Gippsland Biomass Trials

LATROBE VALLEY AUTHORITY

GIPPSLAND Smart Specialisation

GCCN GIPPSLAND CLIMATE CHANGE NETWORK

HYBRID ENERGY AUSTRALIA

Acknowledgements

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Thank you to all the team for poking and prying into what could be possible. This research forms a necessary first step to stand on a mountain of real data and see what the future might be.

Darren McCubbin
CEO
Gippsland Climate Change Network.

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HEA /GCCN Super Sorghum Planting Trial and Pyrolysis Observation Report

Panel conclusions

1. These trials have been valuable in identifying the range and complexity and issues involved in biomass production for pyrolysis highlighting the importance of identifying the desired product or if a waste stream exists what the product opportunities are and also the treatments required to make the crops suitable for pyrolysis.

2. Discussions around the crop trials recognise the potential conflict between the economics of growing energy crops and the production of food for human and animal consumption. The panel recognises the need to adopt a "Food First" priority.

3. Despite adverse and unseasonal weather and growing conditions, there was sufficient evidence to confirm that growing sorghum on prepared marginal grassland could be successful using broad acre farming provided there was adequate ground preparation using raised beds better drainage, and better irrigation management.

   Hybrid Energy Australia (HEA) concluded that the selected sorghum types could in a full growing season, under well drained paddock conditions, using flood, ground, or pivot irrigation deliver the target raw yield rates of 70 Ton per hectare.

4. Any future sorghum planting should not be initiated under the described grey water flood irrigation conditions although the high yielding super sorghum was more tolerant of the adverse conditions than the control crop of corn (wet feet – nutrient issues)

   The sorghum is better suited to formed raise agricultural bed preparation with either pivot or linear or ground irrigation where soil moisture can be controlled.

5. Production of biomass crops will require inputs of fertiliser and water to maximise yields. Low quality will not be suitable unless the objective is to also build up soil fertility and carbon then the yields may be less important.

6. The technique of pyrolysis is a complex process with feedstock type, heating time, ultimate temperature, particle size and original moisture varied to obtain different ratios of bio-oils, biochar, and wood vinegar. Varying any of the parameters of the process often has a significant impact on the outcome.

   This highlights the importance of adequate laboratory scale and pilot scale testing.

7. There are a range of challenges in verifying suitability for pyrolysis for biochar. The need to pelletise and selecting the right pellet diameter and moisture content is a consideration when selecting both the biomass type and the Pyrolysis treatment technology.

   There is a need to consider more detailed Cost/Benefit analysis on yields and products of pyrolysis to determine target yields.

   Despite these considerations, the trials did produce some quality biochar.

8. The work identified that there are opportunities taking account of the limits to the pilot trial to expand trial planting to other crop types to then assess their suitability for pyrolysis and biochar production. Three species of plant stand out as the most promising choices for investigation into biomass production in Gippsland. These are Sorghum, Sunn hemp and Industrial hemp.

9. The panel recognises that the climate of Gippsland, along with its soil types, varies widely, with both poor and prime areas for growing crops. Utilising the poorer areas to their best extent through bioenergy production would create new economic activity and product availability in the region, and thus would be highly beneficial for job creation. These crops may also assist in the constructive regeneration of the soil.

10. Biomass crops could also be used as a “break” crop and then utilised for biomass on higher quality land.

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Executive Summary

The objective of the trial was to grow an agricultural scale quantity of super sorghum for the purpose of evaluating the growth characteristics using broadacre farming under flood irrigation conditions. This was followed by the measurement of the biomass growth characteristics and yield to then on harvest enough to undertake pyrolysis to determine the biochar chemical and energy properties and their carbon sequestration potential.

The location for trial was on productive land suitable for pasture growth leased by the Gippsland Climate Change Network (GCCN) from Gippsland Water (GW).

The trial growing period for the selected sorghum type was initiated by planting on the 13th January 2022, with harvesting and bailing concluded by week 19, the 23rd May 2022. An amount of sorghum was then dried, hammermilled and pelletized in readiness for pyrolysis at the HBC Environmental Solution pyrolysis demonstration plant located in Sydney. Pyrolysis took place on the 23rd August 2022 with samples then shipped to the Southern Cross University, Lismore NSW for analysis and biochar characterization with the results becoming available on the 30th of September 2022.

The trial demonstrated that under adverse weather conditions prevalent during November 2021 to May 2022, sorghum could be successfully grown on an undrained flood irrigated paddock using broad acre farming. The challenges as recorded in the body of the report included having saturated ground conditions in most of the trial paddock combined with high humidity stunting plant growth and reducing plant yield by as much as 50%. Ideally planting should have commenced mid-November and been completed by the following March taking advantage of the maximum sun radiation, high temperature and average rainfall. This was not possible due to total weather disruption to the whole of the summer growing season disrupting agricultural production throughout Victoria and in particular the Gippsland region with some agricultural crops abandoned. Other consequential effects were having to wait for the ground conditions to be sufficiently dry for farm machinery access for ground preparation, planting, and the application of weed control and fertilizer. The same weather disruption occurred to harvesting and bailing which allowed little time for wind row drying before bailing.

The lessons learnt from the trial is that broad acre farming is not a suitable practice for high yielding super sorghum and better suited to formed raise agricultural bed preparation with either pivot or linear or ground irrigation where soil moisture can be controlled. Should flood irrigation be an option this could be successful provided the paddock is well drained by drainage ditches and the water evenly distributed using multiple sluice gates or the establishment of a turkey's nest.

Despite all the weather disruptions and the described paddock conditions HEA considers the agricultural part of the trial experience adds to the body of knowledge for the growing of sorghum or any other biomass other than grass on marginal agricultural land under the described trial conditions.

The next challenge presented in the trial was the adaptation of specifically grown soft tissue biomass crop to produce biochar. Biochar production in the main has been done using wood chips and waste wood products. There were no guidelines with respect to biomass preparation other than trial and error. The first challenge was to take mulched harvested sorghum and dry this to 15% moisture content prior to hammermill and pellet production. Whilst wood-based treatment is well documented each agricultural biomass type has different texture and density characteristics that require equipment settings to be optimized for the biomass. Biochar production in the main at industrial scale has been limited to wood waste and chips, it therefore became necessary to make

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changes to the pyrolysis reactor temperature settings and retention times to ensure pyrolysis occurred through the whole of the pellet structure. The described optimization process became evident during the HBC pyrolysis trial as was the case for other pyrolysis plants as trailed by HEA. Other factors influencing the production rate included the size of the pellet and the base material density. It was also necessary to cool the pellets in an inert atmosphere to prevent the formation of ash.

As part of the trial sorghum's extensive root development was examined and its potential contribution to soil improvement and carbon sequestration documented. The result of the trial puts a persuasive case that sorghum's extensive and deep root development is a positive path for improved soil aeration and oxygenation and carbon sequestration.

In conclusion it can be said that utilization of marginal land not suitable for food production could be effectively utilized with adequate land preparation with respect to drainage as evidenced by the trial.

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Land Condition

The land utilized by HEA for the sorghum growth trial was leased by the Gippsland Climate Change Network (GCCN) from Gippsland Water (GW) for the purpose of trial planting a range of crop types and evaluate their suitability for growing on marginal land not suitable for agricultural crop production.

As time progressed GW advised that their contractors were not in a position to tend to a trial plot of this size, and that it would be GCCN's responsibility to undertake all the preparatory works including land grading, ploughing, harrowing, and planting. To grow at least one crop on GCCN's 5 Hectares leased land, HEA was approached to undertake limited land preparation and planting of their sorghum plant types, harvest and undertake biomass pyrolysis to demonstrate biomass utilization. HEA agreed to the proposal based on an agreed cost contribution by GCCN conditional on the sharing growth and pyrolysis data obtained.

The land provided to HEA comprised a bund bounded paddock of approximately 0.7 hectare of grassland used for cattle adjustment by GW that was periodically flood irrigated with Class C recycled water from their adjacent sewerage settlement ponds. For access purposes HEA selected the paddock as illustrated in the accompanying location plan nearest to the main access gate and GW service sheds. The field dimensions of the paddock were approximately 36 meters wide by 180 meters long.

HEA accepted the paddock from GW sight unseen other than the following provided information:

- Photographs as provided by the Gippsland Climate Change Network (GCCN) of the proposed paddocks.
- HEA's selected Agricultural Contractor's report with respect to site access and suitability for broad acre farming.
- Soil Testing Report from Gibson's Ground Spread provided to HEA's agronomists to determine the fertilizer type and quantity to be applied.
- GW provided information that the land plots were periodically flood irrigated via a sluice fed from an irrigation channel with Class C recycled water pumped from the GW sewerage treatment ponds.
- Based on historical usage and visual inspection it was accepted that the paddock selected was level and suitable for broad acre planting and graded to allow the even flow of water across the selected paddock.

HEA noted and advised the GCCN participating partner that the sweet sorghum types provided by HEA are generally grown on land prepared by ploughing, hoeing, and planting methodology using

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formed planter beds and irrigated using either pivot or linear irrigators or drip irrigation tape and a metered water supply.

The deviation from the established planting norm using flood irrigation was undertaken given the land irrigation system available to GCCN, which is primarily used for pasture growth. HEA noted that flood irrigation with the provided sorghum seed type had never been done in Australia but common in places with an abundance of water. HEA's agronomist reported that his experience in Mexico with the selected seed type using flood irrigation proved successful.

Given the method of irrigation and late engagement of HEA it was decided and acceptable to GCCN to use the provided paddock in its as is condition and rely on the Broad Acre Disk planting methodology to maximize crop production.

Of concern to HEA was the single sluice water source for flooding the paddock. To even water distribution the gate water is usually discharged to a turkey nest to then distribute the water through prepared furrows. Some evidence of this was present but generally the paddock was prepared for grass hay or silage production but not for traditional agricultural production.

On the basis that the sorghum planting was considered a trial and research and development project it was therefore accepted by GCCN and by HEA that the trial utilizing Class C recycled water flood irrigation was worth the risk and could establish the economic viability of using sewerage Class C recycled water irrigation to produce biomass for the purpose of biochar production. The production of other pyrolysis products such as wood vinegar and syngas was conditional on the appropriate pilot plant being available for this purpose.

