Min till Techniques

An opportunity to reduce tractor costs

Min till techniques are often adopted in order to facilitate work organisation on the farm, or for various agronomical reasons. Such techniques can also help significantly reduce machinery costs. Indeed, tractor costs can be considerably lowered, provided, however, that the capital invested in machinery or tractor time are also noticeably reduced.

Soil cultivation and drilling work account for around 60% of machinery costs and a large proportion of labour requirements.

The economic situation gives rise to many uncertainties for agriculture: evolution of prices, permanence of subsidies... Several approaches are possible in order to keep a farm's revenue stable. Reducing machinery and labour costs is most probably the route which gives most room for manoeuvre since those costs represent up to around 45% of the production cost of one tonne of wheat. Among machinery expenses, motor equipment costs are the heaviest. Crop establishment costs, including soil cultivation and drilling, as well as the associated tractor work, represent around 60% of machinery costs. Crop establishment also represents a large proportion of labour requirements.

Better utilisation of equipment and labour

There are three main possible approaches to reducing machinery and labour costs. The first one consists of a better utilisation of equipment. In France, most tractors operate very little, around 200-300 hours per year. This under use means that the weight of machinery costs (depreciation over time, financial expenses) is "diluted" over a small number of hectares or hours of use. There are various ways to better utilise equipment: pooling of equipment by several farming businesses through different legal arrangements, using a contractor, or renting the equipment at the time of need… For example, grouping the equipment fleet of two 150 ha farming businesses often helps to halve the amount of equipment present, without incurring any risks. This usually generates cost savings of around 100 euros/ha/year.

Using min till techniques has the advantage of reducing machinery costs and freeing up time.

Better utilisation of labour is another possible approach. It is a source of additional revenue that many farmers have already explored. This can be achieved through the creation of a new workshop on the farm, like diversification into new plant or animal production, agro-tourism… Some farmers carry out contract work for other farming businesses, which is a way of better utilising their equipment and time. Considering the large part played by tractors in machinery costs, using minimum tillage is an obvious way of reducing costs, including eliminating the most costly operation, namely ploughing. This has the added financial advantage of freeing up labour time which can be utilised elsewhere… In this article, we have tried to calculate the costs generated by eight crop establishment sites, ranging from ploughing to direct drilling. It is worth mentioning that all eight techniques presented here, if they are correctly implemented, produce similar yields.

Cereal rotation

To carry out comparative calculations between the different cropping techniques, we based the experiment on an equipment amortization area of 200 ha and an oilseed rape-wheat-spring barley rotation. The soil, with a medium texture like clayey silt, requires tractor power of 30 hp per plough body. The soil tends to be deep and stone free, which can produce crops with good potential. But in turn, large amounts of straw are returned to the ground and the lack of stones makes residue management more difficult.

The method used to calculate crop establishment costs is described in the insert “some performance indicators”, next page.

The results for each of the eight techniques are outlined on the following pages. Agronomical comments have been added since they are obviously also important when choosing a technique.

Overall costs explained by tractor costs

When analysing machinery costs, capital investment for equipment emerges as one of the main factors. We decided to adapt traction for each crop establishment technique, in order to optimise means of production.
This, of course, involves adapting tractor power to the requirements of the tools in the equipment fleet. We also modified the number of tractors, including making do with one less tractor in the min till scenarios. In such cases, usage time is better spread out over the whole year and there is no longer the need to jointly manage ploughing and drilling operations at the same time of the year. Soil cultivation, essentially stubble cultivation, is planned ahead of sowing time. It is not unusual for farmers who have abandoned ploughing, to reduce their number of tractors. This choice is not a short-term one, but rather a medium-term decision, for instance when the need for replacing a tractor arises. Keeping the soil cultivation unchanged, the decision to reduce the equipment fleet by one tractor has the following consequences in our example: reduction in capital investment of 400 €/ha, reduction in power of 0.9 hp/ha, reduction in machinery costs of 30 €/ha/year. Those differences created by the presence of one extra tractor largely explain the differences noted in our examples, between ploughing and min till. This important fact must be kept in mind! The difference in the amount of labour time devoted to work in the field also leads to considerable variations in cost. Min till techniques, requiring specialised equipment, help, in our example, to really reduce tractor hours, (around 1 hr/ha). This results in savings of around 20-30 €/ha/year in terms of machinery costs. In our example, conventional equipment used with min till techniques must cope with large quantities of straw to manage. This requires careful and more expensive cultivation than with specialised machinery. Rechopping of the straw is added into our calculation. In the situation we chose, we noted fuel savings of 20 l/ha between ploughing scenarios and those implementing the most “simplified” techniques, such as direct drilling. This figure could be slightly greater if it also took into account differences attributable to the reduced number of trips on the road (to and from the fields).

