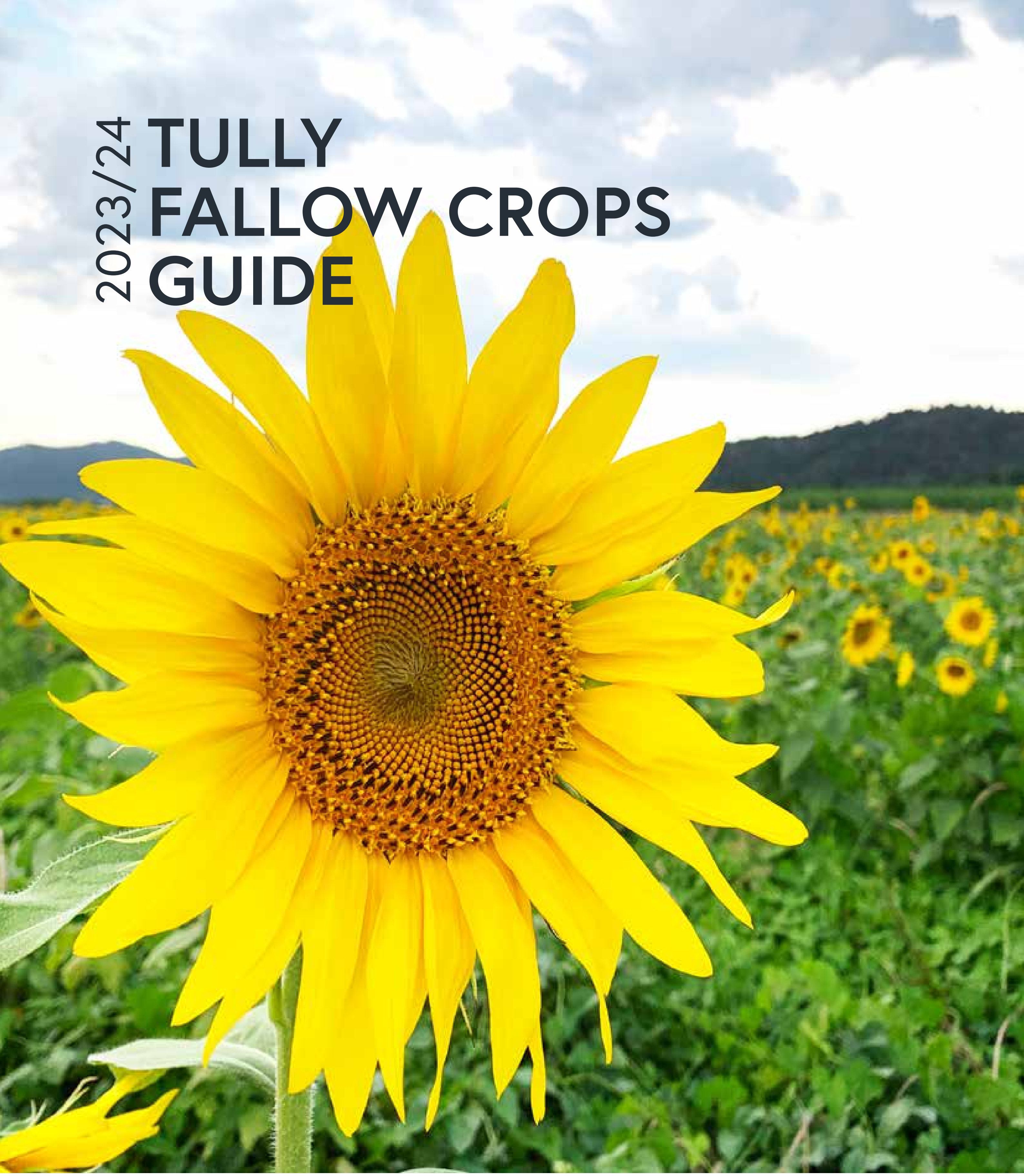
2023/24

TULLY FALLOW CROPS GUIDE



TULLY SUGAR

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sra Sugar Research Australia

CANEGROWERS

CASSOWARY COAST Reef Smart Farming

Australian Government

REEF TRUST

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TERRAIN NATURAL RESOURCE MANAGEMENT

BACKGROUND

- √ **Fallow break crops improve soil health and protect the soil from potential erosion over the wet season.**
- √ **Increasing soil carbon improves the resilience and performance of agricultural production systems.**
- √ **Ebony cowpea, soybean, *Dolichos lablab*, sunn hemp and sunflower are commonly grown in Tully.**
- √ **New legume varieties and mixed species cover crops are becoming more popular.**

PLANTING

√ LEGUMES CAN BE PLANTED DIFFERENT WAYS:

- After the old cane crop is sprayed or disced out legumes can be broadcast and lightly disced in/ scratched in
- After the old cane crop is sprayed or disced out pre-formed beds can be established and legumes planted into these beds
- Legumes can be planted beside the old cane stool which has already been sprayed out (with typically glyphosate) or will be sprayed out using a selective herbicide (e.g. Verdict) after legumes have been planted. This is particularly good for late harvested crops or where there is increased risk of soil erosion as soil disturbance is minimal *(low energy input system)*
- Legume crops require a higher soil pH than sugarcane for successful growth and nodulation. Applying a calcium-based product (e.g. lime or mill mud) prior to planting legumes is recommended. Rates should be determined from soil test results. The application of calcium will also benefit the following sugarcane crop
- Inoculation is important for nodulation.

