.

The four bed types appear across the library: **in-ground** beds are used in Guides 1, 6, 7 wherever caliche permits root depth; **raised beds** are recommended in Guide 11 where caliche is right at the surface; **bato buckets** are the canonical hydroponic system documented in Guide 3; **containers** appear for citrus in Guide 9 and mint in Guide 8. Each pairs differently with the structures in the rest of this guide — for example, a cold frame typically sits over an in-ground or raised bed, while a hoop house usually houses bato buckets or shoulder-height containers.

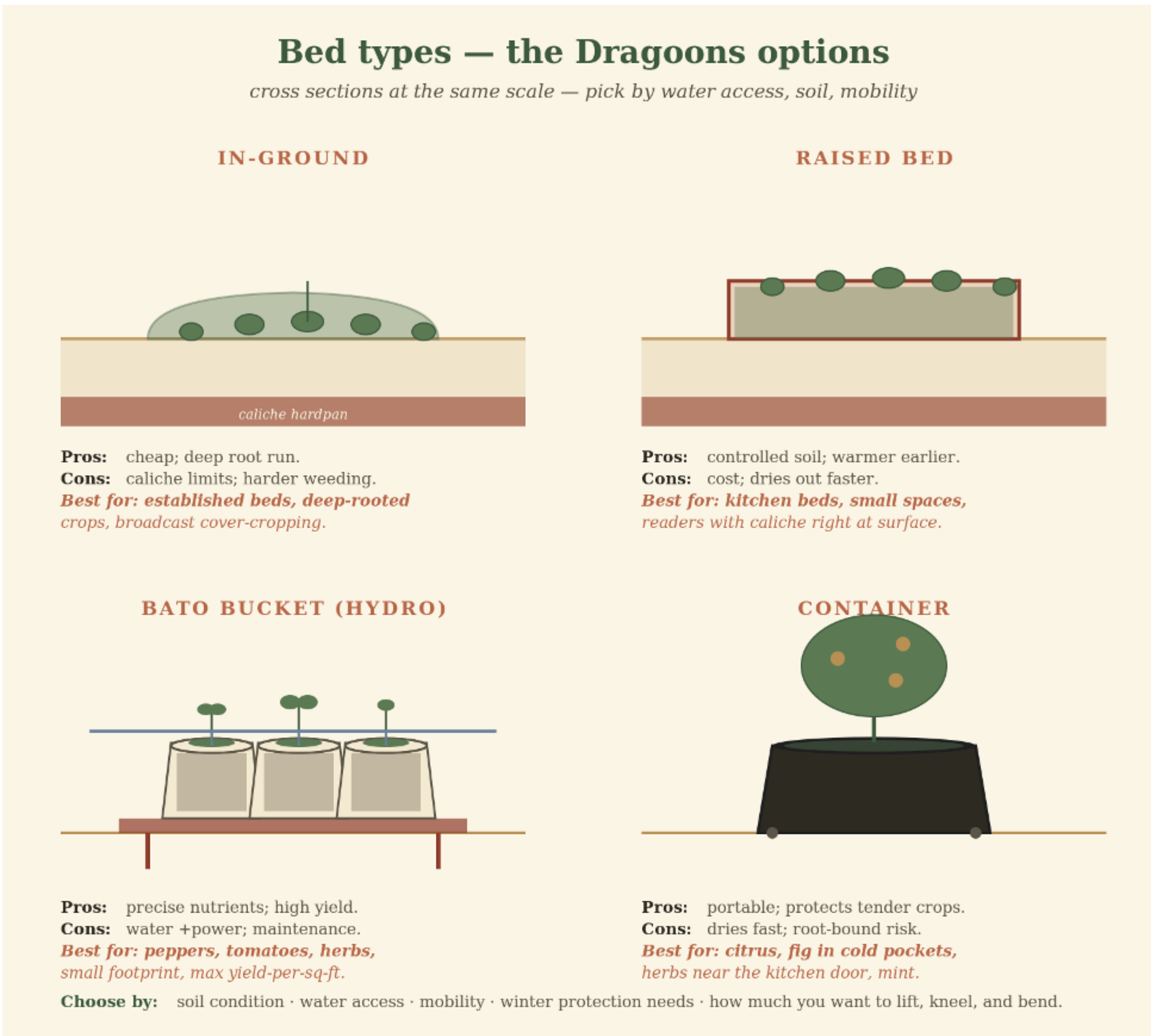

Figure 1: Cross sections of the four bed types used across this library, drawn at the same scale. The decision is usually driven by how much caliche you have to work around and whether your structure needs to be moveable.

2 · The Dragoons cold-season math — when do you actually need protection?

Frost dates · hard-freeze counts · wind-chill · the protection calendar

A grower in Vermont protects every winter night; a grower in Phoenix protects almost none. The Dragoons sit in an unusual middle ground that rewards selective protection — a structure used four months of the year, not twelve. Understanding the protection calendar lets you size and operate structures correctly.

2.1 Frost windows at 4,700 ft

Event	Average date	Earliest in records	Latest in records
First fall frost	October 25–November 10	October 8 (2019)	November 14 (2021)
First hard freeze (< 25 °F)	November 25–December 10	November 8	December 22
Coldest nights of year	January 5–25	—	—
Last hard freeze (< 25 °F)	February 15–March 5	February 1	March 20
Last spring frost	April 5–25	March 22	May 8

The numbers in this table are for the 4,700 ft base elevation across the eastern Dragoon foothills. Higher-elevation sites push every date 1–3 weeks toward the heart of winter. Frost-pocket sites (valley-floor swales, drainage funnels off the high country) push every date in the same direction. A property at 5,200 ft on the northeast slope of the Dragoons typically has a first-frost date a full week before the published average and a last-frost date a full week after — a 14-day shorter unprotected season than the published number suggests.

2.2 Hard-freeze nights — how many to expect

The protection calendar matters because the *number* of nights below thresholds is small in the Dragoons. This is what makes the climate so friendly to passive season extension.

Temperature threshold	Average nights per year at 4,700 ft	Where they fall
Below 32 °F (light frost)	60–90	mostly Nov 15 – March 15
Below 25 °F (hard freeze)	15–30	mostly Dec 15 – Feb 15
Below 20 °F (severe freeze)	5–15	mostly Jan 1 – Feb 5
Below 15 °F (rare deep freeze)	0–4	early January
Below 10 °F (exceptional)	0–1	once per decade or so

The implication: **a structure that handles 20 °F outside with a 12–15 °F lift covers 80 % of the protection days.** A structure that handles 15 °F outside with the same lift covers 95 %. Designing to handle 5 °F is overbuilding for a Cochise County climate; the right design point is "20 °F with confidence, 15 °F with care, and accept the occasional 10 °F night as a single-night emergency." That design point is what every section of this guide assumes.

2.3 Wind-chill — the Dragoons-specific complication

Cochise County winters are calm by Midwest standards, but the Dragoons have a distinct windy season in early spring. **April and May are gusty.** Daytime winds of 25–40 mph are common; gusts to 55 mph happen several times each spring. Most growers do not lose plants to wind itself — they lose plants to wind *dehydration* during a cold dry snap (the so-called "freeze-dry" combination).

Wind makes every protection problem worse:

- A 28 °F still night might leave brassicas untouched outdoors. The same 28 °F night with a 25 mph wind blows the leaf-boundary air layer away and produces visible cold damage even though the air temperature was identical.
- A row cover or cold frame is *more valuable* on a windy night than on a calm one. The structure's first job is windbreak; the cold protection is secondary.

> **WARNING**
>
> **The April-May wind season is the most underestimated risk in the Dragoons calendar.** A spinach bed that survived January under row cover untouched can be shredded by an April 22nd gust event. Anchor every structure to handle gusts, not steady wind. PVC hoops bow and snap; 9-gauge steel wire hoops bend permanently; a 12×24 hoop house can lose its plastic in 20 minutes if a corner lifts. The leeward side of a mesquite hedge or fence is worth more than 5 °F of cold tolerance.

2.4 The protection calendar

Period	Typical protection action
Sep 15 – Oct 15	None routinely. Watch the forecast; have row cover folded by the door
Oct 15 – Nov 15	First-frost row covering on tender summer crops (tomatoes, peppers); hoop house up if used
Nov 15 – Dec 15	Daily structure operations. Vent during the day; close at dusk. Cold-frame harvest of greens

Period	Typical protection action
Dec 15 – Feb 15	Peak protection season. All overwintering crops indoors or in structures with thermal mass. Daily vent management
Feb 15 – Mar 15	Begin starting transplants under cover. Stone-fruit frost protection (Guide 9 §5.2) begins
Mar 15 – Apr 25	The wind & late-frost window. Row covers stay deployed. The most-active management month
Apr 25 – Sep 15	Off-season for cold protection. Shade-cloth season begins

3 · Materials primer — covers, frames, fasteners

Row cover · plastic film · polycarbonate · glass · hoops · cattle panels

The single biggest cost driver of any structure is the cover material. The frame matters but is repairable; the cover is what fails, and what determines light, heat, and longevity. Understanding the cover-material landscape comes before any structural decision.

3.1 Row cover (spunbonded polypropylene)

Row cover is the lightest, simplest, cheapest cover. It is a spunbonded polypropylene fabric — translucent, breathable, slightly stretchy. The standard brand in the Dragoons is **Agribon**, sold in three weights for three jobs.

Product	Weight	Light transmission	Frost protection	Use case	Typical roll cost
Agribon AG-15 / Reemay	0.45 oz/sq yd	90 %	2 °F (28 °F effective from 26 °F)	Insect exclusion, hot-season pest barriers	\$30–50 for 10×50 ft
Agribon AG-19	0.55 oz/sq yd	85 %	4 °F (28 °F from 24 °F)	General frost protection, the standard	\$40–70 for 10×50 ft
Agribon AG-30	0.9 oz/sq yd	70 %	6–8 °F (28 °F from 20 °F)	Hard freezes, overwintering greens	\$80–120 for 10×50 ft
Agribon AG-50	1.5 oz/sq yd	50 %	8–10 °F (28 °F from 18 °F)	Severe-freeze emergency cover	\$130–180 for 10×50 ft

The frost-protection numbers in the table are the manufacturer's claims under still air and clear sky. Under the Dragoons' typical clear-sky winter night with light wind, the realized protection is about 80 % of the claimed number. AG-19 — the standard workhorse — buys you about 3 °F in practice.

Row cover is most useful as a *first* layer. A single layer of AG-19 inside a hoop house adds 3 °F on top of the hoop house's own 10–15 °F lift, getting you to a 18–20 °F total margin. Two layers of AG-19 inside the hoop house — one suspended above the bed, one draped on the plants — push that to 25 °F on the worst nights.

LOCAL TIP

Buy one 12×50 ft roll of AG-19 in October, before the first frost. This is the same recommendation made in **Guide 6 §4.6** and **Guide 9 §5.2** — the row cover is universal across the library. One roll covers most of a backyard's protection needs for an entire winter: brassica beds, salad rows, an apricot tent in March, a pepper bed in November. Store it dry between uses and it lasts 4–5 seasons. Local source: BFI Farm and Ranch Supply in Tombstone stocks it; Tractor Supply does not reliably; online via Johnny's Selected Seeds is the fallback.

