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precision ag facts

controlled traffic farming CTF

You don't drive on your flower beds, so why drive on your crops?

Between 40 and 70 per cent of a cropping paddock will be run over by vehicles in a random traffic system. That is a no-till system with some level of GPS guidance but where equipment and axle widths are not matched (see How much do you traffic? Page 5).

Controlled traffic farming (CTF) is a system designed around permanent wheel tracks to minimise the area trafficked.

Operations run up and down rather than round and round the paddock.

By matching equipment widths and working on a single axle width (most commonly 3m) all paddock operations can occur on the same tracks or tramlines.

This results in the area trafficked being substantially reduced. Commonly the trafficked area is reduced to 12% or less. That means 88% of the paddock can achieve a higher potential yield from the same inputs (Figure 1).

Running a matched system can introduce additional operating efficiencies and CTF dovetails into no-till conservation farming systems, with or without GPS guidance.

Benefits of CTF

- Fewer tracks = less soil compaction
- Less soil compaction = more water infiltration and air spaces
- Improved soil moisture = improved crop yield and resilience to dry seasons
- More air spaces = an improved environment for root growth and soil biology

Other benefits of CTF

- Machinery efficiency
- Precision techniques (inter/intra row sowing, shielded and banded spraying)
- Accurate and simple on-farm trials
- Less weed germination
- Reduced fuel use
- Paddock operations being resumed more quickly after rain events
- Increased operation speed

Soil compaction

All soil types can be compacted by traffic.

- Tyre pressure and axle load squash the soil causing it to compact.
- As equipment becomes larger and heavier, soil compaction becomes greater.
- **About 90% of topsoil compaction is caused by the first pass of the tyre. This compaction is also known as a traffic pan.**
- Deeper, subsoil compaction is usually determined by axle load rather than the pressure under the tyre.

Controlled traffic does not repair compacted soil but over time biological processes will do this.

Deep ripping and growing deep rooting crops such as safflower that can punch through hard pans can help accelerate the remediation of compacted soil.