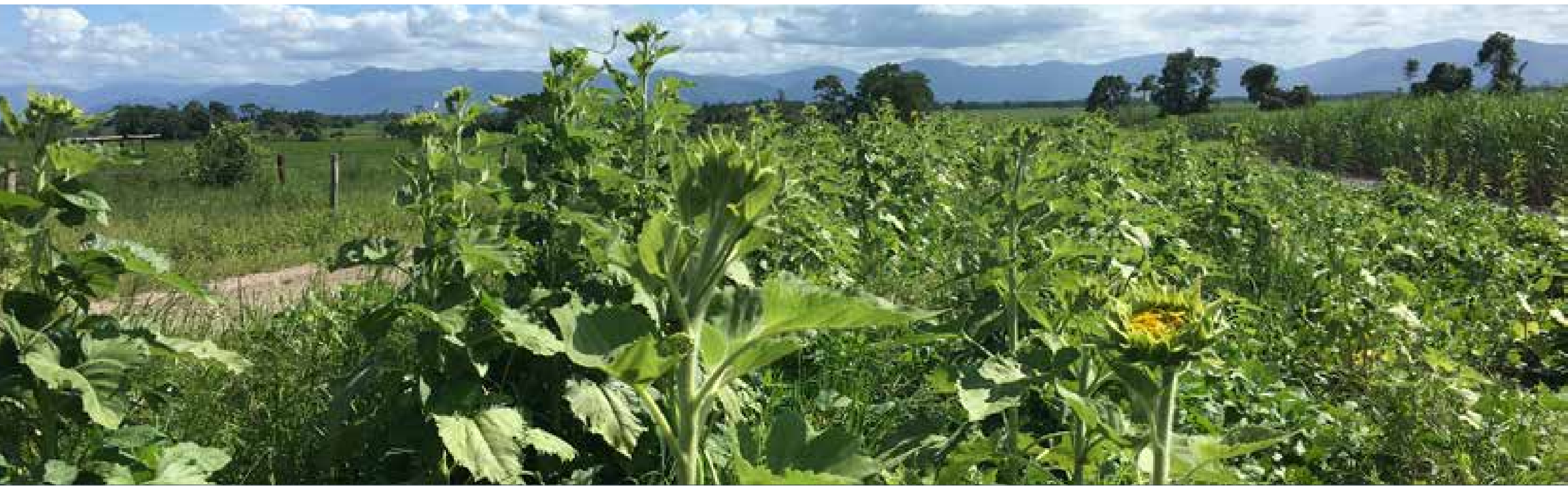
BENEFITS OF ROTATIONAL COVER CROPS

- Improves soil health
- Breaks the sugarcane monoculture
- Adds organic matter to the soil which increases soil carbon
- Helps reduce pest, weed and disease pressure by building resilience
- Organic matter helps improve soil quality. Different forms of organic matter provide important food and energy sources for soil microbes
- Protects the soil from erosion by providing surface cover through the wet season
- Supplies nitrogen to the soil (through a process termed mineralisation).

Inoculation types for different legume species are:

CROP	INOCULATION TYPE
Soybean	Group H
Lablab	Group J
Cowpea	Group I
Sunn hemp	Group I or M

Sunflowers about to bloom 2022.



CHARACTERISTICS OF DIFFERENT LEGUME SPECIES

A) LABLAB – RHONGI

- Easily established - broadcast and lightly disced in or direct drill planted
- Tolerant of dry weather once established
- Moderate biomass and nitrogen input
- Resistant to root lesion nematode but highly susceptible to root knot nematode
- Typical seeding rate of 30 kg/ha for broadcast or 20-30 kg/ha direct drill planting.

B) COWPEA – MERINGA, EBONY, CALOONA

- Easily established – broadcast and lightly disced in or direct drill planted
- Moderate biomass and nitrogen input
- Well suited to a range of soil types and provides excellent ground cover
- Ebony (or Calypso) have greater waterlogging tolerance
- Resistant to root lesion nematode. Meringa is less susceptible to root knot nematode compared to other cowpea
- Typical seeding rate of 30 kg/ha for broadcast or 20-30 kg/ha direct drill planting.

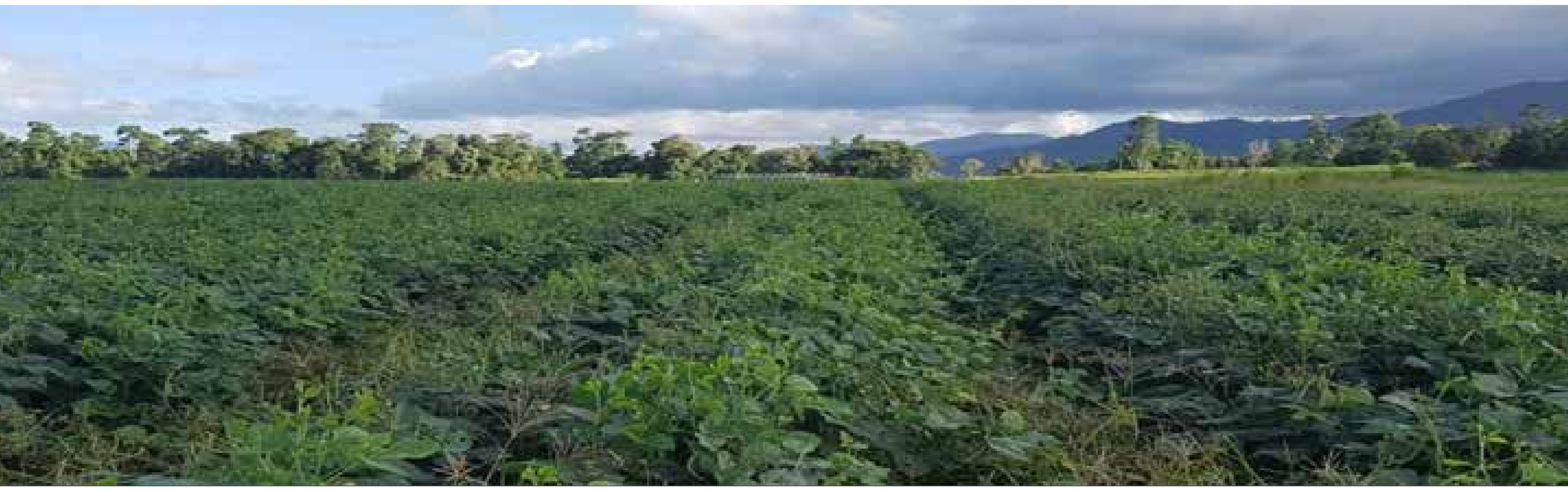
C) SOYBEAN - LEICHARDT, MOSSMAN (NEW)

