Tractors 101 For Small-Scale and Beginning Farmers

By Mike Madison

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1. Mike Madison talking about tractors at his farm, Yolo Press.

It's always good to have help on a small farm, and one of the best helpers you can have is a tractor with its implements. One gallon of diesel fuel, routed through a tractor, will achieve as much work as a fit, adult human using hand tools achieves in 80 to 90 hours of labor. But if you haven't previously owned a tractor, buying your first one can be confusing. These notes are meant to clarify some of the issues.

Tractor Type

A given model of tractor can be set up as a row crop tractor, with tall skinny tires for tiptoeing through the crops; an orchard tractor, with wide, low profile tires so that the tractor can sneak under low hanging branches, and with exhaust system under the tractor rather than sticking up; or a utility tractor, which is intermediate. This depends chiefly on the wheels and tires. There are so many options (row crop, high crop, orchard, construction, utility; turf tires,

ag tires, construction tires) that Kubota ships tractors from Japan without wheels on them. The wheels and tires are added only when the local dealer places an order from the distributor (in Lodi, CA). If you're growing just row crops, you may want to opt for taller, narrower tires, which would make a smaller footprint in the field. If you have orchards, you need a low profile tractor.

2. An array of Mike Madison's essential tractors and implements

Cultivating Tractor

A cultivating tractor is a specialty tractor for row crops that has a mid-body tool bar, and is useful for marking beds, planting, and weeding. These tractors are light weight, low horsepower (15-30 hp) and very nimble. Visibility is increased by having the engine shifted to one side or behind the driver. Cultivating tractors have not been made since the 1980's (except for models currently in production based on the classic rear-engine Allis-Chalmers model G), so old ones are in demand. An advantage of these is that they turn around in a very tight space, so if you have short beds you can save room at the ends of the rows for turning around, compared to using a tractor pulling a cultivating sled.

3. Cultivating tractor with offset engine, mid-mount toolbar, and front weights. Rear tines set up to mark beds.

Crawler Tractor

If you're farming on steep slopes, a crawler (track-laying) tractor might be a good choice. These are heavy machines with a low-center of gravity, and consequently resistant to tipping over. They are also useful in an orchard because typically they are lower than wheel tractors, and so better able to navigate under low branches.

How Big of a Tractor Do I Need?

You need the smallest, lightest tractor that will readily do the work that you need to have done. Partly this is a matter of price. A bigger, more powerful tractor is more expensive, but even more, the implements are expensive. You might think that a 12 foot wide disc harrow would cost twice as much as a 6 foot harrow, but actually it costs five times as much. The prices go up exponentially. You should plan on spending half your budget on the tractor, and half on implements; with a bigger tractor, you might run up much higher costs than you were expecting by the time you add the implements.

For most small-scale specialty farms(< 10 acres), a tractor of 30-50 horsepower is suitable. On bigger acreage, a bigger tractor may justify its cost by savings on labor.

A second issue with the bigger tractor is soil compaction. Compaction is partly a question of pressure (pounds per square inch), so if you put really wide tires on a heavy tractor you could get the ground pressure down to that of a smaller tractor. But compaction also depends on total axle load regardless of pressure, so a heavier tractor will exacerbate compaction.

Engine

For the first half of the twentieth century pretty much all tractors ran on gasoline (or kerosene) with low compression engines. In the 60's diesel became increasingly popular, and by the 80's no one was making gas tractors any more--everything was diesel. Diesel engines have advantages of high torque, better fuel economy, and dependability. Diesel fuel is also more stable in storage. Because old gas tractors are not desired, they often can be had very inexpensively, and they are still perfectly useful for farming. I have two excellent older gas Ferguson tractors from the 1950's that cost about $2k each. Gas engines have the advantage that they are easier (and less expensive!) to work on than diesels.

Modern tractor diesel engines in California are required to meet stringent emission standards. The standards are stricter for more powerful engines, with requirements changing at 25 hp, 50 hp and 100 hp. So you will find many tractors of 24 hp, 49hp or 99hp where the manufacturer is sneaking under the threshold for tighter controls. Newer, larger tractors will require a catalytic emission cleaner using DEF (diesel engine fluid), a urea-based compound. Older tractors that are gross polluters may legally be confiscated. This is taking place county by

county. So far, the authorities are most concerned with retiring tractors of high hours/high horsepower.

