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JINDERA SOLAR FARM

AGRICULTURAL IMPACT STATEMENT

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1.0 EXECUTIVE SUMMARY

This Agricultural Impact Statement has been prepared to independently assess the impact on agricultural production of the proposed Jindera Solar Farm located in the Greater Hume Local Government Area in southern NSW. The development footprint of the proposed solar farm is 337ha.

This report has assessed the:

- Existing land use to be on average 90% livestock and 10% cropping, with the livestock comprising 60% sheep and 40% cattle;
- Alternative land use options to be limited due to a range of constraints;
- Current gross annual farm gate value of production to be $300,000.00; and
- Current gross related economic activity to be $650,000.00.

The landowners' proposed post-development land use is pastures for sheep grazing in and around the solar panels. There is limited information available on pasture productivity under solar panels. This report has assessed the likely impact to be 25% reduction in productivity. The impact on gross annual revenue of a 50% reduction in productivity is also explored in this report, though an impact of this extent is thought to be unlikely.

This report has assessed the:

- Estimated post-development gross annual farm gate value of production to be $200,000.00; and
- Estimated post-development gross related economic activity to be $440,000.00.

Hence the estimated impact of the proposed development is estimated to be a reduction in annual gross revenue of $100,000.00 (farm gate) and $220,000.00 in related economic activity (pre and post-farm gate), assuming a 25% reduction in productivity. This impact will be mitigated by the rental payments the landowners will receive from the solar company, which are expected to be in the order of $337,000 to $674,000 per annum. Having regard for the rental income the landowners' gross revenue will increase. The post farm gate impacts are less certain.

2.0 INTRODUCTION

This Agricultural Impact Statement has been prepared for GreenSwitch Australia to independently assess the economic impact on agricultural production of the proposed Jindera Solar Farm.

This report will assess and quantify the economic impact of the proposed solar development on the agricultural output of the development area relative to:

- Current production systems; and
- Potentially higher value production systems.

This report has not assessed the impacts of the proposed solar development on adjoining landholder agricultural production.

2.1 Report Authors

This report was prepared by Michael Ryan, Principal Consultant of Riverina Agriconsultants and Andrew Bomm, Principal Consultant of Progressive Agriculture, and was prepared following a site inspection of the subject land with the landowners and Symon Grasby of GreenSwitch Australia on 15 January, 2020.

3.0 LAND RESOURCE DESCRIPTION

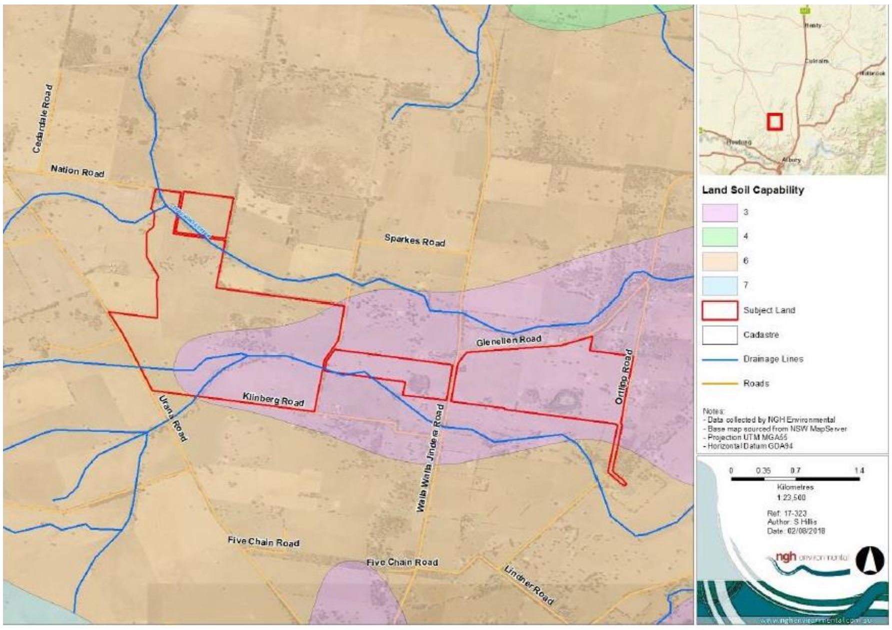
The proposed Jindera Solar Farm is located approximately 4km north of Jindera and 16km north of Albury in an area that runs east/west between the Ortlipp Road and the Urana Road and spanning either side of the Walla Walla Jindera Road. According to the NGH Environmental 2019, with regard to the proposed Jindera Solar Farm:

> *"The development footprint would occupy around 327 hectares (ha) of the 521ha subject land. The proposal would involve the construction of a groundmounted photovoltaic (PV) solar array generating around 150MW DC of renewable energy. The power generated would be exported to the national electricity grid."*
>
> and
>
> *"The land is classified as Class 3 and Class 6 under the Land and Soil Capability Assessment Scheme (OEH 2012) and is described as sloping land capable of sustaining cultivation on a rotational basis. The land is readily used for a range of crops and pastures. Class 3 land is considered High Capability Land: Land that has moderate limitations and can sustain high-impact land uses such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. Class 6 is considered Low Capability Land: Land that has very high limitations for high-impact land uses and is restricted to low-impact land uses such as grazing, forestry and nature conservation."*

The assessed 327ha footprint as set out above appear to be an error. Table 3-2 of the EIS lists the development footprint as 337ha, which is understood to be the correct area and so we will use 337ha in this report.

Figure 6-13 from NGH Environmental 2019 shows Land and Soil Capability for the proposed solar farm and surrounds and is provided as Figure 1 below:

Figure 1: Land and Soil Capability Mapping



Source: NGH Environmental 2019

Features that can be observed in Figure 1 above include:

- Proposed solar farm area marked with a red boundary;
- Class 3 land running east to west covering most of the proposed solar farm area except the western end; and
- The balance of the proposed solar farm area is mapped as Class 6 land.

For the purpose of this report, all of the land proposed for the solar farm is considered to be prime agricultural land capable of the activities described in Section 4.0 of this report. The assessment within this Agricultural Impact Statement is based on the premise that the subject site is highly productive agricultural land, and how it is used, or could potentially be used, in a practical farming context.

The report authors disagree with the classification of the subject land as set out in Figure 1 above. We note this classification arises from the Land and Soil Capability maps.[1] According to the landowners a significant proportion of the land within the proposed solar farm mapped as Class 3 in Figure 1 above is prone to waterlogging for many months during winter, making it less suited to cropping, and as such these areas are not routinely cropped. Observations made during the property inspection on 15 January, 2020 and *Google Earth* 2016 images affirm the landowners' views. According to the landowners the more productive portions of their farms are mapped as Class 6 in Figure 1. These areas are frequently cropped and not considered, in practical farming terms, to be "low capability land". Discrepancies between mapped land capability and actual productivity often arise from interpreting broad-scape data at the property scale.

However, the implications of whether land is correctly or incorrectly classified as Class 3 or 6 need not be overstated as it does not serve as a basis when quantifying agricultural impact. The assessment in this report is based instead on a comparison of the *actual* agricultural production capabilities of the land before and after development, not a comparison relative to a third party classification of the landscape.

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[1] Office of Environment & Heritage, land and soil capability assessment scheme retrieved from https://www.environment.nsw.gov.au/research-and-publications/publications-search/land-and-soil-capability-assessment-scheme

4.0 EXISTING PRODUCTION ANALYSIS

The proposed solar farm area is currently being farmed by two families who have owned and operated land on and around the site since the late 1800s. Across these two separate family farming businesses the current enterprises being run are predominantly pasture based systems that can be described as:

- A sheep breeding enterprise with a cash crop wheat/canola cropping rotation on about one-quarter of the area, hay and silage production, and a cattle breeding/trading enterprise as seasons allow. This enterprise occupies about two-thirds of the proposed solar farm area and is referred to as Farm A below; and
- A cattle and sheep breeding enterprises with hay and silage produced each year, as well as crops for grazing and grain production supplementing feed for the livestock enterprises. This enterprise occupies about one-third of the proposed solar farm area and is referred to as Farm B below.

Both farms run merino and first-cross sheep breeding enterprises. Current livestock numbers are down due to below average rainfall. The landowners' estimated year-in year-out carrying capacity is approximately 10DSE/ha. Pastures are improved with fertiliser applied periodically. Wheat yield potential for non-grazed crops is up to 5 tonnes/ha and non-grazed canola crops up to 2.5 tonnes/ha. These figures are in line with the report authors' expected levels of productivity for the area.

A DSE (dry sheep equivalent) is defined by the NSW Department of Primary Industries[2] as the feed requirements for a 50kg wether (adult male sheep) maintaining a constant weight. Such an animal has a DSE rating of 1.

The two existing livestock enterprises have been assessed as:

- Farm A - Sheep – 75% of the total DSE and cattle – 25%; and
- Farm B - Sheep – 35% of the total DSE and cattle 65%.

Having regard for the existing combined enterprise mix across Farm A and Farm B, the proposed solar farm area the livestock enterprise mix can be described as:

- Sheep – 60% of the total DSE; and
- Cattle 40% of the total DSE.

The value of agricultural production derived from the existing land use on the proposed solar farm area has been calculated using NSW DPI Gross Margins[3] (included as Annexure 1). The **sheep** gross margins show an average income per DSE of $98.00 for a typical merino enterprise and $106.00 for a typical first-cross enterprise. A conservative average gross revenue of $100/per DSE for sheep has been adopted for this report. Both gross

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[2] NSW Department of Primary Industries, Using DSEs and carrying capacities to compare sheep enterprises, sourced from https://www.dpi.nsw.gov.au/agriculture/budgets/livestock/sheep-gross-margins-october-2015/background/dse

[3] NSW Department of Primary Industries, Livestock gross margin budgets sourced from https://www.dpi.nsw.gov.au/agriculture/budgets/livestock

margins are dated October 2018 which, despite being just over 12 months old, are considered relevant having regard for prices used therein being broadly comparable to current market conditions.

For the **cattle** enterprises, NSW DPI Gross Margins dated April 2019 for butcher vealers was adopted as the most representative gross margin and is included in Annexure 1. The gross income from this enterprise as set out in Annexure 1 is $60/DSE.