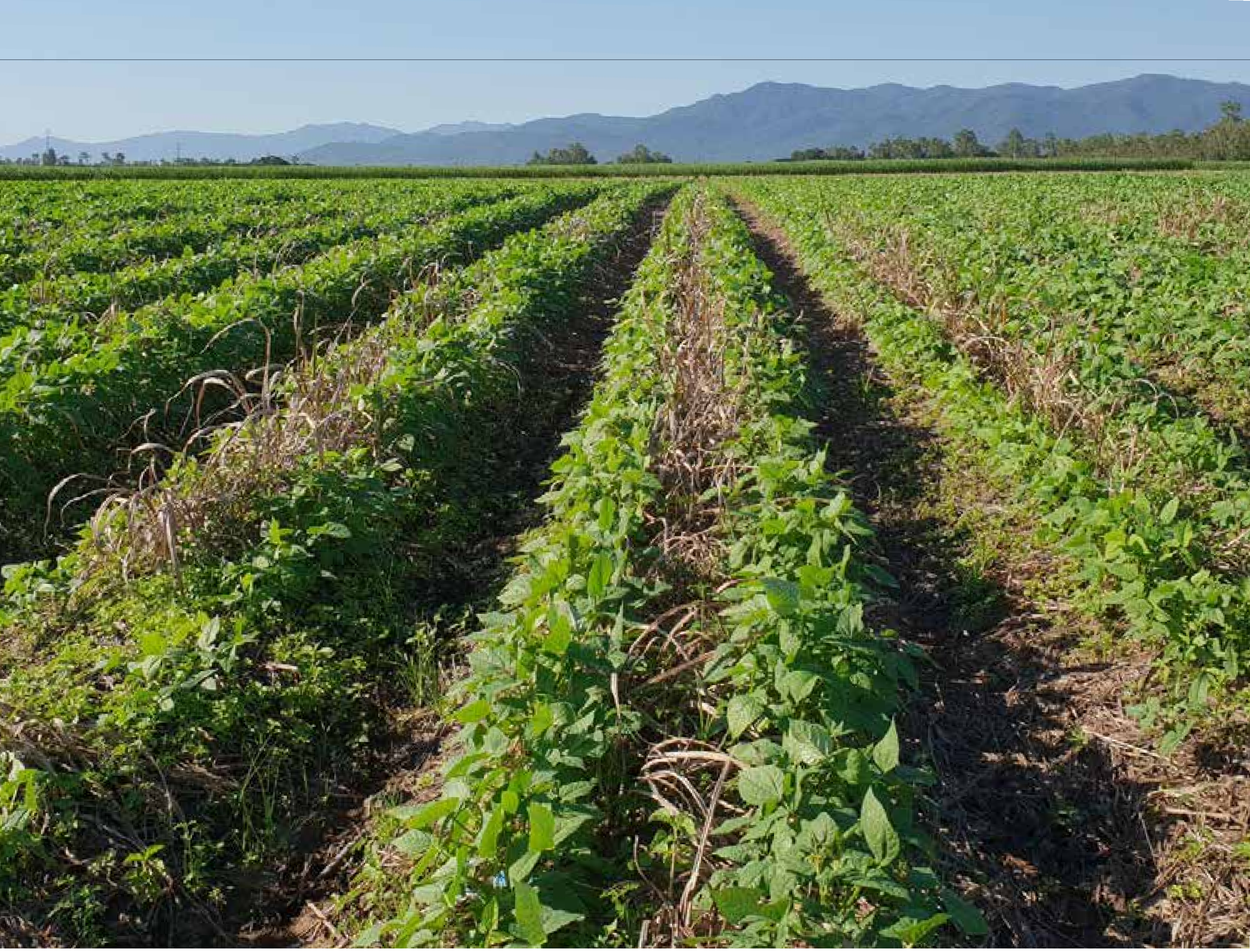
- Best planted in rows using a direct drill planter at a consistent soil depth with a seeding rate of 50 kg/ha
- Soft seed, susceptible to damage - if broadcast planting (not recommended) increase seeding rate (by 50%)
- Requires good weed control due to erect rather than creeping growth habit
- Well grown crops provide high biomass and nitrogen input
- More tolerant of wet conditions.

D) OTHER COVER CROP OPTIONS

- Mixed species - includes various combinations of the crops mentioned below in addition to the commonly grown legume species
- Millett – fast striker, deep roots
- Sunflower – deep roots – can bring phosphorous up from lower down in the soil profile
- Mustard – brassica family - produces a chemical known as isothiocynate, a known soil fumigant
- Tillage raddish - produces a large taproot which can penetrate compacted soil helping increase soil aeration, water infiltration and nutrient retention
- Sunn hemp – otherwise known as *Crotalaria*, a very fast growing, high biomass legume with a strong tap root. Seed can be difficult to source.

Typical Tully legume fallow at Warrami 2016.





POTENTIAL NITROGEN FROM TULLY LEGUME CROPS

√ Tully Sugar Limited (TSL) samples legume crops to provide an estimate of the amount of nitrogen that may be available to the following sugarcane crop.

√ Results of recent sampling events are provided in Table 2 on pages 6 and 7 of this guide.

√ More information on estimating nitrogen input and modifying plant cane nitrogen fertiliser rates is available in the SIX EASY STEPS Toolbox, found on Sugar Research Australia's website - sugarresearch.com.au.

METHOD FOR DETERMINING CROP BIOMASS AND NITROGEN CONTENT

STEP 1 CALCULATE FRESH BIOMSS (T/HA)

- Cut all plants at ground level from a 1 m length of row x row spacing
- Record fresh weight (kg)
- Divide fresh weight (kg) by row spacing (m) to determine kg wet biomass per m^2 (kg/m^2)
- Multiply kg/m^2 by 10 to determine tonnes fresh biomass per hectare (t/ha).

STEP 2 CALCULATE DRY BIOMASS (T/HA)

- Take a subsample of the fresh biomass
- Record subsample fresh weight
- Dry subsamples in an oven at 60°C
- It may take several days to reach a constant dry weight
- Determine percentage dry matter (%):

  - Dry matter (%) = (dry subsample weight/fresh subsample weight x 100)
- If samples cannot be dried, research has shown the dry biomass per hectare is approximately 25% of the fresh biomass
- Dry biomass = fresh biomass (t/ha) x dry matter (%).

STEP 3 DETERMINE NITROGEN CONCENTRATION

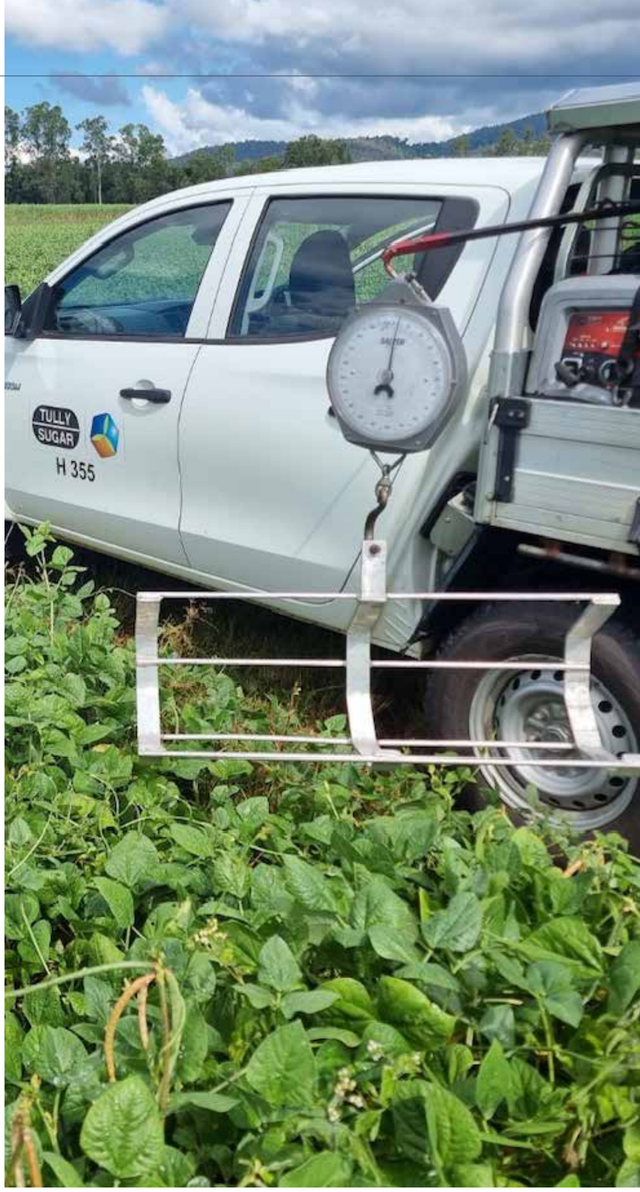
- The nitrogen concentration of dried samples can be analysed by a commercial laboratory or the approximate nitrogen concentration reported in Table 1 (on page 6 of this guide) can be used.