Transmission: Standard, Shuttle, and Hydrostatic

There are three main options for transmissions (the transmission is what takes the power of the engine and directs it to turn the wheels). The first is a standard gear transmission. You might have 3 (or 4) forward gears plus one reverse, as well as a high range and low range, giving you 6 (or 8) forward gears and 2 reverse. So you have two levers--one for the gear, one for high/low range. (Pre-1960 tractors might lack the high/low option). Note that unlike a car, where you start out in first gear and shift up to higher gears as you gain speed, in a tractor you just choose the gear you intend to use for your task and start off in that gear.

The second option is a shuttle transmission. In this you have a gear selector (for example 4 gears), a high and low range, and a third lever for forward and reverse. So you would end up with 8 forward/8 reverse, or 12 forward/ 12 reverse, etc. The advantage of this is that if you are doing a lot of to-and-fro work (grading, mowing a complex shape, scraping out stalls) the shuttle is much easier to use than the standard gear transmission.

The third option is a hydrostatic transmission, which is somewhat like an automatic transmission in a car. Instead of using a gear box, the engine drives a hydraulic pump which in turn drives the tractor. Usually there are three ranges (high, medium, low). Forward and reverse is with a foot pedal. This is ideal for mucking out stalls in a livestock operation, or any other tasks requiring a lot of front-loader work. The loader requires three hands: one to steer the tractor, one to operate the loader, and one to shift back and forth from forward to reverse. By having the forward/reverse on a foot pedal, a skilled operator can work very efficiently with a loader. On the negative side the hydrostatic transmission is more expensive than a gear transmission to purchase, and it is less efficient, i.e. requires more fuel to do the same amount of work.

Tractor Gears

Row crop tractors may have as many as 16 or even 24 forward gears. Why so many? For many tasks that the tractor does it must move at a very specific ground speed. At the same time, the engine should be operating at its optimum speed so as to generate maximum power and efficiency. In order to have different ground speeds at a particular engine speed, you need a lot of gears. You can't achieve low speed simply by slowing down the engine with the throttle, because then the engine is working at low power and low efficiency. On a small farm with an older tractor, the lack of low gears can be a problem. One mile per hour sounds slow, but it is 88 feet per minute, which is too fast for many implements (spading machine, mechanical transplanter, pepper harvester). Older tractors with few gears may not be able to operate slowly enough. This is another area where hydrostatic transmission may be advantageous, as you can have full engine power at a very low ground speed. In fact, the first hydrostatic transmissions were on big IH row crop tractors for precisely that reason.

Three Point Hitch

In the early days of tractors the tractor just had a drawbar at the back, and it dragged the implements around, as if the tractor were simply an iron horse. In the 1930's an Irish engineer, Harry Ferguson, invented the three point hitch which allows the tractor to pick up the implement from the ground to move it about, and also to regulate its depth while working as well as its angle to the ground. By the 1950's most manufacturers had some version of a hitch, and the farmer had to buy his implements from the same company his tractor came from in order to have compatibility of the tractor hitch and the implement. In the mid 1960's, the manufacturers got together and standardized the geometry and pin diameter of the three point hitch. There are five categories of size (zero, 1, 2, 3, and 4). Tractors in the 20 to 50 hp range are category 1; those of 40-100 hp are category 2. You can use a category 1 implement with a tractor that has a category 2 hitch, but not vice versa.

Because the hitch features are standardized, you can use implements from any manufacturer on any kind of tractor (provided they are of the correct hitch category); for example, a John Deere mower on a Ford tractor, or a Kubota rototiller on a Massey Ferguson tractor. So you needn't feel compelled to buy your implements of the same brand as your tractor. But if you have an older tractor (1940's, 1950's) you might be limited in your choice of implements because of its specialized hitch.

PTO

There are two mechanisms by which the tractor imparts work to the soil or crop. Either it can drag the implement (e.g. plow, harrow, wagon) in which case power is transmitted through the tractor's wheels to the ground; or it can drive the implement with a shaft that turns some rotary portion of the implement (rototiller, mower, pump, generator, feed mill). To get power from the engine to a rotating implement, the implement shaft is connected to a device at the back (or front) of the tractor called a 'power take off' (PTO). Like the three point hitch, the geometry of the PTO is standardized across brands (although note: standing behind the tractor and looking at the PTO in action, it turns clockwise; however, there were some Japanese tractors in the 1960's and '70's that had a counterclockwise PTO, which would make your implements run backwards. Luckily, these are rare in the USA).