CTF = more resilient farming systems

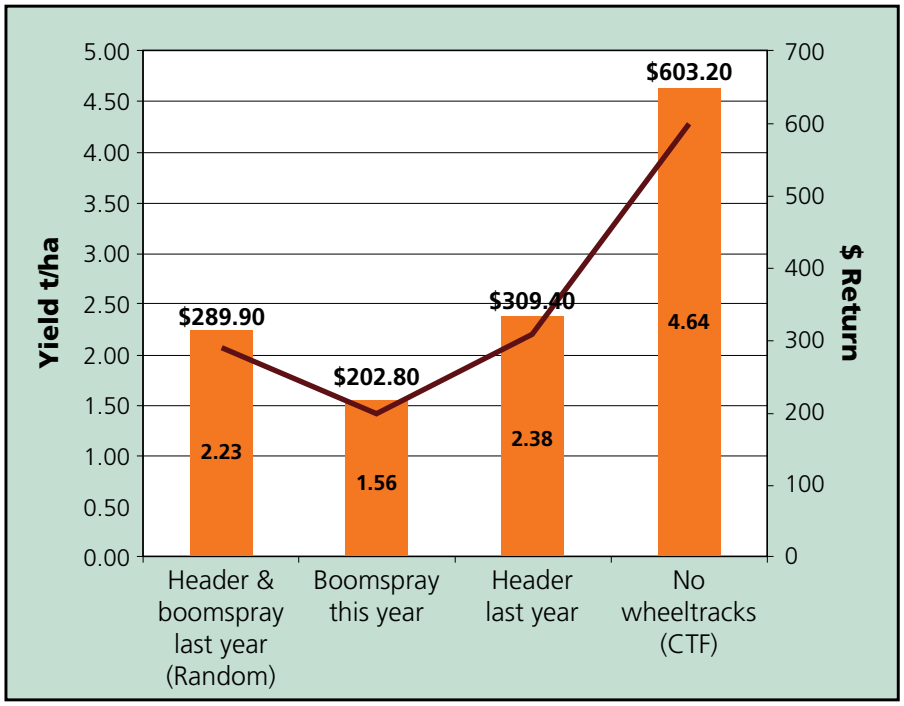

Figure 1 *– Soil compactionn- what is the cost? In this example in a self-mulching clay, the difference in return between random traffic and CTF parts of the paddock was just over $300/ha. All inputs were the same, the only difference was the amount of traffic that crossed the soil and crop. (Also see figure 2).* Source NEWagConsulting

farmer experience

Ashley and Tom Robinson

Location	Hoyleton, South Australia
Farm size	1620 hectares
Soil type	Red brown clay loam
Rainfall	Annual average 350-450mm, GSR 220-350mm
Crops	Wheat (4t/ha), canola

CTF Setup

Base widths and guidance	33.3ft implement, 120 inch axle, RTK guidance
Ratio	3:1
Seeding system	Disc, row spacing 6 inch wheat 12 inch canola
Stubble handling	Stripper front, left standing

Taking the step to standardise wheel centres and matching equipment widths can seem to be harder than it sounds.

For the Robinsons the purchase of a self-propelled sprayer on 120 inch wheel centres was the starting point. This also made the decision that they would use an imperial rather than metric system.

"We had been working up and back for four years and running RTK guidance and autosteer on everything," explained Tom.

"RTK gave us +/-2cm repeatable accuracy, so we were already minimising pass to pass overlap."

However, the sprayer had 120 inch axles, roughly one metre wider than the tractor. This meant they were creating a new set of wheel tracks, resulting in more compaction and crop loss.

So, the Robinsons decided to modify other tractors to run on 120 inch axles.

On the tractor used to pull the disc seeder,the inside duals were removed leaving wheel centres at 120 inches.

A local engineer produced extensions for the front axle of the tractor used to pull the fertiliser spreader. These extensions, commonly known as cotton reels, have been extremely well made and no additional weight is carried on the front of the tractor. Both of these factors are important if cotton reels are to survive the forces placed on them. (See photo A page 6).

The wheels on the air-seeder cart are spaced at 120 inches and the fertiliser spreader was mounted on a new frame fitted with wheels on 120 inch centres.

All vehicles and implements except the harvester are now running on the same wheel centres. Tom Robinson's advice is to just

"start somewhere; have a long term plan about what you want to achieve and implement this as you change over machinery."

"When we change the harvester we will have the new machine modified to 120 inch axles and an extended auger to keep the chaser bin on the tracks."

The Robinsons selected a 100ft boom on the self-propelled sprayer. This was based on matching up with other equipment. The disc seeder is 33.3ft as is the throw achieved by the fertiliser spreader and the cut of the stripper front on the harvester.

Accurate seed depth placement is very important to Tom and his father. With CTF they are not dealing with random traffic marks and this has helped achieve more consistent seeding depth across the sown area.

"From my perspective, changing to CTF is the next logical step after moving to no-till; more tillage is never going to fix soil compaction, so confining compaction to small areas of the paddock is the logical solution," said Tom.

Ross Watson

Location	Swan Hill, Victoria
Farm size	2240 hectares
Soil type	Sandy loam
Rainfall	Annual average 310mm, GSR 50-200mm
Crops	Wheat (1.8t/ha), barley, canola, chickpeas, vetch (brown manure)

CTF Setup

Base widths and guidance	12m implement, 3m axle, RTK guidance
Ratio	3:1
Seeding system	Disc, row spacing 333mm or 666mm
Stubble handling	Spread but not chopped

For Ross Watson the move to CTF was about two things; improving his soil and having a more efficient system.

It is now the fourth season since all his equipment was matched and he is seeing his soil improve year on year.

The figures are suggesting improvements as well. Ross is in a benchmarking group and can see that he is using about a third of the urea of his neighbours without compromising yield.