3.2 Plastic film (greenhouse poly)

Plastic film is the standard cover for hoop houses and high tunnels. Two grades matter:

Grade	Thickness	UV-stable?	Life expectancy outdoors	Typical cost (per linear ft of 24 ft width)
Construction poly (Home Depot)	4 mil or 6 mil	No	6–18 months	$1.50–2.50
Greenhouse poly (UV-treated)	6 mil	Yes (4-yr or 6-yr rated)	4–6 years	$3.00–4.50
IR-blocking greenhouse poly	6 mil	Yes, with IR additive	4–6 years	$4.00–6.00

Construction poly degrades fast under Cochise County UV. The published nominal life is 1–2 years; in practice, on a south-facing hoop house at 4,700 ft, construction poly is brittle and tearing within 12 months. The UV intensity at Dragoon elevation is 15–20 % higher than at sea level, and the marginal cost of greenhouse-grade poly over construction poly pays back in the first season alone. **Always buy greenhouse-rated poly for any structure you expect to use more than one year.**

The major suppliers for greenhouse poly:

- **Farmtek** (online) — the standard. 4-year and 6-year UV-treated poly in widths from 12 to 50 ft. Ships from Iowa; budget 7–10 days.
- **Bootstrap Farmer** (online) — competitive pricing; 6-year poly; ships fast.
- **A. M. Leonard** (online) — wider selection; useful for end-wall plastics in non-standard widths.

The local in-person source for 6-mil greenhouse poly in Cochise County is limited. **BFI in Tombstone** stocks 12 ft and 20 ft widths in 100 ft rolls during peak season (Sep–Nov, Feb–Apr). **Sierra Vista Ag Supply** orders by request, 3–5 day delivery. For larger sheets, ordering online ahead of build day is the most reliable path.

3.3 Polycarbonate (twinwall, multiwall)

Polycarbonate panels are the premium cover — rigid, insulating, long-lived. Two types:

Type	Thickness	R-value	Light transmission	Life	Typical cost (p
Twinwall (8 mm)	8 mm	R-1.6	80 %	10–15 years	$50–80
Triplewall / Multiwall (16 mm)	16 mm	R-2.5	70 %	15–20 years	$90–140
Solid polycarbonate (clear)	6 mm	R-0.85	88 %	10+ years	$80–110

Polycarbonate's three advantages over plastic film: longer life (10–15 years vs 4–6), better insulation (R-1.6 to R-2.5 vs ~R-0.85 for single-layer poly), and rigidity (no flapping in wind). Its disadvantage is cost — a 12×24 hoop house clad in polycarbonate runs $1,500–2,500 in cover material alone. The use case in the Dragoons is **cold frames** (the highest cost-per-sq-ft material works on the smallest structures) and **end walls** of hoop houses (where the rigid material doubles as the door frame).

The light-scatter property of twinwall is a real asset for season extension: scattered light reaches lower leaves better than direct light, which matters for dense plantings of greens.

3.4 Glass (recycled windows)

Glass is the traditional cold-frame top — free if scrounged, permanent if treated well, but heavy and fragile.

Source	Typical cost	Pros	Cons
Recycled patio sliders (Habitat ReStore)	$0–25 each	Free or near-free; lasts forever; flat	Heavy (50–80 lb); fragile; non-standard sizes
Old single-pane window sashes	$0–15 each	Period-correct for cold frame; standard 30×42”	Single-pane has poor R-value (R-0.9); paint contamination risk

Source	Typical cost	Pros	Cons
New twinwall (replacement for glass)	$50–80 per 4×8 panel	Light; safer; insulates better	Higher up-front cost

The classic Cochise County cold-frame top is a salvaged sliding patio door — typically 28×76”, tempered, single-pane. **Habitat ReStore in Sierra Vista** carries 4–10 of these at any given time, $20–40 each. Patio doors are the best scrounge target because they are tempered (won’t shatter into sharp pieces if dropped on the bed), already framed, and the dimensions work well for a 4×6 or 4×8 frame body.

WARNING

Pre-1978 painted window sashes may contain lead paint. If you scrounge old single-pane sashes from a pre-1978 house, scrape and test the paint before bringing food-bed plants into contact with the structure. Use safer alternatives if there is any doubt. The patio-door route avoids the issue entirely — tempered glass with metal/vinyl frames.

3.5 Hoop and frame materials

For the bow that holds the cover up, four common materials in the Dragoons:

Material	Typical size	Strength	Cost per 10 ft hoop	Notes
9-gauge steel wire	5 ft cut into a 4 ft hoop	Moderate	$1.50–2.50	Workhorse for low tunnels; bends permanently in high wind
1/2” PVC schedule 40	10 ft length bent into a 6-ft span	Low (UV-degrades)	$3–5	Cheap; UV-brittle within 2 years; not first choice in Cochise UV
1/2” EMT electrical conduit	10 ft length bent in a hoop bender	High	$8–12	The standard low-tunnel and small hoop-house material

Material	Typical size	Strength	Cost per 10 ft hoop	Notes
13/16” hoop-house bows (Farmtek)	12 ft span bow	High	$25–40 each	The kit-house standard for 12 ft tunnels
Cattle panel (16 ft, 4-gauge)	50” tall arch over a 4 ft bed	High	$25–35 each	The Cochise County backyard workhorse

The cattle-panel hoop. A 16-ft cattle panel bent into an arch produces a tunnel about 4 ft wide and 4.5 ft tall — wide enough to walk through stooped, strong enough to support snow loads (rare here) and 50 mph wind (common in April), and sourced locally from any feed store in Cochise County. Three cattle panels make a 12 ft arched tunnel. They are the most common DIY hoop-house material in the county and the right choice for a first walk-in build.

LOCAL TIP

Cattle panels at Tractor Supply or Bowie Co-op (both stock them) run $28–35 each. Three panels plus 6-mil greenhouse poly plus rebar anchors and a few 2×4s build a 12-ft arched hoop house for under $300 in materials. The same structure as a Farmtek kit runs $1,200+. The trade-off is build time (a weekend with two people instead of a half-day) and aesthetics (the panels show through the plastic). For function, the cattle-panel build is the equal of any kit.

4 · Cold frames — the entry-level structure

The simplest, cheapest, fastest season extender

A cold frame is a low box (12–24” tall at the back, 6–12” at the front), covered by a glazed lid that opens. It captures solar gain by day and holds a thermal pocket through the night. The classic cold frame is 4×8 ft, built with 2× lumber, lidded with a salvaged patio door or a twinwall panel, sited against a south-facing wall.

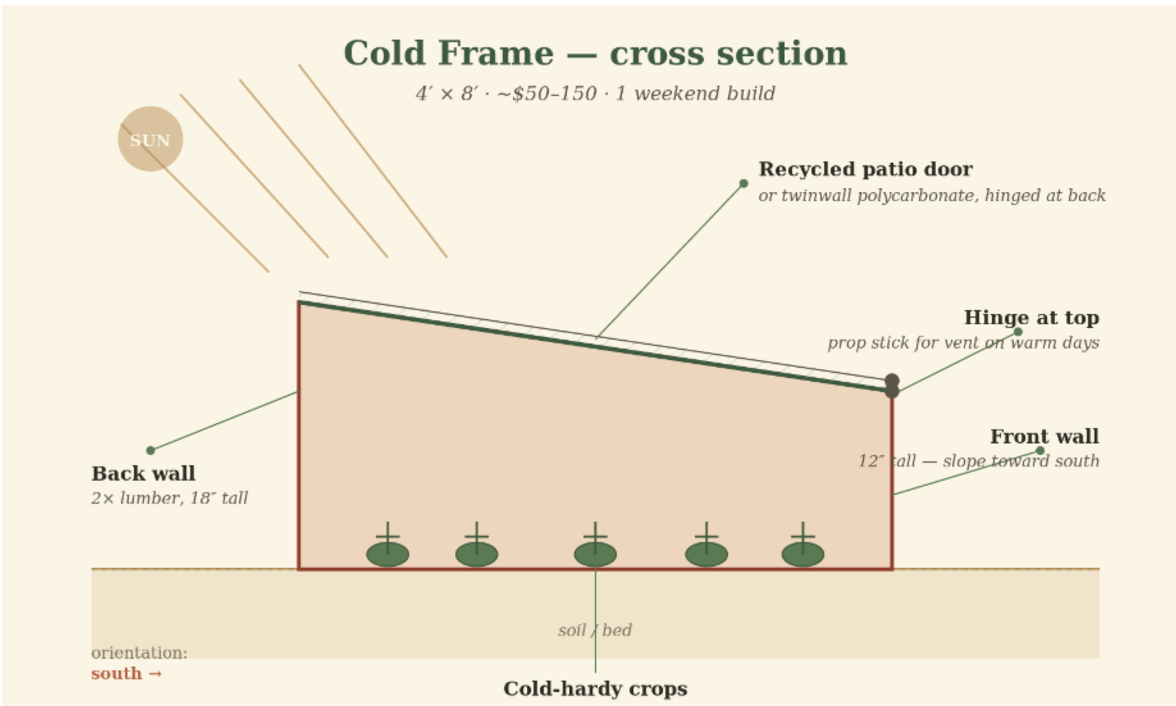

Figure 2: Cross section of the 4×8 ft cold frame. The back wall is taller than the front so the lid slopes toward the south, maximizing winter solar gain and shedding precipitation away from the structure.

4.1 What a cold frame does

Use case	How it earns its keep
Hardening off transplants	March transplants from inside the house spend 7–10 days in the frame before going to the open bed; cuts transplant shock in half
Starting seedlings 4–6 weeks early	March-start brassicas and lettuces ready for April transplant; February-start herbs ready for April transplant

Use case	How it earns its keep
Holding greens through winter	Mâche, spinach, winter lettuce hold actively through January with no other intervention
Overwintering small perennials	A small Rocoto in a 3-gallon pot or a fig cutting in a 1-gal pot rides out the winter; not a substitute for the hoop-house perennial protocol
Stratifying fruit seeds	Apple, pear, jujube seeds stratify under the frame from December through March

The cold frame's economics are unbeatable. A $100 frame protects 30 sq ft, gains 4–6 weeks of spring season, and lasts 10–20 years if maintained. The cost per sq ft per protected season is about $0.35 — the lowest of any structure in this guide.

4.2 Sizes and proportions

The classic dimensions are driven by two constraints: the lid size (whatever you can scrounge) and the reach (you must be able to reach the far back of the frame from the front).

Frame size	Cover sourcing	Reach	Use case
3×3 ft	One small twinwall panel	Easy	Single-tray seedling start
4×4 ft	One patio door or single panel	Easy	Hardening off, single bed
4×6 ft	Two patio doors side-by-side	Comfortable	The standard backyard size
4×8 ft	Two patio doors or one 4×8 twinwall	Tight to the back row	Production scale for a backyard
4×12 ft	Three patio doors	Need access from both long sides	Salad-greens scale

Beyond 4 ft deep, reach becomes a real problem — you cannot kneel at the front edge and tend the back row. Most growers stick to 4 ft deep and extend in length as they need more area.

4.3 The slope of the lid

Set the back wall taller than the front wall. The slope does three things at once: maximizes winter solar gain (the noon January sun hits the slope at a near-perpendicular angle), sheds rain, and makes the lid easy to prop open for venting.

A reasonable slope is 1:2.5 — a 4 ft deep frame is 18” tall at the back and 12” at the front, giving 6” of rise across 24” of run (with the lid resting on the rim of both walls). At the Cochise County latitude of 31–32° N, the winter sun angle at noon in late December is about 35° above the horizon — a 12° lid slope still captures most of that, and a 20° lid slope captures essentially all of it.