4. A rototiller with PTO attachment

The PTO is engaged by moving a lever (with the clutch pedal pushed in). Implements are designed to run at a standard PTO speed of either 540 rpm or 1000 rpm, depending on the implement. Some tractors have a choice of PTO gear for these two speeds, but most smaller tractors have just the 540 rpm option.

There are three mechanisms for getting power to the PTO from the engine: transmission, live, and independent. The oldest (and problematic) system was the transmission mechanism, in which the PTO was directly run by the transmission. Think of it like this: you have three things in a row: the engine, the transmission, and the implement. If you push in the clutch pedal, you disconnect the engine from the transmission, but you do not disconnect the transmission from the implement. Because of this, the momentum of the implement can drive the transmission and make the tractor continue forward when the clutch is depressed, and the tractor fails to stop when you want it to. That is, the momentum in the mower, for example, drives the tractor into the fence or the ditch even though you have depressed the clutch. This can be remedied by adding a device called an 'over-running clutch' to the PTO. This type of PTO is found on older tractors (pre 1965).

The second mechanism for driving the PTO is called a 'live PTO'. In this case there is a two-stage clutch; when you depress the clutch pedal it separates the engine from the transmission as well as the transmission from the implement.

The third option is the 'independent PTO', in which the PTO is driven by a hydraulic pump rather than by gears. This is slightly less efficient than a live PTO in transmitting engine power to the implement. **Either a live PTO or an independent PTO is suitable on a small farm**.

Options

For plowing, ripping, and harrowing, or any other heavy work that involves dragging a device through the soil, **four wheel drive** is advantageous. You can use a much lighter tractor to achieve the same result that you could with a tractor of two-wheel drive. For an implement that is run by the PTO (e.g. mower, rototiller) there is no need for four wheel drive.

Power steering was an option until it became standard in the 1980's. It makes a tractor much easier to drive. On many older tractors power steering is uncommon, but worth the extra cost if you can find it.

Commonly new smaller tractors come equipped with a **front loader**. This is a necessity if you have a livestock operation and are moving feed and mucking out stalls. For a row crop or orchard operation, the loader may be an obstacle, obstructing your vision, getting in the way of branches or preventing tight turns. I have five tractors on my farm, and no front loader.

Why Not a BCS?

I'm not a fan in the sense that the BCS only does some of the work and you do a good amount of work moving it around. You can also get a great used tractor for much less than a new BCS tiller. It makes more financial and health sense to get a tractor, especially as you get older.

5. BSC tiller

6. Front end weights on a tractor.

If you do not have a front loader, you will need **front end weights** to counterbalance the weight of an implement being picked up by the three point hitch; without weights, a very heavy implement could lift your front wheels off the ground, or make steering less secure. If you are buying a new tractor, skip the weights (about $2 per pound from the dealer) and buy them used off Craigslist (40 cents per pound). Tractors can be ballasted with heavy wheel weights as well as by putting a salt solution ($CaCl_2$) in the tires. The total tractor weight can be doubled with a full complement of ballast. The motivation is to increase traction by increasing weight, as well as increasing stability. However, the heavy weight also increases soil compaction. My preference is to keep my tractors light.

By law, tractors sold in the US have a **roll-over protection structure (ROPS)** to protect the driver in case of roll-over or back flip. Older tractors may lack a ROPS. Modern orchard tractors have a ROPS that can be folded down so that it does not get hung up in low branches. If you are using a tractor in the orchard that does not have a folding ROPS, you might have to remove the ROPS for clearance. Understand that in doing so you have defeated a safety feature, and you will need to be especially careful when driving on slopes or near ditches and obstacles.

Buying a Tractor

Tractors, if well cared for, are nearly indestructible. More than half of the tractors manufactured in the 1950's are still working. So buying a used tractor is a more secure proposition than buying a used car. You can get an excellent used tractor for $5,000 that will last the rest of your life. Typically, a smaller tractor has a working life of about 6,000 hours; a bigger tractor (100 hp) has a working life of 12,000 hours. So a used tractor with 2500 hours on the clock still has a lot of life left in it. (Note that the number indicator on the dash refers to hours of operation, not miles driven).

Keep in mind that you should allow half of your equipment budget for the tractor, and half for implements. For small scale vegetable or flower production, the minimum list of implements would be a chisel plow, a rototiller, a tool bar, a flail mower, and probably a trailer (for moving stuff around, and for bringing in the harvest).