"I don't want to squash the life out of my soil; the bugs and roots need air pockets to thrive and no air pockets also means no extra space for water storage," said Ross.

Ross sees CTF as part of the integrated system and finds no-till with a disc is a great match. It allows faster work rates and more ground is covered in less time, even with a narrower, lighter machine.

He ran an 18m tine seeder on duals but now pulls a 12m disc on a single set of 520mm tyres. That still loses 1m to tracks every 12m but before it was 2m every 18m.

A brown manure crop and inter-row sowing are all part of the package for Ross but adding CTF literally puts all of this on the right track.

"As farmers we have become stuck on the treadmill of upgrading to larger machines but I am trying to take a whole farm approach and reduce the size and weight of machines and then to keep that weight either on the track or out of the paddock."

The harvester has an 8.5t grain box and is supported by a 30t chaser bin. Ross finds this combination helps control the maximum weight on the tracks but run lengths and paddock layouts are important to make this system work.

Ross advises those considering CTF that 3:1 configurations are much more efficient than 2:1 and from his experience sowing wheel tracks is essential.

"I don't want a dead, dusty area in my paddock; running tyres on dry matter does less damage. The cracks we see in the tracks allow rain to infiltrate and keep the soil alive."

The disc hardly damages the track when sowing and Ross finds the 800mm header tyres help renovate the track made by the narrower tyres on the seeder tractor and sprayer. To achieve inter-row sowing the bar is shifted 160mm so the tracks are 'fuzzy'.

"Every system has to have some compromises; my aim is to have as few as possible but it can take several years to put the system in place but that should not stop farmers moving to CTF."

Peter Teasdale

Location	Rupanyup, Victoria
Farm size	1620 hectares
Soil type	Black self-mulching clay
Rainfall	Annual 420mm, GSR 305mm
Crops	Wheat (3.5t/ha), barley, canola, lentils, chickpeas

CTF Setup

Base widths and guidance	30ft implement, 120 inch axle, RTK guidance
Ratio	3:1 except sprayer 4:1
Seeding system	Tine with coulters, row spacing 15 inch or 30 inch
Stubble handling	Spread

When Peter Teasdale decided to convert to CTF he was on a 40ft system with 120 inch axles on the tractor, sprayer and harvester. However, he found at seeding that the header tracks and tines were not quite in the same place, so he changed to a 30ft system.

"30ft is just easy, I did the calculation and sowing time would only increase by two days and I could still use my chaser bin, which we set up on 120inch axles," said Peter.

Unlike many Peter did not convert to CTF with new machinery; the Gyral air-seeder he setup for CTF was over 18 seasons old. He widened the back wheels on the air cart but left the dolly wheels at the original width and added an offset hitch for sowing on the inter-row from the same tracks.

"I really converted to CTF for the years with tough finishes but in all years I am seeing more even crops and yields have improved.

"For example, our peak lentil crops were about 2.8t/ha but since CTF have been as high as 3.5t/ha. This increase justifies all my investment in converting to CTF."

As the boomspray is 120ft it creates a bit of a compromise in his 30ft system. The first lap around the paddock the sprayer has to run on its own tracks.

Then Peter programs in a 15ft overlap on the autosteer and the autoboom shut-off automatically switches off the overlapping section. The second run is then put down on the seeder tracks and for the rest of the paddock he can run on every fourth track.

Peter specifically purchased an Australian built sprayer because it is significantly lighter than its North American built competitors.

He runs both his tractor and sprayer on the same 420mm tyres and reports good traction and minimal track deterioration. He reports this tyre width has been especially useful with the shielded sprayer, which he uses in chickpeas and canola.

Canola and chickpeas are sown on 30 inch rows with all other crops on 15 inch rows. This layout results in only one row per tyre being driven over with lentils when offset on 15 inches.

