Sorghum Agronomy for Tropical North Queensland Farmers (Gilbert & Einasleigh Catchment)

Produced by: De-risking broad acre cropping options in Northern Australia

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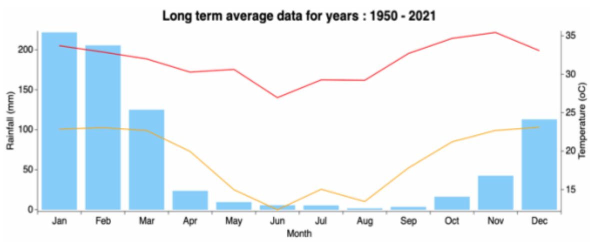
In Northern Australia multiple constraints create complex problems requiring partnerships between farmers, researchers, and agribusinesses to adapt known practices and build skills into profitable and low risk broad acre cropping options. Given that Northern Australia is relatively new to dryland cropping, the need to identify best crop and management options that bridge gaps between present and achievable yields remains highly relevant. This report summarises the learnings from two years of trials across Northern Queensland and aims to supporting farmers and agribusinesses identify best fit cultivars and agronomic practices, and farming system designs that maximise yields and profits, promote rainfall harvesting, increase water use efficiency, and provide diversification options to primarily rangeland grazing businesses.

Important priorities to de-risk broad acre cropping across Northern Australia include:

1. To identify sorghum hybrids better adapted to northern environments
2. To understand the expected effect of alternative agronomic practices, including sowing times, plant densities, row configurations, sources, and rates of nutrients, and weed and pest management options.
3. To identify farming system practices that improve topsoil infiltration and rainfall harvesting.

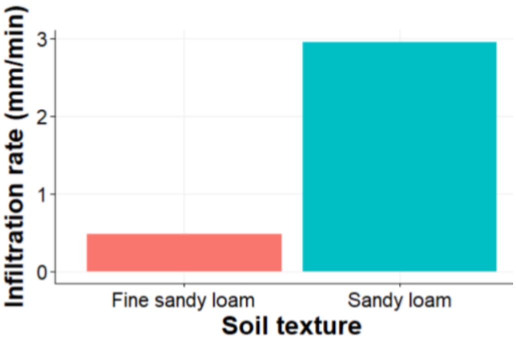
There is already ample information on sorghum agronomy at the GRDC web site, this document aims to fill existing gaps of information for farmers interested in growing grain sorghum in the Northern Queensland Savanah region.

Sorghum [*Sorghum bicolor* (L.) Moench] is an important crop across most arid and semiarid regions in the world. Sorghum has relatively high tolerance to heat and drought stresses. In north Queensland is primarily used to produce feedstock. Over the last fifty years sorghum yields in Australia have increased at about 1.2% pa (about 50kg/ha/year) as result of improvements in breeding and agronomy. These yield improvements resulted from (i) better targeting flowering windows so that this sensitive crop stage takes place during cooler temperatures i.e., maximum temperatures lower than 33°C; and (ii) managing water use before and after flowering to minimise the frequency and intensity of water stresses during grain filling. The latter can be achieved reducing the size of the canopy by planting lower plant populations and or using smaller amounts of mineral fertilisers, so that water use during the early stages of the crop is reduced.



The particularities of growing sorghum in catchment of the Gilbert and Einasleigh rivers relate to the concentration of the rainy season in four months of the year between December and March, and the sandy loam texture of the predominant alluvial soils of the region.
The cropping soils of the Gilbert and Einasleigh catchments are dominated by loamy textures with a high proportion of fine sands. Although spatial variation in soil types and the presence of subsoil constraints is high.

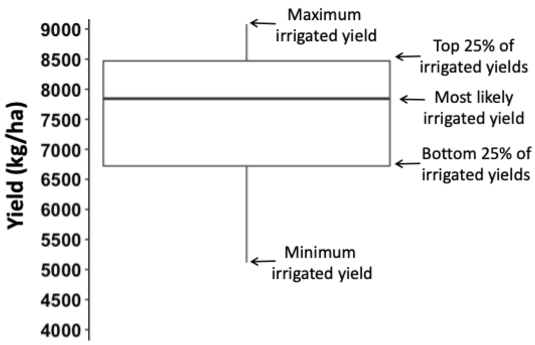
These soils are highly fragile (easily erodible), susceptible to surface sealing and subsequent crusting, which limits rainfall infiltration when bare and exposed to the impact of rain.