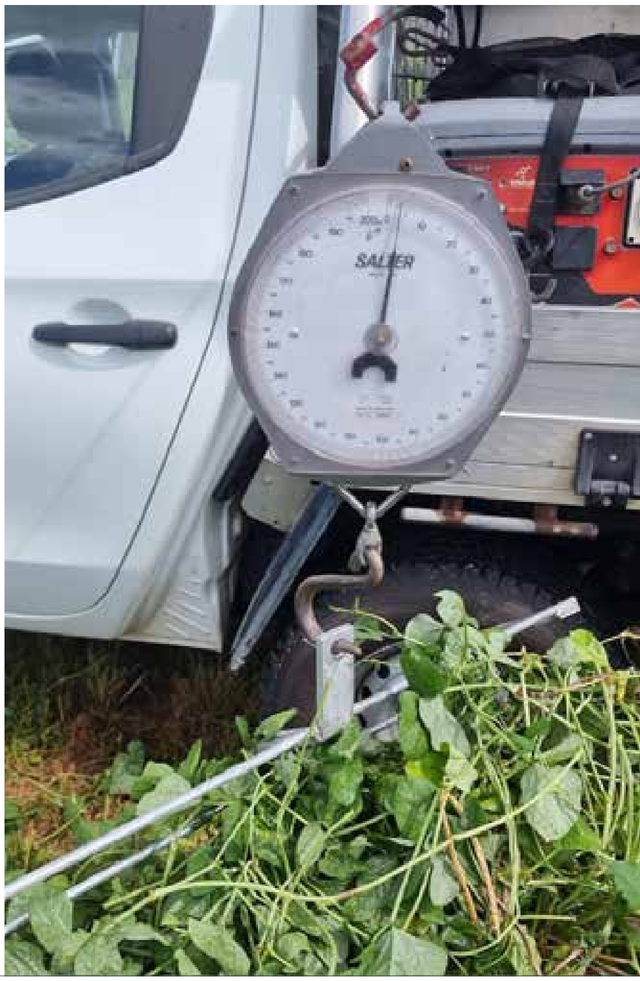
STEP 4 ESTIMATE NITROGEN CONTENT OF ABOVE GROUND BIOMASS

- Dry biomass (t/ha) x nitrogen concentration (%) = t N/ha
- Multiply t N/ha by 1000 = kg N/ha.

STEP 5 ESTIMATE NITROGEN CONTENT OF THE TOTAL CROP

- The nitrogen content of the roots is approximately 30% of the above ground legume nitrogen content
- To estimate root nitrogen content multiply above ground nitrogen content (kg N/ha) by 30%
- Total nitrogen (kg N/ha) = above ground nitrogen content + root nitrogen content.





Sampling fallow legume crops in the field.

NITROGEN CONTENT OF LEGUME CROPS

The amount of organic nitrogen available to the following sugarcane plant crop depends on the size of the legume crop and nitrogen content, management of the legume residue, amount and type of tillage and rainfall.

Table 1: Estimates of legume fallow crop nitrogen (N) content used in the SIX EASY STEPS® (6ES) nutrient management guidelines.

LEGUME CROP	FALLOW CROP ABOVE GROUND FRESH BIOMASS (t/ha)	FALLOW CROP ABOVE GROUND DRY BIOMASS (t/ha)	N %	TOTAL N IN ABOVE GROUND BIOMASS (kg/ha)	TOTAL N IN ALL BIOMASS INCLUDING ROOTS (kg/ha)*	N CONTRIBUTION IF GRAIN HARVESTED (kg/ha)
Soybean	32	8	3.5	280	360	120
	24	6		210	270	90
	16	4		140	180	60
	8	2		70	90	30
Cowpea	32	8	2.8	220	290	100
	24	6		170	220	75
	16	4		110	145	50
	8	2		55	70	25
Lablab	32	8	2.3	185	240	80
	24	6		140	180	60
	16	4		90	120	40
	8	2		45	60	20

Supplied by the Sugarcane Yield Decline Joint Venture

Table 2: Biomass and total potential nitrogen (N) results for legume crops sampled in the Tully mill area during 2019/20, 2020/21 and 2021/22.

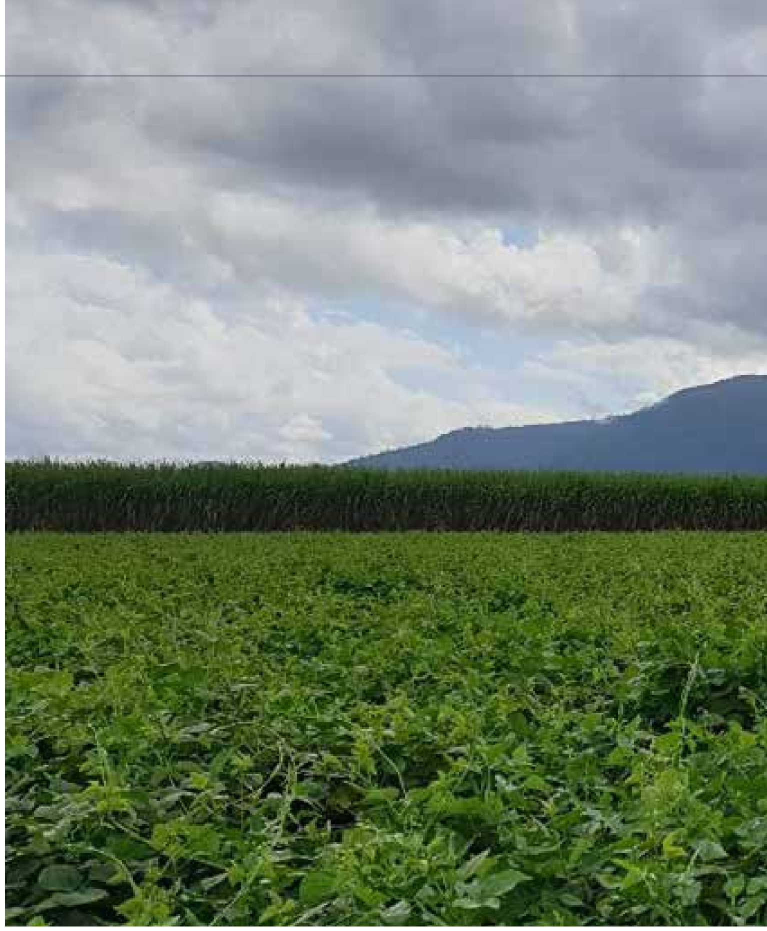
YEAR FALLOW EST.	SITE	LEGUME CROP	N %	WET BIOMASS (t/ha)	DRY BIOMASS (t/ha)	TOTAL POTENTIAL N ESTIMATE (kg/ha)^
2019	Warrami	Cowpea	2.8	8.4	1.9	70
	Riversdale	Cowpea	2.8	7.0	1.5	55
	Murray	Lablab	2.3	5.8	1.3	40
	Kennedy	Cowpea	2.8	8.4	1.7	60
	Riversdale	Cowpea	2.8	9.2	1.8	65
2020	Warrami	Mossman soybean (low)	2.7*	12.8	3.3	115
		Mossman soybean (high)	2.9*	14.7	3.8	140
	Warrami	Ebony cowpea (low)	2.3*	7.0	1.4	40
		Ebony cowpea (high)	2.0*	9.6	2.3	60
	Warrami	Meringa cowpea (low)	3.2*	5.2	0.9	33
		Meringa cowpea (high)	2.5*	6.1	1.1	35
	Riversdale	Ebony cowpea	2.8	12.2	3.1	115
		Sunn hemp	1.6	13.3	3.3	70
	Kennedy	Ebony cowpea	2.8	8.2	2.1	75
		Sunn hemp	1.6	13.7	3.4	75