This row spacing allows spray nozzles to be accurately located in between the cereal rows, so crop shading is minimised. Every other nozzle can be blocked off in the wide row crops and the spray nozzles are located over the rows of canola.

Peter changed to direct heading the canola as it was hard to fit a windrower to the system.

Having matched the harvester exactly to a 30ft system he experienced a few misses at the edge of the comb. The addition of homemade dividers to gather in the outside row has helped overcome this problem. (See photo B page 6).

Chris Densley

Location	Croppa Creek, NSW
Farm size	1400 hectares 1100ha winter crops 300ha summer crop
Soil type	self- mulching clays
Rainfall	Annual average 650mm, in crop winter 200mm
Crops	Wheat (3t/ha), barley, chickpeas, sorghum, long fallow

CTF Setup

Base widths and guidance	12m implement, 3m axle, RTK guidance
Ratio	2:1
Seeding system	Disc or tine, row spacing 333mm cereals, single skip, chickpeas, sorghum 750mm
Stubble handling	Spread and remainder left standing

Farming country with 1 to 2 per cent slope presents Chris Densley with a few challenges not experienced by farmers in the other CTF case studies. He is also growing winter and summer crops.

"We have some irregular shaped paddocks, some with multiple slopes and some banks," explained Chris.

"We usually go up and down the slope that gives us the longest run. It is a paddock by paddock decision and we can be working at any angle to the contour banks.

"CTF requires operations to be executed up and back; it does not work going round and round."

Chris has set up a metric CTF system on 3m axles with 12m planters and 24m sprayer. A 12m Kelly chain is used to level ground when sowing chickpeas at depth as a tine rather than disc planter is used.

Nitrogen is either pre-planted or pre-applied as anhydrous ammonium through the planters, so spread width is not an issue as with fertiliser spreaders.

Chris modifies row spacing by crop type with cereals on single row spacing and chickpeas on single skip. Until recently sorghum was sown on 1m row spacing but this has been changed to 750mm using a three-point linkage disc seeder. Rows are located 375m either side of the centre line and then at 750mm. This configuration fits between the 3m wheel centres of the tractor and sprayer, which run on a maximum tyre width of 480mm, so crop damage is minimal.

The harvester has a 10.97m (36ft) front so does not match the system, nor does the axle width on the chaser bin. Chris feels larger grain boxes and extended augurs on the chaser bin are not feasible with contour banks and multiple slopes. Where possible chaser bins use the tracks and only turn on the paddocks when empty.

"The banks can make equipment feel a bit unstable, the broader and flatter the bank the less this is a problem."

Twelve years ago, Chris re-pushed the contour banks making them steeper, that was before he converted to CTF. Now a combination of CTF, no-till and possibly drier seasons is resulting in less run-off, so he is planning to modify the banks again.

"During the next five years we are going to make the base of the bank broader and in some paddocks might remove every second bank."

For those considering CTF in paddocks that include contour banks, Chris suggests reshaping banks to make them easier to cross as an important starting point.

While Chris does not have all equipment matched he still finds advantages from CTF, especially from reduced soil compaction and reduced overlap.

For example, when worked round and round, a paddock was recorded at 128ha on converting to CTF it reduced to 108ha, a massive 20% reduction in overlap. That means the equivalent reductions in inputs, tractor hours and driver fatigue.

Jarrod Doudle

Location	Coulta, South Australia
Farm size	1600 hectares
Soil type	Loam, sandy loam
Rainfall	Annual 500mm, GSR 440mm
Crops	Wheat (3.5t/ha), barley, lupins, canola

CTF Setup

Base widths and guidance	9m, implement 3m axle, RTK guidance
Ratio	3:1
Seeding system	Tine, row spacing 305mm
Stubble handling	Spread

Staggered flowering in canola and early nitrogen deficiency in wheel tracks were symptoms that Jarrod Doudle hoped to eliminate by changing to CTF. This has been achieved as well as improved trafficability.