7-11: (Top left, clockwise) Essential implements for small-scale production include a flail mower, disc, spring tooth harrow, rototiller bed shaper, and cultivator.

A tractor is one part of your farming system, and you should have the whole system in mind when you are buying the tractor. All of your equipment needs to work together. In the central valley, the standard bed width is 60 inches (from the center of one bed to the center of the next) and so tractors are set up with a tread width (center of one rear tire to center of the other rear tire) of 60 inches, to match the beds. A smaller tractor will work one bed, a larger tractor will work three beds at a time. In the Salinas valley and on the central coast, 40 inch beds are standard, and tractors are set up with 80 inch tread width to work two beds at a time. In other parts of the country, 36 inch and 48 inch beds (e.g. tobacco) are used. You need to decide what bed width you are going to use, and then get all of your equipment to work with that width. (Note that tread width of the tractor is adjustable by reconfiguring the two-part wheel rim).

What combination of tractors do I use on my 5-acre farm?

A 35 HP tractor for basic tilling

A 2-wheel drive tractor with PTO for mowing

A Ferguson gas tractor for pulling a trailer for harvesting large crops (like watermelon)

Brand

As with automobiles, there has been great consolidation in tractor manufacturing over the last 40 years as formerly distinct brands are melded into multinational corporations. CNH (headquarters Turin, Italy) includes the brands Case, International Harvester, New Holland

(formerly 'Ford') and Fiat, as well as others. AGCO (headquarters Duluth, Georgia) includes Massey Ferguson, Challenger (formerly the ag division of Caterpillar), Oliver, Hesston, Minneapolis Moline, and others.

Most tractor manufacturers make only part of their line themselves; the rest are supplied by others (Kubota is an exception, making all their own tractors). For example, smaller John Deere tractors are made by a Japanese company--Yanmar. They are pure Yanmar tractors; what makes them John Deere is green paint. Some larger John Deere tractors are made in India by an independent firm. Similarly, smaller New Holland tractors are made in Korea by LS. Most small tractors (less than 40 hp) are made in Asia or Europe, somewhat larger tractors (40-90 hp) are made in Asia, India, the USA, and Europe, and the biggest tractors are made in USA and Europe. There are also a few models made in many other countries: Turkey, Brazil, South Africa, Kenya, etc.

If you are buying a new tractor, you may get a better price by going to the true manufacturer; for example, buy a Yanmar from a Yanmar dealer instead of from John Deere (red instead of green), or an LS tractor from an LS dealer instead of New Holland. You can save a few thousand dollars for the nearly identical equipment.

I would be reluctant to buy a tractor made in China or Eastern Europe, but other than that the standard brands all make good tractors.

Buying a New Tractor

A new tractor will meet emission standards, it will have a warranty, and it should give you years of trouble-free use. But it is expensive. Do not be seduced by offers of 0% financing for 84 months. It's not really 0%, since if you pay cash they will knock a few thousand dollars off the price. And 84 months is a long time--those payments are relentless. It's a common and tragic error for a starting farmer to buy all new equipment for $50k or more, and then be unable to make the payments.

If you do wish to buy a new tractor, do your homework and figure out exactly what you want. Then e-mail or call the sales manager at several dealerships and ask for a bid.

If you do wish to buy a new tractor, do your homework and figure out exactly what you want. Then e-mail or call the sales manager at several dealerships and ask for a bid. You may save even 20% or more off the list price. Here's an example of a request for bid: 'Kubota MX5200, 4 wheel drive, R1 ag tires, 13.6 x 28 rears, 8x8 shuttle transmission, drawbar with clevis, no front weights, no loader, under-the-tractor exhaust; Cash purchase, to be picked up at time of payment (date). Please reply by (date)'. I did purchase a new tractor this way; the low bid was $13,400; the high bid was $17,800.

Buying a Rental Return

In California, many growers of grapes and stone fruit lease small tractors at harvest time and then turn them back in after harvest, rather than maintaining a fleet of tractors that they own. The result is that there are a lot of lightly used tractors (typically 100 hours on the clock) in the 25-60 hp range available for sale, particularly in October and November. They will still carry the remainder of the warranty. These are a very good deal, usually about 20-25% off list price. The price is usually firm, and not subject to negotiation, but you might get a break if you purchase a loader or implements at the same time.