Schedule to Commence Paddock Preparation and Planting.

Sorghum is a summer crop when grown in the southern regions of Australia. Ideal planting is generally with soil temperature above 16°C and medium soil moisture content to facilitate germination.

Sorghum planting is usually scheduled for November, but due to unseasonal weather conditions prevailing during December/January land preparation and planting could not take place until the 13-Jan-22. Causation for this delay were numerous and included:

- The short notice on the selected contractor and their other commitments to be fulfilled before the GCCN project,
- General delay to planting throughout Victoria was due to adverse weather conditions, wet months in December 2021 preventing equipment access on to land.

Land and Seeding Paddock Preparation on the 13-Jan-22

The following describes the chronological steps:

Step 1: Application of Roundup to eliminate grass growth prior to planting.

Step 2: Application of required fertilizer for adjustment of soil pH including nutrients.

The designated paddock soil was sampled on the 18-Oct-21 by Gibsons Grounspread and a report prepared and submitted to

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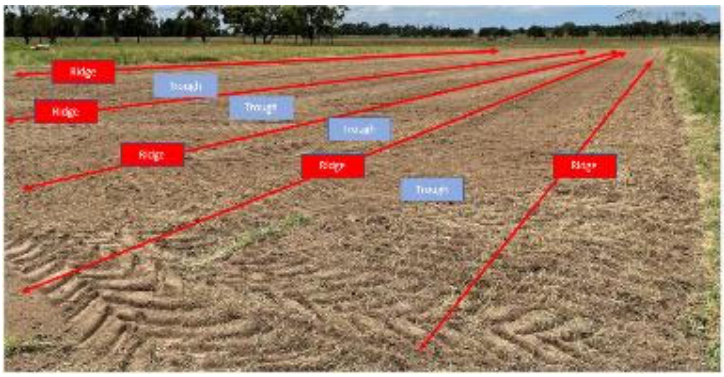
HEA on 8-Nov-21. The same report was submitted to HEA's agronomist, and their pH and fertilizer correction endorsed with the addition of additional nutrients recommended for sorghum.

The soil test interpretation by Gibsons Groundspread indicated: The pH – the soil was moderately acidic, Phosphorus (P) levels high, Phosphorous (P) buffering Index was low, Potassium (K) level low, Sulphur (S) levels low and should not limit Dry Mater (DM) production, Calcium levels desirable, Magnesium (Mg) levels slightly elevated and may effect soil compaction and DM production, Aluminium Level low and desirable, Potassium (K) availability low and will limit DM production, Sodium level high and will severely limit Magnesium (Mg) uptake, Hydrogen levels low and desirable, with a Total Exchange Capacity for the loamy soil that has moderate nutrient holding capacity and low leaching capability.

As recommended by Gibsons Groundspread a blended rate of Capital Fertilisers Blend of 2-1 applied 230 kg/Ha was applied comprising P-14, K-35 and for the pH correction Lime 3.5 ton/ Ha was applied. An additional 400 kg/Ha of Peats soil conditioner was added to improve the microbe health in the soil and enhance the fertilizer efficiency.

Step 3: Rotary Hoeing in preparation for Seeding**.**

System longitudinal traversing of the paddock was undertaken by the illustrated tractor/hoe machine combination.



Not evident during the initial paddock acceptance by GCCN was the level variability of the paddock until completion of the rotary hoeing process. The accompanying photograph illustrates paddock ridge mounding and flat troughs that would later influence the soil moisture retention and plant growth rates. Leveling of the paddock could not be done without extensive ground works that was outside the HEA scope of works.

Step 4: Seed Application.

Three types of seed where applied:

4.8 Kg of Type 1 NexGen Sorghum applied to 0.5 Ha of the 0.7 total paddock area.

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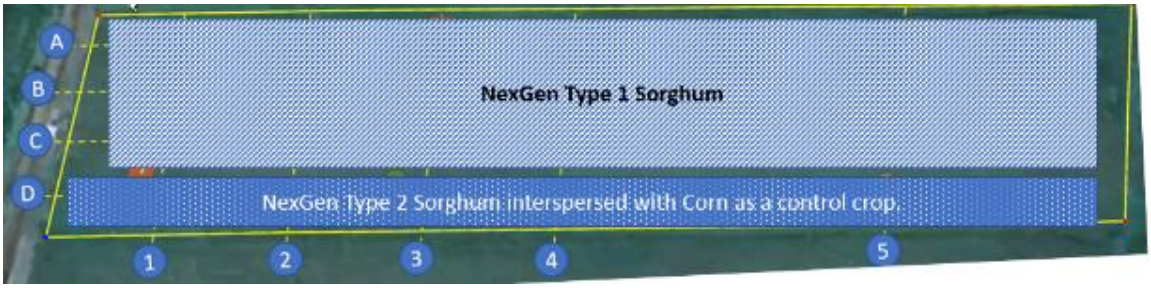
1.2 Kg of Type 2 NexGen Sorghum applied to with 0.2 Ha together with 0.3 Kg of corn used as the control crop.



Soil moisture content at the time of seeding was in the moist rage with little dust and ideal for planting and germination.

Sorghum Type description:

The following describes the sorghum types planted to the illustrated designated areas.

NexGen Type 1 - The sorghum type has good biomass with good protein content suitable for forage. It also has nitrogen fixing capabilities acting as an organic matter booster. Under normal growing conditions there is expected high yields with low fertilizer inputs, good sugar content and late flowering in long day season supporting high biomass production.

NexGen Type 2 - The sorghum type has intense growth, with long stalks with good biomass yields and tolerance to salinity. This was evidenced by the report with respect to recorded growth characteristics for Plant Monitoring Station No.4

Corn – The corn was planted as a control to monitor comparative growth rates with sorghum.

Periodic Observations

The following subsections details progressive growth observations.

Evidence of Germination on 18-Jan-22 (Day 6, Week 1)

Extensive and uniform paddock wide Sorghum germination was observed.

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At this time of plant germination, the soil moisture had reduced from moist to the interface between dry and moist. It was then decided that the first irrigation would need to be applied unless there was imminent rainfall expected.

First Flood Irrigation 21-Jan-21 (Day 9 Week 2)

Based on the germination rate and soil moisture levels it was decided that the first flood irrigation should be enacted.

As evidenced by the photograph the irrigation process was uneven and not ideal and based on the flow rate would dislodge germinating seed and create growth ridges. There was no control over water flow available through a single sluice gate with water discharge controlled by the GW pumping system with just an on and off switch.

The single sluice gate for discharging water was also problematic in distributing water to the paddock. For crop flood irrigation there are usually multiple sluices from the main irrigation channel or syphon pipes. For broad acre farming at the very least there should have been a turkey nest to the allow for the even distribution of water. The creation of ideal flood irrigation for described work would have required significant GW infrastructure investment and operational changes to which there was no commitment. Based on the project weather at that time there was no option but to flood irrigate and accept crop loss. The amount of water applied across the paddock was equivalent to 50 mm.

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Progress Update as at 31 - Jan-22 (Day 19, Week 3)

Good germination and growth of plantlets was observed reaching an average stem hieight of 10 cm, average plantheight 15 cm with good leaf development. Some evidence of broad leaf weed activity but not sufficent to warrant post initial growth herbicide treatment.

Unseasonal rain not expected post flood irrigation significantly increased ground moisture to soil saturation which if continued could severly inhibited plant dvelopment.

	Day	6	19
	Week	W1	W3
	Date	18-Jan-22	31-Jan-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM
1	1	1.5	12
2	1	1.5	15
3	1	1.5	15
4	2	1.5	20
5	1	1.5	15
6	1	1.5	15
7	1	1.5	15
8	1	1.5	12
9	1	1.5	12
Expected Growth Rate		1.5	20

As illustrated in the photographs high germination was observed in the elevated ridges of the paddock with lower plant density in the troughs where there was initial seed washout due to flood irrigation.

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Progress Update as at 8-Feb-22 (Day 27, Week 4)

As illustrated by the moisture meter the whole of the site had soils that were saturated due to unseasonal rainfall as illustrated by the corresponding rainfall records (see the appendix to the report). Optimum growth is achieved with soils in the lower moist to medium range. High moisture soil content can impede growth and effect the plant rooting process. This is illustrated by the growth table expected growth rate.

	Day	6	19	27
	Week	W1	W3	W4
	Date	18-Jan-22	31-Jan-22	8-Feb-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM
1	1	1.5	12	15
2	1	1.5	15	18
3	1	1.5	15	18
4	2	1.5	20	20
5	1	1.5	15	20
6	1	1.5	15	20
7	1	1.5	15	20
8	1	1.5	12	15
9	1	1.5	12	15
Expected Growth Rate		1.5	20	40

Generally, for those plants germinated the growth rate given the ground conditions was as expected with an average stem height of 15 cm, average plant height 20 cm with good leaf development.

Of concern was the emergence of broad leaf weed which needed to be monitored but too early for herbicide application until the development of sorghum leaf cover.

Post germination herbicide application for sorghum requires plants to have a minimum of four to six leaf development.

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Progress Update as at 13-Feb-22, (Day 32, Week 5)

As illustrated by the moisture meter, the paddock has soils that range from high moisture content to saturated due to unseasonal rainfall as illustrated by the corresponding rainfall records.

As stated for previous periods the optimum growth is achieved by the lower moist to medium range. Evidence suggests that the high soil moisture content continues to impede growth.

	Day	19	27	32
	Week	W3	W4	W5
	Date	31-Jan-22	8-Feb-22	13-Feb-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM
1	1	12	15	18
2	1	15	18	20
3	1	15	18	20
4	2	20	20	25
5	1	15	20	25
6	1	15	20	23
7	1	15	20	23
8	1	12	15	18
9	1	12	15	20
Expected Growth Rate		20	40	55

Growth rates as tabled show developed average stem heights between 15 to 20 cm, and average plant heights 18 to 25 cm with good leaf development. Growth rates on average were approximately 2 weeks behind that expected.