Given the livestock enterprises occupy about 90% of the proposed solar farm area, the gross livestock revenue arising from this area has been calculated for 300ha, which is approximately 90% of 337ha as set out in Table 1 below:

Table 1: Gross Livestock Revenue

Pasture Area (ha)	DSE/ha	Total DSE	Sheep			Cattle			
			DSE Proportion	GM $/DSE	$	DSE Proportion	GM $/DSE	$	Total $
300	10	3,000	60%	100	180,000	40%	60	72,000	252,000

With the total gross livestock revenue of $252,000.00 as set out in Table 1 above equates to $84/DSE and $840/ha. For the purpose of this assessment this figure has been rounded to **$250,000.00**. Note income derived from forage, grazing and hay/silage crops is captured within the livestock gross revenue calculation**.**

The balance (37ha) of land is assumed to be used for cropping. Gross income from the cropping enterprise using the upper range of crop yields for the area and average prices for the last five years, according to ABARES[4],and assuming a two-thirds wheat (67%) and one-third canola (33%) rotation, as set out in;

Table 2: Gross Cropping Revenue

Crop	Proportion	Area	Yield	Price	Total
		Ha	T/Ha	$/T	$
Wheat	67%	24.79	5.0	279	34,582.05
Canola	33%	12.21	2.5	534	16,300.35

For the purpose of this assessment these figures have been rounded to **$50,000.00** and/or $1,375/ha.

The total value of production (farm gate) from the proposed solar farm area is therefore estimated to be **$300,000.00** ($250,000.00 + $50,000.00).

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[4] ABARES Agricultural Commodity Statistics 2019 sourced from https://www.agriculture.gov.au/abares/research-topics/agricultural-commodities/agricultural-commodities-trade-data#2019

The related economic activity arising from the proposed solar farm area can be calculated using an economic multiplier. *Upstream* activities for the current landowners' enterprises include contractors, farm input and service providers. *Downstream* activities for the current landowners' enterprises include distribution and processing (value adding). The related economic activity from the proposed solar farm area can be calculated using the economy multiplier of 2.1788, as used by ABS, 2012[5] which equates to:

$300,000.00 x 2.1788 = $653,640.00

For the purpose of this assessment, this figure has been rounded to **$650,000.00.**

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[5] ABS, 2012 Value of Agricultural Commodities Produced in Australia sourced from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/7503.02010-11?OpenDocument

5.0 ALTERNATIVE LAND USES

Farming in the Jindera district is predominantly a mixed broadacre livestock and winter cropping system. Livestock enterprises are most commonly sheep grazing for meat and wool, and cattle grazing for beef. Winter crops grown in the area are wheat, canola, hay/silage, barley and oats. This is reflected by the subject landholders' existing production systems, as outlined in Section 4.0 above of this report. According to ABS (2012), as of 2011, 40% of the value of agricultural commodities produced in the Greater Hume LGA was derived from livestock, and 57% from cropping and hay. The balance (3%) comes from other more intensive land uses such as horticulture. In the adjacent Albury LGA livestock were 63% and crops and hay were 27% of the value of agricultural commodities produced.

Annual rainfall for the locality is about 600mm and annual evaporation is about double (1,200mm). Irrigation is required to support perennial and/or high value crops. Alternative land uses that require irrigation water are therefore not feasible due to the absence of a suitable water supply. Consequently, higher value broadacre cropping options and horticulture, including vegetables, fruit and nut trees, are not viable in the Jindera district.

One land use option for landholders in the Jindera district is to receive stewardship payments for undertaking environmental conservation and stewardship practices. For instance, the *NSW Biodiversity Conservation Trust* has been offering landholders occupying land in the shire between $49/ha and $98/ha, in return for an agreed native vegetation management program. There may exist an opportunity for the current landholders to be paid for managing (under contract) timbered areas of the properties – areas not subject to the proposed solar development.

Alternative animal-based options such as intensive livestock, for example pigs or poultry, may be technically feasible on these properties. However, proximity to nearby residences and the absence of a secure water source (required for intensive animal production) would most likely rule out these options as a land use opportunity in the solar farm area. Notwithstanding these limitations, intensive livestock production does not require large scale land development, so the proposed solar farm would not directly preclude these options being adopted by the current or adjacent landowners.

The productive agricultural impact of the proposed solar farm relative to the opportunity cost of foregoing high value small scale development is not considered relevant. Any technically or economically feasible development of this kind could still be undertaken on residual areas of the landholding. This principle can apply to other potential land uses such as native flower production or other cottage industry options that may return more economic output per hectare than current systems.

When considering alternative land uses for the proposed solar farm area properties, and whether foregoing these future opportunities may exacerbate the impact on agricultural output, the scope of these 'alternatives' is realistically only within the parameters of the current broadacre mixed livestock and cropping system. That is, altering the mix of livestock and cropping enterprises within the current system is the only realistic option.

Assessing the potential value of agricultural output on the proposed solar farm area should include an analysis of potential returns from altering the proportion of cropping in the system relative to livestock production. However, from the report authors' assessment of the proposed solar farm area, the opportunity to substantially increase the productive output of these farms by shifting from livestock to cropping is limited. The primary reasons are:

- Around 50% of land proposed for the solar development is unsuitable for cropping due to waterlogging issues; and
- The current enterprise mix options chosen by the landholders reflect appropriate seasonal risk management in a dryland farming situation.

Consequently, our assessment of the proposed solar farm's impact on the value of agricultural production is predicated on a baseline that broadly reflects current production systems being used on the subject land. We have assumed a mix of livestock and crop production based on agronomic characteristics and appropriate risk management for these circumstances. This assessment is included above in Section 4.0 of this report.

Any foregone alternative enterprises, or substantial changes to current enterprise mixes, have not been quantified, as they are not feasible or likely in the circumstances.

By way of comparison to the analysis to the existing enterprise mix in Section 4.0 of this report, an alternative land use could be an enterprise with a larger cropping component. According to ABS 2012[6] (Value of Agricultural Commodities Produced) in 2011, across nearly 420,000ha in the Albury region, 35% of the land was used for cropping and 65% for pasture. The gross farm gate revenue for a cropping and sheep enterprise occupying 35% and 65% of the proposed solar farm area respectively (assuming waterlogging constraints can be mitigated) is set out in Table 3 below.

Table 3: Alternative Land Use Gross Revenue

Enterprise	Proportion	GM $/Ha	Total $
Livestock	65% (219.05 Ha)	840	184,002.00
Crop	35% (117.95 Ha)	1,375	162,181.25

The total revenue in Table 3 is $346,183.25. For the purpose of this assessment, this figure has been rounded to **$345,000.00.**

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[6] ABS, 2012 Value of Agricultural Commodities Produced in Australia sourced from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/7503.02010-11?OpenDocument

6.0 AGRIVOLTAICS

6.1 Definition

Agrivoltaic systems are predicated on co-locating solar and agricultural systems to maximise the economic productivity of the land.

Agrivoltaic systems may also be expressed as ‘agrovoltaics’ and ‘agrophotovoltaics’ at various times. The terms are interchangeable, but for the purpose of this report we will use the term agrivoltaics, or agrivoltaic systems.

Integrating an agricultural production system into a solar development may include animal grazing between panels or cropping under elevated arrays. Adopting agrivoltaic systems will generally be most beneficial where the agricultural productive capacity of the land developed for solar is high, and there is community demand to maintain agricultural production on that land for socio-economic reasons. For example, where the community values maintaining existing agriculture-related service industries.

6.2 Potential Post-Development Enterprises

International Research and Demonstration

There has been limited international research in this field. However, two recent trials provide background and information about the challenges and opportunities of this production system: being the Oregon University Study and the Fraunhfer Institute Study.

Oregon University Study

Scope and Results

This study sought to measure the effects of a 6 acre agrivoltaic solar farm on microbiology, soil and pasture production. The trial was conducted on the Oregon State University campus, with fixed mounted photovoltaic panels (PVP) 1.1m above ground and a distance between panels of 6m and inclined southward at 18°.

The pasture below the panels and the control areas (areas with no solar panels) were in the same paddock being actively grazed by sheep. Observations within the treatment site were divided between full sun (no shade), partial sun (episodic shade) and fully covered (full shade).[7]

The study found soil moisture depleted more rapidly in the no shade area between the panels, than in the episodic or full shade areas, or the control area. Moisture depletion occurred faster in the no shade area than the control area with no panels. This difference to the control area was unexpected, and the study hypothesised it was associated with long wave radiation transfer affecting evaporation, though indicated further study of this issue was required.

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[7] Adeh et al, ‘Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency’, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203256, p. 3, accessed on 10/01/20

The observation period started with a full moisture profile. At the end of this period soil moisture in the full shade zone was nearly twice the full sun zone, though mean soil moisture across all the solar panel affected zones was similar to the control.[8] The study noted the stark variability of soil moisture across zones, and that this:

> *"creates an undesirable variability across the field and hints that shade uniformity may be an important consideration for the design of future agrivoltaic systems"*[9]

From a water use efficiency perspective (moisture relative to biomass), the full shade area was three times more efficient than the control for the grasses present in the field being used.[10]

The study concluded that solar panels could have a beneficial effect, by reducing potential evapotranspiration in water limited areas, especially semi-arid pastures with wet winters, thus leaving water to be stored in the soil for longer and supporting pasture growth for extended periods.

The study found some evidence that plants with less root density and a high net photosynthetic rate may be best suited.

The authors stated that the economics of this system, including for different crop types, requires further study.[11]

Plate 1: Oregon University Study Area

Image courtesy of Oregon State University

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[8] Adeh et al, 'Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency', https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203256, pp. 9-11, accessed on 10/01/20

[9] Adeh et al, 'Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency', https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203256, p. 11, accessed on 10/01/20

[10] Adeh et al, 'Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency', https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203256, p. 14, accessed on 10/01/20

[11] Adeh et al, 'Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency', https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0203256, p. 16, accessed on 10/01/20

Relevance

We note that day length, seasonal conditions and grass types researched in Oregon vary from the Jindera site, and that as a consequence results would be expected to vary if the same trial methodology were used in the eastern Riverina. For instance, we would be cautious about extrapolating specific soil moisture differences between shading zones expressed in the study to the Jindera site, given the very different rainfall quantities and patterns experienced between locations.

We note that day length, seasonal conditions and grass types researched in Oregon vary from the Jindera site, and that as a consequence results would be expected to vary if the same trial methodology were used in the eastern Riverina. The use of a tracking array at the Jindera site would also mitigate against constant uneven shading, providing a greater degree of shading uniformity than the Oregon study.

Given these issues, we would be cautious about extrapolating specific soil moisture differences between shading zones expressed in the study to the Jindera site.

However, the similar configuration of the solar panels, and the analysis of a comparable grazing system should allow us to draw some inferences from this work. In particular, it appears that the findings of this study reflect certain observations made in discussions with Australian managers co-locating grazing stock with solar developments. In particular, the following key observations:

- Shading can improve soil moisture and maintain pasture growth for longer periods at certain times of the year, especially summer and autumn; and
- Shade and soil moisture variability needs to be factored into the choices pasture species mix and paddock rotations.