Operational costs can also be affected by soil cultivation techniques, mainly due to the impact they can have on weed control. The differences, however, vary greatly depending on the rotation, cropping techniques and farmer’s attention to detail… For instance, the discrepancies averaged 17 €/ha in an AFPP (French Association of Plant Protection) survey in Burgundy and Lorraine regions, with a rotation based on oilseed rape - wheat - winter barley. Those results, obtained in one of the situations least favourable to min till techniques for weed control, showed great differences between farmers. Some of them managed to come up with some of the lowest weed control costs even though they were not ploughing.

Conventional equipment used with min till techniques often has to cope with large quantities of straw, requiring careful and more expensive cultivation than with specialised machinery.

To significantly reduce machinery costs, either reduce the level of capital invested in the equipment fleet, or reduce tractor time quite considerably.

Work organisation determines some of the choices

Conclusions drawn from the comparison of two soil cultivation techniques must never be generalised. They are all based on numerous hypotheses, such as the size of the farm, soil type, rotation, equipment fleet and cropping techniques of each case study… There is nothing better than calculations based on one's own situation!

There is however one fundamental principle. To significantly reduce machinery costs, either reduce the level of capital invested in the equipment fleet, or reduce tractor time quite considerably. In some cases, the way min till techniques are implemented does not help to really reduce machinery costs. Conversely, some cases are textbook examples, where tractor costs are reduced as much by the available power in hp/ha as by labour time inputs.

The margin is however not the only factor considered when choosing a technique. Labour time input and work organisation are factors that are often even more important. Some agronomical factors can also help in the decision process. Moreover, we worked on case studies carried out in different regions, with different soil, rotation, and farm business types. The size of the area over which the equipment fleet could be utilised were also be broached. Those results will not be introduced in this article.

Some performance indicators

Capital investment in equipment: expressed in euros per hectare, it quantifies the total amount invested, in value as new. The higher this amount is, the higher "fixed" machinery costs are: depreciation over time and financial costs. In our examples, we take into account soil cultivation-drilling equipment, as well as tractors.

Tractor power: expressed in horsepower (hp) per hectare. The cost of automotive tools accounting for most of the investment, the number of horsepower per hectare is an easily calculated indicator of the level of investment in equipment. In our examples, we only take into account tractor power.

Fuel consumption: this is the most visible part of machinery costs, although, it does not even account for 10% of it. It is however, a good indicator, directly linked to tractor power and time. The consumption levels given in our examples correspond only to the fuel needed for soil cultivation-drilling operations in the field, exclusive of trips to and from the fields.

Labour and machinery time inputs: expressed in hours per hectare. This is important on two counts as it includes equipment wear and tear as well as labour requirements. Concerning the latter, the concept of work load peaks can be characterised by labour time inputs at sowing time (drilling and other work carried out just before, such as ploughing or non-selective weed control).

The issue of labour for arable farming is not so much a question of accumulated working time as of poor distribution throughout the year. The figures given in our examples only take into consideration soil cultivation-drilling work in the field.

Machinery costs: they include various items: depreciation over time, depreciation through wear and tear, maintenance costs, fuel… Equipment costs are calculated including so-called "technical" depreciation, i.e. the depreciation of a tool varies in length depending on its level of usage. We took into account soil cultivation-drilling work in the field as well as sprayer work during the intercropping season.

Non-selective herbicides: their cost is included because there are some cost transfers with machinery, for instance between "mechanical" and "chemical" weed control.