YEAR FALLOW EST.	SITE	LEGUME CROP	N %	WET BIOMASS (t/ha)	DRY BIOMASS (t/ha)	TOTAL POTENTIAL N ESTIMATE (kg/ha)^
2021	Riversdale	Ebony cowpea	2.8	8	2	70
	Riversdale	Ebony cowpea	2.8	10	2.5	90
	Riversdale	Sunn hemp	1.6	2.1	2.1	45
	Warrami	Ebony cowpea (inoculated)	2.8	9.5	2.4	85
	Murray	Ebony cowpea (inoculated	2.8	9.5	2.4	85
	Murray	Mossman soybean	1.9^	18.1	3.9	95
	Murray	Mossman soybean (inoculated)	2.0^	15.4	3.5	90
	Lower Tully	Mossman soybean (inoculated)	2.1^	29	8.3	225
	Syndicate	Ebony cowpea planted in dry (old)	2.8	9	2.3	85
	Feluga	Ebony mixed with sunflower (inoculated)	2.8	8.5	2.1	75
	Feluga	Leichardt soybean (inoculated)	2.8	9	2.3	85
	El Arish	Ebony cowpea	2.8	8.5	2.1	75
TSL SAMPLING						
2022	Riversdale	Ebony cowpea	2.8	7	1.8	50
	Riversdale	Ebony cowpea	2.8	6	1.4	40
	El Arish	Sunn hemp	1.3	8.5	2.1	25
	El Arish	Ebony cowpea (inoculated)	2.8	7	1.7	50
	El Arish	Ebony cowpea (inoculated)	2.8	9	2.0	55
	Bilyana	Cowpea, soybean, sunflower (inoculated)	2.8	6	1.4	40
SRA SAMPLING *Fallow crop sampling undertaken by SRA was supported by the Mobilising the Murray Project (see next page)*						
2022	Kennedy	Mix legume (inoculated)	1.75*	14.9	2.7	56
	Kennedy	Mix legume (inoculated)	1.76*	16.7	2.8	60
	Kennedy	Mix legume, plus sunn hemp (inoculated)	1.7*	16.2	3.6	75
	Bilyana	Mossman soybean (inoculated)	2.5*	2.1	0.5	15
	Bilyana	Mossman soybean (inoculated)	3.2*	4.8	1.1	45
	Bilyana	Mossman soybean (inoculated)	2.4*	7.9	2.1	65
	Warrami	Mossman soybean	2.5*	7.5	2.3	75
	Warrami	Mossman soybean	2.5*	12.5	4.0	130
	Warrami	Mossman soybean	1.8*	8.1	2.7	60
	Warrami	Mossman soybean (inoculated)	2.5*	21	6.5	210
	El Arish	Mix legume	2.0*	10.2	3.3	85
	El Arish	Sunn hemp (inoculated)	1.3	25	12.6	210

** Indicates samples that were sent to the laboratory for analysis of nitrogen concentration (% dry matter). All other samples use estimated nitrogen concentrations reported in Table 1.*

^ Total potential nitrogen estimate calculations include the additional 30% nitrogen supplied from the roots and have been rounded to the nearest 5 kg N/ha.

Tully district grower Graham Maifredi inspecting the Ebony and Meringa cowpea legume cover crop with Mt Mackay in the background.