Our consideration of current implementation of agrivoltaics in the Australian landscape is included below.

Fraunhofer Institute Study

Scope and Results

A small scale (194KW) agrivoltaic demonstration project has been undertaken in southern Germany, focusing on yield effects across a range of crops.

In this project solar modules for electricity production were installed directly above crops. These panels covered an area of one-third hectare, at 5m above the ground to allow for crop operations beneath the panels. Winter wheat, potatoes, celeriac and clover grass were the first crops to be tested. The trial design ensured that the crops were exposed to uniform solar radiation. The crop yield of clover grass under the PV array was 5.3% less than the reference plot. The yield losses for potatoes, wheat and celeriac were between 1% to 18%.

Researchers indicated further testing is required before drawing firm conclusions.[12]

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[12] Fraunhofer Institute for Solar Energy Systems ISE, Press release 23/11/17, 'Harvesting the Sun for Power and Produce – Agrophotovoltaics Increases the Land Use Efficiency by over 60 Percent', https://www.ise.fraunhofer.de/en/press-media/press-releases/2017/harvesting-the-sun-for-power-and-produce-agrophotovoltaics-increases-the-land-use-efficiency-by-over-60-percent.html, accessed 10/01/20

Plate 2: Fraunhofer Institute Study Solar Panels

Image courtesy of Fraunhofer Institute

Relevance

Given the different solar configuration, climatic conditions, and cropping options demonstrated in this German trial, our view is that no inferences can be drawn that would be relevant to the Jindera site being considered in this study.

Australian Agrivoltaic Systems

There appears to be no formal trial data relating to agrivoltaic systems in Australian conditions. However, the lack of viable agricultural production alternatives to sheep grazing co-located with solar farms, and some practical experiences from existing commercial systems, provide a sound basis on which to assess agricultural impact in this circumstance.

Grazing Sheep

The adoption of agrivoltaics in Australia has, to date, involved incorporating pasture-based sheep grazing systems into solar production. The reasons for this are outlined below. Accordingly, this assessment of its potential impact on agricultural production, is predicated on incorporating sheep grazing into solar farm developments. This is reflected in the intent of the landholders and development proponents as stated in the Jindera solar development proposal.

The preference for sheep grazing reflects some clear realities with solar and agricultural production across the Australian landscape. Firstly, Australia has an abundance of land that may be suited to solar development (notwithstanding network capacity constraints), with solar development being undertaken at large scale on-farms where broadacre production systems have been operating.

There are also practical challenges with incorporating other production systems into an Australian solar farm. Broadacre cropping is not a feasible option due to lack of access for cropping machinery. The alternate broadacre livestock option of running cattle is also problematic, as they are likely to damage solar infrastructure. Allowing goats to graze alongside solar panels would present an even greater risk to infrastructure. Integrating smaller scale and/or more intensive farming enterprises appears unlikely for economic reasons. While some horticultural options (such as vegetables) within a solar development may be practically feasible, it would not make sense to diminish the productive capacity of a high value crop where alternative solar farm locations exist.

Trial Work

Agrivoltaics is a relatively new concept In Australia and globally, with limited formal trial work undertaken, which has been small scale in a commercial agricultural setting, or in limited formal research trials. There appears to have been no formal trial work undertaken in Australia to either:

- Compare the viability of incorporating different production systems into solar developments; or
- Assess the costs and benefits of sheep grazing within a solar array.

Given the clear impediments to co-locating most agricultural production systems with solar, it is not surprising that formal trial work to compare outcomes across varying production systems has not been conducted.

If community and government appetite builds for having agrivoltaics as a condition of solar approval, there would be a case to undertake research into the following issues:

- Quantifying the difference between the productive capacity of a pasture-based sheep grazing system in a typical farm setting, and agrivoltaics;
- Understanding the most suitable pasture seed mix in an agrivoltaic environment characterised by highly modified shading patterns and soil moisture distribution; and
- The effect on pasture growth of varying solar panel configurations.

With appropriate foresight and planning, this work could conceivably occur on the site of a current or future commercial solar development, as part of a collaboration between government, researchers, developers, and land managers. From our discussions with industry participants, there are reportedly discussions between a solar company and CSIRO to undertake quantitative trial work on sheep-based agrivoltaic systems in Australia.

For now, without relevant Australian trial data on the effects of agrivoltaic systems on productive capacity, this report has been guided by local observations of systems in a commercial setting, and consideration of issues arising from the Oregon University study.

Commercial Operations

Neoen – Numurkah

French solar company Neoen has recently commenced commercial operation of a 128 MW solar farm at Numurkah in northern Victoria, on a 515ha site. It generates 255 GWh of solar energy per annum, with agreements in place to supply the Melbourne tram network and the Laverton steelworks.[13]

One of the original landholders, Eddie Rovers, sold land to the developers and reached an agreement with the company to graze 750 of his sheep among the solar panels. In a filmed interview he indicates optimism about the benefits of shading and creating irrigated strips of pasture from dripping dew.[14]

Downer Utilities Australia 2019,[15] outlines observations made about using sheep grazing for vegetation management at the Neoen solar farm at Numurkah. The key findings of the report include:

- Sheep grazing was a successful means by which to control vegetation among the panels, as an alternative to mechanical options;
- Damage and other negative impacts on the solar infrastructure or operations were not observed;
- Prior to construction, it is important to establish clearly defined roles and responsibilities of those responsible for grazing their sheep within the facility, including vegetation management parameters, fencing and other infrastructure, animal purchase and husbandry, and other terms of access;
- Proper planning in advance of construction to establish a seed bank of an agreed pasture mix;
- Sowing a clover species can reduce prevalence of invasive species and avoid high grasses (such as ryegrass) that pose fire risk; and
- Livestock fencing should be incorporated into design plans prior to construction.

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[13] Neoen, Media Release, 19 July 2019, 'Neoen's Numurkah Solar Farm begins full scale commercial operations for its Victorian customers', https://www.neoen.com/var/fichiers/190719-numurkah-full-scale-operations.pdf, accessed on 25/01/20

[14] Eddie Rovers, Direct comments, https://www.abc.net.au/7.30/renewable-energy-projects-helping-to-revitalise/11484992, accessed on 25/01/20

[15] Downer Utilities Australia 2019, sourced from https://www.planningportal.nsw.gov.au/major-projects/project/10916

Plate 3: **Sheep grazing at Neoen Solar Farm at Numurkah**

Image courtesy of ABC News

Neoen – Dubbo

Neoen commenced commercial operations of their 55ha solar farm in June 2018, which incorporates sheep grazing among the panels. The land had primarily been used for grazing prior to the development.

Dubbo farmer Tom Warren, who owns the land and grazes sheep at Neoen's solar farm, has made the following observations about co-locating sheep and solar:

- The productive capacity of pastures is around 80% of typical sheep grazing systems;
- Performance may potentially be better during drought due to shade and moisture retention protecting pastures;
- Dew run off from the panels creates irrigated green strips of pasture growth; and
- Merino wethers are best suited because of their temperament, using cell grazing rotation.[16]

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[16] Neoen Australia Dubbo Agriculture & Solar Video, https://www.youtube.com/watch?v=uO3k9EdZjmI, accessed 25/01/20

Plate 4: **Neoen Solar Farm at Dubbo**

Image courtesy of Western Magazine

Wynergy

Wynergy is a solar farm construction company that claims to have developed a ‘stock-proof’ solar tracking system. The technology has not yet been implemented in a commercial setting.

Photon Energy

Netherlands-based company Photon Energy have indicated that they intend to graze sheep on several proposed developments across NSW. However, none of these projects have yet completed construction and commenced commercial operation.

Conclusion

The report authors are of the view that the emerging sheep grazing approach to agrivoltaic systems in Australia is the most suitable, where co-location is considered necessary or desirable.

This reflects the intent of the Jindera solar farm landowners, as expressed in the environmental impact statement, and in discussions with the proponents and land managers. From our investigations, alternative production systems such as cropping or other livestock grazing would not better mitigate the production ramifications of co-locating agricultural and solar energy production.

Sheep grazing is already intrinsic to current land use on the properties proposed for development, and in the district generally. Therefore, shifting to agrivoltaics would not require major systems upheaval on the part of the landowners, and as they both intend to continue to focus on-farming as their primary source of revenue, represents a practically feasible option across the life of the development.

In discussions with industry participants with experience of agrivoltaic systems, there was a strong view that co-locating a solar farm with sheep grazing had little or no deleterious effects on agricultural production. However, these estimates of reduced production should be considered in the context of various risk factors associated with agrivoltaic systems that can influence practical outcomes in a farming environment.

Current Australian experiences, technical advice provided to the authors of this study, and agrivoltaic production risk factors are reflected in the observations we make in section 6.3 below.

In the following section, this report will assess the likely impact of co-located solar production on the value of agricultural output from that land.

6.3 Impact on Value of Production

Issues for consideration

To assess the effect of an agrivoltaic system on overall agricultural productivity, the following issues need to be considered:

- Proportion of productive area removed by solar infrastructure;
- Effect of shading on pasture growth;
- Soil moisture retention and distribution;
- Effect of panels on moisture (including dew) capture and distribution;
- Suitable pasture species mix for the agrivoltaics environment;
- Limitations on fertiliser application;
- Preferred sheep breed to protect infrastructure;
- Paddock design for effective mustering and pasture management;
- Flexibility to vary stocking density for pasture management;
- Weed control; and
- Dust suppression practices.

Proposed agrivoltaic systems at Jindera site

Full details of the proposed solar development are included in the EIS prepared on behalf of the proponent. For the purpose of the agricultural focus of this report, the key elements of the proposed solar development are:

- Solar panels and associated energy and logistics infrastructure occupying 337ha of the 521ha subject land; and
- Single axis tracker photovoltaic solar panels (2m x 1m) mounted on steel frames at approximately 3m maximum panel height above ground at maximum tilt, with approximately 5.5m row spacing.

Figure 2: Proposed Solar Farm Indicative Plan

Source: NGH Environmental 2019

As indicated in Section 4.0 of this report, approximately 10% of the development footprint is cropped annually, while the remainder is used for grazing livestock. This is a function of the mix of enterprises favoured by the landowners for profit and management reasons, and agronomic constraints inherent to the landscape, especially from waterlogging.

As set out in Section 5.0 of this report, cropping enterprises across the local region on average represent about 35% of the agricultural land use.

