3. WHAT IS CONSERVATION FARMING?

Conservation farming is any system or practice which aims to conserve soil and water by using surface cover (mulch) to minimise runoff and erosion and improve the conditions for plant establishment and growth. It involves planting crops and pastures directly into land which is protected by a mulch using minimum or no-tillage techniques.

Many individual practices can be integrated into a conservation farming program. These include:

<table>
<thead>
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<th>Conservation farming - components and practices</th>
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<tbody>
<tr>
<td>• no-tillage</td>
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<td>• minimum and reduced tillage</td>
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<td>• agro-forestry</td>
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<td>• trap cropping</td>
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<td>• cover and green manure cropping</td>
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<td>• alley cropping</td>
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<td>• contour farming &amp; strip cropping</td>
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<td>• organic and biodynamic farming</td>
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<td>• stubble mulching</td>
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<td>• integrated pest management (IPM)</td>
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<td>• crop and pasture rotation</td>
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Conservation farming systems are designed to:

• use mulch cover to reduce soil erosion and land degradation
• reduce soil temperature and conserve moisture for plant growth
• increase organic matter levels and improve soil structure and fertility
• reduce reliance on cultivation
• achieve viable and sustainable productivity

3.1 THE BACKGROUND TO CONSERVATION FARMING

Conservation farming was first investigated in the 1940s in Nebraska, USA where mulch was used to control wind erosion. Since the introduction of new herbicides and specialised machinery in the 1960s, ’70s and ’80s, development of the technology has accelerated.
Conservation farming in the NT is largely based on crop and pasture rotations using no-tillage, minimum tillage and integrated pest management.

**No-tillage**, also referred to as zero-tillage, replaces all cultivation with herbicides so that soil disturbance occurs only at sowing time when the planting implement engages the soil. Mulch cover is maintained at a maximum level.

**Minimum tillage** involves some primary cultivation for weed control, mulch management and seed bed preparation. Herbicides are usually used in conjunction with tillage. Minimum and no-tillage can be used alternatively, depending on conditions which will vary from paddock to paddock and season to season. Conservation farming is a flexible system where tillage practice is chosen to suit the particular situation.

*The objective of conservation farming is to reduce runoff and erosion. This can only be achieved by reducing cultivation and maintaining soil surface cover.*

Plate 8a, b, c
(a) Seeding no-tillage sorghum into chemically killed pasture.
(b) Established no-tillage sesame in Katherine.
(c) No-tillage mungbean.
3.2 Why we need conservation farming!

There are many good reasons for the adoption of conservation farming. Some of those are presented below.

What will grow when 100 tonnes per hectare of top soil is lost?

This question will need to be answered if soils in the Top End are continually cultivated or over-grazed. Over 40% of tropical storms result in runoff with the potential to cause erosion. High energy raindrops dislodge soil particles which are carried away in runoff water. Over 100 tonnes of soil per hectare per year can be lost from exposed land in the tropics.

Figure 3
The effect of soil surface cover in reducing erosion. With 80 to 100% mulch cover there is a 90% reduction in soil loss.

Plate 9
Erosion risks are increased under cultivation.

Mulch cover protects the soil by absorbing raindrop impact, increasing infiltration and slowing the speed at which water runs over the land, thereby reducing soil movement. A study in the Daly Basin showed that conventionally cultivated areas produced twice the runoff and lost on average 1.5 to 6 times more soil than no-tillage areas despite all areas being protected by soil conservation banks. In some seasons no-tillage areas suffered negligible soil loss while cultivated areas lost up to 8 t/ha.
Average soil loss in conventional farming systems in the Top End may range from 20 to 40 t/ha. Continued losses of this magnitude would result in a loss of 1 to 2 cm of top soil over five to ten years.

Erosion rates will vary depending on storm intensity, soil conditions and other factors but surface cover has the potential to decrease soil loss by 90%.

Can seedlings survive temperatures of 55-60° Celsius?

The short answer is no, but in many instances they are expected to! Dry conditions at, or after, planting are accentuated by high soil temperature. Bare soils can reach temperatures of 55-60°C, killing seedlings and reducing plant stands. Protecting the soil with mulch has the combined effect of conserving moisture and reducing temperatures by 8-16°C.

Reducing ground temperature is critical as many crop seedlings are adversely affected by soil temperatures over 30°C. Maintaining mulch is the only way a farmer can reduce soil temperature in dryland agriculture in the tropics.

Conserving moisture and increasing yields!

Moisture availability determines crop and pasture productivity. Crop failures can occur despite ample rain because much of the moisture is lost through runoff and evaporation.
In the Top End exposed soil can lose 60% of the rainfall through runoff and up 50% of soil moisture can be lost through evaporation directly from the soil surface.

For example when a 30 mm storm falls on bare soil, up to 18 mm may run off leaving only 12 mm to enter the soil. Evaporation from the soil surface may leave only 6 mm for plant use. Mulch retention can halve runoff and will decrease evaporation, making more soil moisture available for plants. Specific studies in various tropical regions have shown that by maintaining mulch, yield could be increased by up to 80%, 78% and 33% in sorghum, upland rice and peanut, respectively.