These soils can retain 90-150mm of plant available water, and to some extent buffer the impact the hot dry spells typical of TNQ's high intensity - low frequency – high spatial variability Monsoon rainfall. However, rainfall infiltration frequently limits soil water content. Adapting known and developing new technologies to build and maintain surface soil structure in mixed crop-livestock systems remains the highest priority for de-risking the introduction of cropping across the region.

Regional yield potential

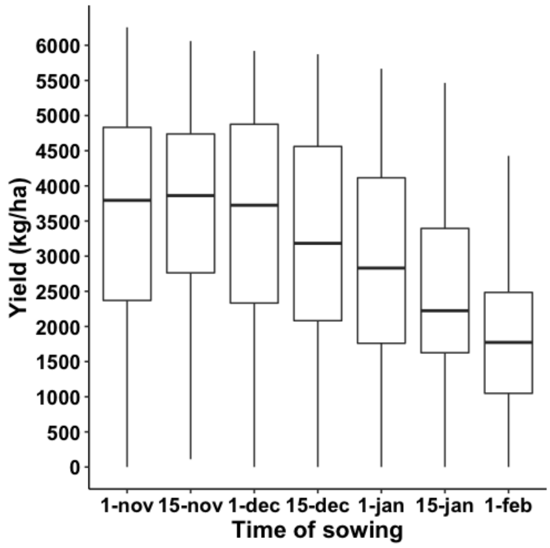
Understanding the maximum achievable yield can help inform the potential for cropping in the region, and likely returns from investment in irrigation. Fully irrigated grain sorghum yields for the region are likely to vary between 5000 and 9000 kg/ha, with an average yield of about 7800 kg/ha.



Even though, maximum yields are about 3-4 t/ha lower than fully irrigated yields in the Darling Downs, these results show that sorghum can be a valuable crop in the north. The main constraint to achieve yields like those in southern locations is most likely the occurrence of heat stresses (temperatures higher than 34°C) around flowering.

Sowing time

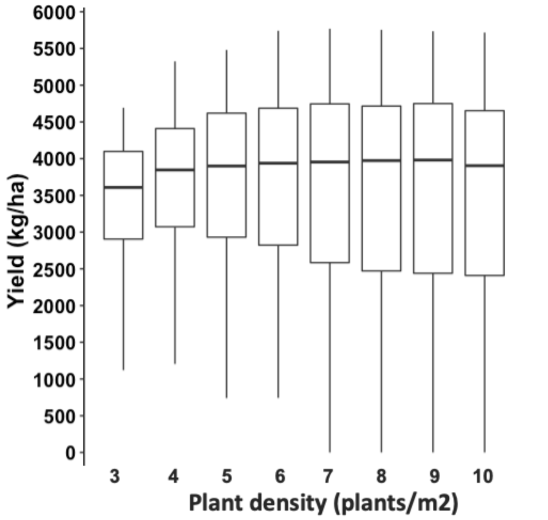
As a basic principle, early sown crops will have a higher likelihood of achieving high yields, however the time of sowing will be determined by the start of the wet season. Analysis of Georgetown climate records shows that the average start to the wet season is the 15th December. The most likely dryland yield is about 3500 kg/ha, though, in long wet seasons with frequent rainfall events (i.e., good wet season), dryland crops could yield up to 5500 kg/ha. Dryland crops will have a 25% chance of achieving less than 2500 kg/ha if sown early in November, and less than 1000 kg/ha if sown late in February.



Plant density

The size of the crop canopy will determine its water requirements. Plant density and row configuration are the main variables farmers can use to design the size of the crop size. As plant density increases the achievable yield is likely to increase during good wet seasons, though at the expense of a higher chance of low yields and poor grain quality in short or low rainfall frequency wet seasons. So, there is a significant trade-off between yield and risk of crop failure.

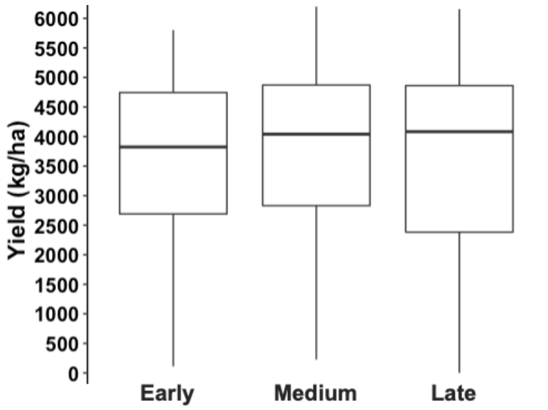
The most likely simulated yield shows a small yield gain from increasing plant densities from 3 to about 6 pl/m2. This includes a higher chance of achieving high yields in good seasons, with a small trade-off in the poorer seasons.