NGH Environmental 2019 in relation to the proposed solar farm makes the following comments about intended agrivoltaic system adoption:

> *"The solar array would be mounted above the ground and suitable ground cover would be established and maintained beneath the panels. Groundcover, vegetation would be affected by shading, varying according to time of day and time of year. Groundcover grass species would be selected which are tolerant of these shading conditions and suitable for the soil type and climate at the proposed site."*[17]

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[17] NGH Environmental, 2019 'Environmental Impact Statement Jindera Solar Farm', p37

and

> *"...agricultural activities in the form of grazing can continue on the site. It is the intention of the proponent and the relevant landowners to continue low density, strategic grazing on the site. Strategic sheep grazing would be used to reduce vegetation biomass and put grazing pressure on weeds adjacent to the solar panels."*[18]

and

> *"During the operational phase, not all agricultural activities would be precluded, and it is highly likely that limited production such as occasional grazing could continue. As such, it can be expected that the nature of the agricultural activities would change from cropping and grazing to predominantly grazing within the proposal area."*[19]

Both landowners interviewed for this report indicated they would run Merino wethers or weaner ewes between the solar panels. Operational questions such as pasture species mix, paddock layout and fertiliser application have been considered but not yet resolved.

Observations

On the basis of our assessment of current industry practice and the characteristics of the proposed solar farm area, and taking into account that the proposed agrivoltaic system to be implemented has yet to be determined, we make the following observations:

- The paddock area available for stocking would be reduced by approximately 10%, at the most. This accounts for solar panel array, battery and inverter stations, a substation, buildings, access roads, fencing, additional fire breaks, etc;
- Shading from the solar panels will likely reduce overall pasture growth in the winter and early spring, however it will assist to support extended pasture growth in summer and autumn. This may have some complementary benefits with grazing on other parts of the landholders' farming enterprises;
- The unevenness of soil moisture retention and distribution will not greatly affect available soil moisture overall but will encourage altered patterns of pasture growth. This includes possible dew capture to 'irrigate' pasture rows below the panels;
- A pasture species mix needs to be selected that will be best suited to meeting pasture height parameters, will best respond to periodic shading and will provide cover for avoiding invasive weed infestations. Options for pasture species for agrivoltaics is provided within the **Pasture Species Options** subsection below;
- Planning and implementing ground preparation, timing and the pasture seed mix prior to construction will achieve the best outcome, as undertaking sowing post-construction will limit pasture establishment potential;

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[18] NGH Environmental 2019, 'Environmental Impact Statement Jindera Solar Farm', p62

[19] NGH Environmental, 2019, 'Environmental Impact Statement Jindera Solar Farm', p179

- Fertiliser applications will be able to be maintained, albeit using smaller scale equipment, potentially with a similar approach taken in a viticultural or orchard setting. Aerial applications may not be feasible as damage to panels will likely be perceived as a risk by the solar company;
- Stocking the area with Merino wethers or weaner ewes is preferable to other breed options due to their temperament and non-wool shedding nature. This option should minimise potential for sheep damaging the panels and other infrastructure;
- Manual weed control is still likely to be required, including the use of smaller and more labour intensive spray rigs capable of operating between panel arrays;
- Careful planning and design work will be required to ensure paddock size and layout is conducive to both the construction and management of solar infrastructure, and the rotational grazing, watering and mustering requirements of the sheep enterprise. Each design solution will need to be negotiated and developed to meet the individual circumstances of the site, the intended development, and the preferences of the farm manager;
- The landholders' overall farming operation will need to ensure there is flexibility to vary stocking density within the solar paddocks, so as to avoid loss of ground cover and dust creation during dry periods and to avoid excessive pasture growth when wet. There may be contractual and other limitations preventing the area to be grazed in the same manner as typical grazing paddocks, including minimum and maximum pasture length; and
- A clear agreement between the solar company and grazier will be required in advance of construction planning being finalised, to ensure pasture sowing, paddock layout, vegetation management and other key issues are understood and implemented prior to construction, after which decisions to alter arrangements become more difficult.

The report authors estimate that an agrivoltaic system at this location would reduce the productive sheep carrying capacity of affected paddocks by 25%, and the worst case scenario would be a 50% reduction.

This estimate is based on assumptions drawn from the current information available on agrivoltaic systems, including insights from the Oregon University study and interviews with landholders that have adopted or are considering this system, and agronomists. These assumptions are conservative, as they potentially overestimate the reduction in agricultural output from the development. The key assumptions are:

- 10% of the land will be removed from agricultural productivity due to the construction of physical infrastructure. This equates to a loss of productive area of 34ha at the proposed solar farm;
- A reduction in solar radiation across the site has the potential to limit pasture growth overall, though the exact quantity by which this will occur is difficult to determine without formal trial work being conducted. It is worth noting that the current key limiting factor to pasture growth is rainfall; whether this remains the same post-development is possible but not clear;
- The different patterns and timing of pasture growth compared with typical grazing paddocks may have some overall benefit to the farming operation. However, contractual terms with the developer pertaining to managing pasture to specific parameters, may offset broader farming system benefits; and

- There are risks that:
  - The pasture species mix ultimately selected is not well suited to the agrivoltaics environment, or there is sub-optimal sowing practice and/or timing;
  - Fertiliser regimes are not conducted to the same extent as in other paddocks due to inconvenience and cost; and
  - An optimal rotational grazing layout cannot be negotiated and implemented, hindering efficient mustering, pasture management and stock watering.

Pasture Species Options

Investigations carried out preparing this report indicated there is little known about the best species mix for solar farm pastures, as part-shading is uncommon in broadacre pasture systems, and little or no research has been undertaken. Shading may impact on pasture palatability and energy density, but there is no known research in this area to affirm this.

NSW Department of Primary Industries[20] suggested pasture mixes for the Upper South West Slopes (being the region nearest to the proposed solar farm) recommends for moderate rainfall (600mm+) phalaris, cocksfoot and sub clover with perennial ryegrass as optional.

Pastures species mix in the local region include perennial and annual grasses such as phalaris, fescue and rye grass. All of these grasses have the propensity to grow to 1 metre (or more) tall in the spring. This is an issue for solar farms as:

- Tall grass creates fire management issues;
- When species mature and become unpalatable the only means of control is mechanic, which is costly and difficult to carry out in a solar array; and
- Tall vegetation (such as perennial grasses) growing underneath the solar panels interferes with drive shafts, transmission lines and other equipment.

Accordingly, the most appropriate pasture species for the proposed solar farm are annual clover pastures comprising sub-clover (subterranean clover), balansa clover and gland clover. These pastures are well suited to the region and produce significant biomass without growing to a height that will interfere with the operation of the solar farm. Biomass production from a sub-clover only pasture may be less than a grass and clover pasture mix, however the differences are not material relative to the cost of managing tall grasses. Sub clover pastures will germinate in the autumn and hay off in the late spring and provide palatable dry feed over the summer period. Research work done on irrigated sub-clover pastures in the 1990s in the Murrumbidgee Irrigation Area showed sub-clover pastures could be set stocked by sheep 12 months of the year.

Upland cocksfoot and/or annual ryegrass would be suitable to plant at 6kg/ha – 8kg/ha with the sub-clover which would improve pasture production and provide increased competition for weed control, if the height of solar panels could be raised and/or spring grazing management practices can be put in place to manage pasture height.

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[20] NSW Department of Primary Industries - *Suggested Pasture Mixes for the Upper South West Slopes* sourced from https://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/pasture-mix/upper-south-west-slopes

NSW Department of Primary Industries[21] states:

> *Ryegrass - Annual (Lolium rigidum)*
>
> *Annual self-regenerating aggressive winter-spring growing ryegrass. Suited to drier margin of ryegrass zone. Note that this species can be a weed in winter crops. Annual ryegrass toxicity, ergot and herbicide resistance can be a problem with this species.*
>
> *Usually sown at 15 kg/ha when sown alone or 5–10 kg/ha in a mixture."*

NSW Department of Primary Industries[22] states:

> *"Subterranean Sub Clover (Trifolium subterraneum)*
>
> *A self-regenerating annual. Grows mainly in autumn, winter and spring. Suited to moderately acid to neutral soils. Best suited legume for large areas of southern New South Wales. Resists grazing as seeds are buried.*
>
> *Ensure reliable seed set and improved persistence by using the most suitable variety for a particular district. Mixtures of varieties can be used to take advantage of extended seasons, for example, by including a slightly longer-season (later maturing) variety, and improve persistence by including a slightly shorter-season (early maturing) variety that has a higher proportion of hard seed. (The subterranean clover varieties are listed from late to early maturity). Sow in early to late autumn.*
>
> *4 – 10kg/ha. Inoculant Group C."*

NSW Department of Primary Industries[23] states:

> *"Balsana clover (Trifolium michelianum)*
>
> *A self-regenerating annual legume that grows mainly in spring. Suited to soils of pH (Ca) 4.5-7.0. Tolerates waterlogging. Resists clover scorch and root rot.*

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[21] NSW Department of Primary Industries – Ryegrass sourced from https://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties/ryegrass---annual

[22] NSW Department of Primary Industries - Subterranean Clover sourced from https://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties/subterranean-sub-clover

[23] NSW Department of Primary Industries – Balansa Clover sourced from https://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties/balansa-clover

> *Slow early growth but increases rapidly in late winter and spring as temperatures rise. Produces good quality hay. It has a high proportion of hard seeds. Sow in autumn (dryland) with good moisture or early autumn (irrigated).*
>
> *2-5kg/ha. 0.5-10 kg/ha when used in mixtures, 5 kg/ha when used as a 1-year forage crop."*

NSW Department of Primary Industries[24] *states:*

> *"Gland clover (Trifolium glanduliferum)*
>
> *A self-regenerating, semi-erect annual legume, suitable to neutral to mildly acid soils. The major advantage of gland clover is its resistance to red legged earth mite and aphids. Resistant to scorch. Moderately tolerant of waterlogging. Growth period similar to early maturing sub clovers (e.g. Dalkeith). Useful in mixtures with other temperate legumes or lucerne. Produces high seed yields.*
>
> *2-4 kg/ha. Inoculant Group C."*

The final line in the above quotes is the sowing rate. For those areas not prone to waterlogging a mix of Prima gland clover gland, Paradana (or similar) balansa clover with Seaton Park and Coolamon sub-clover would be best suited. For those areas prone to waterlogging, gland and balansa clover with Yaninnicum sub-clover varieties such as Trikkela and Riverina would be best suited.