Jarrod chose to setup a metric CTF system as this was the measurement system he knew. He selected a 9m base implement width as it enabled him to achieve adequate stubble spreading without investing in new equipment. It also allowed him to easily use his chaser bin and existing air-seeder with minimal modification. The harvester is imperial (30ft) which gives adequate overlap on the 9m system.

Jarrod started CTF in 2011 but since then has removed some fence lines to enlarge paddocks. This caused a few problems as the A-B lines in adjoining paddocks were not the same, resulting in tracks having to be moved to produce single run lines.

"Farm layout and any modifications that might occur in the next five to ten years should be considered before moving to CTF," said Jarrod.

Contract trucks are used at harvest. To help ensure drivers embrace the system and do not turn off the tracks Jarrod has setup 'in and out' gateways and improved his roadways.

While all this takes a bit of planning and discipline Jarrod knows from experience that it is worthwhile.

As several farmers have said sometimes you have to accept compromises in the CTF system, for Jarrod this is rolling rocks in paddocks. The roller is only 3.5m wide so it does not fit on the system and is just used randomly where required but the tractor stays on the tracks.

While Jarrod has found improvements in trafficability due to the tram tracks, some rutting of tracks has started. To help repair this Jarrod has extended six points by about 2.5cm so these run in the wheel tracks at seeding. The wheel tracks are sown and the deeper tillage helps provide a bit of renovation.

Jarrod has replaced the 380mm tyres on the self-propelled sprayer/windrower with 580mm, which has helped to reduce rutting.

More serious rutting will be renovated but renovation is targeted only to the areas of need.

Anthony Litster

Location	Stansbury, South Australia
Farm size	900 hectares
Soil type	Sand over clay, clay loam, non-wetting
Rainfall	Annual 400-450mm, GSR 320mm
Crops	Wheat (5t/ha), barley, chickpeas, faba beans, lentils, canola

CTF Setup

Base widths and guidance	9m, implement 120inch and 3m axles, RTK guidance
Ratio	3:1
Seeding system	Disc, row spacing 375mm and 750mm
Stubble handling	Spread

As part of changing to CTF, Anthony Litster converted to a 9m disc, from a wider tined implement and dropped to a 270hp tractor from a 350hp articulated tractor with duals. With these he is achieving seeding in the same time but using much less power.

In addition to saving power the disc is helping Anthony manage his stubble. The low disturbance disc leaves stubble standing enabling improved trellising by lentils, which in turn allows increased harvesting speed and less grain on the ground.

However, it is the combination of CTF, RTK guidance and inter-row sowing that really helps Anthony maximise the amount of stubble that is left undisturbed. With his new CTF and disc system much less stubble is driven over.

"Before converting to CTF I was running over about 50% of my stubble, now it is between 13 and 15%."

"Even after a heavy wheat crop I am not experiencing any problems due to stubble and reaping speed has increased due to less crop being knocked around," said Anthony.

Anthony is running a 30ft header with a 9m system which gives 7cm overlap each end of the comb; this helps prevent misses. To this he has fitted a Redekop straw chopper to the back of the harvester and this design is providing an even spread across his 9m system. (See photo C page 6).

He is running some equipment on 120 inch axles and other on 3m. He admits this is a compromise and results in more area being trafficked but says it is better than delaying the conversion to CTF.

One of the hidden benefits of CTF is the ability to setup precise on-farm trials to assess different practices.

"I can now run small on-farm trials anywhere and at harvest the sowing width and swath width match perfectly."

In 2014, Anthony Litster delved the last paddock of a program of incorporating clay to reduce non-wetting soil properties. As he was already using CTF he decided to delve in the same direction as the paddock operations but not delve the tracks. This was relatively easy with 1.5m spacing on the delver and tracks set at 3m.

This system worked really well for seeding but during post emergent spraying, in a very wet winter, he managed to bog the sprayer three times. So, his initial enthusiasm for this approach has diminished.