4.4 Construction — the 4×8 standard frame

Materials list for a 4×8 cold frame using one or two scrounged patio doors as the lid:

Material	Quantity	Notes	Approx cost
2×12 cedar or pressure-treated lumber, 8 ft	2	Back and front walls; rip the front to 12” tall	$40–60
2×12 cedar or pressure-treated lumber, 4 ft	2	Side walls cut to slope (18” back, 12” front)	$30–45
Patio door, 28×76” tempered	1–2	Lid; salvaged	$20–40
3” exterior wood screws	1 box (50 ct)	Frame fasteners	$8
Hinges (3” exterior)	2 per door	Stainless preferred	$6–10
Lid-prop stick	1 piece scrap	Notched for 3–4 vent positions	$0
Weatherstripping (foam)	1 roll	Seal lid-to-frame contact	$6
Total			**$110–170**

If the lid is twinwall instead of salvaged glass, add $50–80 for a 4×8 sheet. If the lumber is fully scrounged (a real possibility — fence-board rebuilds, pallet wood), the total can drop to $40–60.

Build sequence (one afternoon for two people):

1. **Cut the lumber.** The front wall is one 8 ft length of 2×12 (12” tall). The back wall is one 8 ft length of 2×12 (and if you want a taller back, sister a 2×6 on top — the back is 18” total). The two side walls are 2×12 boards cut on a diagonal from 12” (front edge) to 18” (back edge).
2. **Site and level the frame.** Find a south-facing spot against a wall or fence if possible (the wall is thermal mass). Level the four corners to within 1/2” — this matters more than it sounds, because an unlevel frame means an unsealed lid.
3. **Assemble with 3” screws.** Pre-drill the ends of the 2×12s to prevent splits. Screw

the side walls onto the back, then the front onto the sides. Square up before tightening the last screws.

4. **Mount the hinges.** Set the hinges on the back wall such that the lid closes flush against the front lip. Use the lid itself to mark the hinge location.
5. **Add weatherstripping** along the top rim of all four walls. Foam strip compresses to seal the lid against the frame.
6. **Cut a prop stick** with notches for 4 positions: closed, 2” vent, 6” vent, fully open. The prop stick is the daily-operations tool — it lives next to the frame and gets adjusted twice a day in season.
7. **Fill with soil or set a tray inside.** A cold frame can be filled with growing soil (an actual planted bed) or used as a tray-rack for seedlings; either works.

4.5 Operating the cold frame

The cold frame is the structure most actively operated. Daily routine, October through April:

- **8–9 am**: open the lid 2–4” if forecast high is above 50 °F. Inside temperatures hit 70 °F by 11 am on most clear winter days; without venting, plants cook by noon.
- **2–3 pm**: depending on temperature, close lid or leave open. If forecast low is below 30 °F, close by 3 pm to trap day-heat.
- **Cold-snap nights (forecast < 20 °F)**: add a layer of row cover *inside* the frame, draped over plants. The frame plus row cover handles 15 °F outside without damage.
- **Snow nights (rare)**: brush snow off the lid in the morning. A 4-inch snow load on a 4×8 lid is 160 lb — within tempered glass tolerance, but only just.

> **The single most common cold-frame failure in the Dragoons is heat death, not cold death.** A closed cold frame on a clear 55 °F February afternoon will hit 95–110 °F inside within 90 minutes. Lettuce wilts; spinach bolts; transplants die. **Open the lid every clear morning, no exceptions.** An automatic vent opener (Bayliss MK7 or Univent, $50–70) pays for itself the first time you forget on a Saturday morning.

5 · Low tunnels — hoops over a bed

Wire or pipe arches with row cover or plastic

A low tunnel is the simplest “frame plus cover” structure: a row of hoops, 30–48” tall, set 4–6 ft apart along a bed, with row cover or plastic stretched over the top and pinned to the ground at both edges. It is the single best frost-protection investment for someone who has more bed than budget — covering 50 linear ft of bed with low tunnels costs $50–100 and handles every routine cold event in the Dragoons calendar.

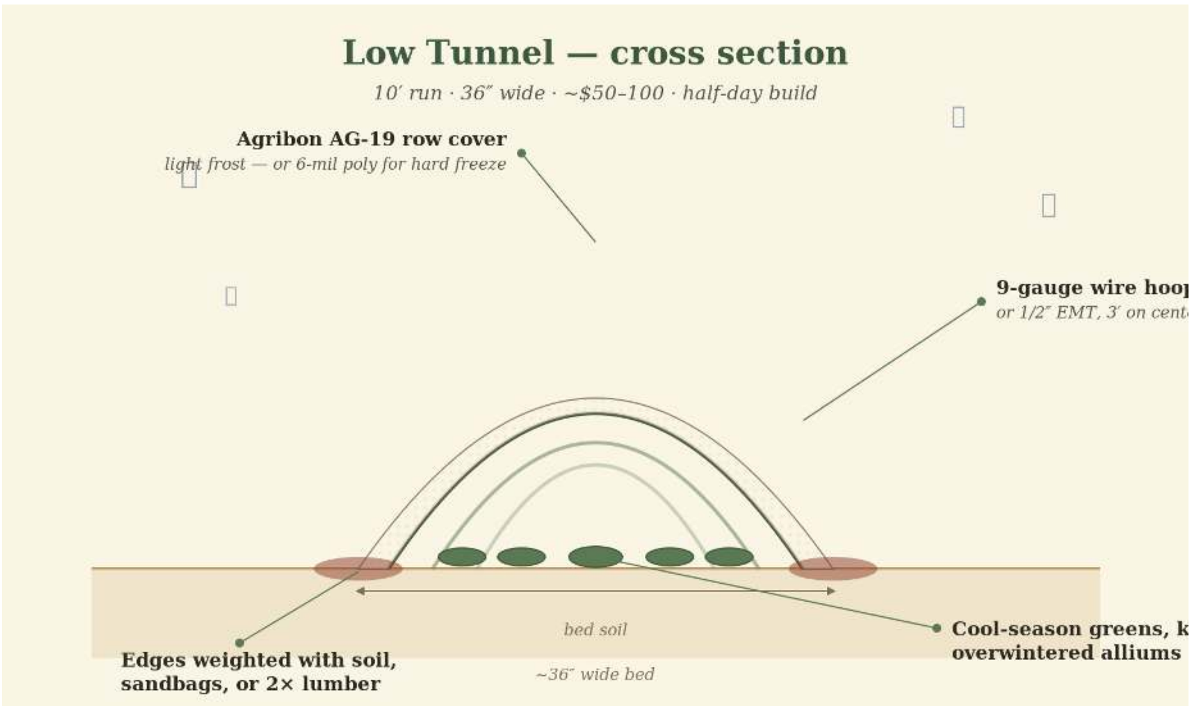

Figure 3: Cross section of a low tunnel over a 36” wide bed. Hoops on 3 ft centers; cover edges weighted with soil or 2× lumber. Use row cover for light frost (down to 26 °F); switch to 6-mil poly for hard freezes.

5.1 What a low tunnel does

Use case	How it earns its keep
Spring-extending brassicas	Cabbage, broccoli, kale transplanted under tunnel in early March; ahead of schedule by 3–4 weeks
Fall-extending salad greens	Lettuce and spinach beds run through January without bolting or freeze damage
Overwintering kale and chard	A single layer of AG-30 carries kale through the entire winter at zero structural cost beyond hoops

Use case	How it earns its keep
Late-fall pepper rescue	Last 3–4 weeks of pepper season pushed past the first frost when row cover is deployed at 32 °F forecast
Pest exclusion in spring	Tunnel with insect-grade row cover (AG-15) keeps cabbage moth, flea beetle off brassicas in April

A low tunnel is *the structure for an existing bed*. If you already have a bed laid out and irrigated and planted, the low tunnel is the cheapest way to extend that bed's season without rebuilding the layout.

5.2 The 10×4 standard tunnel

The standard backyard low tunnel covers 10 linear ft of a 4 ft wide bed.

Materials list:

Material	Quantity	Notes	Approx cost
1/2" EMT conduit, 10 ft length	3	Bend each into an arch with a hoop bender; spaced 4 ft apart along the bed	$25–35
9-gauge wire alternative	6 cuts at 5 ft each	Less durable; OK for short-term beds	$8
Sandbags, 5 lb each	6	Two per arch base for stability	$15 (or sew your own from scrap fabric)
AG-19 row cover, 10 ft wide × 14 ft long	1 piece	Enough to drape and pin both sides	$30–45
Steel landscape pins (8" U-pins)	12	Pin row cover edge to soil	$8
Total			**$80–110**

If the tunnel uses 6-mil plastic instead of row cover, swap in 6-mil greenhouse poly for $20 of that 14-ft length and add hardware: it becomes an enclosed-microclimate tunnel (warmer but requires daily venting). If the tunnel uses AG-30 instead of AG-19, swap in $40 of heavier cover for the longer-life freeze use case.

Build sequence (90 minutes for one person):

1. **Mark hoop positions.** 4 ft on center along the 10 ft bed: positions at 1, 5, 9 ft

from one end. Pre-drive a stake or punch holes for the conduit at each position on both sides of the bed.

2. **Bend the conduit.** A 10 ft length of 1/2” EMT in a Johnny’s Seeds hoop bender ($85, reusable for years) produces a 4 ft wide × 30” tall arch. Without a bender, two people can hand-bend over a stake-set template; results are less consistent.
3. **Set the hoops.** Push each leg of each arch 8–12” into the soil. The legs anchor the structure against wind.
4. **Lay the row cover.** Drape over all three hoops, centered over the bed, with 2 ft of overhang on both long sides and 1 ft on both ends.
5. **Pin the edges.** Pin one long edge first along the soil with landscape pins, then weight with sandbags every 4 ft. Pull the other long edge taut and pin similarly. Pin the two short ends last.
6. **Verify the seal.** A low tunnel is only as cold-resistant as its edge seal. A gap at the ground = no protection. Walk around the perimeter and add weight wherever wind can lift the cover.

5.3 Operating a low tunnel

Forecast	Action
Daytime high > 50 °F	Roll one long edge back 1/3 of the way for venting from 10 am–3 pm
Daytime high 40–50 °F	Leave closed; light comes through anyway
Forecast low < 25 °F	Add a second layer of AG-19 on top of the first
Forecast low < 20 °F	Add second layer of AG-30 and a stack of water-filled jugs inside the tunnel for thermal mass
Wind > 30 mph	Recheck edge weights; add sandbags where needed

The most important daily check is the edge — wind in early spring can lift a corner of the cover and within an hour the bed inside the tunnel is at outside temperature.

WARNING

Low tunnels with plastic (not row cover) must be vented daily. A closed 6-mil plastic tunnel on a 55 °F afternoon will hit 95–105 °F inside. The plants cook in two hours. If you use plastic, build a daily-vent habit before you plant anything sensitive. Most growers in the Dragoons stick to row cover because it self-vents (passes moisture) and forgives missed days.

6 · Hoop houses — the workhorse season extender

Walk-in protected growing · 12×24 ft as the backyard standard

A hoop house is the first structure tall enough to walk into and the first that genuinely transforms what is possible in a Cochise County backyard. A 12×24 ft hoop house (~290 sq ft of growing space) overwinters peppers, fits a fig in a pot, holds salad greens through December, starts 200+ transplants in February, and runs warm-season crops into mid-November. It is the structure that pays back its build cost within two seasons for any serious grower.