Of concern continued to be the emergence of broad leaf weed which was monitored but too early for herbicide application. Post germination herbicide application with sorghum requires the sorghum plant to have a minimum of four to six leaf development. This on average is close to being the case and next report period application of a suitable herbicide was considered.

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Progress Update as at 17-Feb-22, (Day 36, Week 6)

Stem heights are averaging between 25 to 30 cm, average plant height 20 to 30 cm, stem diameter in the range of 8 to 10 mm, with good leaf development.

	Day	27	32	36
	Week	W4	W5	W6
	Date	8-Feb-22	13-Feb-22	17-Feb-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM
1	1	15	18	20
2	1	18	20	25
3	1	18	20	25
4	2	20	25	30
5	1	20	25	30
6	1	20	23	28
7	1	20	23	28
8	1	15	18	20
9	1	15	20	23
Expected Growth Rate		40	55	70

Moisture meter readings with rain over the past week again boosted the soil moisture content to saturation inhibiting plant growth.

It became evident through paddock wide observations that there were significant plant growth rate differences between those plants located in flood irrigation furrows versus those on dryer ridges.

Broad leaf weed was identified as a combination of: Portulaca (also called Pig weed and Purslane), Fat Hen and Barnyard grass, the weed competing for sorghum plant nutrients.

The post emergent treatment and herbicide application was canvased with both the GCCN and HEA's agronomist for the selection of the most suitable herbicide.

The herbicide selected for this purpose was Starane (Dow Chemical Product). Arrangements were made with GCCN approval for a local contractor to apply the treatment.

The level of weed and density was unexpected by HEA with no information available from GW at the time of land handover for any pre-treatment spray necessary based on their experience of pasture management. It is not unusual for post treatment spray to be applied but best to be avoided.

It is suspected that flood irrigation could also have introduced and spread weed plant seed.

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Progress Update as at 24-Feb-22, (Day 43, Week 7)

Day 43, Week 6 is 40% through the expected 107 Day, 15-week growth timeline. Comparison with the crop baseline held by HEA under controlled conditions shows the plant growth is approximately 30% behind that expected under normal growth conditions.

Delayed growth is attributed to several factors including:

- Excessive and variable soil moisture content that could not be controlled due to exceptionally wet summer conditions and high humidity.
- Significant presence of weeds competing for nutrients.

Significant plant damage observed to leaves as illustrated and attributed to Brown Rot. There were many brown rot warnings issued for the Maffra and East Gippsland regions. These warnings occurred on the: 15-Jan-22, 2-Feb-22, 21-Feb-22, 25-Feb-22, 27-Feb-22, 1-Mar-22. It was expected based on the current long-range weather forecast that more brown rot events could be experienced.

Brown rot is a fungal disease that breeds in humid, wet weather. Weather records show over the report period a Relative Humidity (RH) in the range of 88% to 100%. Under these conditions fungus spreads rapidly, and the entire structure of the plant including the flower, branch, leaf and fruit can turn brown and shrivel, making the fruit inedible.

Whilst sorghum is not a fruit, evidence of leaf shrivel was evident throughout the paddock, this could be attributed to persistent high soil moisture content and high RH.

Whilst at the time of observation soil moisture was in the Medium Moist range, this was variable across the paddock. Further flood irrigation was considered but postponed as the forecast was for more rain in the coming weeks.

	Day	32	36	43
	Week	W5	W6	W7
	Date	13-Feb-22	17-Feb-22	24-Feb-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM
1	1	18	20	30
2	1	20	25	35
3	1	20	25	38
4	2	25	30	45
5	1	25	30	40
6	1	23	28	30
7	1	23	28	32
8	1	18	20	25
9	1	20	23	30
Expected Growth Rate		55	70	100

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Plant development continued to be variable across the paddock based on soil moisture content and location with those plants on the irrigation furrow peaks thriving with stem heights in the range of 20 to 35 cm with average plant height 25 to 45 cm, stem diameter in the range of 8 to 12 mm, with good leaf development.

Weed continued to choak the sorghum plantlets competing for nutrients whilst approval was sought from GCCN/GW to apply herbicide.

A contractor to apply Starane herbicide was selected and scheduled to apply herbicide as soon as weather and the paddock conditions permitted to support the weight of tractor and application boom.

Progress Update as at 3-Mar-22, (Day 50, Week 8)

Based on the variable plant growth rates across the paddock it was decided to revise the plant monitoring system to allow for the monitoring of plant growth at nine selected meter square plots representative of the growth conditions.

Paddock Monitoring Cycle: Temperature and Soil Moisture Reading at each marker, with plant measure at each of the nine designated plot areas.

Designated 1 meter square plots for average plant monitoring of plants: A1=14, C1=5, B2= 6, D2=12, A3=23, C3=8, A4=23, C4=7, B5=20

	Day	36	43	50
	Week	W6	W7	W8
	Date	17-Feb-22	24-Feb-22	3-Mar-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM
1	1	20	30	35
2	1	25	35	40
3	1	25	38	45
4	2	30	45	50
5	1	30	40	45
6	1	28	30	43
7	1	28	32	43
8	1	20	25	28
9	1	23	30	40
Expected Growth Rate		70	100	130

Location & Type	Near	No of Plants/m2
1	A1	24
2	C1 & D1	9
3	B2	11
4	D2	24
5	A3	23
6	C3 & D3	22
7	A4	15
8	C4 & D4	20
9	B5	17

The revised plot area captured a combination of plant growth, survivability metrics and used to determine the

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expected biomass yield based on the paddock ground condition variability.

The table illustrates the variability of plant density across the paddock attributed to a combination of soil variability, initial flood irrigation seed germination disruption and variable soil moisture and drainage conditions. The most successful of growth and density being attributed to germination on ploughed ridges of the paddock.

The photographs bellow illustrates the described plant density variability and emergence of competing weeds for soil nutrients and moisture.

Site wide grid and plot temperature readings indicate an average ambient temperature between 25°C and 30°C with an average soil moisture reading between moist and dry but variable across the paddock.

With forecast rain for the weekend the decision to flood irrigate was postponed by one week at that time and in any case delayed until the application of selected herbicide and insecticide if required.

Plant development continues to be variable across the paddock and tied to irrigation furrow peaks and troughs. Growth statistics by the established nine designated monitoring plots show an average stem height range of 20 to 40 cm with average plant height range of 28 to 50 cm, stem diameter in the range of 15 to 15 mm, with good leaf development. It was expected that with the application of the herbicide that plant growth could significantly improve.

First examination of root system showed development in line with the maturity of the plants.

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Close examination of the leaves identified the presence of insects such as aphides.

In consultation with the HEA agronomist, it was suggested that if aphid infestation persisted that post herbicide application an insecticide should be applied. It was recommended that this be Confidor Imadacloropid.

It was proposed that insecticide be applied post the described herbicide.

Should it then become necessary to raise the paddock moisture content this would be followed by a second flood irrigation.

Progress Update as at 10-Mar-22, (Day 57, Week 9)

Significant amount of rain since the last plant growth examination fully saturated the paddock soil with the moisture meter off the wet scale. The paddock saturation has to date prevented the contractor tasked to apply the specified herbicide.

The photographs bellow illustrates the competition between sorghum plants and weeds.

	Day	50	57
	Week	W8	W9
	Date	3-Mar-22	10-Mar-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM
1	1	35	40
2	1	40	45
3	1	45	60
4	2	50	80
5	1	45	70
6	1	43	70
7	1	43	70
8	1	28	30
9	1	40	45
Expected Growth Rate		130	160

Growth statistics by the established nine designated monitoring plots show an average stem height range of 25 to 70 cm with average plant height 30 to 80 cm, stem diameter in the range of 12 to 15 mm, with good leaf development. The rain significantly boosted growth to the drained elevated zones but generally continued to be impaired by weed infestation. No plant losses were identified in the control plots. Application of herbicide should significantly improve plant growth.

Notes: Herbicide was applied to the paddock on Friday 11-Mar-22 and should take some three to four days to show results. On reviewing plant condition and extensive rain and at the recommendation of the HEA Agronomist it was recommended that a quantity of Urea should be applied to augment fertilizer that may have been leached out of the soil due to excessive rain.

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Progress Update as at 18-Mar-22, (Day 65, Week 10)

	Day	57	65
	Week	W9	W 10
	Date	10-Mar-22	18-Mar-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM
1	1	40	70
2	1	45	50
3	1	60	110
4	2	80	120
5	1	70	80
6	1	70	80
7	1	70	90
8	1	30	30
9	1	45	55
Expected Growth Rate		160	190

Periodic rain events continued to keep the soil moisture in the moist to wet gauge range.

Measurable growth was evident between report periods as measured within the monitoring zones.

The growth spurt attributed to less moisture in the soil and the effects of the application of herbicide in weed control. Plant leaf observed to be healthy.

Growth corridors are becoming more evident in line with variability of soil characteristics and moisture retention and drained elevated ridge zones.

To promote growth a generous application of Urea at 100 Kg per hectare was applied to plant rows.

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Progress Update as at 25-Mar-22, (Day 72, Week 11)

During this report period the emphasis was on obtaining average growth rates post weed control and the application of Urea to boost plant growth.

	Day	57	65	72
	Week	W9	W 10	W11
	Date	10-Mar-22	18-Mar-22	25-Mar-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM
1	1	40	70	90
2	1	45	50	90
3	1	60	110	130
4	2	80	120	130
5	1	70	80	100
6	1	70	80	100
7	1	70	90	100
8	1	30	30	30
9	1	45	55	80
Expected Growth Rate		160	190	225

Soil moisture for the period remained steady between moist and wet.

The application of urea showed evidence of accelerated growth with good leaf and stem development.

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Progress Update as at 5-Apr-22, (Day 82, Week 12)

Soil moisture for the period remained steady between moist and wet.

With the application of Urea substantial accelerated growth was observed in those areas where plants germinated in the drained elevated ridge zones in the main on the periphery of the paddock as illustrated by the photographs below. The photographs illustrate good leaf development and continued stem growth.