Labour costs: when some working time is freed up by not ploughing, there are various possibilities for utilising this time: savings on salaried manpower, additional revenue from a new activity, comfort, leisure time, free time for training and farm improvement... Faced with a huge array of possibilities for labour costs, we used an average value of 15 euros per hour, based on the time spent in the field.

Crop establishment costs: this is the sum of machinery and labour costs to which weed control costs are added.

Crop establishment site N°1: ploughing

Capital investment in equipment	1590 €/ha
Tractor power	2.3 hp/ha
Fuel	32 l/ha
Labour and machinery time inputs of which drilling time	2hr/ha 1hr 05mn/ha

Machinery costs	187 €/ha
Non-selective herbicides	0 €/ha
Labour costs	30 €/ha
Crop establishment costs	217 €/ha

Strengths

- Easily managed and reliable system
- Facilitates weed control
- Systematic and deep soil restructuring
- No viable plant or weed residue in the seedbed at sowing time
- Facilitates late crop establishment in autumn in wet conditions

Weaknesses

- High labour and machinery time inputs as well as cost, especially in clayey soil
- Significant labour requirements
- No surface residue encourages capping in some soils
- Deep incorporation of organic matter
- Coarse seedbed if soil is clayey
- Stones tend to come to the surface if soil is very stony

Agronomical characteristics

- Crop establishment after ploughing is still the most common practice. It is the easiest to manage in so far as the plough “erases” a lot of mistakes.
- This type of crop establishment is often reassessed now because ploughing is labour intensive and requires a great deal of tractor power.
- The disadvantages attributed to ploughing (bare soil, incorporation of organic matter) can lead to abandoning this operation or, more simply, to improving its use, by reducing ploughing depth and refining the setting of skim coulters.

Additional information

3 tractors with 180, 150 and 120 hp. 4.50 m disc harrow. Plough with 6 x 18’’ bodies. Rotary harrow + 4 m shoe drill. Annual ploughing to a depth of 25 cm.

Crop establishment site N°2: shallow ploughing with stubble plough

Capital investment in equipment	1510 €/ha
Tractor power	2.1 hp/ha
Fuel	27 l/ha
Labour and machinery time inputs of which drilling time	1hr 50mn/ha 1hr/ha

Machinery costs	174 €/ha
Non-selective herbicides	0 €/ha
Labour costs	27 €/ha
Crop establishment costs	201 €/ha

Strengths

- Faster and cheaper ploughing than conventional ploughing
- Multipurpose stubble cultivator for stubble cultivation and ploughing
- Organic matter less diluted and stones do not tend to come up to the surface as badly as with conventional ploughing
- Turning soil over facilitates weed control

Weaknesses

- Stubble cultivation tool is slow and leaves the soil bare
- Ploughing not suited to large amounts of plant residue
- Not enough soil restructuring in cases of deep compaction
- Difficult stubble cultivation in dry conditions

Agronomical characteristics

- This system is a compromise. It helps move towards more shallow soil cultivation, and helps lessen organic matter dilution by reducing ploughing depth.
- Turning the soil over facilitates weed control.
- The development of stubble ploughs is particularly noticeable in organic farming. They help reduce cultivation depth while still managing to control weeds by turning the soil over.

Additional information

3 tractors with 150, 150 and 120 hp. Plough with 10 x 11’’ bodies. Rotary harrow + 4 m shoe drill. Annual ploughing to a depth of 15 cm.

Crop establishment site N°3: occasional ploughing

Capital investment in equipment	1590 €/ha
Tractor power	2.3 hp/ha
Fuel	28 l/ha
Labour and machinery time inputs of which drilling time	1hr 45mn/ ha 0hr 50mn/ ha

Machinery costs	182 €/ha
Non selective herbicides	2 €/ha
Labour costs	26 €/ha
Crop establishment costs	210 €/ha

Strengths

- Choice between establishing crops with or without ploughing, depending on circumstances
- Work organisation is easier as workload peaks are more limited, especially in autumn
- Easier weed control, even if ploughing only occurs every 3 to 4 years
- Summer or autumn crop establishment is made easier when the weather is dry.