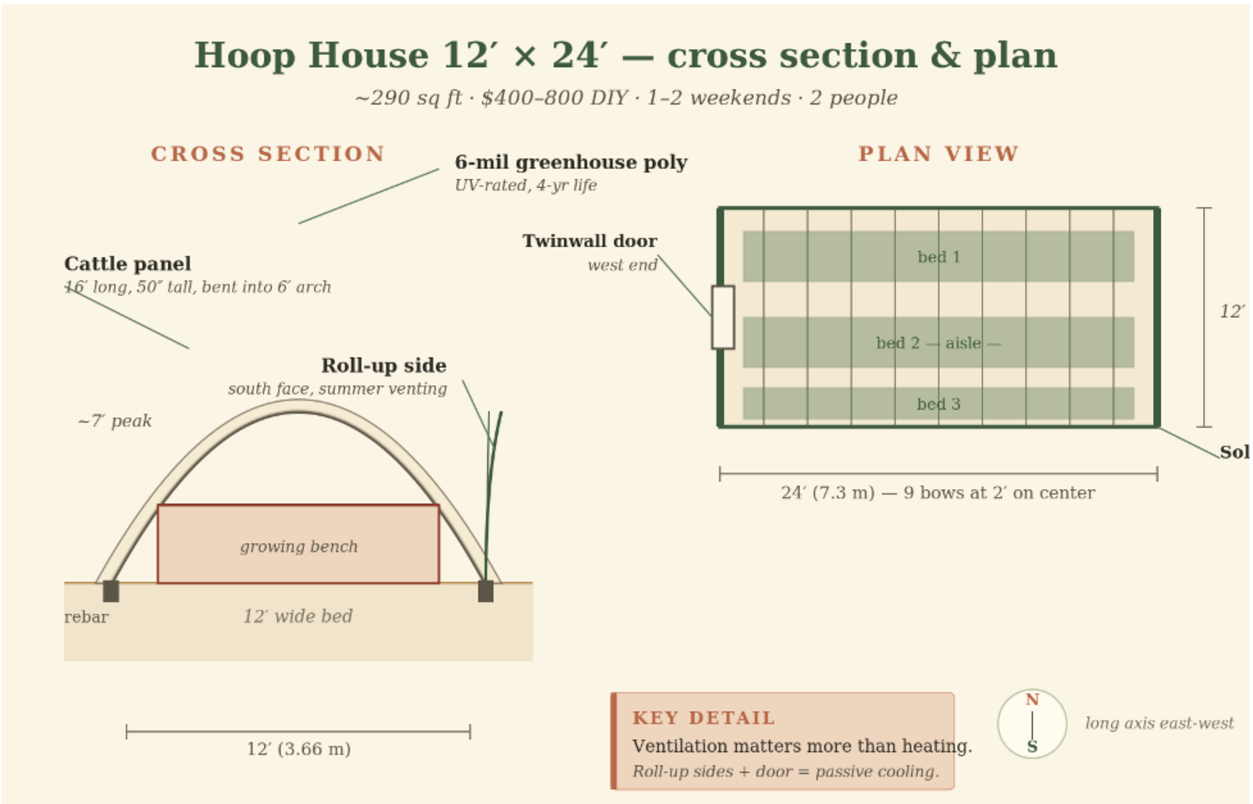

Figure 4: Hoop house 12×24 — the cattle-panel-arch design. Cross section (left) shows the bow profile, growing bench, roll-up side, and rebar anchors. Plan view (right) shows 9 bows on 2 ft centers, end-wall door on the west, and three growing beds inside. Orient the long axis east-west for maximum winter solar gain.

6.1 What "hoop house" means and where the size lands

The term "hoop house" is often interchangeable with "high tunnel." The distinction used in this guide:

- **Hoop house** — a smaller-scale tunnel, typically 10–14 ft wide and 16–24 ft long. Walk-in but not commercial-scale. Built DIY or from kit. Permits not normally required if under 200 sq ft.

- **High tunnel** — a larger commercial-scale tunnel, 20–30 ft wide and 48–96 ft long. NRCS-eligible. Permitted. See chapter 7.

The Dragoons backyard standard is the **12×24 ft hoop house** — 288 sq ft, right at the Cochise County permit threshold but typically still exempt as an agricultural structure. This chapter assumes that size.

6.2 Frame options

Three frame choices for a 12×24 DIY hoop house:

Frame type	Material cost	Build difficulty	Lifespan	Notes
Cattle panel (5 panels × 16 ft)	\$150–180	Easy	15–20 years	The Cochise County workhorse. Strong, local, ugly
1” EMT conduit bows (custom-bent)	\$200–260	Moderate (need bender)	20+ years	Cleaner look; requires Johnny’s bender or shop access
Kit bow frame (Farmtek, Bootstrap Farmer)	\$800–1,400	Easy	25+ years	Professional finish; ships heavy

The cattle-panel build dominates Cochise County backyards because the materials are local, the build is genuinely manageable in a weekend, and the structure is overbuilt for any wind event the Dragoons throw at it. The rest of this chapter walks the cattle-panel build.

6.3 The 12×24 cattle-panel build — full materials list

Material	Quantity	Notes	Approx cost
Cattle panels, 16 ft × 50” (4-gauge)	5	Bent into arches; spaced 5 ft on center	\$150–180
#4 rebar, 4 ft length	20	Two per panel-end, driven 24” into ground	\$40

Material	Quantity	Notes	Approx cost
2×6 pressure-treated baseboards, 12 ft	4	Long-axis baseboards	$80–100
2×6 PT baseboards, 24 ft (joined from 2× 12 ft)	2	Hip boards (overlapping the long-axis at the top of the wall)	included in above
2×4 framing for end walls, 8 ft	14	End-wall studs + headers + ridge	$80–110
6-mil greenhouse poly, 24 ft × 30 ft sheet	1	UV-treated, 4-yr rated	$180–240
Wiggle wire and channel (“Wiggle Wire System”), 100 ft	1 set	Fastens plastic to baseboards	$80–100
Or batten tape + screws (simpler)	as needed	Alternative to wiggle wire	$30
Roll-up sides hardware (Big Tops or DIY)	1 set	Crank handle + clamp	$80–150
Hinged door + frame (build from 2×4 and twinwall)	1 (or 2 for both ends)	End-wall door	$60–120
Polycarbonate twinwall for end walls, 4×8 ft	2–3 sheets	Or use the same poly stretched and stapled	$100–240
Self-tapping screws, lath strips, hardware	misc		$40
Anchors (auger-style for the corners)	4	Optional for extra wind resistance	$30
Total — cattle-panel DIY			**$900–1,300**
With basic poly end walls (skipping twinwall)			**$700–900**
With scrounged or used components			**$400–700**

This is the standard build and runs $700–1,300 with all-new materials. The actual lower bound of $400–500 is reached when the baseboards are scrounged from a job-site offcut pile, the doors are built from pallet wood, and the end walls are wrapped with the same 6-mil poly stretched and stapled (instead of clean twinwall doors).

6.4 Build sequence — the 12×24 cattle-panel build

This is two weekends for two people, working the cooler side of the day.

Weekend 1 — site, base, hoops (Saturday and Sunday, ~12 hours total)

1. **Mark the footprint.** Stake out a 12 ft × 24 ft rectangle. Orient the long axis east-west (see chapter 11 for siting). Square the corners using the 3-4-5 rule. Level the corners to within 1” if possible.
2. **Drive the rebar.** Two pieces of #4 rebar per panel, 24” into the ground, on each side of the structure. Twenty pieces total, 5 pairs per long side. Spacing: 5 ft on center along each 24-ft side, with the first pair 2 ft in from the corner.
3. **Lay the baseboards.** 2×6 pressure-treated, set on edge against the rebar on the outside of the rebar. The baseboard is what the plastic clamps onto and what the ground edge of the panel anchors against. Connect the baseboards at the corners with structural screws.
4. **Bend and set the cattle panels.** Each 16 ft panel forms an arch 12 ft wide and 4.5 ft tall. With two people, walk the panel into position: one end of the panel slots onto the rebar pair on one side; the panel is then bent until the other end slots onto the rebar pair on the opposite side. The arch springs into tension and locks the panel in place. Repeat for all 5 panels.
5. **Tie the panels to each other.** Run a horizontal length of conduit or rebar along the peak of all 5 panels, lashed with bailing wire. This is the ridge line and prevents lateral racking. Add two more horizontal stiffeners on each side, halfway up the arch.

Weekend 2 — end walls, plastic, doors, ventilation (Saturday and Sunday, ~10 hours total)

1. **Frame the end walls.** Build a 2×4 frame at each end of the structure: a header at the top following the curve of the panel, vertical studs every 24“, a doorway in the middle (typically 36” wide for a person + wheelbarrow).
2. **Hang the plastic.** With wind down, drape the 24×30 ft sheet of 6-mil poly over the structure. Center it. One person on each side pulls the sheet taut.
3. **Lock the plastic with wiggle wire.** Insert the wiggle-wire channel along the baseboard on both long sides. Push the plastic into the channel; press a wiggle-wire strand into the channel on top of it. The plastic is now clamped along its long edges.
4. **Trim and seal the end walls.** Stretch the plastic over each end wall. Either

staple it to the end-wall framing (and add a lath strip over the staple line), or fit a polycarbonate twinwall panel into the door frame for a cleaner finish.

5. **Hang the door.** Build a 2×4 door with twinwall infill or with the same 6-mil plastic stretched over the frame. Hinge it.
6. **Add roll-up sides.** A roll-up side is a strip of plastic along one long side (typically the south side) that crank-rolls up onto a pipe to vent the structure. Hardware kits run $80–150 per side; DIY is a length of 1-1/2” PVC, two flange brackets, and a length of cord. **This is the single most important ventilation feature in a Cochise County hoop house.**

6.5 Cost summary

Build path	Approximate cost	Build time	Lifespan
Cattle-panel DIY, all new materials	$700–1,300	1–2 weekends, 2 people	15–20 years
Cattle-panel DIY, scrounged base components	$400–700	1–2 weekends, 2 people	15–20 years
EMT-conduit DIY frame	$900–1,500	2 weekends, 2 people	20+ years
Bootstrap Farmer 12×24 kit	$1,400–2,000	1 weekend, 2 people	20+ years
Farmtek 12×24 kit	$1,800–2,500	1 weekend, 2 people	20+ years

LOCAL TIP

The 12×24 cattle-panel build is the most replicated structure in the Dragoons. Three observations from veteran builders: (1) Orient long axis east-west, full stop. The 30 % winter-sun gain over north-south orientation is the single biggest design decision. (2) Build the roll-up side on the *south* face, not the north. Cool air enters from the north (or end-wall door) and warm air exits the south roll-up — the natural airflow direction in this orientation. (3) Bury the bottom 8” of plastic in the soil along the long sides, *under* the baseboard. This blocks ground-level cold air infiltration and is invisible from outside.

7 · High tunnels — the NRCS cost-share opportunity

20×48 and 30×96 scale · the EQIP program

A high tunnel is a hoop house scaled up — typically 20×48 ft (960 sq ft) or 30×96 ft (2,880 sq ft). It is the structure that turns season extension from a hobby into a production system. It is also the structure for which the federal government will reimburse 50–75 % of the cost.