The sub-clover pastures should be sown in the autumn following a winter clean the year prior. Sow 1.5kg/ha each of gland and balansa clover with 5kg/ha of sub-clover. Pastures should be sown with a starter fertiliser that includes nitrogen, phosphorous and sulphur. Pastures will perform best when topdressed annually and are subject to ongoing weed management.

With or Without Assessment

As set out in Section 4.0 of this report, the current farm gate value of production arising from the proposed solar farm is estimated to be $300,000.00 per annum. The landowners have indicated a plan to run merino wethers or weaner ewes in the proposed solar farm area post-development. As set out in Section 6.2 of this report, such enterprises appear to be the best option as a productive post-development land use.

Included in Annexure 1 is a NSW DPI gross margin for a merino wether enterprise which best represents the intended post-development enterprise. The gross revenue from this gross margin is $89/DSE. Subject to the extent of reduced pasture productivity post-development as set out in Section 6.2 of this report, the post-development carrying capacity and gross revenue is set out in Table 4.

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[24] NSW Department of Primary Industries – Gland Clover sourced from https://www.dpi.nsw.gov.au/agriculture/pastures-and-rangelands/species-varieties/gland-clover

Table 4: Post-Development

Area (ha)	DSE/ha	Reduced Productivity	Total DSE	Gross Revenue (Farm Gate)	Related Economic Activity
303	10	25%	2,272.5	$202,252.50	$440,667.75
303	10	50%	1,515.0	$134,835.00	$293,778.50

For the purposes of this report the post development farm gate annual gross revenue figures have been rounded to **$200,000** and **$135,000** and related economic activity figures have been rounded to **$440,000.00** and **$295,000.00**, based on an economic multiplier of 2.1788 as set out in Section 4.0 of this report.

Hence, the reduced value of production arising from the proposed development assuming reduced productivity of 25% is set out in Table 5. Related economic activity impacts are based on an economic multiplier of 2.1788 of the farm gate reduction in gross revenue as set out in Section 4.0 of this report.

Table 5: Gross Revenue Analysis (25% reduction in productivity)

	Gross Revenue (pa)		Post Development Impact (pa)	
Enterprise	Pre-Development	Post-Development	Farm Gate	Related Economic Activity
Current (refer to Section 4.0)	$300,000	$200,000	$100,000	$217,880
Increased Cropping (refer to Section 5.0)	$345,000	$200,000	$145,000	$315,926

The assessment in Table 5 indicates the most likely outcome of the proposed solar farm is a reduction in annual farm gate gross revenue of $100,000.00 and a reduction in annual related economic activity of $215,000.00 (rounded from $217,880.00).

The reduced value of production arising from the proposed development assuming reduced productivity of 50% is set out in Table 6. Related economic activity impacts are based on an economic multiplier of 2.1788 of the farm gate reduction in gross revenue as set out in Section 4.0 of this report.

Table 6: Gross Revenue Analysis (50% reduction in productivity)

	Gross Revenue (pa)		Reduction in Gross Revenue (pa)	
	Pre-Development	Post-Development	Farm Gate	Post-Farm Gate
Current (refer to Section 4.0)	$300,000	$135,000	$165,000	$359,502
Increased Cropping (refer to Section 5.0)	$345,000	$135,000	$210,000	457,548

The assessment in Table 5 indicates the most likely outcome of the proposed solar farm is a reduction in annual farm gate gross revenue of $165,000.00 and a reduction in annual related economic activity of $360,000.00 (rounded from $359,502.00). Related economic activity from the existing landowners' enterprises includes upstream activities such as contractors, farm input and service providers. The key downstream activities include processing and distribution. Impacts of the proposed solar farm will include less reliance on contractors, input and service providers and less produce to be transported to off take locations. There is limited (if any) processing facilities within the Greater Hume local government area. Some but not all of the related economic activity impacts will be felt within the Greater Hume local government area, rather more likely across the broader region.

The assessment in Table 5 and Table 6 (above) does not consider rental income derived from the proposed solar farm rent as this report relates to agricultural impacts only. Based on the range of solar farm rental income as set out in Section 7.2 below, the combined post development rental of between $337,000 and $674,000 per annum and grazing income will exceed the existing gross revenue derived from the subject land.

7.0 SOCIAL IMPACTS

7.1 Employment pre and post-development

The two farm businesses that own and manage the proposed solar farm area each provide employment for two full time equivalent (FTE) employees, plus some casual employment at peak times.

On one farm, the employees are multi-generational family members, and their arrangements are not expected to change as a consequence of the proposed solar development. The other farm has one non-family employee, whose employment is not expected to be affected by the solar development. No direct loss of farm-based employment is anticipated from the proposal.

According to the development proposal EIS, there will be two to three new FTE positions created from the solar farm's ongoing management, six contractors required over the life of the project on an as needs basis, and up to 200 employees during the construction phase. However, the scope of this assessment is limited to quantifying the direct and downstream impacts attributable to any reduction of agricultural production capacity.

7.2 Secondary support business impacts

There are a range of upstream and downstream employment roles associated with agricultural production in the Jindera district. These include:

- Agronomy services;
- Input providers (chemical, fertilisers, etc);
- Machinery sales and mechanical support;
- Grain and livestock transport;
- Production marketing; and
- Shearing, fencing, harvest and other contractors.

As indicated in Section 6.0 above, the reduced carrying capacity of the proposed solar farm area post-development is estimated to be 25% with a reduced annual gross revenue of approximately $100,000 per annum based on the existing enterprise mix. Assuming a two-year period of disruption to agricultural output during the land preparation and construction period, the first two years of the project will generate reduced agricultural revenue of $600,000. Over the 30 year life of the project, we estimate reduced farm gate revenue of approximately $3,400,000 (in 2020 dollar values). Applying an economic multiplier of 2.1788 (as set out in Section 4.0), the related economic activity reduction is approximately $7,407,920 (in 2020 dollar values). These estimates do not consider the construction period expenditure such as on fences and roads.

The post-development sheep enterprises will generate upstream and downstream benefits as is the case now for the existing enterprises, albeit at a reduced (up to 25%) level of productivity. All current and potential cropping activities on the land will cease post development. Such changes in land use are typical of what is happening across the broader farming region with cropping land being converted to livestock production and vice versa with seasons, market and other forces dictating ongoing transitions between enterprises at the farm level.

The landowners will be receiving rental payments from the solar company, which is another source of business revenue, albeit from a non-agricultural land use enterprise. Typical industry arrangements indicate that rental income in this circumstance would range from $1,000/ha to $2,000/ha.

Although rental income from solar farming does not attract the same agricultural service industry expenditure, a significant portion of the revenue could be expected to be re-invested in supporting the productive capacity of the businesses' remaining agricultural enterprises. For example, investing in infrastructure upgrades on-farm, more efficient machinery, or soil health improvements, with resulting related economic activity benefits.

Finally, in a transition from regular production to solar farming, some service industries will benefit. For instance, fencing and civil contractors are likely to experience higher demand for that site than would have been the case, while agronomic consultants and spray and spreading contractors may only experience marginal downturn in requirement for their services, if at all. Businesses related to servicing grain production on the site would be most affected.

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Annexure 1

NSW DPI Gross Margin

1st CROSS EWES - Terminal Meat Rams

Farm Enterprise Budget Series - Oct 2018 (average wool and sheep price 1 Apr to 30 Sep)

Flock size: 1000 ewes
Ewe body weight: 76 kgs
DSE rating: 2.99 DSEs/ewe

					Standard Budget ($)	Your Budget ($)
INCOME						
Wool	**number**	**class**	**kg /hd**	**$/kg**		
Shear	960	ewes	4.50	$6.10	$26,352	
	20	rams	3.50	$4.49	$314	
Crutch	1020	adults	0.30	$3.31	$1,012	
	1176	lambs	0.25	$3.31	$972	
Sheep Sales	**number**	**class**	**$ /hd**			
	177	CFA ewes	$142.34	(30.8 kg cwt)	$25,195	
	4	CFA rams	$87.95		$352	
8 months	578	mixed sex lambs	$157.47	(21.0 kg cwt)	$91,018	
9 months	578	mixed sex lambs	$171.73	(23.0 kg cwt)	$99,260	
Fodder	**tonnes**	**type**	**value per tonne**			
Graz/fodder crop	0 t	0	$0 /t		$0	
			A. Total Income:		**$244,474**	
VARIABLE COSTS						
Replacements	**number**	**class**	**cost ($)/hd**	**reps**		
	4	rams	$1,200.00		$4,800	
	217	ewes (1.5 years)	$210.00		$45,570	
Cartage	217	ewes (1.5 years)	$2.00		$434	
Cartage	4	rams	$50.00		$200	
Wool Harvesting & Selling Costs						
Shearing	960	ewes	$7.15	1	$6,866	
	20	rams	$10.26	1	$205	
Crutching	2176	ewes/lambs	$1.18	1	$2,570	
	20	rams	$2.64	1	$53	
Wool tax			2.00%		$573	
Commission, warehouse, testing charges			$40.50/ bale		$1,134	
Wool - cartage	28	bales	$10.00		$280	
- packs	28	packs	$13.50		$378	
Sheep Health	**number**	**class**				
Broadspectrum	1020	adults	$1.51	2	$3,080	
	1210	lambs	$0.71	3	$2,577	
Narrowspectrum	1020	adults/hoggets	$0.36	1	$367	
	1156	lambs	$0.16	1	$185	
Lice control	0	adults	$1.13	1	$0	
Fly control (long acting)	1000	adults	$1.80	1	$1,800	
fly control (short acting)	1156	weaners	$0.44	1	$509	
Vaccination- 6 in 1	1020	adults	$0.30	1	$306	
	1210	lambs	$0.30	2	$726	
Marking	1210	lambs	$1.85	1	$2,239	
Scanning	1000	ewes	$0.80	1	$800	
Livestock Selling Costs						
Livestock cartage	1,337	sale sheep	$2.00		$2,674	
Commission on sheep sales			4.95%		$10,683	
Levies (Yard dues, MLA Transaction levy and LLS rates)					$3,978	
Pasture maintenance	299 ha	@	$37 /ha		$11,078	
Fodder						
		Supplementary feed @ $320 /t				
Ewes	960	4.2 kg/hd/week	$0.32 /kg	10 weeks	$12,902	
Mixed sex lambs	1156	5.0 kg/hd/week	$0.32 /kg	8 weeks	$14,797	
	Total feed	86,560 kg	@	$320	**$27,699**	
Graz/fodder crop	0 ha	@	$0 /ha		$0	
			B. Total Variable Costs:		**$131,765**	
				excl. fodder	incl. fodder	
GROSS MARGIN (A-B)				**$140,408.13**	**$112,708.93**	
GROSS MARGIN /EWE				**$140.41**	**$112.71**	
GROSS MARGIN /DSE				**$46.96**	**$37.70**	
GROSS MARGIN /HA				**$469.59**	**$376.95**	

This budget should be used as a GUIDE ONLY and should be changed by the grower to take account of movements in commodity and input prices, changes in seasonal conditions and individual farm characteristics. Estimated prices are GST exclusive.