"CTF and soil delving are a perfect fit; the delving helps remove hard pans and the CTF reduces the area compacted but delving at an angle and in the same direction of working both have limitations."

After three years of CTF he is doing some track renovation; this is mainly where tracks were ripped in the old layout for delving and where he got bogged in winter 2014.

He is not totally happy with the renovator which consists of contoured discs and crumble roller.

Renovation is done where required and his aim is to only renovate after faba beans as there is less stubble from the wide row crop. Incorporating stubble in the tracks can make them spongy and Anthony wants hard tracks, even after they have been sown.

steps to getting started

1. Metric or imperial?

Machinery originating in the US is built using imperial measurements, that from Europe is generally in metric and from Australia it can be either. Experience has shown that when converting to controlled traffic it is important to decide whether you are going to work in imperial or metric – then stick to that choice.

Ideally widths should be exact, identical and in the same units (metric or imperial) to maximise the benefits of CTF. If imperial systems are converted to metric and the figure is rounded up or down errors can occur (Table 1).

The exception is if a metric system is selected then an imperial header front is usually best as this provides a little extra width (Table 1) and prevents crop misses along the edge of the crop.

2. Choose your configuration

Bigger is not necessarily better when it comes to CTF equipment, because in addition to reducing soil compaction CTF systems can help improve overall operating efficiency.

Most farmers implement a 3:1 system – for example 9m seeder and harvester and 27m sprayboom. Some farmers have a 3:2:1 system that is a 40ft header front, 60ft seeder and 120ft boom. The footprint is slightly higher than a 3:1 system but efficiencies gained in seeding can offset this increased footprint.

Factors to consider:

- Farm size and sowing window.
- Run length – size of grain tank, seeder box, spray tank, use of chaser bin etc.
- Current equipment widths – often the harvester comb is the starting point.
- Residue management – can you achieve an even spread across your nominated width?
- Where do want to be in 5-10 years time?

(See Tables 2-4 page 6).

Table 1 *Common implement widths (or multiples of) in imperial and metric used for CTF and the degree of error that arises if imperial systems and metric are mixed without using three decimal places.*

Imperial	Accurate metric conversion 1 width	Accurate metric conversion 3 widths	Error if conversion is rounded to nearest metric equivalent not to 3 decimal places.	Metric equivalent CTF system if only working in metric
30ft	9.144m	27.432m	43.2cm per run	9m
35ft	10.668m	32.004m	4cm per run	10.6m
40ft	12.192m	36.576m	57.6cm per run	12m
45ft	13.716m	41.148m	14.8cm per run	13.5m

How much do you traffic?

Wheeltrak Calculator' - a new free app has been developed with funding from GRDC, DAFWA, CTF Alberta, Beyond Agronomy, SPAA - Precision Ag Australia, Condamine Alliance, and the Fitzroy Basin Association.

This app allows you to enter your current machinery and tyre details to calculate the percentage coverage across the paddock.

You can look at the impact that changing axle widths, implement widths and tyre size could have on the percentage of paddock that is trafficked.

Visit - www.spaa.com.au/pa-tools

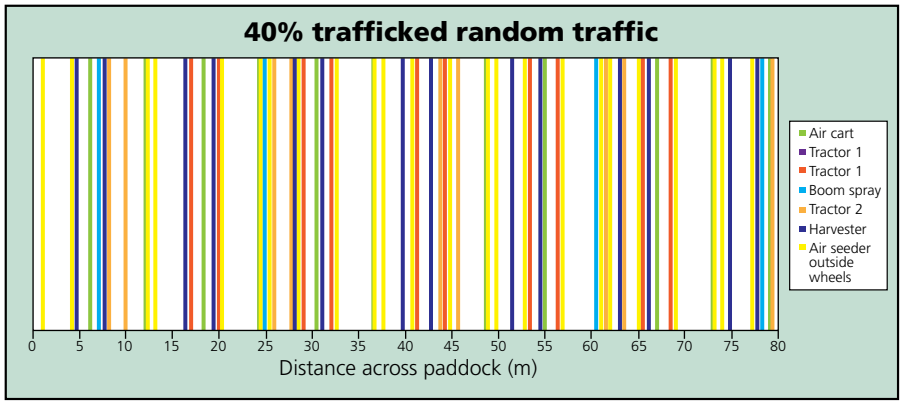

Figure 2a *A 40ft no-till system where axle and implement widths have not been matched*