		18-Mar-22	25-Mar-22	5-Apr-22
	Day	65	72	82
	Week	W 10	W11	W 12
Location	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM
1	1	70	90	130
2	1	50	90	130
3	1	110	130	150
4	2	120	130	165
5	1	80	NA	NA
6	1	80	100	120
7	1	90	100	120
8	1	NA	30	35
9	1	NA	80	95

The growth monitoring stations illustrate the steady weekly plant growth post week 10. The period prior to week 10 were severely affected by soil water saturation and the initial wash out of seed by the initial flood irrigation event.

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Progress Update as at 28-Apr-22, (Day 106, Week 16)

An intermediate inspection between week 12 and 16 was hindered by COVID effecting the inspection staff. The purpose of the inspection was to ascertain the plant development of heads and to then schedule harvesting and crop baling. As evidenced by the photographs some 75% of the plants in the high growth paddock peripheral and drained zones displayed evidence of seed head development indicating no further growth and time for harvesting. For sorghum type 1 and 2 this generally occurs at week 14. The late head development was attributed to the unseasonal severe rain events and the high and persistent soil moisture content in the wet to saturated meter range.

Selected 22 Plants	
Gross Weight in kg	10.45
Container in kg	1.03
Raw Weight in kg	9.42
Dry Weight in Kg	2.62
Weight Reduction Factor	0.28

The photographs illustrate plant head development in the drained paddock ridge zones Row A (Plant Type 1) and Row D (Plant Type 2).

Some 22 selected mature plants were harvested to confirm the expected yield and dry weight. This was found to be in the expected 0.25 to 030 range for sorghum.

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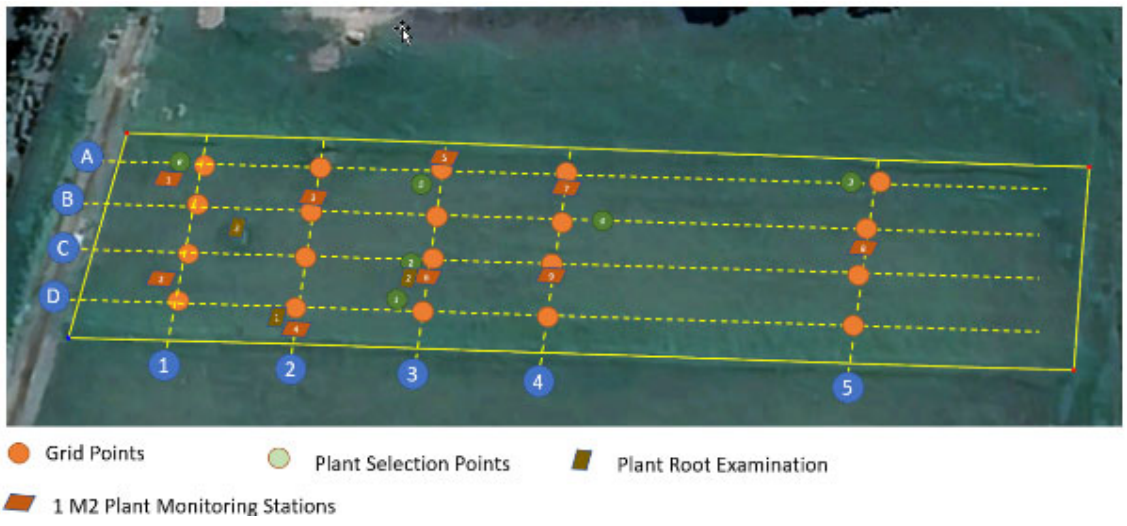
Progress Update as at 10-May-22, (Day 118, Week 17) (Final Inspection & Plant Measure before Harvest)

Based on the previous site visit of the 28-April-22 and expected 95% flowering, it was decided that final and full plant yield measurement should be made on the 10-May-22 with harvesting then scheduled subject to weather for 14-May-22 and bailing for 19-May-22.

Plant Heads - The following photographs illustrate the sorghum plants with developed heads at week 17 with 95% flowering ready for harvesting.

Plant Measurement Locations - The final measure was based on 7 Plant Section Points representative of plant type and maturity and paddock location as identified on the accompanying key plan.



Measurements taken included plant height to flowering head tip, average stem height, and average stem diameter. These plants were then harvested, and their raw and dry weight measured under lab conditions to determine plant water content reduction. The results are presented in the following table.

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GCCN - GW - Plant Measurment Data as at 10-May-22.

Plant Selection Points	CODE	LOCATION	PLANT TYPE	BASE TO HEAD AV. HEIGHT	AVERAGE PLANT STEM HIGHT	AVERAGE PLANT STEM DIAM	CENTRE ROOT DEBTH	PHOTO	RAW WGT	DRY WGT	DRY WGT/T RAW	NOTES
2	SNAIL	D1/D2	T1	2010	1950	20		X	0.48	0.17	0.35	
3	CAT	A4/A5	T1	1930	1790	17	300	X	0.34	0.12	0.35	
4	DOG	B4	T1	2100	1900	14		X	0.33	0.13	0.39	
5	FROG	A3	T1	2130	1960	18		X	0.33	0.10	0.30	
6	SPIDER	A1/A2	T1	1740	1600	12		X	0.17	0.04	0.24	
	AVRERAGE	SITE	T1	1982	1840	16.2			0.33	0.112	0.33	
7	SLUG	B1/B2	T1	900		7	120	X				Poor Growth Area
1	BEE	C1/C2	T2	2678	2478	20	400	X	0.60	0.21	0.35	
8	CONT	MEL	T1	2300	No Head	9		X	0.13	0.05	0.38	
	EXPECTED	MEL/SA	T1	3000	2800	25	600	X	0.8	0.28	0.35	

The table includes plant characteristics covering the Average Plant and Stem Heights, Stem Base Diameter, Raw and Dry Weight. The data confirms that 1 ton of Sorghum Biomass will deliver 0.3 to 0.35 Ton of dry biomass at 15% moisture suitable for pyrolysis.

In addition to above ground characteristics the root system was examined at 3 selected points to determine the average root system penetration.

Plant Root System - The following photographs illustrate the sorghum root penetration at Plant Root Location 1 and 2.

Plant Root Location 1 represents the root system development for Sorghum Type 2.

Plant Root Location 2 represents the root system development for Sorghum Type 1.

Digging of the slit trenches showed extensive compaction of soil below the 50 cm mark, evidence that the paddock had not been ploughed for a long period of time which would impede root penetration. This combined with high unseasonal rainfall with soil water saturation over the growth period would as evidenced keep root development to shallower than expected levels.

For both plants, the root development occurred from the surface down to 75 cm with the main root bulb located at 35 cm. Should the planting have been under ideal conditions with better soil preparation, ideal weather conditions and with drip irrigation conditions the root penetration would be down to 100 cm with a corresponding plat average height of 300 to 350 cm. The illustrated root system being typical of the described non-ideal growing conditions.

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The following photographs illustrate expected root penetrations and development for Type 1 & 2 Sorghum under tape irrigation conditions.

The following photographs illustrate the stunted sorghum plants with root penetration at Plant Root Location 3 for Type 1 Sorghum.

The selected plant is representative of that identified as growing in a trough corridor subject to initial intense flood irrigation and subject to higher water retention during intense rain periods, denying the plant aeration and oxygenation.

Whilst the root system was comparable to more productive plants it suggests the plant was seeking nutrients that may have been washed out during the initial flood irrigation and intense rain over the growth period.

Progress Update as at 14-May-22, (Day 122, Week 17) (Harvest)

Due to weather conditions the crop cutting had to be postponed to 14-May-22. The photographs illustrate the cutting and windrowing of the sorghum crop.

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Progress Update as at 19-May-22, (Day 127 Week 18) (Bale)

The crop bailing operation was delayed to 19-May-22 to take advantage of good weather to dry the sorghum before bailing. For cattle feed silage the crop would have been immediately baled. For pyrolysis it is necessary for the biomass moisture content to be significantly reduced to between 20% and 15% maximum. It was proposed that post baling drying to take place using a solar drying glasshouse for the 300 Kg required for pyrolysis testing.

Illustrated in the photographs below is the two-stage bailing process. First the bailing machine gathers the crop and in the process cuts the sorghum plants into 20 cm strips which are then compacted into circular bales held together by a degradable plastic mesh. Second the bail is collected by the wrapping machine and systematically wrapped in six layers of plastic sheet to ensure water and air proofing to eliminate biomass composting.

A total of 11 bales were collected from the paddock. As the planting and harvesting was done on a broad acre basis and not in prepared and formed agricultural beds and amount of grass contamination of up to 40% by weight was expected to be present in each bale. It was proposed that the sorghum be separated from the grass during the solar drying process.

Progress Update as at 23-May-22, (Day 131, Week 19) (Bales in Storage)

The bales where collected, weighed, and transported to the HEA storage yard located in Bruthen East Gippsland in preparation to solar drying.

A total of 11 bales were harvested with a total raw weight of 7.3 Tons.

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Assessment of Paddock Plant Yield

Based on growth rate tracking and the final plant productivity metrics obtained from the combined initial grid points, plant monitoring stations and the final plant selection points, an assessment was made for the allocated area productivity.

Weight Raw of Bales in Tons	7.30
% of Grass	40%
Calculated Raw Sorghum in Tons	4.38
Plant Weight Raw	0.3
Estimated No of Sorghum Plants	14,600
Average Productive area in Ha	0.15
No plants per HA	97,333

The accompanying table summarizes the results.
For the 7.3 Ton of bailed raw biomass and estimate of sorghum plant density and estimate of grass growth, it was calculated that some 4.38 Ton of raw sorghum was harvested.

Taking the measured mean average of plant raw weight of 0.3 kg it was estimated that some 14,600 sorghum plants germinated and grew to measurable height.

Using the plant density and the photographic records it was determined that the effective broad acre planting amounted to the equivalence to 0.15 hectare out of the 0.70 hectare of land initially brought under cultivation. This translates to a raw yield rate of some 70 Ton/ha versus 100 Ton/Ha for ideal irrigated conditions. The 30 Ton/Ha difference being in the main attributed to soil moisture variations and ground saturation over 50% for the 16-week effective extended growing period.

Given the described adverse and unseasonal weather and growing conditions, there was sufficient evidence substantiated by plant measurement data to confirm that growing sorghum on prepared marginal grassland could be successful using broad acre farming provided there was adequate ground preparation and drainage.