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A good place to look for lightly used tractors is Tractorhouse.com. A few individuals list on this site, but most of the listings are from tractor dealers who have rental returns, trade-ins, or other late model tractors with low hours of use. A friend who deals in tractors, and who favors this site, told me that he thought the best value point was a tractor a few years old with 1,000 - 2,000 hours on the clock at about half the original price.

Buying Used Tractors on Craigslist

There is a lot of trash for sale on Craigslist, as well as some good bargains. You really need some expertise about what you're looking at. If you don't feel confident, get some help from someone knowledgeable. For starters, at least a third of the tractors on Craigslist are incorrectly identified as to make, model, and year, (especially the common old Ford tractor models 9N (1939-1941), 2N (1942-1947) and 8N (1948-1952)). I believe this is more ignorance than deception, but you need to verify what it is that you are looking at. Some people have absurdly exaggerated notions of the value of their tractor, and you should also consult someone knowledgeable about current prices so that you don't overpay.

How to test a used tractor

When you check out a used tractor, drive it in all of the gears, verify that the hitch goes up and down (preferably with an implement attached) check the PTO, look for oil leaks, exhaust smoke, etc. --all the usual things. Examine the tires--a new set of tires costs minimum $1,000, and it could be quite a bit more. If you're happy with the tractor, make an offer that you think is fair. If you can't come to an agreement on the price, offer to split the difference (if that works for you). If not, walk away, but leave your phone number--the seller might relent.

In looking at tractors on Craigslist, study the background in the photographs. If the place is a mess with junk strewn around and piles of unfinished projects, you can assume that the tractor was not well maintained. If the tractor is parked neatly in a shed, the floor swept, and tools hanging in order on the walls, those are signs that the owner is compulsive and orderly and probably the tractor was properly maintained.

Buying at Auction

This can be a good option for those of you with nerves of steel. Go to the farm on the inspection days ahead of the auction, carefully evaluate the equipment, do your homework on it, and in a cool-headed mood decide on your maximum price. At the time of the auction, if your maximum price is surpassed, drop out. Occasionally an item sells for far below its market value, and this is part of the attraction of auctions. I watch the farm auctions in the Central Valley, and it strikes me that prices for smaller-scale equipment tend to be high, sometimes surprisingly so. Most of the bargains are on larger equipment.

Some Tractors to Look Out For (and Some to Avoid)

Just as with cars, there are models of tractors that have reputations for outstanding reliability, and others that are problematic. Possibly the greatest small tractor of all time is the Massey Ferguson 35 (which morphed into the 135, 235, and 245, the numbers reflecting changes in sheet metal, while the underlying tractor remained the same) with a 3 cylinder Perkins diesel engine of about 45 horsepower. This tractor has been in production since 1960, and is still in production, with a few changes, in India, East Africa, Turkey, and Brazil. It is simple, perfectly designed, and completely reliable, and is in use all over the world. The 35's big brother, the 65 (165, 265) is also good.

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12. Massey Ferguson tractor.

Another good choice is any of the older two-cylinder John Deeres with a three point hitch. These are simple, reliable, gas tractors with a distinctive engine sound (pop, poppity, pop). Later John Deeres with diesel engines, made by Yanmar, are also excellent.

The commonest old tractors are the flat-head Fords (9N, 2N,8N). They're okay as a cheap tractor for pulling a trailer, but not ideal for farming, with only three (or four) gears, and usually lacking a high range/low range option. The similar looking Ferguson tractors of the same era are much superior, with an overhead-valve Continental engine. Ford switched to

overhead-valve engines with the model NAA in 1953. From the late 70's to 2000 Ford made some excellent diesel tractors in the 45 to 60 horsepower range. These include the 2910, 3910, 3930, 4600, 4610, and 4630. Only at the very end of the run was four wheel drive available. Any of these in good condition would be suitable on a small farm.

13. Kubota MX 4700 Tractor.

Any Kubota tractor of the 'M' series is a good choice. In the 'L' series, those with numbers above 2800 are good. The smaller 'L' tractors, as well as the 'B' and 'BX' series will often turn out to be too small for many farm tasks, although they may be excellent for working in tight space inside a greenhouse or high tunnel. Kubotas tend to have very high resale value, so for a used tractor a different brand might be a better bargain.