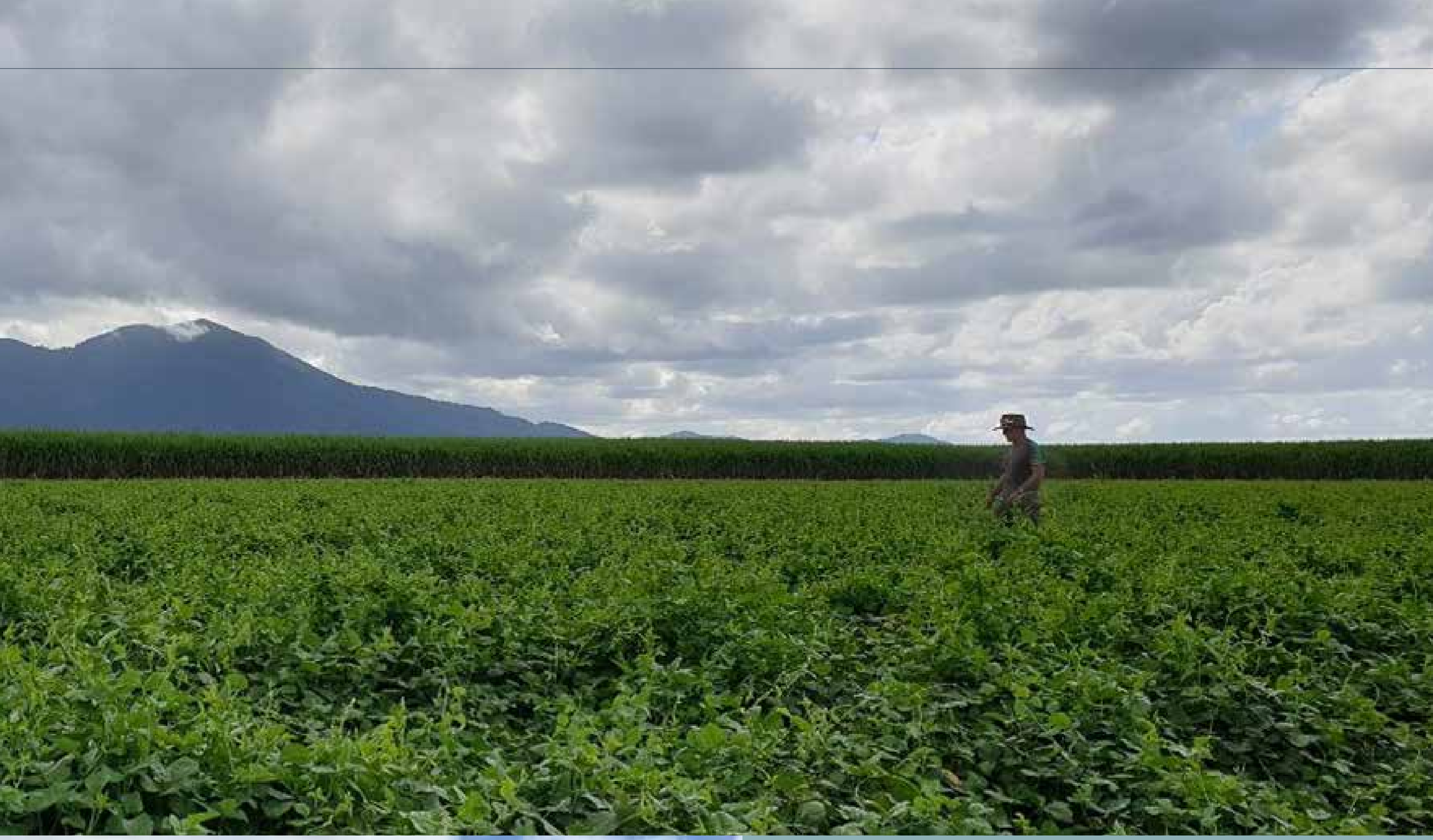
KEY FINDINGS FROM THE 2023 MURRAY DEMONSTRATION SITES

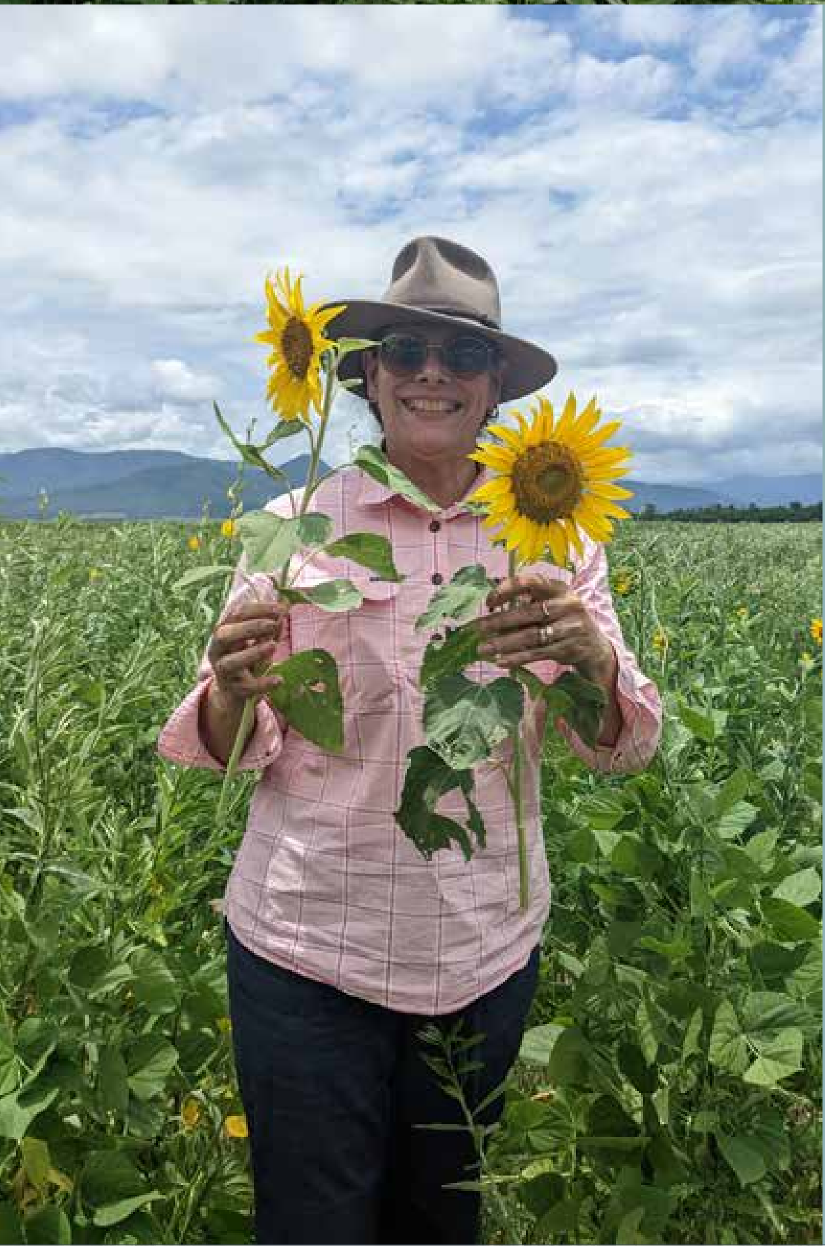
Sugar Research Australia through the *Mobilising the Murray* project established demonstration sites with local growers to better understand how plant cane nitrogen rates could be adjusted following legume cover crops.

- Data collected during 2022 and 2023 indicated sugarcane plant crops did not require additional fertiliser N at side dressing
- Soil samples were collected to assess changes in soil mineral N (ammonium [NH_4^+] and nitrate [NO_3^-]) from the end of the legume crop up until the sugarcane plant crop was approximately six months of age. A total of 202 soil samples were collected and analysed during this period
- Regular monitoring of soil mineral N over time provided valuable information about potential N supply following a well-managed legume cover crop
- Changes in total soil mineral N were observed in response to management (tillage) and rainfall
- Changes in soil mineral N levels can be used to make more informed decisions about whether to apply additional fertiliser N at side dressing or if the N supplied from the legume cover crop and applied at planting is sufficient to support optimal sugarcane growth
- Reducing the plant cane N fertiliser rate to account for some of the N supplied by the legume cover crop did not restrict N uptake by the sugarcane crop during the 2022/23 growing season
- Leaf samples to assess N uptake taken in January 2023 confirmed the crop was not N deficient. Third leaf N concentrations [% dm] were well above the critical value (1.90 % dm). A total of 24 leaf samples were collected and analysed
- At all sites, the growers applied some N at planting. This ranged from 21 to 60 kg N/ha
- Monitoring soil mineral N in combination with leaf analysis, allows situations where plant cane side dressing N rates could be reduced to be identified without impacting crop performance
- Better understanding if N is required at side dressing will help reduce fertiliser costs and the potential for N losses to the environment without affecting productivity
- These observations were collected from working with eight farmers, across 12 blocks and sampling multiple sites per block to ensure differences in soil type, legume species and the impact of waterlogging on legume crop growth was well represented.