Progressive Average Growth Rate Data, Graph and Observations

The following table summarizes the progressive average growth rates by Plant Monitoring stations from planting to harvesting.

	Day	6	19	27	32	36	43	50	57	65	72	82	106	118
	Week	W1	W3	W4	W5	W6	W7	W8	W9	W 10	W11	W 12	Wk16	W 17
	Date	18-Jan-22	31-Jan-22	8-Feb-22	13-Feb-22	17-Feb-22	24-Feb-22	3-Mar-22	10-Mar-22	18-Mar-22	25-Mar-22	5-Apr-22	28-Apr-22	10-May-22
Plant Monitoring Stations	Plant Type	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM	Average Height in CM
1	1	1.5	12	15	18	20	30	35	40	70	90	130	160	174
2	1	1.5	15	18	20	25	35	40	45	50	90	130	175	190
3	1	1.5	15	18	20	25	38	45	60	110	130	150	175	193
4	2	1.5	20	20	25	30	45	50	80	120	130	165	220	268
5	1	1.5	15	20	25	30	40	45	70	80	100	122	185	213
6	1	1.5	15	20	23	28	30	43	70	80	100	120	185	210
7	1	1.5	15	20	23	28	32	43	70	90	100	120	188	210
8	1	1.5	12	15	18	20	25	28	30	30	30	35	90	130
9	1	1.5	12	15	20	23	30	40	45	55	80	95	155	193
Expected Growth Rate		1.5	20	40	55	70	100	130	160	190	225	270	300	300

The following Chart is based on the preceding table and illustrates the plant growth rates for the designated monitoring locations and for comparative purposes includes the expected growth rate for the ideal growing conditions for an irrigated paddock with a 90-day growth period January to April with average summer rains.

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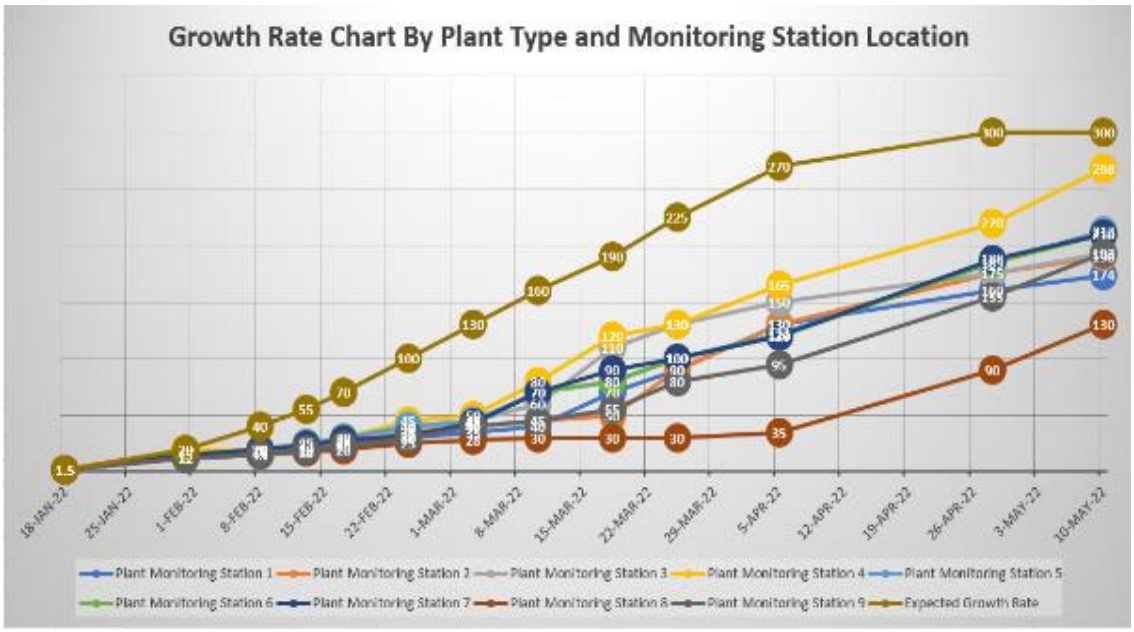
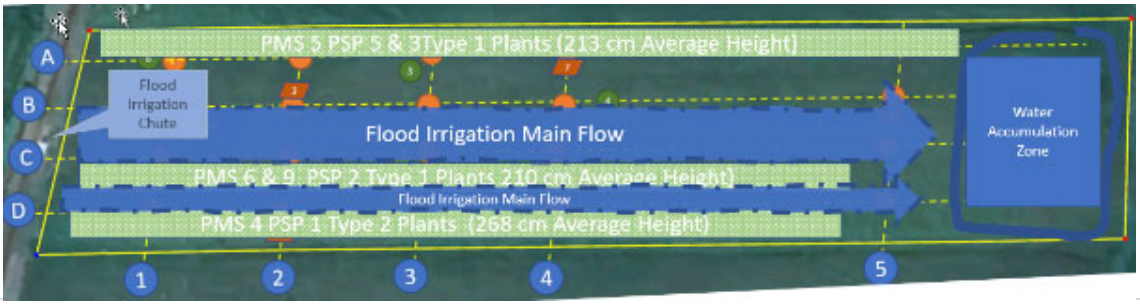


The graph clearly demonstrates the results for less-than-ideal growth conditions from the paddock being subjected to heavy and unseasonal rain causing ground saturation, cloud cover with lower-than-average sunlight. The best growth results were achieved with Type 2 Sorghum reaching an average full plant head height of 268 cm at Plant Monitoring Station No.4 located in the paddock ridge peripheral zone adjacent to Grid D. The next best results were achieved with Type 1 Sorghum reaching an average full plant head height of 213 cm at Plant Monitoring Station No.5 located in the paddock ridge peripheral zone adjacent to Grid 5. The worst results as typical of Plant Monitoring Station 8 were associated with paddock trough zones with pervasive and continuous high moisture content. These areas were also the subject of suspected initial flood irrigation damage with displaced germinating seed reducing the plant density.

The planted control crop of corn had an initial germination then by week 10 was at 110 cm stopped growing with stunted corn cobs. It became clear that the ground conditions were not suitable for this crop type and further corn monitoring was disregarded.

Additional soil testing in the poor growth zones was recommended by HEA as it was suspected that in addition to soil moisture saturation there may be a nutrient imbalance due to previous Class C recycled water irrigation. The recommendation was not pursued by GCCN as it was deemed unlikely that future sorghum planting would be initiated under the described Class C recycled water flood irrigation conditions.

The following site plan illustrates the best growth corridors confined to paddock ridges with the main drainage channels as confirmed by the tabled growth rate records.



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The accompanying panoramic photographs clearly illustrate the high and low growth corridors in line with paddock ridges and drainage troughs.

The resulting growth rate records including moisture content analysis points to the sorghum being severely affected by saturated soil conditions in particular in the paddock trough zones. Oxygen is required by plants for respiration both above ground for shoots and leaves including below ground root plant tissue development. Respiration is the process where plants metabolize sugars, producing energy needed for growth development. Soil generally contains approximately 50% pore space that is occupied by air and water. Near flooding conditions experienced at the site due in the main to severe and unseasonal rain events that included brown rot warnings increased the amount of pore space occupied by water and reduced the exchange of air between soil and atmosphere. Oxygen does not easily move through water so saturated soils will limit oxygen to the plants especially the roots. The growth stage of the crop especially young plants is more susceptible to damage to this type of damage especially with leave development less than six. The growth stages are further exasperated where high saturation is followed by high daily temperature. Looking at the weather records there is a direct correlation between poor plant yield, high rainfall and short intervals between rainfall and high temperature as experienced during the months of February and March-2022.

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Production of Biochar

Some 120 kg of bailed silage (raw biomass) was selected from that harvested for the purpose of biochar production and shipped to HBC Environmental Solution pyrolysis demonstration plant located in Sydney, NSW. The subject plant undertakes the treatment of organic waste. The GW harvested biomass comprised a combination of 120 Kg of raw sorghum and grass which was segregated at HEA's drying facility to produce 21 Kg of dry Sorghum and 20 Kg of dry grass. The raw to dry mass represents the reduction of moisture by weight.

Both biomass types were packed and shipped to HBC Environmental Solutions for pyrolysis feed preparation including hammermilling then pellet manufacture. The pyrolysis process takes place in a packed-bed reactor. To avoid biomass being entrained in the hot gas flow and carried out of the reactor it is necessary to densify the feedstock by pelletisation. Pyrolysis was successfully completed at HBC Sydney test facility on the 23rd August 2022.

The HBC pyrolysis demonstration plant has a capacity for treating up to 20 kg per hour of dry biomass with an expected biochar yield of 30% by dry weight. A HEA representative was present during the pyrolysis trial with HBC monitoring and fully documenting the biomass inputs and outputs. Based on the instrumented mass balance the expected plant production metrics was achieved. On completion of the test, samples of both Sorghum and Grass Biochar was forwarded to the Southern Cross university for testing. The test results are tabled below and included in Appendix C.

Illustrated is the following: Sorghum Drying, Pellet Machine, 12 mm pellet production, the HBC Demonstration Pyrolysis plant together with the produced Biochar.

Several technical challenges emerged in the end-to-end process including sorghum drying scheduled at HEA's new solar drying facility at Bruthen Vic having due to council construction permitting issues be relocated to Melbourne, delaying planned early pyrolysis. Other challenges included drying the hammermilled biomass to the optimum 15% moisture content, pellet densification to obtain pellet uniformity, balancing the reactor pyrolysis settings from wood waste to soft plant tissue sorghum to produce biochar in quantity sufficient for laboratory testing.

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Biochar Testing

Tests included:

- Sorghum Feedstock characterisation including Moisture %, Ash Yield, Calorific Value, Total Halides (S & Cl) and CHN (Carbon, Nitrogen). The test results are tabled in Appendix B. These tests were performed by H.R.L laboratories in Melbourne Vic.
- Biochar Testing included: C%, N%, C/N Ratio, Estimated Organic Matter % OM, % Ash Content, Total Hydrogen %, Total Oxygen % moisture and calorific value. The test results as tabled in Appendix C. These tests were performed by Southern Cross University, Lismore, NSW.