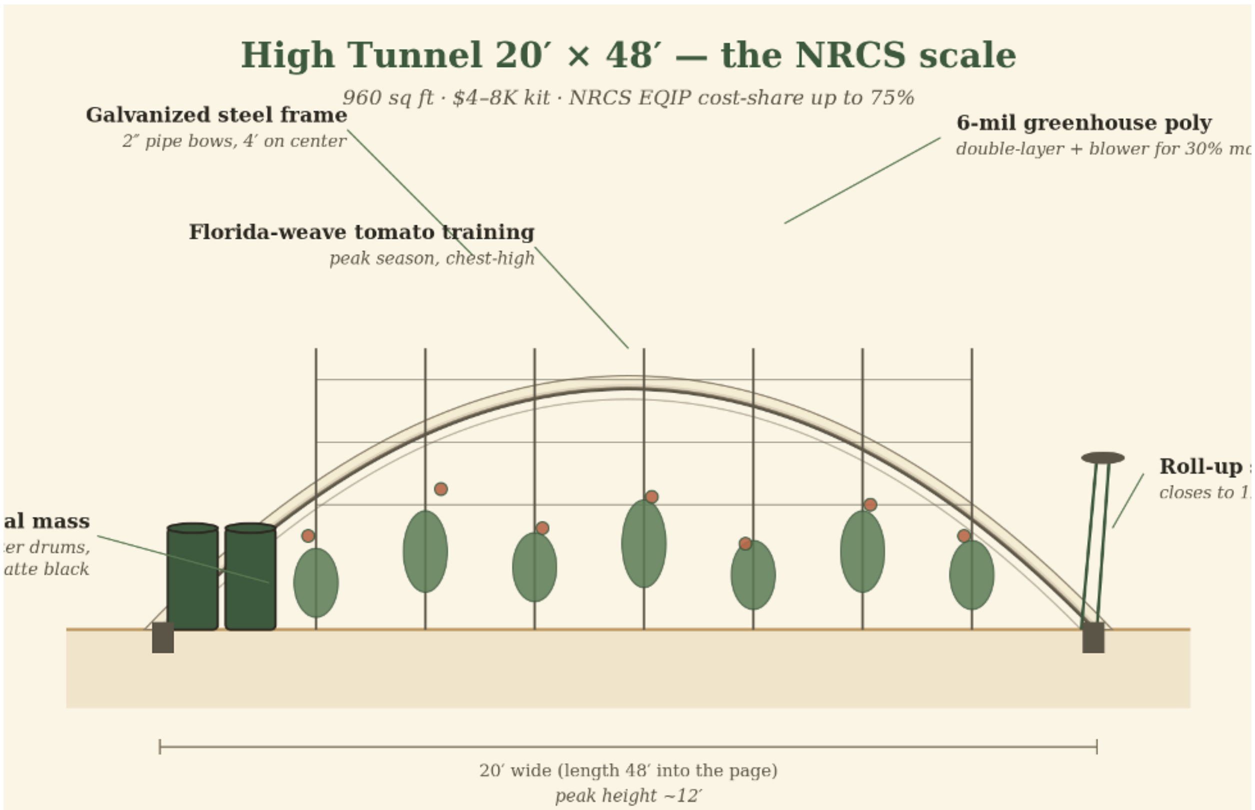

Figure 5: High tunnel 20×48 — the NRCS-scale structure. Galvanized steel bows on 4 ft centers, double-layer 6-mil greenhouse poly, roll-up sides on both long sides, twin-wall end walls. Florida-weave tomatoes shown at peak season; 55-gal water drums against the north wall serve as thermal mass.

7.1 What's different at the high-tunnel scale

Dimension	12×24 hoop house	20×48 high tunnel	30×96 high tunnel
Square feet	288	960	2,880
Walk-in clearance at the peak	7 ft	11 ft	14 ft
Roll-up side length	24 ft	48 ft	96 ft
Plastic sheet size	24×30 ft	30×60 ft	42×110 ft

Dimension	12×24 hoop house	20×48 high tunnel	30×96 high tunnel
Approximate cost (kit)	$1,400–2,500	$4,500–7,000	$9,000–14,000
NRCS cost-share eligible?	Sometimes	Yes (standard)	Yes (standard)
Build time	1–2 weekends, 2 people	1 week, 4 people	2–3 weeks, 4 people + a contractor for frame

At high-tunnel scale, the frame is no longer cattle panel. **Steel bow pipe** (1 5/8” or 1 7/8” galvanized, in 4-piece bows) is the structural standard. This is the structure the Farmtek and Rimol catalogs are built around.

7.2 The NRCS EQIP cost-share program

The **Environmental Quality Incentives Program (EQIP)**, administered by the USDA Natural Resources Conservation Service (NRCS), funds season-extension structures as a “high tunnel system” conservation practice (Practice Standard 325). For a qualifying applicant, the program reimburses **50 % of approved costs** as a baseline, or **75 %** for historically underserved farmers (beginning, socially disadvantaged, or limited-resource).

Eligibility basics:

- You must have a **USDA Farm Number** (apply through your local Farm Service Agency office; the application is free and takes 30–45 days).
- You must have control of the land — own it, hold a lease, or have written landowner permission.
- The land must be classified as cropland for the purposes of EQIP. A residential backyard can qualify if you can demonstrate agricultural production from the land.
- The structure must be at least 6 ft tall at the peak and at least 350 sq ft in floor area (which excludes most 12×24 hoop houses; a 14×24 or 20×48 hits the threshold).
- The plan must be approved before construction begins. **You cannot retroactively cost-share a structure you already built.**

Application timeline:

Stage	Timeline
Initial inquiry at field office	Day 0
Farm Number from FSA	Day 0–45
Conservation plan developed with NRCS	Day 30–90

Stage	Timeline
Application submitted	Day 90–120
Application ranked and funded (or deferred)	Day 120–270
Contract signed	Day 270–300
Construction begins	Day 300+
Construction must complete within	12–18 months of contract
Reimbursement paid after construction verified	Final 30–60 days

In practice the process is 6–12 months from first call to ground-break, and another 4–8 months to reimbursement. Most growers who pursue this should plan 18 months from idea to a high tunnel they can plant in.

Arizona NRCS contacts:

- **Arizona State NRCS Office** — Phoenix; main number 602-280-8800; nrcs.usda.gov/wps/portal/
- **Sierra Vista NRCS Field Office** — serves Cochise County south; 520-458-0303 (verify before calling)
- **Willcox NRCS Field Office** — serves Cochise County north and the Sulphur Springs Valley; 520-384-2229 (verify before calling)
- **Cochise FSA Office** — for the farm number; same buildings as NRCS in Sierra Vista and Willcox

> **LOCAL TIP**
>
> **The 75 % beginning-farmer rate is genuinely accessible.** "Beginning farmer" in the NRCS sense means you have operated a farm or ranch for fewer than 10 years. Most backyard Dragoons growers planning a first high tunnel qualify. The application paperwork is real but manageable in 5–10 hours of effort spread over a couple of months, and the difference between 50 % and 75 % cost-share on a $7,000 tunnel is $1,750 — enough to justify the paperwork on its own.

7.3 Pros and cons of going to high-tunnel scale

Pros:

- 3–10× the protected growing area for 4–6× the cost (the economies of scale work in your favor)
- True production capability — a 20×48 tunnel can produce $4,000–8,000/yr of greens at retail prices
- Roll-up sides on both long axes give superb ventilation

- Walk-in scale with a wheelbarrow path; one row in the middle and two beds on the sides
- Shade cloth attaches the same way the winter plastic does; summer use is built in
- NRCS cost-share reduces the effective cost dramatically

Cons:

- The 6–12 month application window before you can start. Some growers find this discouraging.
- The structure becomes a building permit conversation with the county. Most ag exemptions still apply, but check first.
- Maintenance scales with size. Replacing plastic on a 30×96 is a major job.
- The structure is a visual element of the property; some HOAs and neighbors react.
- Ongoing operational discipline — daily vent management at this scale matters more, not less.

> **The single most common reason growers do not pursue NRCS cost-share is "I didn't know it existed."** A 50 % federal reimbursement on a $5,000 structure is $2,500 in real money, available to most Cochise County growers who can demonstrate agricultural intent on their land. The starting point is one phone call to the Sierra Vista or Willcox field office. The conversation is friendly, no-commitment, and may save you several thousand dollars on the next structure you build. The 18-month timeline is real, but so is the reimbursement.

8 · Ventilation — the most important detail

Why overheating kills more than freezing · passive vs active · the 90 °F rule

Ventilation is the single most underestimated requirement of every structure in this guide. Every cold frame, low tunnel, hoop house, and high tunnel that operates in the Dragoons will overheat on a clear winter afternoon if not vented. **Overheating kills more crops in Cochise County structures than freezing does, by a wide margin.**

8.1 Why a structure overheats so fast in this climate

The Dragoons winter has a combination that makes overheating extreme:

- **High direct-sun intensity at 4,700 ft.** UV and total irradiance are 15–20 % higher than at sea level on the same latitude.
- **Low ambient humidity.** Dry air holds less heat than humid air, so when the structure heats, the air inside heats fast.
- **Clear-sky frequency.** December through February in the Dragoons has cloud cover only 20–30 % of daylight hours. Most winter days are clear.
- **Low ambient temperatures keep operators complacent.** “It’s 38 °F outside, the plants can’t possibly be too hot inside” — but inside, with the sun direct on the plastic, it is 95 °F by 1 pm.

The internal temperature of a closed 6-mil plastic hoop house on a clear 40 °F winter day in the Dragoons routinely hits **80–110 °F by noon** and stays there for 4–5 hours. A cold frame can climb to 120 °F. Lettuce wilts at 90 °F; spinach bolts after 1–2 days above 85 °F; pepper blossoms drop above 95 °F. Most of the “my structure killed everything” stories in the Dragoons end with “I closed it on a sunny Friday and didn’t come back until Sunday.”

8.2 Passive ventilation

Passive ventilation uses the structure’s geometry and the daily heat differential to drive airflow without any electrical input. It is the standard system for every structure in this guide.

For cold frames:

- Prop the lid 2–4” with a notched stick on any day with forecast high > 50 °F.
- Two ventilation stages: a small crack (1–2“) for 40–50 °F days, a larger crack (4–8”) for 50–70 °F days.
- The automatic vent opener (Bayliss MK7, Univent E10) — a wax-piston-driven mechanism that opens the lid as temperature rises — is the single best $50 a cold-frame owner spends.

For low tunnels:

- Roll one long edge back 1/3 of the way during 50 °F+ days.
- On 60 °F+ days, lift the row cover entirely.

For hoop houses:

- **Roll-up sides.** A 24 ft roll-up side on a 12×24 hoop house vents about 80 % of the heat load at the half-rolled position. The crank handle and rope-and-pulley designs both work.
- **End-wall door.** Open the door on the prevailing wind side; the side-roll lets warm air out the other side. The structure becomes a wind tunnel.
- **Ridge vents** (rare in DIY builds) — a flap at the peak. Most effective passive vent but requires a more sophisticated build.

Sizing rule. For passive ventilation in a Dragoons hoop house, the total vent area should be **20–25 % of the floor area**. A 12×24 (288 sq ft) hoop house needs 58–72 sq ft of vent area — easily achieved with a 24 ft × 3 ft roll-up side (72 sq ft) plus an open end-wall door (15–20 sq ft).

8.3 Active ventilation

For larger high tunnels or for structures left unattended on workdays, active (powered) ventilation pays back:

Device	Cost	Use case
Bayliss MK7 automatic vent opener	$50–70	Cold-frame lid; opens at 70 °F, closes at 60 °F
Univent E10 / E15	$60–90	Same; smoother action; longer life
Solar-powered exhaust fan (8–12”)	$80–200	End-wall fan; turns on when interior > 80 °F
Standard 110V exhaust fan + thermostat	$150–250	High tunnel; reliable; needs electrical service
Misted evaporative cooler (swamp cooler)	$200–500	Summer use only; for shade-cloth-covered structures with crops

The Bayliss and Univent vent openers are the workhorses of small-scale season extension in the Dragoons. They run with no battery, no plug, no maintenance — a wax piston expands with temperature and lifts the lid. Set the trigger temperature in fall (typically 70 °F) and the device operates daily until you take it down for the windy season.