Read more about the *Mobilising the Murray* project at sugarresearch.com.au/research/mobilising-the-murray.

A fallow crop information session with SRA Agronomist Nancy Rincon.





The* Mobilising the Murray *Project is funded by the Australian Government's Reef Trust and delivered by Terrain NRM in partnership with Sugar Research Australia.

The integrated approach of the project aims to leave a legacy of enhanced industry capability driven by productivity and efficiency gains that also deliver water quality outcomes.

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DISCUSSION

In the Wet Tropics legume cover crops are grown primarily for soil health benefits. Increases in soil mineral nitrogen following a legume cover crop is a bonus.

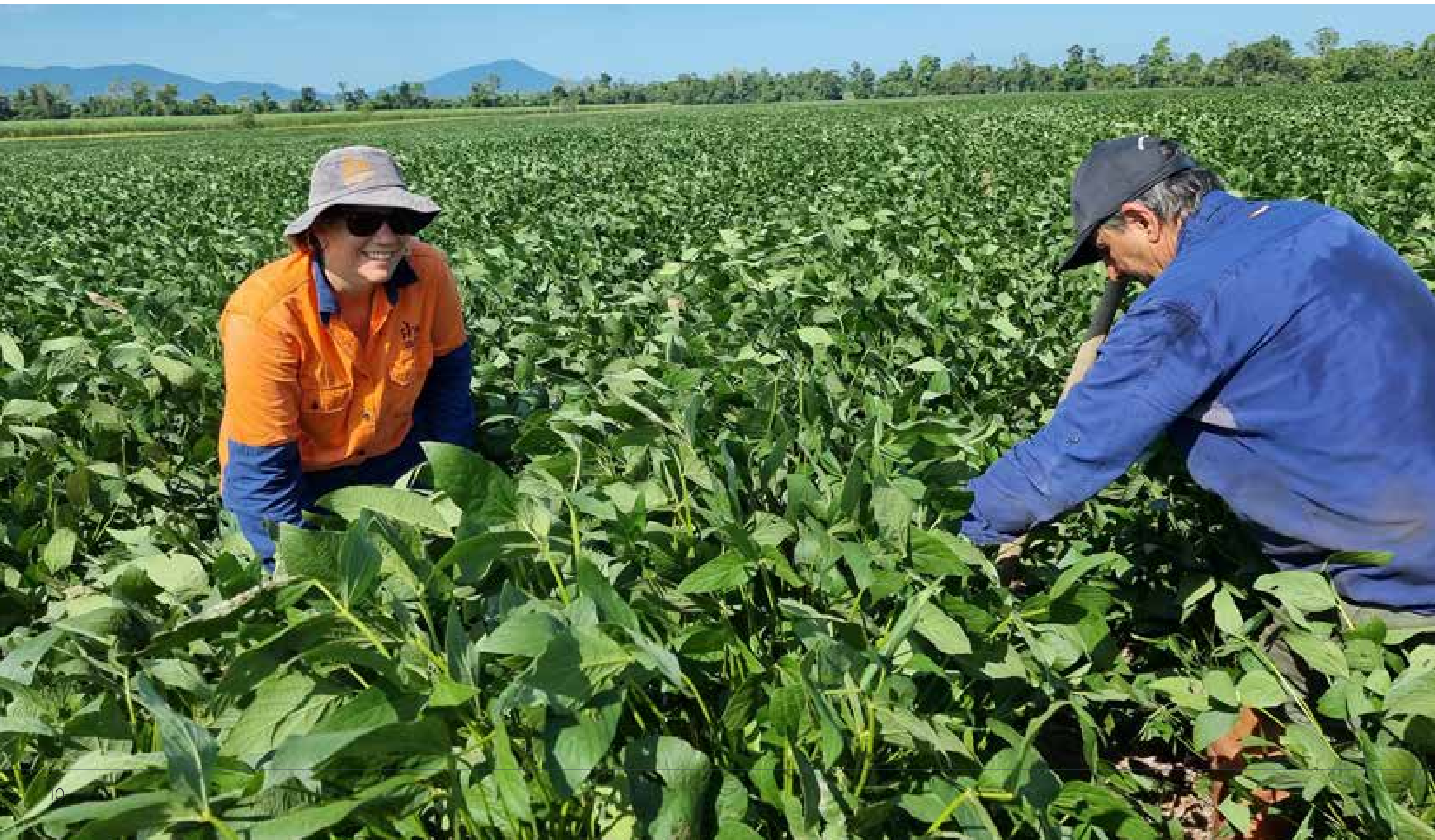
- The amount of nitrogen supplied by a legume crop can vary. Estimating the amount of potential nitrogen supplied and incorporating this estimate into plant cane fertiliser programmes is also an important consideration in SIX EASY STEPS.
- Ideally legumes should be sprayed out and the residue left on the surface until close to planting. This provides a) soil cover in case high rainfall is experienced and b) improves the availability of nitrogen to the following sugarcane plant crop.
- As legume cover crops may contain significant amounts of nitrogen, plant cane nitrogen fertiliser rates should be adjusted. Refer to the SIX EASY STEPS Toolbox 'Adjusting nitrogen rates following legume fallow crops' for more information relating to the availability of legume nitrogen to the following sugarcane plant crop.
- You can find the SIX EASY STEPS Toolbox at **sugarresearch.com.au/growers-and-millers/nutrient-management/six-easy-steps-toolbox/refining-nutrients-for-specific-circumstances/accounting-for-legume-fallow-crops**.

Or by scanning the QR code.

NEED HELP WITH YOUR LEGUME COVER CROPS?

Greg Shannon, Cane Productivity and Development Manager (Tully Sugar Limited) and Nancy Rincon and Erin Headon, Agronomists (Sugar Research Australia) can assist Tully growers measure and estimate the potential benefits from their legume cover crops – see back page for contact details.

SRA Principal Agronomist, Dr Danielle Skocaj with grower Alf Nucifora assessing nodulation of a Mossman soybean cover crop in the Murray district, 2022.