The table below summarizes the test results and compares these against a typically composted product under Australian Standard AS4454.2012.

[No Title]		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	*Guideline*
Product Name:		99	100	101	102	103	104	105	
Product Type:		Raw	BioChar	BioChar	BioChar	Grass	BioChar	BioChar	*AS4454:2012*
Manufacturing Site:		Jihany Pty Ltd	Jihany Pty Ltd	Jihany Pty Ltd	Jihany Pty Ltd	Jihany Pty Ltd	Jihany Pty Ltd	Jihany Pty Ltd	*Composted Product*
Manufactured Date:		..	..	..	..	..	..	..	
Application:		..	..	..	..	..	..	..	
Test Applicable:		SS-PACK-	SS-PACK-	SS-PACK-	SS-PACK-	SS-PACK-	SS-PACK-	SS-PACK-	
Parameter	**Method Reference**	**N2162/1**	**N2162/2**	**N2162/3**	**N2162/4**	**N2162/5**	**N2162/6**	**N2162/7**	
Moisture Content (%)	**Inhouse S2 (105°C)	11.8	2.29	10.3	11.1	11.2	2.62	17.7	*> 25*
		6.13	3.33	4.09	3.93	8.00	2.00	4.81	
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	45.0	52.1	50.3	57.3	44.6	57.7	49.4	*≥ 20*
Total Nitrogen (%)		1.43	2.79	1.94	2.56	2.01	3.08	1.76	*≥ 0.8*
Carbon/Nitrogen Ratio	**Calculation - Total Carbon/Total Nitrogen	31	19	26	22	22	19	28	..
Estimated Organic Matter (% OM)	**Calculation - Total Carbon x 1.7	76.5	88.5	85.5	97.4	75.8	98.1	83.9	..
Total Sulfur (%)	Inhouse S4a (LECO Trumac Analyser)	0.21	0.33	0.26	0.32	0.31	0.21	0.26	
Ash Content (% ash)	Inhouse 750°C	7.50	19.3	13.2	16.9	9.16	16.6	11.2	
Total Hydrogen (%)	ASTM D5291	5.41	4.08	4.61	4.33	5.40	4.04	4.95	
Total Oxygen (%)	**Calculation	40.0	23.4	28.8	19.4	38.0	17.6	31.6	
	Method	**Sample 1 99**	**Sample 2 100**	**Sample 3 101**	**Sample 4 102**	**Sample 5 103**	**Sample 6 104**	**Sample 7 105**	
	Job No.	*N2162/1*	*N2162/2*	*N2162/3*	*N2162/4*	*N2162/5*	*N2162/6*	*N2162/7*	
Moisture Content (% moisture)	% of as received sample - Inhouse - 105°C	11.8	2.3	10.3	11.1	11.2	2.6	17.7	
NET Energy Value (MJ/kg DryMatter)	Subcontracted NSW DPI Report No. R22-01259	17.34	21.28	19.67	22.93	16.80	22.39	19.55	
Total Non-Structural Carbohydrates (%)	Subcontracted NSW DPI Report No. R22-00729-F-V1								

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The tabulated data shows superior carbon retention, Total Nitrogen, and the Carbon/Nitrogen characteristics over the referenced standard composted products. Hydrophilic characteristics including surface area were not measured but using the carbon content this is a good indicator the biochar's high surface area and water retention capability. The calorific value for sorghum showed a marked increase through the pyrolysis process from 17.34 MJ/Kg to 21.16 MJ/Kg. Also tested was that for grass at 16.80 MJ/Kg.

Sorghum Biochar for Soil Conditioning

Should the biochar produced be utilized for soil enhancement it is expected that utilizing HBC pyrolysis technology some 3.6 Ton/Ha could be produced from each crop cycle. This equivalent to generating 10.44 Ton of CO2 Australian Carbon Credit Units. This report does not document the benefits of biochar production for the purpose of soil enhancement and other environment benefits that it can bring.

Carbon Sequestration for Sorghum Root System

GCCN requested post the trial for HEA to assess the potential for carbon sequestration of the plant root system. It is noted by HEA that sorghum and any other plant root system carbon retention (sequestration) is presently not recognized by the Australian Department of Agriculture and Water despite persuasive scientific based evidence to the contrary.

The adjacent photograph illustrates the dry sorghum stems post harvesting.

The photographs below illustrate the 16 week sorghum root system density that developed for HEA's control plot simulating broad acre farming.

The literature search by HEA and completed studies by the US Texas A&M AgriLife Research scientists and verified by field studies postulate that the biomass weight of the sorghum root system can be as much as 100 grams for a typical 500-gram sorghum plant. Applying the raw to dry weight reduction for the above ground plant at 30% to the root system then applying the pyrolysis biochar production rate by weight of 50% per plant, the biochar yield could be as high as 15 grams per plant. Using the average 100,000 sorghum plants per hectare this could amount to some 1.5 ton of carbon sequestered per hectare during one growing season. Published data places this at 3.1 Ton per hectare. Using the more conservative value of 1.5 Ton/Ha and the 2.9 Ton of CO2 sequestration per ton of biochar, it is estimated that each hectare per growing season sequesters 4.4

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Tons of CO2 that should be claimable as Australian Carbon Credit Units (ACCU's) as defined by the Australian Carbon Regulator. As published by the Texas A&M AgriLife carbon sequestration could be as high as 9 Ton of CO2 per hectare. It is presently agreed by scientists that more quantitative studies are necessary to verify the published numbers.

Other evidenced benefits beyond doubt include a significant increase in crop production post initial sorghum planting with reduced requirements for fertilizer and water.

Summary of Trial Findings

The following summarizes HEA's Trial findings.

The trial mixed crop planting and germination was successful be it late in the normal planting season, for sorghum January versus November, to take advantage of the hours of available sunlight. The main delay being excessive seasonal rain that prevented earlier access to the paddock for soil preparation and planting.

Challenging was the GCCN allocated paddock for the trial it being effectively a sewerage evaporation pond used for grass growing and cattle adjustment. The only option for water application was to use flood irrigation through a single flood gate. The paddock was also bounded by a retention mound with no drainage effectively creating a basin. The consequential effect of the paddock physical constraints was the evidence of high moisture content of the soil effecting growth plant rates at critical plant development stages. The weather records show periods of regional days of brown root warnings (days of high humidity and precipitation) which resulted in sorghum plant lower leaf deterioration.

The other challenges related to, despite treatment of grass, the excessive presence of weeds which had to be treated post initial sorghum growth. Whist initially considered a problem once the plants were established the concern with insect attack waned it was not necessary to apply insecticide.

Despite the described challenges, plant growth on paddock ridge lines was successful and sufficient for HEA to conclude that the selected sorghum types could in a full growing season, under well drained paddock conditions, using flood, ground, or pivot irrigation could deliver the target raw yield rates of 70 Ton per hectare.

With respect to pyrolysis the objective was to verify the suitability of the sorghum crop for manufacturing biochar. This was achieved by first air drying a quantity of raw sorghum then due to its low specific gravity, unlike wood chips, having to be pelletized to allow travel through the pyrolysis reactor. Challenges to this process was selecting the right pellet diameter and moisture content, a consideration when selecting both the biomass type and the Pyrolysis treatment technology. Pyrolysis was achieved utilizing the HBC Demonstration Pyrolysis plant. Biochar samples were then shipped to the Southern Cross University laboratory to obtain the comparative chemical characteristics. The findings tabled in the annexure show product in accordance with AS4454.2012 to be superior to a composted product for carbon and nitrogen content. The biochar was also tested by the HRL Technology Group with high calorific comparable to wood, high carbon content, low chlorine and sulphur with the later influenced by the growing soil characteristics. A representative sample of the biochar was separately delivered to GCCN during January 2023.

There are opportunities taking account of the limits to subject trial to expand trial planting to other crops types to then assess their suitability for pyrolysis and biochar production.

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Appendix A

Site Visit, Recorded Weather Station Temperature and Rainfall Data, Average Growth Data.

Appendix B

H.R.L Sorghum sample characteristics and chemical composition

Appendix C

Southern Cross University Sorghum and Grass chemical composition and calorific values

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Appendix A

Water Application to Irrigation Zone	0.7	Ha	0.7	Ha
Growing Season	3	ML/Ha	5	ML/Ha
Flood Irrigator #	6		6	
Volume per Flood	350	mx3	583	mx3
Height per Flood	50	mm	83	mm

		Week 1							Week 2							Week 3							Week 4						
Day	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**
Date	**10/01/2022**	**13/01/2022**	**14/01/2022**	**15/01/2022**	**16/01/2022**	**17/01/2022**	**18/01/2022**	**19/01/2022**	**20/01/2022**	**21/01/2022**	**22/01/2022**	**23/01/2022**	**24/01/2022**	**25/01/2022**	**26/01/2022**	**27/01/2022**	**28/01/2022**	**29/01/2022**	**30/01/2022**	**31/01/2022**	**1/02/2022**	**2/02/2022**	**3/02/2022**	**4/02/2022**	**5/02/2022**	**6/02/2022**	**7/02/2022**	**8/02/2022**	**9/02/2022**
Day	Mon	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed
Irrigation in mm		0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainfall in mm	CUM 28	0	0	1.6	0.2	0	0	1.4	0	0	0	0	0	0	0	0	0.6	38	14.8	0.6	0	0	0	0	0	0	0	0	0
Ambiant Temperature		24.5	28.4	26.8	26.4	25.5	23.9	22.9	23.5	25.1	26.3	26.7	28	29.6	25.9	26.2	34.4	20.6	22.4	26.8	27.4	20.1	21.9	22.8	23.3	23.5	23.1	23.7	26.5
Humidity % - 3 pm		71	68	67	54	59	50	60	54	52	51	57	60	54	65	92	42	97	88	74	62	52	43	61	51	55	57	62	62
Site Visit		MN & RTH					RTH			RTH					MN					DM									DM	
Soil Average Temperature Reading		23°C					24°C			24°C					24°C					24°C									24°C	
Soil Average Moisture Reading		Medium					Low to Medium			Low					Medium/High					High									High (Wet)	
Average Plant Height in cm							0.50			5 to 10					10 to 15					12 to 18									Av 20	
Average Stem Length in cm															8 to 12					10 to 16									Av 15	
Average Stem Diameter in mm										4					4					5									5 to 8	