WARNING

A hoop house full of overwintering peppers, closed on a Friday with a forecast 65 °F Saturday and 68 °F Sunday, will reach 105–115 °F by Saturday noon and the peppers will defoliate by Sunday evening. This is the single most expensive ventilation lesson learned by Dragoons growers. If you cannot be home to vent daily, install an automatic opener (cold frame), build roll-up sides that stay half-open all winter (hoop house), or install a thermostatic fan (high tunnel). Do not leave a closed structure unattended above 50 °F outside.

9 · Heating — usually not needed in zone 8a

Why passive solar covers most of it · the rare cold-snap night · supplemental options

Most season-extension structures in the Dragoons do not need supplemental heat. The combination of bright winter sun, passive solar gain through the plastic, and modest thermal mass (water drums, soil, the bed itself) is usually enough to handle 20 °F outside without active heating. The exception is the handful of nights per year below 15 °F, when supplemental heat is the difference between alive and dead.

9.1 When supplemental heat is justified

Outside temperature forecast	Hoop house with thermal mass	Cold frame	Low tunnel
25 °F or warmer	No supplemental heat needed	No	No
20–25 °F	None needed if mass is sufficient	Add row cover layer inside	Add row cover layer
15–20 °F	Optional: row cover layer; jugs of warm water	Row cover + second cover	Second layer of cover
10–15 °F	Christmas lights, propane radiant briefly	Inside row cover + lights	Insufficient: bring plants inside
Below 10 °F	Propane heater on overnight	Move plants indoors	Insufficient

9.2 The Christmas-light heater

The cheapest, most effective supplemental heat for backyard scale: **incandescent Christmas lights strung inside the structure**, draped on a string or arranged in a circle around the plants. Each old-style C9 or C7 incandescent bulb produces 5–7 watts of heat. A 100-bulb string produces 500–700 watts, enough to lift a small hoop-house volume by 8–12 °F. LED lights produce essentially no heat and do not work for this purpose; **buy actual incandescent strings** while you still can.

This is the same trick used in Guide 9 §5.2 for stone-fruit frost protection — Christmas lights inside a frost-cloth tent. The Dragoons use case is identical at structure scale: one 100-bulb string draped through a 12×24 hoop house lifts the interior 8–10 °F on a 15 °F night.

9.3 Propane radiant heaters

For structures larger than 20×48 or for the rare 5 °F night, a portable propane radiant heater is the next step up:

Heater	BTU output	Coverage	Cost	Notes
Mr. Buddy radiant (4,000–9,000 BTU)	9,000 BTU max	200–300 sq ft	$80–130	The standard backyard tool; runs 3 hr on a 1-lb propane bottle
Mr. Buddy Big Buddy (4,000–18,000 BTU)	18,000 BTU max	400–500 sq ft	$130–180	For a full hoop house through a hard night
L. B. White Premier (60,000 BTU)	60,000 BTU	1,000–2,000 sq ft	$700–1,200	Commercial-scale; thermostat-controlled

The hard rule: propane heaters inside a sealed structure produce carbon monoxide and water vapor. Never run a non-vented propane heater in an unventilated space. The Mr. Buddy units have low-oxygen shutoff sensors, but the right practice in a hoop house is to crack the roll-up side 3–4” while the heater runs — sacrificing some heat for venting safety.

9.4 Thermal mass — the passive solar secret

Thermal mass is what makes a Dragoons hoop house work without active heating. It is also the cheapest single upgrade to a working structure.

The basic mechanism: the dense material (water, rock, concrete) absorbs heat during the day from direct sun and warm air, then releases it slowly through the night, smoothing the day-night temperature swing. A 55-gallon barrel of water (458 lb) holds about 7,800 BTU per °F. As the barrel cools from 70 °F to 50 °F overnight, it releases about 156,000 BTU into the structure — roughly equivalent to running a 1,500-watt electric heater for 30 hours.

Thermal mass	Volume / mass	Heat capacity	Notes
55-gal water drum, painted black	458 lb	458 BTU per °F	The standard. Two drums per 12×24 hoop house

Thermal mass	Volume / mass	Heat capacity	Notes
30-gal water drum, painted black	250 lb	250 BTU per °F	The smaller alternative; easier to move
5-gal water jug, painted black	42 lb	42 BTU per °F	The cold-frame thermal mass; 4–6 per frame
Cinder block wall (north end)	180 lb/block	0.2 BTU/lb/°F	Stone gives less per pound than water
Stone or rock pile	varies	0.2 BTU/lb/°F	Pretty but lower density per dollar than water
Concrete slab floor (4” thick)	50 lb/sq ft	0.21 BTU/lb/°F	The high-tunnel approach

Sizing rule for the Dragoons hoop house: roughly **2 gallons of water per square foot of structure** is the minimum to get meaningful nighttime lift. A 288 sq ft hoop house needs 580 gallons — eleven 55-gal drums. Most backyard growers find space for 4–6 drums (220–330 gallons), which is enough to lift 6–8 °F on a cold night, not the full 12–15 °F that the math suggests is possible. The remainder comes from row cover layers and (on the worst nights) supplemental heat.

The drums are sited along the north wall of the structure — where they intercept direct south sun all winter, do not shade the growing beds, and release heat into the colder side of the structure overnight. Paint them flat black. Cover them with row cover or shade cloth in summer (they overheat the structure and create algae problems).

10 · Thermal mass — building it in from the start

Water drums · stone walls · buried mass · sizing math

Thermal mass deserves its own chapter because it is the single best upgrade to any season-extension structure in the Dragoons. The climate's combination of bright winter days and cold winter nights is exactly what passive solar mass is designed to exploit.

10.1 Water drums — the standard

A 55-gallon barrel of water is the workhorse of thermal mass in this climate.

Sourcing. Used food-grade plastic 55-gallon drums sell for $20–40 each in Cochise County:

- **Bowie Co-op** (Bowie) — periodically stocks former-pickle and former-fruit-juice drums.
- **Tractor Supply** (Sierra Vista, Benson, Willcox) — sells new and refurbished. Higher price but reliable stock.
- **Craigslist Tucson "farm and garden"** — frequent listings of used drums, $15–25 each, pick up.
- **Cash Drive-Thru Pickle Co.** — occasionally has used drums for free or near-free; ask.

Preparation. Wash the drum with hot water and dish soap; rinse thoroughly. Paint the outside with flat black exterior paint (Rust-Oleum 7776 or equivalent) — the paint should match the wavelength absorption of the sun. Avoid dark green or dark brown — they look more natural but absorb 10–15 % less solar energy than true black.

Filling. Use clean water — rainwater is ideal, well water is fine. Add 1 tablespoon of bleach per drum to suppress algae growth. Reseal the drum tightly.

Placement. Along the north wall of the structure, where the drums catch direct south sun all day and shade nothing important. Stack two-high if necessary (use a 2×4 frame to hold the upper row).

10.2 Stone walls and the "north-wall trick"

The traditional Southwest approach: build the structure against an existing stone or concrete-block wall on the north side, using the wall itself as the thermal mass.

A 4-ft-tall × 24-ft-long × 8-inch-thick concrete-block wall represents about 6,400 lb of mass — equivalent in heat capacity to 1,400 gallons of water. It is structurally permanent, looks intentional, and serves double duty as a windbreak and as visual privacy.

The cost is real ($600–1,200 for a 4×24 concrete-block wall) and the build is a substantial side project. But for a structure that is going to be permanent, the wall is the highest-quality thermal mass available. If a property already has a south-facing stone wall (an old foundation, a retaining wall, a barn wall), building the hoop house against it is the highest-leverage decision available.

10.3 Buried thermal mass — earthbag and cob

For a fully thermal-mass-designed structure, an earthbag or cob construction at the foundation provides massive thermal capacity below ground level. This is the construction style of the **walipini** (earth-sheltered greenhouse popular in high-altitude regions) and of Mike Oehler's classic earth-sheltered greenhouse designs.

Approach	Approx cost (12×24)	Thermal performance	Build difficulty
Standard hoop house, no thermal mass	$700–1,300	8–10 °F lift	Easy
Standard hoop house, 4 water drums	+$100–160	14–18 °F lift	Easy
Hoop house against existing stone wall	+$0 (if wall exists)	18–24 °F lift	Easy
Earthbag knee-wall + hoop house	+$400–800	22–28 °F lift	Hard
Full earth-sheltered walipini	$3,000–8,000 total	30+ °F lift	Very hard

Most Dragoons growers stop at the second row — a standard hoop house with 4 water drums. The marginal lift from earthbag construction is real but the build effort is several times higher. For overwintering peppers, the 4-drum hoop house is usually enough.

> **Two 55-gallon barrels of black-painted water along the north wall of a 12×24 hoop house adds about $40–80 in cost and 6–8 °F of nighttime lift.** No other upgrade in this guide offers as much performance per dollar. If you are building a hoop house, plan the drum location from day one — it is much harder to add 458 lb of water after the bed is planted.

11 · Shade structures for summer — the inverse problem

Lath houses · shade cloth · summer lettuce

The Dragoons summer is brutal for cool-season crops. June and July temperatures routinely hit the upper 90s; UV is high; bare-soil surface temperatures climb to 130 °F. A bed of lettuce that thrived in April is bolted and bitter by June. A shade structure inverts the season-extension problem: instead of trapping heat in winter, it sheds heat in summer.

11.1 What shade-cloth percentage means

Shade cloth is rated by the percentage of light it blocks. Higher percentages block more light, drop temperatures more, and slow growth of light-loving crops.

Shade %	Light blocked	Use case	Temperature drop under cloth
20 %	20 % blocked, 80 % transmitted	Pepper bloom-set summer cooling	4–6 °F
30 %	30 % blocked, 70 % transmitted	Tomato bloom-set, late spring lettuce	6–10 °F
40 %	40 % blocked, 60 % transmitted	Brassica summer hold, half-shade greens	8–14 °F
50 %	50 % blocked, 50 % transmitted	Summer lettuce in full sun, shaded transplant area	12–18 °F
60 %	60 % blocked, 40 % transmitted	Cool-season summer trial, light-loving crops will languish	15–22 °F
80 %	80 % blocked, 20 % transmitted	Storage area only; too dark for crops	18–25 °F

For most Dragoons summer uses, **30 % or 40 % shade is the right pick**. 50 % is appropriate for the most heat-sensitive crops (summer lettuce) but slows growth of everything else; below 30 % gives too little protection to be worth the cost.

11.2 Lath house — the traditional Southwest design

A lath house is a permanent structure made of wood slats (lath) spaced 1–2” apart, producing a roughly 50 % shade effect. The classic Southwest gardens of Tucson and Phoenix use lath houses to grow summer brassicas, transplant seedlings, herb beds, and orchids.

Material	Quantity for 10×10 lath house	Approx cost
4×4 posts, 8 ft	4	$40–60
2×4 framing, 10 ft	10	$40–60
1×2 lath strips, 8 ft	50	$50–80
6×6 concrete footings (or post anchors)	4	$20–40
Hardware	misc	$20
Total		**$170–260**

The lath house is the most durable shade structure — it has no plastic to replace, no fabric to UV-degrade, and weathers gracefully for 15–25 years. The 1×2 lath strips run east-west (the spacing creates striped shadow patterns that move across the bed during the day, giving plants both shade and light, which is gentler than uniform shade).