CHECKLIST FOR GROWING LEGUME COVER CROPS IN THE WET TROPICS

1. PREPARATION

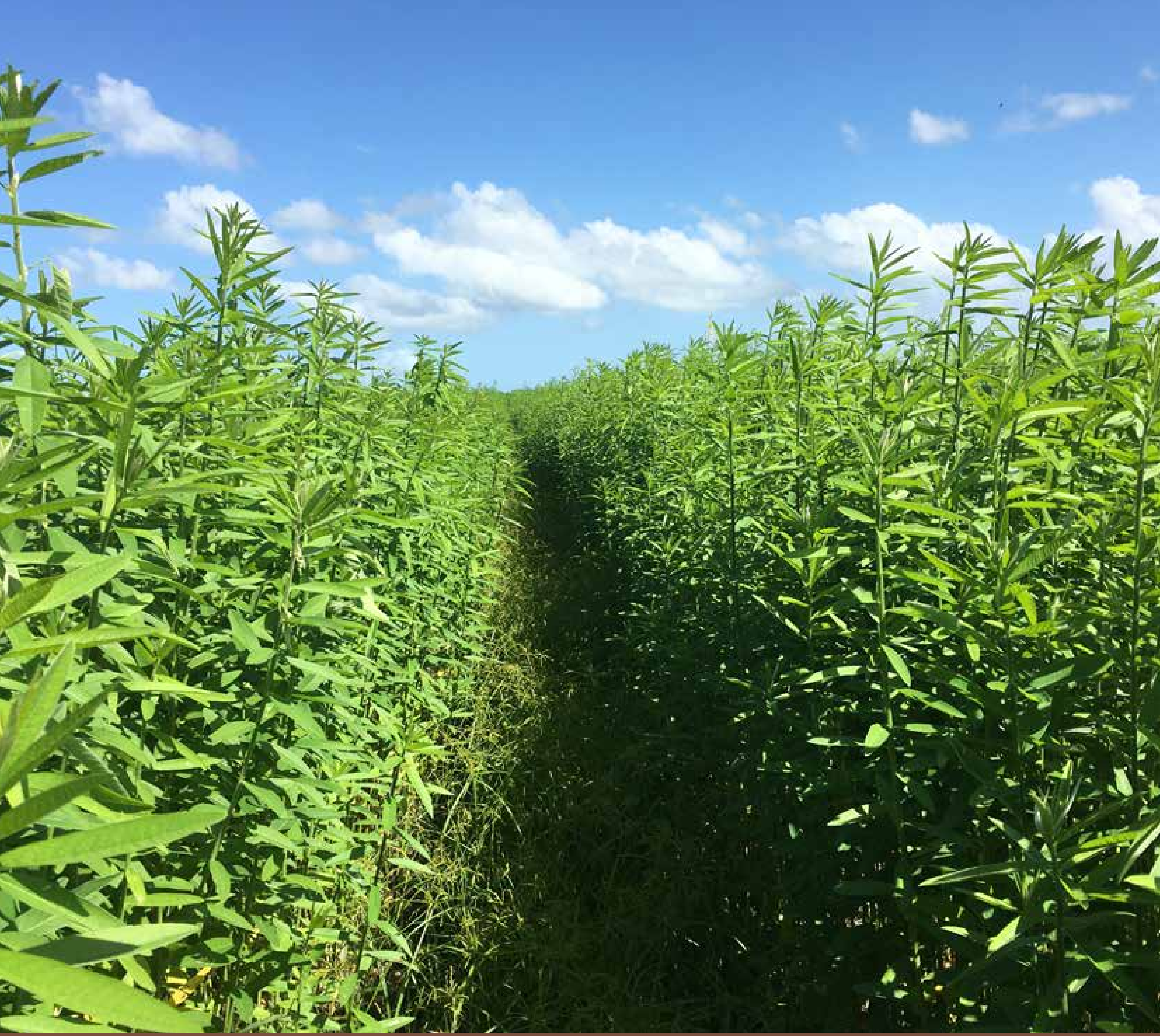
- [ ] Take a soil test. The best time to soil sample is immediately after harvesting the final sugarcane ratoon crop. This soil test will identify nutrient requirements and potential soil constraints.
- [ ] Apply and incorporate required soil ameliorants (e.g. lime). Applying ameliorants at the commencement of the fallow period is important for successful growth of the legume crop and following sugarcane crop.
- [ ] Prepare the block to a good soil tilth unless direct drilling legume seeds into existing sugarcane rows.
- [ ] If forming beds or hills, use an appropriate row spacing to ensure good plant population, rapid canopy cover and to minimse waterlogging.
- [ ] It is ideal to plant legume seeds into moist soil or when rain is forecast soon after planting.
- [ ] Apply a knockdown herbicide prior to planting if needed to remove any weeds and volunteer sugarcane plants. Preventing the growth of volunteer sugarcane plants during the fallow period will reduce pest and disease pressure.
- [ ] Select the appropriate legume variety. Refer to SRA Information Sheet "Legumes Pros and Cons" for more information on different legume varieties.

2. PLANTING & APPLYING INOCULANT

- [ ] Source fresh seed. Do not use old seed or seed that has been stored incorrectly (exposed to heat and humidity). If unsure do a quick germination test!
- [ ] Determine the correct planting rate. This will depend on the planting method and legume variety.
- [ ] Calibrate the planter for legume seed (particularly when direct drilling).
- [ ] Purchase the correct inoculant. If mixing different legumes more than one inoculant group will be required.
- [ ] Keep the inoculant cool **(refrigerate, DO NOT FREEZE)** and out of direct sunlight.
- [ ] Ensure all containers used for mixing inoculant are clean and free of contaminants.
- [ ] Always use potable water when mixing inoculant. The water should be 'soft' and as close to a neutral pH as possible.
- [ ] Keep inoculated seed as cool as possible to ensure maximum rhizobia survival.
- [ ] Only treat the quantity of seed that can be planted in a reasonable timeframe. High ambient temperatures at planting reduces rhizobia survival time.
- [ ] Ensure even coverage of the seed with inoculant.
- [ ] Check sowing depth (25 to 50 mm is ideal).

3. MONITORING CROP PERFORMANCE

- [ ] Monitor weed pressure. Select appropriate registered herbicides and apply according to recommended label rates if required.
- [ ] Check nodulation four to six weeks post planting when nodules can be easily seen by eye.
    - Remove plants from the soil using a shovel or garden fork as pulling plants by hand my rip nodules off the roots and wash soil from roots.
    - Assess the location (close to the crown of the plant and/or along the length of roots), number, size and colour (an active nodule will be pinkish or red on the inside whereas a white or green nodule is not fixing nitrogen from the atmosphere) of the nodules.
- [ ] Measure legume biomass. This will allow nitrogen contributions from legume crops and potential plant cane nitrogen fertiliser rate reductions to be determined. Refer to SIX EASY STEPS Toolbox for more information.
- [ ] Consider timing and method of legume cover crop destruction and incorporation of legume residue. This will depend on the desired cane planting time, soil type, soil moisture and weather conditions.



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Printing of the 2023/24 Tully Fallow Crops Guide was supported by the Cassowary Coast Reef Smart Farming project which is funded by the partnership between the Australian Government's Reef Trust and the Great Barrier Reef Foundation.