ASSUMPTIONS 1st CROSS EWES - Terminal Meat Rams

1. Flock Parameters

Flock mortality	4%	Ram %	2%
Productive life	5 years	Marking %	121%
Ewe body weight	76 kg	Weaning %	118%
DSE rating /ewe	3.0	Selling age	6-8 months
Stocking rate/ha	10 dse's		

Pasture maintenance = 90kg/ha single super @ $3450t + $6.00/ha application

2. Flock

Structure Sheep numbers are modified to reflect mortality throughout the year.

Age	Number of ewes
1.5	217
2.5	208
3.5	200
4.5	192
5.5	184
6.5	0
Total	**1000**

217 **Replacements Bought** → 217

200 → 1210 **lambs** → 1180 **weaned lambs** → 1156 **mixed sex lambs sold**

184 → 177 **CFA's sold**

3. Wool Prices

1st Cross Ewe	**Micron**	**AWEX Type**	**Clean price**	**Yield**	**Greasy price**	**Specifications (all 35n/ktex)**	**Proportion of Clip**
- Fleece GTM	28	XF5B	$9.72	71%	$6.86	1%VMB, 90mm	75%
- Skirtings/bellies	26	XP5B.	$7.13	55%	$3.94	4.8%VMB, 80mm	20%
- Cardings	28	XZ2B.	$5.47	61%	$3.35	2.9%VMB.	5%
					$6.10	→	used in budget

4. Sensitivity Tables - Changes in Gross Margin $/DSE (includes fodder)

CFA ewes $/hd	**Replacement ewe cost $/hd**				
	$147.00	$178.50	**$210.00**	$241.50	$273.00
$99.64	$39.86	$37.58	$35.29	$33.01	$30.72
$120.99	$41.07	$38.78	$36.49	$34.21	$31.92
$142.34	$42.27	$39.98	**$37.70**	$35.41	$33.12
$163.70	$43.47	$41.18	$38.90	$36.61	$34.32
$185.05	$44.67	$42.38	$40.10	$37.81	$35.53

Domestic Lmb $/Hd	**Weaning %**				
	83%	100%	**118%**	136%	153%
$110.23	$16.19	$22.63	$29.02	$35.46	$41.86
$133.85	$19.23	$26.32	$33.36	$40.45	$47.51
$157.47	$22.26	$30.01	**$37.70**	$45.44	$53.15
$181.09	$25.30	$33.70	$42.04	$50.44	$58.79
$204.71	$28.34	$37.39	$46.38	$55.43	$64.43

Export lamb $/Hd	**Weaning %**				
	83%	100%	**118%**	136%	153%
$120.21	$15.64	$21.96	$28.23	$34.55	$40.84
$145.97	$18.95	$25.99	$32.96	$40.00	$46.99
$171.73	$22.26	$30.01	**$37.70**	$45.44	$53.15
$197.49	$25.58	$34.04	$42.43	$50.89	$59.30
$223.25	$28.89	$38.06	$47.16	$56.34	$65.46

Domestic Lamb $/Hd	**Export Lamb $/Hd**				
	$120.21	$145.97	**$171.73**	$197.49	$223.25
$110.23	$19.55	$24.28	$29.02	$33.75	$38.48
$133.85	$23.89	$28.62	$33.36	$38.09	$42.82
$157.47	$28.23	$32.96	**$37.70**	$42.43	$47.16
$181.09	$32.57	$37.30	$42.04	$46.77	$51.50
$204.71	$36.91	$41.64	$46.38	$51.11	$55.84

Note: The above sensitivity tables vary price and quantities by +/- 15% and +/- 30%.

Feed m/sex lamb kg/Hd/wk	**Feeding ewes kg/Hd/week**				
	2.10 kg	3.15 kg	**4.20 kg**	5.25 kg	6.30 kg
2.50 kg	$42.33	$41.25	$40.17	$39.09	$38.01
3.75 kg	$41.09	$40.01	$38.93	$37.85	$36.77
5.00 kg	$39.85	$38.77	**$37.70**	$36.62	$35.54
6.25 kg	$38.62	$37.54	$36.46	$35.38	$34.30
7.50 kg	$37.38	$36.30	$35.22	$34.14	$33.06

Feed m/sex lamb kg/hd/wk	**Grain price $/Tonne**				
	$160.00	$240.00	**$320.00**	$400.00	$480.00
2.5 kg	$43.56	$41.87	$40.17	$38.47	$36.77
3.8 kg	$42.95	$40.94	$38.93	$36.93	$34.92
5.0 kg	$42.33	$40.01	**$37.70**	$35.38	$33.06
6.3 kg	$41.71	$39.08	$36.46	$33.83	$31.21
7.5 kg	$41.09	$38.16	$35.22	$32.29	$29.35

Note: The feeding sensitivity table varies quantities by +/- 25% and +/- 50%.

Sheep and wool prices thanks to MLA market reporting, AuctionsPlus and AWEX.

MERINO EWES (20 micron) - Terminal Rams

Farm Enterprise Budget Series - Oct 2018 (average wool and sheep price 1 Apr to 30 Sep)

Flock size:	**1000 ewes**
Ewe body weight:	**59 kgs**
DSE rating:	**2.30 DSEs/ewe**

INCOME					**Standard Budget** ($)	**Your Budget** ($)
Wool	**number**	**class**	**kg /hd**	**$/kg**		
Shear	940	ewes	5.16	$13.10	$63,480	
	20	rams	3.50	$4.49	$314	
Crutch	1000	mixed ages	0.40	$8.61	$3,445	
	893	xb lambs/rams	0.25	$3.31	$738	
Sheep Sales	**number**	**class**	**$ /hd**			
	165	CFA ewes	$124.05	(26.0 kg cwt)	$20,468	
	4	CFA rams	$87.95		$352	
8 months	437	mixed sex lambs	$147.94	(20.0 kg cwt)	$64,576	
10 months	437	mixed sex lambs	$164.60	(22.0 kg cwt)	$71,848	
Fodder	**tonnes**	**type**	**value per tonne**			
Graz/fodder crop	0 t	0	$0 /t		$0	
			A. Total Income:		**$225,222**	
VARIABLE COSTS						
Replacements	**number**	**class**	**cost ($)/hd**	**reps**		
	4	rams	$1,200.00		$4,800	
	225	ewes	$170.00		$38,250	
Cartage	225	ewes	$2.00		$450	
Cartage	4	rams	$50.00		$200	
Wool Harvesting & Selling Costs						
Shearing	940	ewes	$7.15	1	$6,723	
	20	rams	$10.26	1	$205	
Crutching	1000	ewes	$1.51	1	$1,506	
	20	rams	$2.64	1	$53	
	873	weaners	$1.51	1	$1,315	
Wool tax			2.00%		$1,360	
Commission, warehouse, testing charges			$40.50/ bale		$1,336	
Wool - cartage	33	bales	$10.00		$330	
- packs	33	packs	$13.50		$446	
Sheep Health	**number**	**class**				
Broadspectrum	1020	adults/hoggets	$1.51	2	$3,080	
	900	lambs	$0.71	3	$1,917	
Narrowspectrum	1020	adults/hoggets	$0.32	1	$326	
	900	lambs	$0.16	1	$144	
Lice control	0	adults	$1.13	1	$0	
Fly control (long acting)	1020	adults	$1.80	1	$1,836	
Fly control (short acting)	900	weaners	$0.44	1	$396	
Vaccination- 6 in 1	1020	adults	$0.30	1	$306	
	930	lambs	$0.30	2	$558	
Mark	930	lambs	$1.85	1	$1,721	
Scanning	1000	ewes	$0.80	1	$800	
Livestock Selling Costs						
Livestock cartage	1,042	sale sheep	$2.00		$2,084	
Commission on sheep sales			4.95%		$7,784	
Levies (Yard dues, MLA Transaction levy and LLS rates)					$3,047	
Pasture maintenance	230 ha	@	$37 /ha		$8,522	
Fodder						
		Supplementary feed @ $320 /t				
Ewes	940	3.5 kg/hd/week	$0.32 /kg	10 weeks	$10,408	
Mixed sex lambs	873	5.0 kg/hd/week	$0.32 /kg	12 weeks	$16,762	
	Total feed	84,904 kg	@	$320.00	**$27,169**	
Graz/fodder crop	0 ha	@	$106 /ha		$0	
			B. Total Variable Costs:			
	GROSS MARGIN (A-B)					
	GROSS MARGIN /EWE			**$135.73**	**$108.56**	
	GROSS MARGIN /DSE			**$59.01**	**$47.20**	
	GROSS MARGIN /HA			**$590.12**	**$472.00**	

This budget should be used as a GUIDE ONLY and should be changed by the grower to take account of movements in commodity and input prices, changes in seasonal conditions and individual farm characteristics. Estimated prices are GST exclusive.

ASSUMPTIONS MERINO EWES (20 micron) - Terminal Rams

1. Flock Parameters

Flock mortality	6%	Ram %	2%
Productive life	5 years	Marking %	93%
Ewe body weight	59 kg	Weaning %	90%
DSE rating /ewe	2.3	Weaning age	3 months
Stocking rate/ha	10 dse's		

Pasture maintenance = 90kg/ha single super @ $3450t + $6.00/ha application

2. Flock Structure

Sheep numbers are modified to reflect mortality throughout the year.