For plant populations higher than 6 pl/m2 the chance of poorer yields in poor seasons increases. Seed germination needs to be checked before sowing to make sure that the target plant population is achieved. Other factors that might affect the selected plant density might include weed pressure. Under high weed pressures narrowing rows and maintaining or increasing plant density might pay off – though the risk of terminal water stresses should be considered. A good practice is to check soil moisture at sowing, so that if sowing into a full soil profile risks of crop loss would be minimised.

Cultivar selection

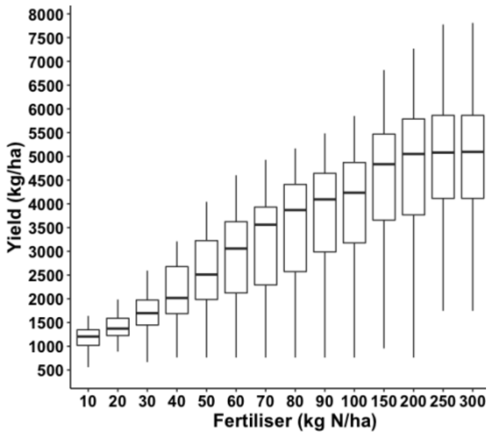
As a general principle, the longer the crop cycle the higher the yield potential. For the region, however, expected yield differences between an early and a late maturing cultivar were small (about 500kg/ha).



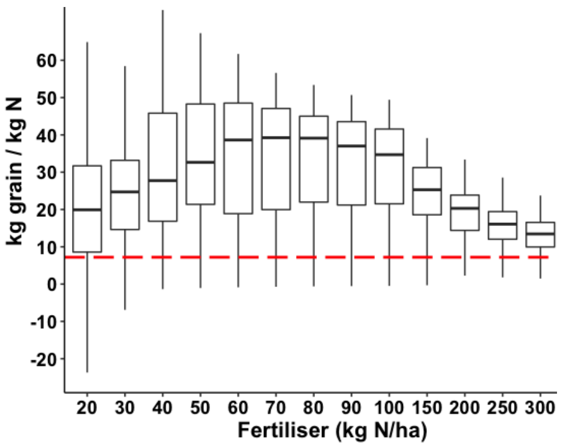
For northern Queensland, results from cultivar trials using commercial and experimental hybrids showed that some new experimental red, white and high digestibility grain sorghum hybrids produced grain yields similar or higher than the yields from the commercial check hybrids, differences of up to 4t/ha between these hybrids were recorded in TNQ trials.

Crop nutrition

Given the low levels of soil organic matter in these soils Nitrogen (N) fertilisation will increase early crop growth, the size of the canopy and total crop water use. The yield of sorghum can be expected to increase by a factor of five when the fertilisation increases from 10kg N/ha to 150 kg N /ha as shown in the simulated yields below.



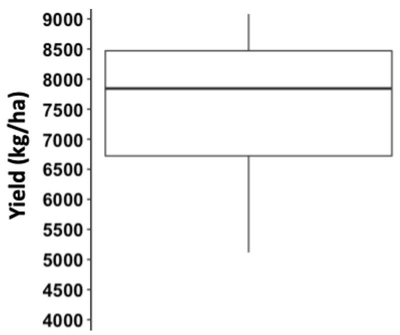
In the figure below the expected responses to increasing levels of N fertilisation were calculated for a Tonks Camp sandy loamy soil having a water storage capacity of 150mm. The minimum profitable response is added in the graph as a red dashed line (~7.3 kg grain / kg N applied. This was calculated for a urea (46% N) price of ~1200 $/t urea (March 2022), and a grain sorghum price of ~300 $/t sorghum). Responses lower than that will incur in an economic loss. This figure shows that the profitability of the practice is highest and risks lowest for N application rates of between 40 and 60 kg N/ha. The maximum chances of negative returns (about 25%), defined as downside risk, can be expected at very low levels of fertilisation, 20kg N/ha.