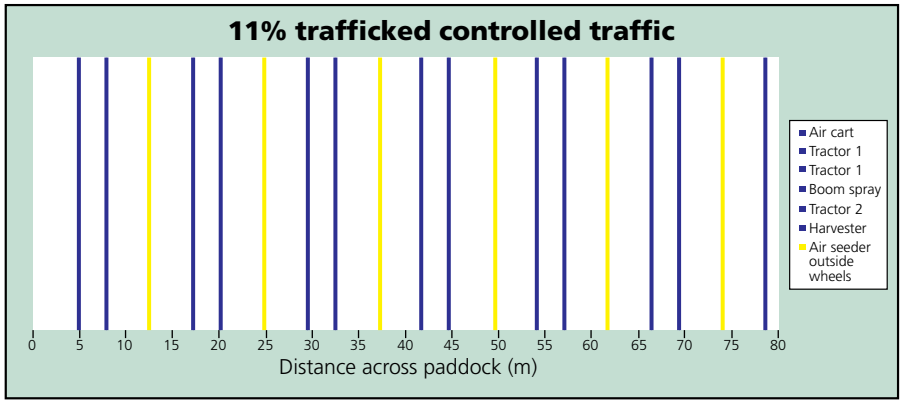

Figure 2b *The same 40ft no-till system where all axle widths and implement widths have been matched. Source NEWag Consulting*

CTF setup guides

When establishing a CTF system it is helpful to consider work rates and the area covered by different equipment widths working at different speeds. The following tables provide a quick reference for common combinations of equipment widths, operating speeds and crop yields.

Table 2 *Hectares per hour (seeding, harvest or spraying)*

	6km/h	8km/h	10km/h	15km/h	20km/h	25km/h
30′	5.5	7.3	9.1	13.7	18.3	22.9
35′	6.4	8.5	10.7	16.0	21.3	26.7
40′	7.3	9.8	12.2	18.3	24.4	30.5
45′	8.2	11	13.7	20.6	27.4	34.3
60′	11	14.6	18.3	27.4	36.6	45.7
80′	14.6	19.5	24.4	36.6	48.8	61.0
120′	21.9	29.3	36.6	54.9	73.2	91.4

Table 3 *Hectares per pass*

	0.5km	1km	1.5km	2km	2.5km	3km
30′	0.46	0.91	1.37	1.83	2.29	2.74
35′	0.53	1.07	1.60	2.13	2.67	3.20
40′	0.61	1.22	1.83	2.44	3.05	3.66
45′	0.69	1.37	2.06	2.74	3.43	4.11
60′	0.91	1.83	2.74	3.66	4.57	5.49
80′	1.22	2.44	3.66	4.88	6.10	7.32
120′	1.83	3.66	5.49	7.32	9.14	10.97

Table 4 *Metric tonne harvested/km*

	1t/ha	2t/ha	3t/ha	4t/ha	5t/ha	6t/ha
30′	0.91	1.83	2.74	3.66	4.57	5.49
35′	1.07	2.13	3.2	4.27	5.33	6.4
40′	1.22	2.44	3.66	4.88	6.10	7.32
45′	1.73	2.74	4.11	5.49	6.86	8.23

A – Cotton reel extensions must be well made

B – Crop dividers can help misses in completely matched imperial systems

C – Achieving even straw spread helps seeding and establishment in the following crop

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The contact details of the farmers featured in the case studies on pages 2 to 4 are available from SPAA.

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