Age	Number of ewes
1.5	225
2.5	212
3.5	199
4.5	187
5.5	176
6.5	0
Total	**1000**

225 **replacements bought** → 1.5 (225)

199 → 930 **lambs** → 900 **weaners** → 873 **mixed sex lambs sold**

176 → 165 **CFA's sold**

3. Wool Prices

Merino Ewe	**Micron**	**AWEX Type**	**Clean price**	**Yield**	**Greasy price**	**Specifications (all 35n/ktex)**	**Proportion of Clip**
- Fleece GTM	20	MF5B.	$22.12	65%	$14.42	1%VMB, 90mm	75%
- Skirtings/bellie	19	MP5B.	$17.87	56%	$9.97	4.8%VMB, 80m	20%
- Cardings	20	MZ2B.	$11.07	52%	$5.75	2.9%VMB.	5%
					$13.10 →		used in budget

4. Sensitivity Tables - Changes in Gross Margin $/DSE (includes fodder)

Wool Cut kg/hd	**Adult Greasy Wool Price $/Kg greasy**				
	$9.17	$6.55	**$13.10**	$15.07	$17.03
3.61 kg	$33.63	$29.84	$39.31	$42.15	$44.99
4.38 kg	$36.36	$31.76	$43.25	$46.70	$50.15
5.16 kg	$39.09	$33.68	**$47.20**	$51.26	$55.31
5.93 kg	$41.81	$35.59	$51.15	$55.81	$60.48
6.70 kg	$44.54	$37.51	$55.09	$60.37	$65.64

Cast for age $/Hd	**Replacement ewe cost $/Hd**				
	$119.00	$144.50	**$170.00**	$195.50	$221.00
$86.83	$49.65	$47.16	$44.66	$42.17	$39.67
$105.44	$50.92	$48.43	$45.93	$43.44	$40.94
$124.05	$52.19	$49.69	**$47.20**	$44.71	$42.21
$142.66	$53.46	$50.96	$48.47	$45.97	$43.48
$161.26	$54.73	$52.23	$49.74	$47.24	$44.75

Domestic Lamb $/Hd	**Weaning %**				
	63%	77%	**90%**	104%	117%
$103.56	$28.13	$33.65	$39.19	$44.71	$50.26
$125.75	$30.93	$37.05	$43.20	$49.31	$55.46
$147.94	$33.73	$40.45	**$47.20**	$53.92	$60.66
$170.13	$36.54	$43.86	$51.20	$58.52	$65.87
$192.32	$39.34	$47.26	$55.21	$63.13	$71.07

Domestic Lamb $/Hd	**Export Lamb $/Hd**				
	115.22	139.91	**164.60**	189.29	213.98
$103.56	$30.29	$34.74	$39.19	$43.65	$48.10
$125.75	$34.29	$38.74	$43.20	$47.65	$52.10
$147.94	$38.29	$42.75	**$47.20**	$51.65	$56.11
$170.13	$42.30	$46.75	$51.20	$55.66	$60.11
$192.32	$46.30	$50.75	$55.21	$59.66	$64.11

Note: The above sensitivity tables vary price and quantities by +/- 15% and +/- 30%.

Feed m/sex lamb kg/Hd/wk	**Feeding ewes kg/Hd/week**				
	1.73 kg	2.60 kg	**3.46 kg**	4.33 kg	5.19 kg
2.50 kg	$53.11	$51.97	$50.84	$49.71	$48.58
3.75 kg	$51.28	$50.15	$49.02	$47.89	$46.76
5.00 kg	$49.46	$48.33	**$47.20**	$46.07	$44.94
6.25 kg	$47.64	$46.51	$45.38	$44.25	$43.12
7.50 kg	$45.82	$44.69	$43.56	$42.42	$41.29

Feed m/sex lamb kg/hd/wk	**Grain price $/Tonne**				
	$160.00	$240.00	**$320.00**	$400.00	$480.00
2.5 kg	$54.93	$52.89	$50.84	$48.80	$46.76
3.8 kg	$54.02	$51.52	$49.02	$46.52	$44.03
5.0 kg	$53.11	$50.15	**$47.20**	$44.25	$41.29
6.3 kg	$52.20	$48.79	$45.38	$41.97	$38.56
7.5 kg	$51.28	$47.42	$43.56	$39.69	$35.83

Note: The feeding sensitivity tables vary quantities/cost by +/- 25% and +/- 50%.

Sheep and wool prices thanks to MLA market reporting, AuctionsPlus and AWEX. Wool cuts based on wether trial data

NSW Department of Primary Industries

MERINO EWES (20 micron) - Maternal Meat Rams

Farm Enterprise Budget Series - Oct 2018 (average wool and sheep price 1 Apr to 30 Sep)

Flock size: **1000 ewes**

Ewe body weight: **59 kgs**
DSE rating: **2.77 DSEs/ewe**

INCOME

Wool	**number**	**class**	**kg /hd**	**$/kg**	**Standard Budget ($)**	**Your Budget ($)**
Shear	950	ewes	5.16	$13.10	$64,156	
	20	rams	4.50	$4.49	$404	
	440	ewe lambs	1.13	$8.93	$4,420	
	429	ewe hoggets	4.50	$8.93	$17,239	
Crutch	1020	adults	0.40	$8.61	$3,514	
	880	lambs	0.25	$3.31	$727	
Sheep Sales	**number**	**class**	**$ /hd**			
	171	CFA ewes	$124.05	(26.0 kg cwt)	$21,212	
	4	CFA rams	$87.95		$352	
8 months	440	weth lambs	$147.94	(20.0 kg cwt)	$65,094	
	429	ewe Hoggets	$210.00	(16 months)	$90,090	
Fodder	**tonnes**	**type**	**value per tonne**			
Graz/fodder crop	0 t	0	$0 /t		$0	
			A. Total Income:		**$267,209**	

VARIABLE COSTS

Replacements	**number**	**class**	**cost ($)/hd**	**reps**	**Standard Budget ($)**	**Your Budget ($)**
	4	rams	$1,200.00		$4,800	
	221	ewes (1.5 years)	$170.00		$37,570	
Cartage	221	ewes (1.5 years)	$2.00		$442	
Cartage	4	rams	$50.00		$200	
Wool Harvesting & Selling Costs						
Shearing	1399	adults/hoggets	$7.15	1	$10,006	
	20	rams	$10.26	1	$205	
	440	ewe lambs	$7.15	1	$3,147	
Crutching	1880	ewe/lambs	$1.51	1	$2,831	
	20	rams	$2.64	1	$53	
Wool tax			2.00%		$1,809	
Commission, warehouse, testing charges			$40.50/ bale		$1,822	
Wool - cartage	45	bales	$10.00		$450	
- packs	45	packs	$13.50		$608	
Sheep Health	**number**	**class**				
Broadspectrum	1020	adults	$1.51	2	$3,080	
	880	lambs	$0.71	3	$1,874	
Narrowspectrum	1020	adults/hoggets	$0.32	1	$326	
	880	lambs	$0.16	1	$141	
Lice control	0	adults	$1.13	1	$0	
	0	ewe lambs	$1.13	1	$0	
Fly control (long acting)	1020	adults/hoggets	$1.80	1	$1,836	
Fly control (short acting)	880	weaners	$0.44	1	$387	
Vaccination- 6 in 1	1020	adults	$0.30	1	$306	
	930	lambs	$0.30	2	$558	
Mark	465	wether lambs	$1.85	1	$860	
Mark/OJD vaccine	465	ewe lambs	$4.80	1	$2,230	
Scanning	1000	ewes	$0.80	1	$800	
Livestock Selling Costs						
Livestock cartage	1,044	sale sheep	$2.00		$2,088	
Commission on sheep sales			4.95%		$8,749	
Levies (Yard dues, MLA Transaction levy and LLS rates)					$3,100	
Pasture maintenance	277 ha	@	$37 /ha		$10,263	
Fodder						
		Supplementary feed @ $320 /t				
Ewes adults/hoggets	950	3.5 kg/hd/week	$0.32 /kg	10 weeks	$10,518	
Ewe lambs	440	2.8 kg/hd/week	$0.32 /kg	12 weeks	$4,731	
Wether lambs	440	5.0 kg/hd/week	$0.32 /kg	10 weeks	$7,040	
	Total feed	69,654 kg	@	$320	**$22,289**	
Graz/fodder crop	0 ha	@	$0 /ha		$0	
			B. Total Variable Costs:		**$122,831**	

	excl. fodder	incl. fodder	
GROSS MARGIN (A-B)	**$166,666.77**	**$144,377.49**	
GROSS MARGIN /EWE	**$166.67**	**$144.38**	
GROSS MARGIN /DSE	**$60.17**	**$52.12**	
GROSS MARGIN /HA	**$601.69**	**$521.22**	

This budget should be used as a GUIDE ONLY and should be changed by the grower to take account of movements in commodity and input prices, changes in seasonal conditions and individual farm characteristics. Estimated prices are GST exclusive.

ASSUMPTIONS MERINO EWES (20 micron) - Maternal Meat Rams

1. Flock Parameters

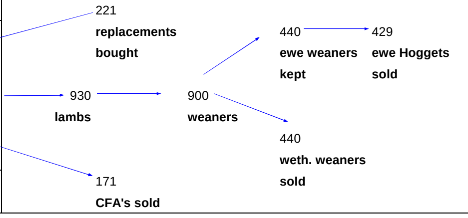
Flock mortality	5%	Ram %	2%
Productive life	5	Marking %	93%
Ewe body weight	59 kg	Weaning %	90%
DSE rating /ewe	2.77	Weaning age	3 months
Stocking rate/ha	10 dse's		

Pasture maintenance = 90kg/ha single super @ $3450t + $6.00/ha application

2. Flock Structure

Sheep numbers are modified to reflect mortality throughout the year.

Age	**Number of ewes**
1.5	221
2.5	210
3.5	199
4.5	189
5.5	180
6.5	0
Total	**1000**



3. Wool Prices

Merino Ewe	**Micron**	**AWEX Type**	**Clean price**	**Yield**	**Greasy price**	**Specifications (all 35n/ktex)**	**Proportion of Clip**
- Fleece GTM	20	MF5B.	$22.12	65%	$14.42	1%VMB, 90mm	75%
- Skirtings/bellie	19	MP5B.	$17.87	56%	$9.97	4.8%VMB, 80m	20%
- Cardings	20	MZ2B.	$11.07	52%	$5.75	2.9%VMB.	5%
					$13.10	→	used in budget

4. Sensitivity Tables - Changes in Gross Margin $/DSE (includes fodder)

Wool Cut kg/hd	**Adult Greasy Wool Price $/Kg greasy**				
	$9.17	$11.14	**$13.10**	$15.07	$17.03
3.61 kg	$40.73	$43.11	$45.50	$47.88	$50.26
4.38 kg	$43.02	$45.92	$48.81	$51.70	$54.60
5.16 kg	$45.31	$48.72	**$52.12**	$55.53	$58.93
5.93 kg	$47.60	$51.52	$55.43	$59.35	$63.26
6.70 kg	$49.89	$54.32	$58.75	$63.17	$67.60

Cast for age $/head	**Replacement ewe cost $/Hd**				
	$119.00	$144.50	**$170.00**	$195.50	$221.00
$86.83	$54.01	$51.97	$49.94	$47.90	$45.87
$105.44	$55.10	$53.06	$51.03	$49.00	$46.96
$124.05	$56.19	$54.16	**$52.12**	$50.09	$48.05
$142.66	$57.28	$55.25	$53.21	$51.18	$49.14
$161.26	$58.37	$56.34	$54.31	$52.27	$50.24

1st X weth.lmb $/Hd	**Weaning %**				
	63%	77%	**90%**	104%	117%
$103.56	$32.36	$38.94	$45.42	$51.92	$58.50
$125.75	$34.71	$41.79	$48.77	$55.77	$62.86
$147.94	$37.05	$44.64	**$52.12**	$59.63	$67.21
$170.13	$39.40	$47.49	$55.47	$63.48	$71.57
$192.32	$41.74	$50.34	$58.82	$67.33	$75.93

1st X weth.lmb $/Hd	**1st X ewe Hoggets $/hd**				
	$147.00	$178.50	**$210.00**	$241.50	$273.00
$103.56	$36.15	$40.78	$45.42	$50.06	$54.70
$125.75	$39.50	$44.13	$48.77	$53.41	$58.05
$147.94	$42.85	$47.48	**$52.12**	$56.76	$61.40
$170.13	$46.20	$50.84	$55.47	$60.11	$64.75
$192.32	$49.55	$54.19	$58.82	$63.46	$68.10

Note: The above sensitivity tables vary price and quantities by +/- 15% and +/- 30%.