		Week 5							Week 6							Week 7							Week 8						
Day	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**	**55**	**56**
Date	**10/02/2022**	**11/02/2022**	**12/02/2022**	**13/02/2022**	**14/02/2022**	**15/02/2022**	**16/02/2022**	**17/02/2022**	**18/02/2022**	**19/02/2022**	**20/02/2022**	**21/02/2022**	**22/02/2022**	**23/02/2022**	**24/02/2022**	**25/02/2022**	**26/02/2022**	**27/02/2022**	**28/02/2022**	**1/03/2022**	**2/03/2022**	**3/03/2022**	**4/03/2022**	**5/03/2022**	**6/03/2022**	**7/03/2022**	**8/03/2022**	**9/03/2022**
Day	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon	Tue	Wed
Irrigation in mm/Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainfall in mm	0	0.2	0.2	0.4	0	0	0	6.6	0	0	0	0	0	0	0	0.2	1.2	0.2	0	0	0.2	0	0	0.4	17.4	16.2	0.4	2.8
Ambiant Temperature	23.6	24.6	22.2	31.6	34	26.3	27.2	24.3	22.9	22.8	27.4	23.7	23.1	31.1	27.9	24.8	23.6	26.1	25.3	27.3	26.2	26.9	27.6	23.9	18.2	21.3	20.2	20.8
Humidity % - 3 pm	66	50	60	48	38	60	68	57	54	51	55	39	60	43	64	67	76	60	95	78%	88%	88%	86%	88%	96%	92%	82%	77%
Site Visit				DM				DM, MN, RTH							DM							MN & RTH						
Soil Average Temperature Reading				24°C				24°C							24°C							25°C to 30°C						
Soil Average Moisture Reading				High (Moist-Wet)				High (Moist-Wet)							Medium (Moist)							Moist to Dry						
Average Plant Height in cm				20 to 25				25 to 30							35 to 45							35 to 45						
Average Stem Length in cm				15 to 20				20 to 25							31 to 35							35 to 50						
Average Stem Diameter in mm				6 to 8				8 to 10							8 to 12							10 to 15						

		Week 9							Week 10							Week 11							Week 12						
Day	**57**	**58**	**59**	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**	**77**	**78**	**79**	**80**	**81**	**82**	**83**	**84**
Date	**10/03/2022**	**11/03/2022**	**12/03/2022**	**13/03/2022**	**14/03/2022**	**15/03/2022**	**16/03/2022**	**17/03/2022**	**18/03/2022**	**19/03/2022**	**20/03/2022**	**21/03/2022**	**22/03/2022**	**23/03/2022**	**24/03/2022**	**25/03/2022**	**26/03/2022**	**27/03/2022**	**28/03/2022**	**29/03/2022**	**30/03/2022**	**31/03/2022**	**1/04/2022**	**2/04/2022**	**3/04/2022**	**4/04/2022**	**5/04/2022**	**6/04/2022**
Day	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed
Irrigation in mm/Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainfall in mm	0	0	0	0	0	0	0.20	0	0	3.20	0	0	0	9.00	0	0	0.20	0	0	0	0	3.60	20.80	6.20	21.60	30.40	0	0
Ambiant Temperature	22.00	23.00	22.20	28.10	28.40	24.80	25.50	29.70	22.30	22.20	24.10	23.40	25.00	21.20	21.30	22.30	22.40	26.10	28.60	24.30	22.80	19.80	16.30	19.90	17.40	20.40	22.10	19.70
Humidity - 3 pm	88%	95%	94%	100%	86%	89%	92%	99%	86%	87%	91%	100%	95%	82%	87%	93%	100%	100%	93%	99%	88%	81%	92%	97%	99%	88%	88%	96%
Site Visit	DM	Appication of Herbicide							RTH/MN Appication of Eurea							DM/L						MN					DM	
Soil Average Temperature Reading	25°C to 30°C								27 °C							27 °C						27 °C					25 °C	
Soil Average Moisture Reading	Off Wet Scale								Moist to Wet							Moist to Wet						Moist to Wet					Wet	
Average Plant Height	30 to 80								50 To 120							30 To 130						35 To 145					35 To 165	
Average Stem Length	25 to 70								40 To 105							30 To 120						30 To 140					30 To 150	
Average Stem Diameter	5 to 10								7 to 12							8 to 13						8 to 13					10 to 13	

		Week 13							Week 14							Week 15							Week 16						
Day	**85**	**86**	**87**	**88**	**89**	**90**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**	**101**	**102**	**103**	**104**	**105**	**106**	**107**	**108**	**109**	**110**	**111**	**112**
Observation Date	**7/04/2022**	**8/04/2022**	**9/04/2022**	**10/04/2022**	**11/04/2022**	**12/04/2022**	**13/04/2022**	**14/04/2022**	**15/04/2022**	**16/04/2022**	**17/04/2022**	**18/04/2022**	**19/04/2022**	**20/04/2022**	**21/04/2022**	**22/04/2022**	**23/04/2022**	**24/04/2022**	**25/04/2022**	**26/04/2022**	**27/04/2022**	**28/04/2022**	**29/04/2022**	**30/04/2022**	**1/05/2022**	**2/05/2022**	**3/05/2022**	**4/05/2022**
Day	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon	Tue	Wed
Irrigation in mm/Day	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rainfall in mm	1.20	0.20	0	0	0	0	0	0.20	0	0	0.20	4.00	17.40	5.80	0	0	0	0.20	0	0.20	0.20	0.20	0	12.60	0	0	0	0
Ambiant Temperature	21.00	20.90	23.50	27.20	17.30	17.60	20.30	24.00	23.40	24.20	27.20	19.10	19.30	19.50	17.30	17.70	20.00	17.60	18.80	18.90	21.50	23.20	24.10	17.90	20.30	22.00	20.90	20.80
Humidity - 3 pm	95%	85%	79%	82%	75%	90%	73%	100%	88%	82%	100%	94%	100%	81%	80%	69%	87%	99%	100%	100%	91%	100%	100%	69%	74%	77%	86%	85%
Site Visit																						RTH						
Soil Average Temperature Reading																						25 °C						
Soil Average Moisture Reading																						Wet						
Average Plant Height																						90 to 220						
Average Stem Length																						80 to 208						
Average Stem Diameter																						12 to 15						

		Week 17							Week 18							Week 19				
Day	**113**	**114**	**115**	**116**	**117**	**118**	**119**	**120**	**121**	**122**	**123**	**124**	**125**	**126**	**127**	**128**	**129**	**130**	**131**
Observation Date	**5/05/2022**	**6/05/2022**	**7/05/2022**	**8/05/2022**	**9/05/2022**	**10/05/2022**	**11/05/2022**	**12/05/2022**	**13/05/2022**	**14/05/2022**	**15/05/2022**	**16/05/2022**	**17/05/2022**	**18/05/2022**	**19/05/2022**	**20/05/2022**	**21/05/2022**	**22/05/2022**	**23/05/2022**
Day	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon	Tue	Wed	Thur	Frid	Sat	Sun	Mon
Irrigation in mm/Day	0	0	0	0	0	Final Inspection	0	0	0	Harvest	Air Dry				Baile				Transport
Rainfall in mm	8	0.2	0	0.6	0.2	0.2	0.2	0.4	1.8		0.6		2.4	0.2	0				To Storage
Ambiant Temperature	15.50	16.30	15.10	17.30	17.10	17.00	14.90	16.90	18.70	16.2	22.7	18.5	16.1	15.9	15.8				
Humidity - 3 pm	86%	87%	58%	81%	100%	99%	100%	100%	100%	100%	86%	66%	66%	69%	86				
Site Visit						RH/MD/L				RH					RH				
Soil Average Temperature Reading						25 °C				25 °C									
Soil Average Moisture Reading						Wet				Moist									
Average Plant Height						130 to 268				NA									
Average Stem Length						110 to 245				NA									
Average Stem Diameter						13 to 18				NA									

Result Sheet

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Date: 21/06/2022 File No. 67210283 Report No. 220637

To:	Name	Roland Horat	
	Company	Hybrid Energy Australia	
	Address		
	Fax No.		Tel No.
From:	Name	Andrew Gietman	Tel No.

Number of pages including this page: 3

ANALYSIS OF SORGHUM

1. INTRODUCTION

1 sample was received from HEA for analysis. Samples were analysed for parameters listed below, according to standard methodologies.

Results from this analysis are presented below.

Signed:.....
Andrew Gietman
Analytical Chemist – LATS

Approved:.....
Jarryd Cutting
Analytical Chemist, Biomass – LATS

Distribution: Copy 1: Client. Copy 2: HRL Project File.

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The results presented in this report relate exclusively to the samples selected by the client for the purpose of testing. No responsibility is taken for the representativeness of these samples.

HRL's ISO9001 Quality Management System is certified by BSI under certificate number FS605116 QA741F

2. ANALYTICAL METHODS

Sample Preparation

All samples were recorded in the HRL LIMS database and given a unique identification number.

Each sample was weighed and then dried at 40°C in order to remove all free moisture from the sample.

Each sample was taken following drying and milled in order to prepare an analysis sample.

The preparation process required to produce an analysis sample involved the grinding and milling of the sample to reduce the particle size to a nominal top size of <1mm.

Analytical Methods

Analysis	Test Method
Sample Preparation and size reduction	I.S. EN 15413:2011 & I.S. EN 15443:2011
Total Moisture (Free and Inherent Moisture)	CEN/TS 15414:2010
Calorific Value (gross dry, gross wet & net wet)	I.S. EN 15400:2011
Ash Yield	I.S. EN 15403:2011
Total Halides (S & Cl)	I.S. EN 15408:2011
Carbon, Hydrogen, & Nitrogen	I.S. EN 15407:2011

3. ANALYTICAL RESULTS

Results from the analysis of the samples are presented below.