Weaknesses

- Less of a reduction in tractor time
- Equipment fleet cannot be rationalised
- Limited savings in terms of machinery
- Soil still behaves very similarly to ploughed soil (trafficability, levelling, etc.)

Agronomical characteristics

- Alternating between ploughing and minimum tillage depending on the circumstances, is becoming the most common practice. It allows the farmer to choose the best technique. Work organisation is made easier, without taking any risks. However cost reduction expectations must be limited.

Additional information

3 tractors with 180, 150 and 120 hp. 4.50 m disc harrow. Plough with 6 x 18'' bodies.

Crop establishment site N°4 : shallow cultivation with conventional equipment + subsoiling

Capital investment in equipment	1130 €/ha
Tractor power	1.4 hp/ha
Fuel	29 l/ha
Labour and machinery time inputs of which drilling time	2hr/ha 0hr 30mn/ha

Machinery costs	144 €/ha
Non-selective herbicides	5 €/ha
Labour costs	30 €/ha
Crop establishment costs	179 €/ha

Strengths

- No investment in specialised equipment, except for subsoiler
- Possibility of carrying out deep cultivation which is necessary in water logged or often compacted soils
- Work organisation made easier compared with a system which includes ploughing.

Weaknesses

- Need to compensate the absence of ploughing with careful soil cultivation, to ensure a conventional drill can operate properly
- Difficulty in controlling seed positioning with high quantities of residue (e.g. rapeseed after cereals, wheat after corn..)

Agronomical characteristics

- This system is quite commonly used and results from the wish to avoid investing in specialised equipment. The limitations of this system lie in post-harvest plant residue which is quite costly to manage when large quantities of the preceding straw are left and not removed
- Regular subsoiling is "reassuring". But is it really effective agronomically and economically speaking? In our example, its cost is estimated at 10 €/ha/year, either by carrying out this special operation every three years, or by systematically combining subsoiling and drilling, with additional power of 30 hp.

Additional information

2 tractors with 150 and 120 hp. 4.50 m cover-crop. 3 m subsoiler. Rotary harrow + 4 m shoe drill. Crop establishment without ploughing including 1 rechopping and 2 stubble cultivations. Subsoiling every three years.

Crop establishment site N°5 :
Shallow cultivation using conventional equipment

Capital investment in equipment	1100 €/ha
Tractor power	1.4 hp ha
Fuel	25 l/ha
Labour and machinery time inputs of which drilling time	1hr 50mn/ha 0hr 30mn/ha

Machinery costs	138 €/ha
Non-selective herbicides	5 €/ha
Labour costs	27 €/ha
Crop establishment costs	170 €/ha

Strengths

- No investment in specialised equipment
- Work organisation made easier compared with a system which includes ploughing.

Weaknesses

- Need to compensate for the absence of ploughing with careful soil cultivation, to ensure a conventional drill can operate properly
- Difficulty in controlling seed positioning with high quantities of residue (e.g.: rapeseed after cereals, wheat after corn…).

Agronomical characteristics

- This system is quite commonly used and results from the wish to avoid investing in specialised equipment. The limitations of this system lie in post-harvest plant residue which is quite costly to manage when large quantities of the preceding straw are left and not removed
- The absence of subsoiling helps reduce machinery costs slightly. This is usually of no consequence with cereal and oilseed rape rotations in well drained soils.

Additional information

2 tractors with 150 and 120 hp. 4.50 m disc harrow. Rotary harrow + 4 m shoe drill. Crop establishment without ploughing including 1 rechopping and 2 stubble cultivations.

Crop establishment site N°6 :
shallow cultivation with specialised equipment

Capital investment in equipment	1090 €/ha
Tractor power	1.4 hp/ha
Fuel	15 l/ha
Labour and machinery time inputs of which drilling time	1hr 10mn/ha 0hr 25mn/ha

Machinery costs	122 €/ha
Non-selective herbicides	5 €/ha
Labour costs	17 €/ha
Crop establishment costs	144 €/ha

Strengths

- Equipment can cope with plant residue and truly helps simplify cropping techniques
- Cost saving technique whilst still maintaining good crop management in terms of parasite control, through stubble cultivation (stale seedbed, slugs…)
- Special 3 m drill not much more expensive than a combined 4 m rotary harrow-drill.