11.3 Shade-cloth retrofit on existing hoop houses

The simpler approach for a grower already using a hoop house for winter: in summer, **replace the 6-mil plastic with 30 % or 40 % shade cloth**. Same frame, same roll-up sides, same end walls — but a different cover. This makes the structure a year-round tool.

Cover for season	Material	Replacement frequency
Winter (Nov–Apr)	6-mil UV-treated greenhouse poly	Every 4–6 years
Summer (May–Oct)	30 % or 40 % shade cloth	Every 6–10 years

The transition happens twice a year. The cover swap takes 2–3 hours for two people on a 12×24 structure. The retained frame, baseboards, wiggle wire channel, and roll-up hardware all work for both covers. The cost of the second cover (30 % shade cloth for a 24×30 ft sheet) is $80–150.

This year-round approach is the highest-leverage use of a hoop house in the Dragoons — a single structure that produces salad in February and again in July.

> **LOCAL TIP**
>
> **The summer-shade-cloth-on-hoop-house pattern is the move that converts a “winter project” into a year-round tool.** The first season you do this, you discover that the 30 % shade cloth on a 12×24 frame produces July lettuce, August spinach, and a shaded nursery for pepper and tomato trans-

plants in late summer. The structure goes from earning its cost in 6 months a year to earning it in 11 months.

12 · Siting — where to put a structure

Solar orientation · slope · wind · access

Where you put the structure matters as much as how you build it. Siting decisions are nearly impossible to reverse — the wrong orientation costs you 30 % of your winter solar gain, every year, for the life of the structure.

12.1 The four siting axes

1. **Solar orientation.** Long axis east-west. This is the single most important siting decision.
2. **Slope and drainage.** Gentle south-facing slope is best; avoid frost-pocket low spots.
3. **Wind protection.** Leeward of an existing windbreak (mesquite hedge, fence, building).
4. **Access.** Water nearby, electricity if needed, easy walk from the house.

12.2 Solar orientation — long axis east-west

The Cochise County latitude is 31–32° N. The winter sun arc runs across the southern sky from southeast (sunrise) through south (noon) to southwest (sunset). A structure with its long axis east-west presents its long south wall to that arc all day — maximizing solar gain. A structure oriented north-south presents only its narrow end to the sun in the morning and again in the evening.

The difference in winter solar gain between the two orientations is roughly 25–35 %. For a hoop house that depends on passive solar to handle cold nights, this is the single biggest single-decision energy difference available.

Summer (when shade-cloth covers the structure) reverses the calculation: a north-south oriented structure self-shades and runs cooler. For a structure that is going to be used year-round with cover swaps, the east-west orientation is the correct compromise — winter solar gain matters more for the structure's economic case.

12.3 Slope and drainage

A gentle (3–8°) south-facing slope is the ideal site:

- The slope tilts the structure toward the sun, adding a few degrees of solar efficiency.
- Cold air drains downslope past the structure rather than pooling under it.
- Rainwater runoff runs away from the structure foundation.

Avoid:

- **Valley-floor swales and frost pockets.** Cold air pools here. A frost pocket can be 8–10 °F colder than a slope 30 ft above it. The same frost-pocket logic from Guide

9 §3 applies: if you observe frost forming first on the candidate site relative to the surrounding terrain, plant somewhere else.
- **Compacted soil under the footprint.** Whatever soil is under your hoop house in year 1 is the soil you garden on for the life of the structure. Soil prep before construction is the only time it is easy.
- **Drainage paths.** If runoff during the monsoon flows through the site, the structure floods. Trace the watershed before you commit to the location.

12.4 Wind protection

Wind dehydrates, lifts plastic, racks frames, and (in the Dragoons April–May wind season) routinely takes down poorly-anchored structures. Site leeward of an existing windbreak whenever possible:

- A mesquite hedge or grove on the prevailing-wind side (typically west or southwest in the Dragoons)
- A property fence with vegetation grown into it
- An outbuilding or barn on the prevailing-wind side
- A natural ridge or rise

The reduction in wind exposure of a structure sited 20–40 ft leeward of a windbreak is dramatic — the windbreak shadow extends about 5–10 windbreak-heights downwind. A 12-ft mesquite hedge protects a hoop house up to 60–120 ft downwind.

12.5 Access

Three considerations:

- **Water access.** A frost-free hose bibb within 50 ft. Drip irrigation lines (see Guide 13 chapter 11) run cleanly through the side of the structure under the baseboard.
- **Electricity (if needed).** For active ventilation, supplemental heat, or grow lights — a buried direct-burial cable from the house to a sub-panel near the structure.
- **Sight line from the house.** This sounds soft, but it matters. A hoop house you can see from the kitchen window is a hoop house you operate daily. A hoop house behind the barn is a hoop house with a closed-on-Friday problem.

13 · Permits, zoning, and the 200 sq ft threshold

Cochise County rules · setbacks · HOAs

Most Dragoons growers can build a backyard hoop house with no formal permitting. The relevant rules are simple, but worth knowing.

13.1 The Cochise County rules

Cochise County classifies hoop houses and similar agricultural structures separately from residential buildings. Three thresholds matter:

Structure size	Permit requirement	Notes
Under 200 sq ft total footprint	**No building permit required**	Includes most cold frames, low tunnels, and 12×16 hoop houses
200–600 sq ft	**Agricultural exemption usually applies**	Must demonstrate agricultural use; setbacks still enforced
Over 600 sq ft	**Building permit usually required**	Includes most high tunnels; inspection process applies

These rules apply to unincorporated Cochise County. Incorporated cities (Sierra Vista, Benson, Willcox, Bisbee, Tombstone, Douglas) have their own ordinances; check city planning offices for those.

The **200 sq ft threshold** is the most useful number for the backyard builder. A 12×16 hoop house (192 sq ft) is comfortably under it; a 12×24 (288 sq ft) is over it but typically still exempt under the agricultural use clause.

13.2 Setbacks

Agricultural structures in Cochise County must respect property-line setbacks:

Property type	Setback from property line
Rural residential (1+ acre lots)	25 ft
Suburban residential (under 1 acre)	10 ft (verify with planning)
Agricultural zoned	15 ft typically

The setback rule applies to the structure footprint, not to incidental shade. A hoop house 25 ft from the property line is compliant; the same structure 20 ft from the line is not, even if no one would notice.

13.3 HOA covenants

If the property is in an HOA or planned community, the HOA's covenants override the county's permissive rules. Common HOA constraints:

- Structures visible from the street prohibited
- Plastic-covered structures explicitly forbidden (this is the common one)
- Height limits (typically 8–12 ft)
- Color and visual-impact requirements

Read the HOA covenants before building. If the HOA prohibits hoop houses, lath houses (which look like permanent garden structures rather than greenhouses) often pass review where plastic structures do not.

13.4 Cochise County contacts

Office	Contact	What they handle
Cochise County Planning & Zoning	520-432-9240 (Bisbee main); cochise.az.gov	Building permits, setbacks, zoning verification
Cochise County Building Safety	520-432-9240	Inspections of permitted structures
Cochise FSA Office	520-364-5800 (Willcox) / 520-458-3192 (Sierra Vista)	Farm number for NRCS eligibility
Cochise County Health Department	520-803-3923	Greywater approvals if installed

LOCAL TIP

Call the planning office before you build, even for a small structure. The conversation is friendly, takes 10 minutes, and saves several thousand dollars in case-by-case worst-case outcomes. Explain the size, materials, and intended use ("a 12×16 hoop house, plastic on cattle-panel frame, for backyard vegetable production"). The standard answer is "no permit required, just respect setbacks." Document the call (date, time, who you spoke with). If a neighbor complains later, the documented call is your standard reply.

14 · Annual maintenance

Spring · summer · fall · winter

A structure that gets routine maintenance lasts 15–25 years; a structure that doesn't lasts 3–5. Most maintenance is light — an hour or two per season — but is the difference between a stable structure and one that fails in a wind event.

14.1 Spring maintenance (March–April)

Task	Frequency	Notes
Inspect plastic for tears and UV-degradation	Annual	Patch with greenhouse repair tape (3 mil clear, $20 per roll); replace plastic at 4–6 yrs
Check baseboards for rot	Annual	Pressure-treated lumber lasts 10–15 years in this soil; replace as needed
Tighten all fasteners	Annual	Wood swells and contracts; screws back out over a winter
Verify roll-up side function	Annual	Lubricate cranks; replace fraying rope
Inspect end-wall door hinges	Annual	Hinge wear is common; replace bent hinges
Replace foam weatherstripping	Every 2–3 years	UV-degrades faster than plastic

14.2 Summer maintenance (May–September)

Task	Frequency	Notes
Swap plastic for shade cloth	May (if using year-round)	2–3 hours for two people on a 12×24
Inspect shade-cloth seams	Annual	Most shade cloth degrades along the binding edge first
Monitor for rodent ingress	Monthly	Pack rats build nests inside hoop houses in summer; trap immediately

Task	Frequency	Notes
Refresh interior soil mulch	Annual	Wood chip mulch (Guide 11 chapter 7) blocks weeds and moderates soil temperature

14.3 Fall maintenance (September–November)

Task	Frequency	Notes
Swap shade cloth for plastic	September (if using year-round)	Before first cold-front forecast
Inspect frame for rust	Annual	Cattle panels develop surface rust at the bend points; clean with wire brush, paint with cold galvanizing spray
Verify thermal-mass barrels are full and topped off	Annual	Evaporation drops 55-gal drums 1–2 gal per summer; refill
Stake-down end-wall doors	Annual	Spring-wind hinge damage is the most common end-wall failure
Re-anchor any loose corners	Annual	Drive rebar deeper if soil has shifted

14.4 Winter maintenance (December–February)

Task	Frequency	Notes
Brush snow off plastic	After snow events	Rare in Dragoons but happens; 4” of wet snow on a 12×24 is 1,400 lb
Watch for ice on roll-up sides	After freezing rain	Don’t crank an iced roll-up — wait for thaw
Replace any failed Christmas-light strings	As needed	Heat-source maintenance for cold snap nights
Restock propane bottles	November + January	Mr. Buddy heater needs 1-lb bottles; keep 4–6 on hand

14.5 The replacement schedule

Component	Typical replacement interval
6-mil UV-treated greenhouse poly	4–6 years
Construction-grade poly	1 year
Row cover (AG-19)	4–5 seasons of use, stored dry
Shade cloth	6–10 years
Wiggle-wire strands	5–8 years
Wood baseboards (pressure-treated)	10–15 years
Cattle-panel hoops	15–25 years
EMT bows	20+ years
Steel kit frames	25+ years

15 · Cost-benefit by structure

CapEx · annual yield bump · payback

The final question: which structure is worth building first? The answer depends on the goal (chapter 1), but the cost-benefit math gives a defensible ranking.