**Mulch cover will conserve more rainfall and turn it into productive plant growth.**

**Better crops and healthier soil!**

Mulch plays a vital role in promoting the uptake and cycling of plant nutrients. Earthworm numbers and beneficial microorganisms increase under mulch, improving soil structure and increasing its capacity to hold water and nutrients. Up to 90% of the nitrogen, phosphorus and potassium lost from farming systems can occur through erosion. Mulch helps to reduce this loss and also acts as a storehouse for many essential nutrients which are gradually released and used by plants.

Conservation farming provides more reliable yields than those achieved under conventional tillage. In a four year study at Katherine, no-tillage grain sorghum averaged 3.22 t/ha while conventionally sown crops averaged 1.80 t/ha.

**Figure 4**

The effect of tillage practice and mulch cover on sorghum grain yield over 4 years at Katherine. No-tillage with mulch produced on average 6 times more grain than no-tillage without mulch, highlighting the importance of mulch in the system.
Figure 2
The effect of three different planting dates on relative water demand for a mid-maturity grain sorghum at Katherine.

Line A: represents the relative water requirement of a crop sown at the optimum time. Peak water demand occurs during a reliable rainfall period. There is a high probability of a good crop yield.

Line B: represents a later sown crop where peak water demand occurs when the likelihood of rainfall is reduced, decreasing the chances of a good yield.

Line C: represents a crop sown well beyond the optimum date. Peak water demand occurs when the reliable rainfall period is over. There is a high probability that this crop will fail. This principle applies to any dryland crop sown in the Top End.

At Douglas Daly Research Farm, no-tillage maize and soybean, on average, out-yielded conventional crops by 33% and 31%, respectively, over nine years. In dry seasons, conservation tillage has produced double the yield of conventionally sown crops.

Optimum planting time gives optimum results!

There are many reasons for poor crop performance but two factors have been largely responsible in this environment.

They are:

• the failure to sow at the optimum time

• the failure to achieve adequate plant populations

The optimum sowing period for any crop in the Top End is about 7-14 days. In many seasons only one or two sowing opportunities may occur when moisture and other factors are favourable. Optimum conditions may last for as little as 24-48 hours and missing such an opportunity may result in sowing late or sowing into declining moisture. This invariably results in poor establishment or moisture stress at the end of the season.

Conservation tillage enables sowing to be carried out as soon as moisture conditions are favourable and many of the delays associated with cultivation are avoided. Moisture is retained for longer enabling plants to better withstand dry spells after sowing.
The ability to sow crops earlier into optimum moisture is one of the major advantages of conservation tillage and experience has proven that this translates into better yields.

*Optimum time of sowing is critical for good yields. Conservation farming enables sowing to be undertaken on time and into good conditions.*

**Farming with less energy, labour and machinery!**

Machinery and fuel costs have risen by over 500% in the past 20 years. Fuel is now the largest single cost, with tillage consuming over 11% of total energy used on farms. Ploughing and cultivating can use between 6.0 and 17.0 L/ha of fuel while no-tillage uses between 2.0 and 4.0 L/ha depending on the operation.

Conservation tillage can reduce fuel consumption, tractor hours, maintenance and labour by as much as 40-60%.

**Conservation farming offers many benefits to Top End agriculture including:**

- reduced erosion and improved soil structure
- improved infiltration and moisture efficiency
- improved soil health and nutrient retention
- lower soil temperatures and better establishment
- increased planting opportunities and flexibility
- lower machinery, labour and maintenance costs and
- more reliable yields
3.3 SO WHAT'S THE CATCH?

No single farming system or technique is perfect for all applications and conservation farming is no exception. Conservation farming involves more planning, management and a commitment to sustainability. Trade-offs are necessary and extra costs may be incurred in the initial years. Herbicides and specialised machinery are needed in most conservation farming systems.

Conservation farming will not always result in higher yields especially in seasons where rainfall is ample and well distributed. The effectiveness of some herbicides is reduced by mulch on the surface as high rates of organic matter 'tie up' many chemicals. Fertilisers such as nitrates and herbicides may leach more readily through the soil due to higher infiltration rates under conservation tillage, however, runoff losses will be reduced. These aspects are being addressed through improvements in fertiliser and herbicide formulation, application technology and better management practices.

Conservation farming systems are dynamic and call for innovation and continual improvement. Grazing, weed, insect and fertiliser management are required for successful conservation farming and it takes time and experience to develop these skills.

A good understanding of the interaction between plants, animals, the soil and the environment is necessary. Conservation farming systems are intended to be flexible, responsive and to work within the constraints of the environment rather than against it.

Management aspects of conservation farming:

- longer term planning and commitment to sustainability
- commitment to learning and developing a system
- skills in mulch management, weed control and herbicide use
- skills in soil nutrient and pest management
- understanding soil, plant and animal interactions
- rotations and integrating crops, pastures and livestock
- requires specialised or modified planting machinery

No technique yet devised by mankind has been anywhere near as effective at halting soil erosion and making food production truly sustainable, as no-tillage.
Figure 6
Likely outcomes resulting from conservation farming in the NT. Average crop yields are likely to improve and be more stable than conventional farming once experience with the system has been developed.