Weaknesses

- Need to amortize the equipment over suitable areas
- Need for well thought out choice of tools and cropping techniques.

Agronomical characteristics

- Investing in specialised equipment is a technical “insurance” which facilitates crop establishment, including when there are large quantities of plant residue.
- However, investments must be well thought out in order to control the capital invested, making sure for instance that the amortisation area is big enough. Choosing tools suited to the farm is also crucial since reselling is an expensive exercise.

Additional information

2 tractors with 150 and 120 hp. 3 m short disc harrow.. Special 3 m disc drill. Crop establishment without ploughing including 2 stubble cultivations.

Crop establishment site N°7 : shallow cultivation with till-seeding kit

Capital investment in equipment	990 €/ha
Tractor power	1.4 hp/ha
Fuel	13 l/ha
Labour and machinery time inputs of which drilling time	0hr 50mn/ha0hr 20mn/ha

Machinery costs	103 €/ha
Non-selective herbicides	5 €/ha
Labour costs	13 €/ha
Crop establishment costs	121 €/ha

Strengths

- Multipurpose stubble cultivation and drilling tools, which helps reduce investment
- Equipment can cope with plant residue and truly helps to simplify cropping techniques
- Cost saving technique whilst still maintaining good crop management in terms of parasite control, through stubble cultivation (stale seedbed, slugs…)
- System suited to shallow soil with an oilseed rape-wheat-winter barley rotation
- Limited investment.

Weaknesses

- Soil must be well levelled
- Some tools do not allow control of sowing depth which can be detrimental to the emergence of some spring crops
- Need to carefully think about the choice of tools as some designs are better suited to large amounts of plant residue and to spring sowing than others
- Tractor-mounted tools often equipped with a hopper which limits the level of autonomy at sowing time.

Agronomical characteristics

- This new generation of tools combining a stubble cultivator and a drill, is the type of equipment suited to simplified cultivation techniques, and represents a moderate investment. The broadcast sowing method was used here and proved well suited to sowing autumn crops and cover crops
- Some of the tools will prove limited when it comes to spring crops (no control over sowing depth). The lack of autonomy of the seed hopper on tractor-mounted tools also limits the potential of this type of machine.

Additional information

2 tractors with 150 and 120 hp. 4 m short disc harrow equipped with a seed hopper. Crop establishment without ploughing including 2 stubble cultivations.

Crop establishment site N°8 : direct drilling

Capital investment in equipment	970 €/ha
Tractor power	1.2 hp/ha
Fuel	9 l/ha
Labour and machinery time inputs of which drilling time	0hr 45mn/ha 0hr 40mn/ha

Machinery costs	111 €/ha
Non-selective herbicides	14 €/ha
Labour costs	11 €/ha
Crop establishment costs	136 €/ha

Strengths

- Very limited capital investment for equipment and tractors
- Considerably reduced labour time input and machinery costs
- High level of ground cover to limit erosion or evaporation

Weaknesses

- Pest control (slugs, field mice) is tricky
- Crop protection relies entirely on rotation and pesticides
- Need to do utmost to spread straw as well as possible with the combine harvester
- It is imperative to adapt the order in which crops are grown, to facilitate their establishment and control weeds.

Agronomical characteristics

- Direct drilling is becoming more widely used in France, this having been inspired by its successful development in South America. It is being adapted to French conditions. Rotation is one of the mainstays of direct drilling as it is one of the only agronomical crop protection methods left. Crop establishment can prove tricky, especially for oilseed rape and peas
- Note: Crop establishment costs are similar with a 3 m drill moving at a speed of 6 km/h and a 3 m drill sowing at a speed of 12 km/h using a tractor with an additional 30 hp.

Additional information

2 tractors with 120 hp. Special drill for direct drilling with 3 m cover. Crop establishment with real direct drilling (absolutely no soil cultivation).

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