Analytical results:

HRL Sample Description	220637-1
Clients sample Description	Sorghum
Total Moisture	
Moisture, % (ar)	22.0
Ash Yield (550°C)	
Ash Yield, % (db)	4.2
Calorific Value (CV)	
Gross Dry Calorific Value, MJ/kg (db)	17.9
Gross Wet Calorific Value, MJ/kg (ar)	14.0
Net Wet Calorific Value, MJ/kg (ar)	12.5
Total Halides (S & Cl)	
Sulphur, % (db)	0.10
Chlorine, % (db)	0.53
CHN	
Carbon, % (db)	45.3
Hydrogen, % (db)	5.8
Nitrogen, % (db)	1.33

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COMPOST 'TOTALS' ANALYSIS REPORT

7 samples supplied by Jihany Pty Ltd on the 30 August 2022. Lab Job No. N2162.
Analysis requested by Joseph Taouk**. Your Job: mulch/bio char testing**.

125 Cosgrove Road BELFIELD NSW 2191

		Sample 1	Sample 2	Sample 3
	Product Name:	99	100	101
	Product Type:	Sugar Cane Mulch	BioChar	BioChar
	Manufacturing Site:	Jihany Pty Ltd	Jihany Pty Ltd	Jihany Pty Ltd
	Manufactured Date:	..	..	..
	Application:	..	..	..
	Test Applicable:	SS-PACK-012	SS-PACK-012	SS-PACK-012
Parameter	**Method Reference**	**N2162/1**	**N2162/2**	**N2162/3**
Moisture Content (%)	**Inhouse S2 (105°C)	11.8	2.29	10.3
		6.13	3.33	4.09
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	45.0	52.1	50.3
Total Nitrogen (%)		1.43	2.79	1.94
Carbon/Nitrogen Ratio	**Calculation - Total Carbon/Total Nitrogen	31	19	26
Estimated Organic Matter (% OM)	**Calculation - Total Carbon x 1.7	76.5	88.5	85.5
Total Sulfur (%)	Inhouse S4a (LECO Trumac Analyser)	0.21	0.33	0.26
Ash Content (% ash)	Inhouse 750˚C	7.50	19.3	13.2
Total Hydrogen (%)	ASTM D5291	5.41	4.08	4.61
Total Oxygen (%)	**Calculation	40.0	23.4	28.8

* < LOR Less than limit of reporting. *ND* Not detected. *NA* Not applicable. *NR* Not required.

Notes:

1. All analysis is dry weight – Samples reported on an oven dried basis at 105˚C (testing conducted on finely ground sample dried at 40˚C).
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Indicative guidelines are based on those in AS4454:2012 for a composted product.
4. Total Acid Extractable Nutrients indicate a store of nutrients.
6. Conversions for 1 mg/kg = 1 ppm; 1 % = 10,000 ppm
7. Conversions to kg/ha = mg/kg x 2.24
8. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
9. Testing completed in a NATA accredited laboratory.
10. Analysis conducted between sample arrival date and reporting date.
11. This report is not to be reproduced except in full. Results only relate to the item tested.
12. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs or on request).
13. This report was issued on 27/09/2022.

Quality Checked: Brian Smith
Compost & Landscape Soils Co-ordinator

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COMPOST 'TOTALS' ANALYSIS REPORT

7 samples supplied by Jihany Pty Ltd on the 30 August 2022. Lab Job No. N2162.
Analysis requested by Joseph Taouk**. Your Job: mulch/bio char testing**.

125 Cosgrove Road BELFIELD NSW 2191

		Sample 4	Sample 5	Sample 6
	Product Name:	102	103	104
	Product Type:	BioChar	Sugar Cane Mulch	BioChar
	Manufacturing Site:	Jihany Pty Ltd	Jihany Pty Ltd	Jihany Pty Ltd
	Manufactured Date:	..	..	..
	Application:	..	..	..
	Test Applicable:	SS-PACK-012	SS-PACK-012	SS-PACK-012
Parameter	**Method Reference**	**N2162/4**	**N2162/5**	**N2162/6**
Moisture Content (%)	**Inhouse S2 (105°C)	11.1	11.2	2.62
		3.93	8.00	2.00
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	57.3	44.6	57.7
Total Nitrogen (%)		2.56	2.01	3.08
Carbon/Nitrogen Ratio	**Calculation - Total Carbon/Total Nitrogen	22	22	19
Estimated Organic Matter (% OM)	**Calculation - Total Carbon x 1.7	97.4	75.8	98.1
Total Sulfur (%)	Inhouse S4a (LECO Trumac Analyser)	0.32	0.31	0.21
Ash Content (% ash)	Inhouse 750˚C	16.9	9.16	16.6
Total Hydrogen (%)	ASTM D5291	4.33	5.40	4.04
Total Oxygen (%)	**Calculation	19.4	38.0	17.6

* < LOR Less than limit of reporting. *ND* Not detected. *NA* Not applicable. *NR* Not required.

Notes:

1. All analysis is dry weight – Samples reported on an oven dried basis at 105˚C (testing conducted on finely ground sample dried a
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Indicative guidelines are based on those in AS4454:2012 for a composted product.
4. Total Acid Extractable Nutrients indicate a store of nutrients.
6. Conversions for 1 mg/kg = 1 ppm; 1 % = 10,000 ppm
7. Conversions to kg/ha = mg/kg x 2.24
8. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
9. Testing completed in a NATA accredited laboratory.
10. Analysis conducted between sample arrival date and reporting date.
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13. This report was issued on 27/09/2022.

Quality Checked: Brian Smith
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COMPOST 'TOTALS' ANALYSIS REPORT

7 samples supplied by Jihany Pty Ltd on the 30 August 2022. Lab Job No. N2162.
Analysis requested by Joseph Taouk**. Your Job: mulch/bio char testing**.

125 Cosgrove Road BELFIELD NSW 2191

		Sample 7	*Guideline*
	Product Name:	105	
	Product Type:	BioChar	
	Manufacturing Site:	Jihany Pty Ltd	*AS4454:2012 Composted Product*
	Manufactured Date:	..	
	Application:	..	
	Test Applicable:	SS-PACK-012	
Parameter	**Method Reference**	**N2162/7**	
Moisture Content (%)	**Inhouse S2 (105°C)	17.7	*> 25*
		4.81	
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	49.4	*≥ 20*
Total Nitrogen (%)		1.76	*≥ 0.8*
Carbon/Nitrogen Ratio	**Calculation - Total Carbon/Total Nitrogen	28	..
Estimated Organic Matter (% OM)	**Calculation - Total Carbon x 1.7	83.9	..
Total Sulfur (%)	Inhouse S4a (LECO Trumac Analyser)	0.26	
Ash Content (% ash)	Inhouse 750˚C	11.2	
Total Hydrogen (%)	ASTM D5291	4.95	
Total Oxygen (%)	**Calculation	31.6	

* < LOR Less than limit of reporting. *ND* Not detected. *NA* Not applicable. *NR* Not required.

Notes:

1. All analysis is dry weight – Samples reported on an oven dried basis at 105˚C (testing conducted on finely ground sample dried a
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Indicative guidelines are based on those in AS4454:2012 for a composted product.
4. Total Acid Extractable Nutrients indicate a store of nutrients.
6. Conversions for 1 mg/kg = 1 ppm; 1 % = 10,000 ppm
7. Conversions to kg/ha = mg/kg x 2.24
8. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
9. Testing completed in a NATA accredited laboratory.
10. Analysis conducted between sample arrival date and reporting date.
11. This report is not to be reproduced except in full. Results only relate to the item tested.
12. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu
13. This report was issued on 27/09/2022.

Quality Checked: Brian Smith
Compost & Landscape Soils Co-ordinator

RESULTS OF ANALYSIS

7 samples supplied by Jihany Pty Ltd on the 30 August 2022. Lab Job No. N2162.
Analysis requested by Joseph Taouk. **Your Job: mulch/bio char testing.**
125 Cosgrove Road BELFIELD NSW 2191

	Method	Sample 1 99	Sample 2 100	Sample 3 101	Sample 4 102	Sample 5 103
	Job No.	*N2162/1*	*N2162/2*	*N2162/3*	*N2162/4*	*N2162/5*
Moisture Content (% moisture)	% of as received sample - Inhouse - 105˚C	11.8	2.3	10.3	11.1	11.2
NET Energy Value (MJ/kg DryMatter)	Subcontracted NSW DPI Report No. R22-01259	17.34	21.28	19.67	22.93	16.80
Gross Calorific Value (MJ/kg)	Calculation	15.3	20.8	17.6	20.4	14.9

Notes:

1. ppm = mg/Kg dried sample
2. All results as dry weight DW - samples were dried at 40oC for 24-48hrs prior to crushing and analysis.
3. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
4. Analysis conducted between sample arrival date and reporting date.
5. ** NATA accreditation does not cover the performance of this service.
6. .. Denotes not requested.
7. This report is not to be reproduced except in full.
8. All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs or on request).
9. Results relate only to the samples tested.
10. This report was issued on 27/09/2022.

checked: .....
Graham Lancaster
Laboratory Manager

RESULTS OF ANALYSIS

7 samples supplied by Jihany Pty Ltd on the 30 August 2022. Lab Job No. N2162.
Analysis requested by Joseph Taouk. **Your Job: mulch/bio char testing.**
125 Cosgrove Road BELFIELD NSW 2191

	Method	Sample 6 104	Sample 7 105
	Job No.	*N2162/6*	*N2162/7*
Moisture Content (% moisture)	% of as received sample - Inhouse - 105˚C	2.6	17.7
NET Energy Value (MJ/kg DryMatter)	Subcontracted NSW DPI Report No. R22-01259	22.39	19.55
Gross Calorific Value (MJ/kg)	Calculation	21.8	16.1

Notes:

1. ppm = mg/Kg dried sample
2. All results as dry weight DW - samples were dried at 40oC for 24-48hrs prior to crushing and a
3. Methods from Rayment and Lyons, Soil Chemical Methods - Australasia
4. Analysis conducted between sample arrival date and reporting date.
5. ** NATA accreditation does not cover the performance of this service.
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checked: .....
Graham Lancaster
Laboratory Manager