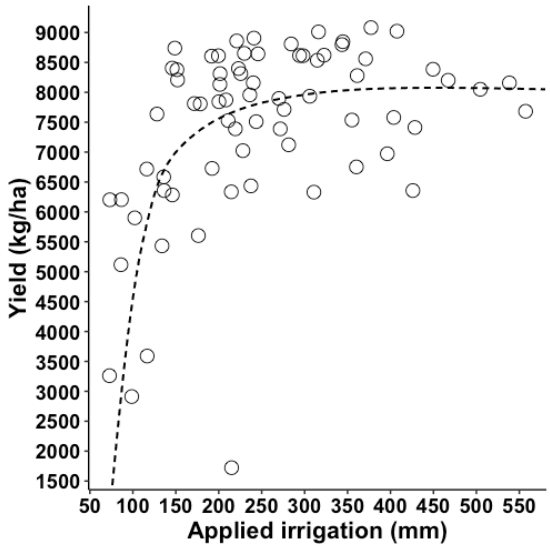
These results were obtained running the APSIM model (www.apsim.info) for 50 years of Georgetown climate. The most likely response is shown as a horizontal bar inside each boxplot. Though it is important to note that the variability in the response to nitrogen fertilisers is large, as north Queensland's climate is highly variable. Factors that will reduce this variability include increasing rainfall infiltration through stubble retention, sowing into a full soil profile, rotating cereals, and legumes, primarily drought tolerant legumes such as pigeon peas and sun hemp. Cotton is high value crop highly suitable for the region to be grown rainfed or under irrigation.

Irrigated yields

The potential to develop irrigation infrastructure in the Gilbert & Einasleigh Catchments is presently under discussion. Across the region, a few growers already irrigate cereal, pulse, and cotton crops. For the case of sorghum, irrigation can be expected to significantly lift and stabilise yields.



The amount of irrigation water required to maximise yields is not large. About 200 mm or 2ML/ha of irrigation would allow farmers achieve ca. 80% of the potential yield.



Weed control

Weed control in grain sorghum across southern Australia is strongly reliant on pre-emergent herbicides such as atrazine and s-metolachlor. Factors to consider, specifically for the lighter sandy loamy soils of the catchment is the likelihood of sorghum injury in addition to product label. Also, erosion and water logging can concentrate the herbicide in the furrows causing sorghum damage. The use of seed safeners e.g., Epivio C® (that replaces Concep II®) and the use of seed having high germination will help to minimise injury. For further information visit GRDC. There are no post-emergent herbicides for grass weed control in sorghum; therefore, achieving a high efficacy of pre-emergent herbicides is very important. The use of herbicide-tolerant sorghum (e.g., igrowth™) could provide opportunities for in-crop grass weed control; however, strong stewardship guidelines should be adopted to delay the evolution of herbicide resistance in weed species.

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Pests and diseases

Even though sorghum is susceptible to be damaged by a range of pests in the southern regions, over two years of trials across the catchment no yield impacting damage was recorded. The main identified pests included armyworms and fall armyworm. Armyworms and fall armyworm can cause defoliation during early crop stages though unless plants are lost, impact from the loss of leaf material before the crop reaches the stage of flag leaf can be expected to be of no significance not warranting control. Late infestations of fall armyworm affecting the panicle might require to be controlled. Economic thresholds are being developed by QDAF, for more information access GRDC's resources or check https://thebeatsheet.com.au/.

Mixed cropping – grazing systems


Photos: Desmanthus growing on sole stands and intercropped with grain sorghum near Georgetown, North Queensland.

The main enterprise across the region is the rangeland production of beef cattle. Though there are multiple opportunities for cropping to create synergies with grazing enterprises. Ideally farmers should aim to specialise and separate land used for cropping and grazing activities. However, when not possible, adding an underlay growing forage shrub such as Desmanthus, a perennial legume (see photo above), in intercropping systems with grain sorghum may increase the quality of the stubble for the cattle while helping maintain ground cover and improve soil structure and rainfall infiltration. Initial results show potential for the practice while the main constraint remain having cattle trampling the soil on crop land, and the difficulty in establishing Desmanthus on sandy-loamy soils. More research is clearly needed on the matter.

Further reading

- Sorghum insect control GRDC https://grdc.com.au/resources-and-publications/grownotes/crop-agronomy/sorghumgrownotes/GrowNote-Sorghum-North-07-Insects.pdf
- Sorghum diseases GRDC https://grdc.com.au/resources-and-publications/grownotes/crop-agronomy/sorghumgrownotes/GrowNote-Sorghum-North-09-Diseases.pdf
- Integrated weed control GRDC https://grdc.com.au/resources-and-publications/all-publications/publications/2019/iwmm
- Keeping sorghum safe GRDC https://grdc.com.au/resources-and-publications/all-publications/factsheets/2016/04/tt-keepingsorghumsafe
- Sorghum GrowNotes, GRDC https://grdc.com.au/
- Developing Northern Australia https://www.csiro.au/en/Showcase/Northern-Australia
- Leading from the North https://press.anu.edu.au/publications/leading-north
- Desmanthus sp https://www.daf.qld.gov.au/business-priorities/agriculture/plants/crops-pastures/pastures/desmanthus

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