15.1 The cost-benefit table

Structure	CapEx	Annual yield bump (retail $ value)	Payback period	Annual maintenance	Lifespan
Row cover stash (one roll AG-19)	$40–70	$50–150 (frost-saved harvests)	<1 yr	$0 (replace every 4–5 yrs)	4–5 seasons
Low tunnel system (3 beds)	$150–250	$150–400	1–2 yrs	$20/yr	5–10 years
Cold frame (4×8)	$100–170	$150–300 (seedlings + winter greens)	<1 yr	$10/yr	10–20 years
12×24 hoop house (cattle panel DIY)	$700–1,300	$800–2,500	1–2 yrs	$50/yr	15–20 years
12×24 hoop house (kit)	$1,400–2,500	$800–2,500	2–3 yrs	$50/yr	20–25 years
20×48 high tunnel (no NRCS)	$4,500–7,000	$3,000–8,000	2–3 yrs	$200/yr	25+ years
20×48 high tunnel (with 75 % NRCS)	$1,125–1,750 net	$3,000–8,000	<1 yr	$200/yr	25+ years
Lath house (10×10)	$170–260	$200–500 (summer crops)	1–2 yrs	$20/yr	15–25 years

Ranking by payback period:

1. NRCS high tunnel (if you qualify) — <1 year payback. The cost-share program transforms the economics.
2. Cold frame (4×8) — <1 year payback. The cheapest “real” structure.
3. Row cover stash — <1 year payback. The lowest-CapEx option.
4. 12×24 hoop house (DIY) — 1–2 year payback. The single best backyard return.

5. Low tunnel system — 1–2 years.
6. Lath house — 1–2 years.

The four-year-or-less payback structures are within reach for nearly every Dragoons grower. The 12×24 cattle-panel hoop house is the best single decision for someone who is past row cover and ready to scale.

15.2 The non-financial benefits

The cost-benefit table prices retail equivalent value, but several benefits don't fit on it cleanly:

- **Variety access.** A hoop house lets you grow Rocoto and Manzano and Asian greens that simply do not finish on the open Dragoons calendar. Some varieties are not available to a grower without a structure.
- **Reduced pest pressure.** A row-cover-protected bed has near-zero cabbage moth, flea beetle, cucumber beetle damage (Guide 10). The reduced spraying and crop loss is real value, hard to price.
- **Season-extension experience itself.** The first hoop house teaches climate management — vent management, thermal-mass behavior, cover-swap timing — in a way no other gardening activity does. The grower who builds one is a meaningfully better grower five years later.
- **Resilience to weather.** A late-March frost destroys an open peach bloom; the same bloom inside a hoop house survives. The 4-of-10-years frost loss in Guide 9 §5.1 drops to 0-of-10 under structure.

16 · Build plans — three concrete projects

Project A: Cold frame · Project B: Low tunnel · Project C: Hoop house

This chapter is the take-home reference: three full materials lists with cost ranges and step-by-step build sequences. Each project is sized for a Dragoons backyard.

16.1 Project A — 4×8 cold frame from scrounged windows

Goal: Protect 32 sq ft of cool-season greens; harden off March transplants; start February seedlings. South-facing wall recommended.

Materials list:

Item	Quantity	Source	Cost
2×12 PT lumber, 8 ft	2	Home Depot / Lowes Sierra Vista	$50
2×12 PT lumber, 4 ft (cut)	2	same	$30
Scrounged patio door, 28×76”	2	Habitat ReStore Sierra Vista	$40
3” exterior screws (1 box)	1	local	$10
Stainless hinges, 3”	4	local	$15
Foam weatherstrip	1 roll	local	$8
Lid prop stick (scrap)	1	from offcuts	$0
Automatic vent opener (Bayliss)	1	Farmtek	$55
Total			**$208**

Without the vent opener: $153. With fully scrounged lumber: $90.

Build sequence: See chapter 4.4 for the full sequence. Total time: one afternoon for two people, or one weekend day for one person.

16.2 Project B — 10×10 low tunnel for cool-season greens

Goal: Protect 100 sq ft of greens beds (two 4×10 beds with a path between, or one 8×10 bed); operate October through April; frost protection plus pest exclusion.

Materials list:

Item	Quantity	Source	Cost
1/2” EMT conduit, 10 ft	6 (one per 2 ft of bed)	Home Depot	$36
Hoop bender for EMT	1 (or borrow)	Johnny’s Seeds	$85 (or $0 borrowed)
Rebar 24” pieces	12	Home Depot	$20
AG-19 row cover, 10 ft × 25 ft	1	Johnny’s Seeds (online)	$55

Item	Quantity	Source	Cost
Landscape pins (8”)	24	Home Depot	$16
Sandbags, 5 lb	12	DIY from feed bags	$0
Total (with bender purchase)			**$212**
Total (bender borrowed)			**$127**

The bender pays back across multiple projects — if you plan more than one tunnel, buy it. If this is a one-off, borrow.

Build sequence:

1. **Mark and prepare beds.** Bed already exists. Pre-mark hoop positions at 2 ft on center along each bed edge.
2. **Drive rebar.** 12” pieces driven 6” into the soil at each hoop position (2 per hoop, one per side).
3. **Bend EMT.** Each 10 ft length bent with the Johnny’s bender into a 4 ft × 30” arch. 30 minutes for 6 hoops.
4. **Set hoops.** Slide each EMT leg over its rebar stake. The arch is now held by the rebar.
5. **Drape row cover.** Center over the structure; pull taut.
6. **Pin edges.** Pin one long edge first with landscape pins; weight with sandbags. Pin the other long edge; pin the two short ends.
7. **Stash spare cover.** Keep a second AG-19 piece folded by the back door for emergency double-layer cold snaps.

Total build time: 2–3 hours for one person; 90 minutes for two.

16.3 Project C — 12×24 cattle-panel hoop house

Goal: Walk-in structure for overwintering peppers and figs, year-round growing space, transplant starting, summer shade with cover swap. The Dragoons workhorse.

Materials list: See chapter 6.3. Approximately $700–1,300 in materials all-new, $400–700 with scrounged baseboards and basic poly end walls.

Build sequence: See chapter 6.4. Total time: two weekends for two people (about 22 hours of build work spread over four days).

First-season operating notes:

- Plant cool-season greens (lettuce, spinach, kale) October 1
- Start warm-season transplants (peppers, tomatoes, eggplant) inside the structure February 15

- Transition to summer shade cloth May 15 (cover swap, 2–3 hours)
- Plant summer salad greens under shade June 1
- Return to winter plastic September 15
- Bring in overwintering peppers (Guide 2 §10) October 1
- First-year retail-value yield: $800–1,200, depending on crop choice and intensity

17 · Closing — what a hoop house transforms

A first cold frame teaches you the rhythm of climate management. A first hoop house teaches you that the rhythm scales — that the same daily vent-and-close discipline you applied to a 4×8 box applies to a 12×24 structure, and the same cold-snap forecast that triggered an extra row cover at bed scale triggers an extra thermal-mass barrel at structure scale.

What changes at hoop-house scale is what becomes possible. A Rocoto stays alive 15 years instead of dying every November. A late-March apricot bloom finishes into fruit instead of into mush. An October pepper crop ripens through Thanksgiving. A January salad cuts the grocery list in half. A July lettuce bed proves that summer is not “off-season” — it is just the inverse problem.

The first one pays for itself in two seasons. By the third season it has paid for itself twice. By the tenth season it has paid for itself five times and is still standing. By the time the original plastic comes down for replacement, the structure has shaped half a decade of how you grow.

The Dragoons reward the grower who plans the structure first and grows in it second. The climate is genuinely hard at the margins — the late frosts, the April winds, the July afternoons. It is also genuinely friendly to passive solar season extension — the clear winter days, the cool nights, the dry air, the bright sun. A well-built structure leans into what the Dragoons gives and protects against what it takes. That is the entire trick.

Build the cold frame this fall. Build the hoop house next year. Apply for the high tunnel the year after that. Five years on, the gap between what your bed can produce and what you wish it could is mostly closed.

18 · Sources & references

A working library of useful resources for season-extension construction in Cochise County, in rough order of usefulness for a backyard builder.

Government and Extension

- **USDA Natural Resources Conservation Service (NRCS)** — nrcs.usda.gov. EQIP cost-share program; conservation planning; the high-tunnel funding pathway.
- **Arizona NRCS State Office** — Phoenix; 602-280-8800; nrcs.usda.gov/wps/portal/nrcs/site/az/ho
- **Sierra Vista NRCS Field Office** — Cochise County south. Call to confirm; 520-458-0303.
- **Willcox NRCS Field Office** — Cochise County north and Sulphur Springs Valley. 520-384-2229.
- **Cochise County Farm Service Agency (FSA)** — for the USDA farm number that NRCS eligibility requires; 520-364-5800 (Willcox) / 520-458-3192 (Sierra Vista).
- **Cochise County Planning & Zoning** — Bisbee main office; 520-432-9240; cochise.az.gov. Permit thresholds and setbacks.
- **University of Arizona Cooperative Extension — Cochise County** — Sierra Vista; 520-458-8278; extension.arizona.edu/cochise. Master Gardener program; horticultural bulletins.

Suppliers — online

- **Farmtek** (farmtek.com) — the catalog standard. Greenhouse plastic, frame kits, accessories, twinwall panels, automatic vent openers.
- **Bootstrap Farmer** (bootstrapfarmer.com) — competitive pricing; 6-year poly; complete tunnel kits; ships fast.
- **Johnny's Selected Seeds** (johnnyseeds.com) — Agribon row cover; hoop bender; tools.
- **A. M. Leonard** (amleo.com) — wider selection of cover materials; non-standard widths.
- **Rimol Greenhouse Systems** (rimol.com) — high-end kits at the high-tunnel scale.
- **Growers Supply** (growerssupply.com) — value-priced kits and components.

Suppliers — local Cochise County

- **BFI Farm and Ranch Supply** (Tombstone; 520-457-3334) — Agribon row cover; some 6-mil poly; cattle panels; rebar; lumber.
- **Tractor Supply Co.** (Sierra Vista, Benson, Willcox) — cattle panels; rebar; fencing; some structure components.
- **Bowie Co-op** (Bowie) — cattle panels; lumber; used drums for thermal mass.
- **Sierra Vista Ag Supply** (Sierra Vista) — orders greenhouse poly by request; 3–5 days.

- **Habitat ReStore** (Sierra Vista) — salvaged patio doors and window sashes for cold frames.
- **Home Depot / Lowes** (Sierra Vista, Benson) — lumber; EMT conduit; rebar; basic hardware.

Books and references

- *The Winter Harvest Handbook* — Eliot Coleman. The reference text for season-extension growing. Coleman's work is grounded in coastal Maine, but the protected-growing principles translate cleanly to the Dragoons.
- *Four-Season Harvest* — Eliot Coleman. The companion volume; more accessible for the backyard scale.
- *The New Organic Grower* — Eliot Coleman. Broader scope; chapters on hoop-house economics and crop rotation are directly applicable.
- *The Greenhouse Gardener's Manual* — Roger Marshall. The mainstream reference for greenhouse construction and operation.
- *Solviva* — Anna Edey. A more idiosyncratic but influential reference on passive-solar greenhouse design with thermal mass.
- *The Earth-Sheltered Solar Greenhouse Book* — Mike Oehler. Earthbag and walipini construction; the deep-dive reference.

Online resources

- **NRCS EQIP — High Tunnel System Initiative** (nrcs.usda.gov, search "high tunnel") — full program description and Practice Standard 325 documentation.
- **University of Arizona Cooperative Extension high-tunnel publications** (extension.arizona.edu) — Arizona-specific operation guidance.
- **High Tunnel Hoophouse forum** (hightunnels.org) — practitioner Q&A across climates including Southwest.
- **YouTube channels** — Curtis Stone (commercial market gardening with high tunnels), Diego Footer (Permaculture Voices interviews with high-tunnel growers).

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