The most desired off-set cultivating tractors are the diesel-powered Deere 900 Hi-Crop and the Kubota 245H High Clearance. These haven't been made since the early '80s, and they are rare and expensive. The offset Farmalls with gas engines (Cub, A, SuperA, 100, 130, and 140) are common and inexpensive, and they are simple, reliable useful tractors. Farmall's ('Case-IH' by then) first venture into a diesel cultivating tractor was the 274. These had a problem-plagued Nissan diesel engine that was soon taken out of production; parts are difficult or impossible to find. The failed 274 was followed by the 265 with a Mitsubishi diesel. The 265 is an acceptable tractor. The rear-engine Allis-Chalmers Model G (1948-1953) with a Continental gas engine is a classic, useful cultivating tractor. Modern variations of the G are currently in production by three manufacturers (Tuff-Bilt, Tilmore, and Ogun).

From 1939 to 1979, Detroit Diesel made two-stroke diesel engines ranging in size from 2-cylinder to 16-cylinder. They have a distinctive high-pitched scream of an engine noise, and they were gross polluters. They found their way into a number of tractors, including those made by Deere, Allis-Chalmers, Oliver, and Minneapolis Moline. They are interesting as artifacts of the history of technology, but are not a good choice for a modern farm. In California they are likely to be confiscated by the state as gross violators of air quality standards.

There are some sophisticated and complex walk-behind tractors made in Asia, but these are not available in the USA. And the walk-behind tractors that are available here are better suited to a home garden than to a farm. It requires considerable strength and energy to use a walk-behind--by no means does the machine do all the work. And for the price of a new walk-behind (e.g. BCS) you could buy an excellent used four-wheel tractor, which is the better choice.

Tractor Number Two and Beyond

One good tractor and a collection of implements is all you really need on a small farm, but there are good reasons to have additional tractors. With one tractor, if you have a complex mix of crops, you may spend a lot of time swapping implements--time that could be saved if you had several tractors. An inexpensive older tractor used just for pulling a trailer can be very useful for moving stuff around the farm and bringing in the harvest. I have a 1951 Ferguson TO-30 (cost $1500) and a 5 x 10 trailer (cost new $1500) that I use in this way. They are an inexpensive alternative to purchasing a utility vehicle (Kubota RTV, $12,000) which has a much smaller cargo capacity.

14. A Ferguson TO-30 tractor pulling a trailer

A dedicated cultivating tractor set up for your standard bed and crop spacing is a very useful second tractor. It will also use very little fuel compared to a big 4 wheel drive tillage tractor pulling a cultivating sled.

A Short Note on Maintenance

Caring for your tractor is not difficult. Change the oil every 200 hours and the other fluids every 800 hours. If you are working in dusty conditions, clean the radiator screen, the radiator, and the air filter *several times every day*. A clogged radiator can cause the engine to overheat, potentially catastrophically (blown head gasket, warped head). If the air filter is not maintained, dust can be sucked into the engine, radically shortening its life, or it can cause the engine to run with insufficient oxygen, leading to poor power, carbon build-up, and excessive exhaust pollution.

Check tire pressure occasionally. Tractor tires are designed to run at low pressure (12-14 psi). Over-inflation can greatly increase problems of soil compaction.

On the Down Side

Any device that burns fossil fuels contributes to air pollution, noise pollution, bad foreign policies, oil wars, and climate change. Moreover, you cannot use your tractor without causing unintended damage. You may unwittingly kill beneficial animals (insects, frogs, snakes) and destroy the nests of birds and other animals. And you cannot use the tractor without causing some measure of soil compaction.

For these reasons one can make a compelling ethical and aesthetic case for farming with hand tools only. The problem with that is that in modern California the high cost of labor and low cost of fossil fuel makes it very difficult to survive economically by using hand labor in place of machinery. The best possibility is a diversified fruit orchard (citrus, stone fruits, persimmons, olives, etc), with perhaps a few sheep to maintain the orchard floor; for annual row crops, to make a living with hand labor only would be very difficult. A love/hate relationship to your tractor is entirely appropriate. On the one hand, it is an interesting and ingenious device that increases the productivity of your labor and makes your life easier; on the other hand, it is an integral part of a technology that is destroying the planet.

Photo Credits

1-4, 6-14: Margaret Lloyd
5: BCS Tiller *http://cdn3.volusion.com/ksrw4.hvr2v/v/vspfiles/photos/BCS-722-2.jpg?1499899102*