Feed weth. lamb kg/Hd/wk	**Feeding ewe lambs kg/Hd/week**				
	1.40 kg	2.10 kg	**2.80 kg**	3.50 kg	4.20 kg
2.5 kg	$54.25	$53.82	$53.39	$52.97	$52.54
3.8 kg	$53.61	$53.18	$52.76	$52.33	$51.90
5.0 kg	$52.98	$52.55	**$52.12**	$51.69	$51.27
6.3 kg	$52.34	$51.91	$51.49	$51.06	$50.63
7.5 kg	$51.71	$51.28	$50.85	$50.42	$50.00

Feed Adult Ewes kg/hd/wk	**Grain price $/Tonne**				
	$160.00	$240.00	**$320.00**	$400.00	$480.00
1.7 kg	$57.09	$55.56	$54.02	$52.48	$50.95
2.6 kg	$56.62	$54.85	$53.07	$51.30	$49.52
3.5 kg	$56.15	$54.13	**$52.12**	$50.11	$48.10
4.3 kg	$55.67	$53.42	$51.17	$48.92	$46.67
5.2 kg	$55.20	$52.71	$50.22	$47.74	$45.25

Note: The feeding sensitivity tables vary quantities/cost by +/- 25% and +/- 50%.

Sheep and wool prices thanks to MLA market reporting, AuctionsPlus and AWEX. Wool cuts based on wether trial data

BEEF CATTLE GROSS MARGIN BUDGET

Farm enterprise Budget Series: April 2019

Enterprise: **Butcher vealers**

Enterprise Unit: **100 cows**

Pasture: **Improved pasture**

INCOME:

			Standard Budget	**Your Budget**
32	steer vealers @	$880 /hd	$28,160	
13	store steers @	$771 /hd	$10,021	
32	heifer vealers @	$825 /hd	$26,400	
13	store heifers @	$695 /hd	$9,033	
1	CFA Bull @	$1,800 /hd	$1,800	
9	CFA cows @	$1,124 /hd	$10,114	
9	Other culls @	$1,124 /hd	$10,114	
	A. Total Income:		**$95,641**	

VARIABLE COSTS:

Replacements	1	Bull @	$3,500 /hd	$3,500
	18	Replacement heifers @	$700 /hd	$12,600
Livestock and vet costs: see section titled beef health costs for details.				$1,405
Fodder crops / hay / grain				$0
Drought feeding costs.				$0
Pasture maintenence (improved pasture costs for 209 ha per 100 cows)				$20,900
Livestock selling cost (see assumptions on next page)				$7,231
B. Total Variable Costs:				**$45,636**

	GM including pasture cost	GM excluding pasture cost
GROSS MARGIN (A-B)	**$50,005**	**$70,905**
GROSS MARGIN/COW	**$500.05**	**$709.05**
GROSS MARGIN/DSE*	**$29.98**	**$42.51**
GROSS MARGIN/HA	**$239.26**	**$339.26**

Change in gross margin ($/cow) for change in price &/or the weight of sale stock

(Note: Table assumes that the price and weight of other stock changes in the same proportion as steers. As an example if steer sale price falls to 540c/kg and steer weight to 140 kg, gross margin would fall to $369 per cow. This assumes that price and weight of all other sale stock falls by the same percentage.

Liveweight (kg's) of Stock sold		**Steer sale price cents/kg dressed**				
		530	**540**	**550**	**560**	**570**
	Steer wt.					
-40 kgs	**120**	242	255	268	281	294
-20 kgs	**140**	354	369	384	399	414
0	**160**	466	483	**500**	517	534
+20 kgs	**180**	579	597	616	635	653
+40 kgs	**200**	691	711	732	753	773

GM $ per Cow

An increase of 5% in weaning percentage increases gross margin per cow by $38.17

Assumptions **Butcher vealers**

Enterprise unit is 100 cows weighing on average 540 kg
Weaning rate: 90% (higher than other enterprises because replacements purchased PTIC)

Sales

70% steers sold at 9 months	160 kg	@550c/kg	dressed weight
30% store steers sold at 10 months	270 kg	@286c/kg	live weight
70% heifers sold at 8 months	150 kg	@550c/kg	dressed weight
30% store heifers sold at 9 months	250 kg	@278c/kg	live weight
18 replacement heifers purchased pregnancy tested in calf @ $800/head			
Cull cows cast for age at 10 years	280 kg	@401c/kg	dressed weight
100% of empty cows culled at weaning	"	"	"
4% cows culled for other reasons	"	"	"
Bulls run at 3% & sold after 4 years use	450 kg	@400c/kg	

Selling costs include: Commission 4%; MLA levy $5hd; freight to abattoirs @ 10c/kg dw for stock sold on dressed basis. freight to saleyards @ $12.00/hd + yard dues @ $8/hd for lw sales. NLIS tags @ $3.60 for all progeny sold.

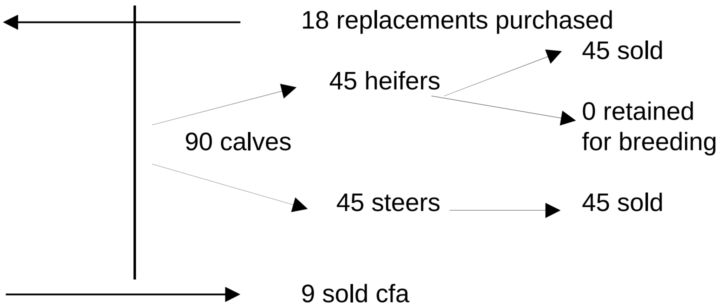
Cows: age at first calf : 24 months

Mortality rate of adult stock: 2%

The average feed requirement of a cow + followers is rated at 2.29 LSU or15.84 dse's*. This is an averag figure and will vary during the year. Note that dse rating is lower than some other enterprises because replacement heifers are purchased.

Age structure

Age	**Number**
2	17
3	16
4	14
5	13
6	12
7	10
8	9
9	9
Total joined	**100**
10	9



Marketing Information:
The majority are sold as vealers to local trade categories with the balance sold into the feeder market. MSA vealer protocols will influence management. For example vealers must be processed within 24 hours of separation from dams.

Production Information:
Cows for this enterprise will most likely be crossbreds put to a terminal sire or good milking pure bred lines. Female offspring usually sold with males. Early-mid maturity essential.
Good quality replacements are purchased pregnancy tested greater than 5 months in calf to calve in line with the rest of the herd. Early calving (June/July) desirable for this enterprise in northern areas. Selection of efficient dams with good milking ability and lighter liveweights can improve stocking rates and profitability.
Note that herd structure table assumes a high culling rate in early years due to the culling of cows that are tested as empty (100% culling assumed on pregnancy test results), poor performers and off types. However, as replacements are purchased PTIC** numbers required are less than the self replacing enterprises.

** PTIC = Pregnancy tested in calf.

MERINO WETHERS (20 micron)

Farm Enterprise Budget Series - Oct 2018 (average wool and sheep price 1 Apr to 30 Sep)

Flock size:	**1000**	**wethers**
Wether body weight:	**59**	**kgs**
DSE rating:	**1.18**	**DSEs/wether**

					Standard Budget $	Your Budget $
INCOME						
Wool	**number**	**class**	**kg /hd**	**$/kg**		
Shear	1000	wethers	6.06	$13.32	$80,784	
	174	wethers 4 month	1.26	$5.96	$1,310	
Crutch	990	wethers	0.40	$8.61	$3,411	
Sheep Sales	**number**	**class**	**$ /hd**			
	156	CFA wethers	$124.05	(26.0 kg cwt)	$19,308	
Fodder	**tonnes**	**type**	**value per tonne**			
Graz/fodder crop	0 t	0	$0 /t		$0	
			A. Total Income:		**$104,812**	
VARIABLE COSTS						
Replacements	**number**	**class**	**cost ($)/hd**			
	174	wethers	$85.00	(4 months)	$14,790	
Cartage	174	wethers	$2.00		$348	
Wool Harvesting & Selling Costs				**reps**		
Shearing	1174	wethers	$7.15	1	$8,397	
Crutching	990	wethers	$1.58	1	$1,566	
Wool tax			2.00%		$1,710	
Commission, warehouse, testing charges			$40.50/ bale		$1,498	
Wool - cartage	37	bales	$10.00		$370	
- packs	37	packs	$13.50		$500	
Sheep Health						
Broadspectrum	826	wethers	$1.51	2	$2,495	
	174	weaners	$0.71	2	$247	
Narrowspectrum	1000	wethers	$0.32	1	$320	
Lice control	1174	wethers	$1.13	1	$1,327	
Fly control (long acting)	1000	wethers	$1.80	1	$1,801	
Vaccination- 6 in 1	1000	wethers	$0.30	1	$300	
Livestock Selling Costs						
Livestock cartage	156	CFA wethers	$2.00		$311	
Commission on sheep sales			4.95%		$956	
Levies (Yard dues, MLA Transaction levy and LLS rates)					$402	
Pasture maintenance	118 ha	@	$37 /ha		$4,372	
Fodder						
		Supplementary feed @ $320 /t				
Wethers	826	3.5 kg/hd/week	$0.32 /kg	4 weeks	$3,659	
Wether weaners	174	2.8 kg/hd/week	$0.32 /kg	10 weeks	$1,559	
	Total feed	16,308 kg	@	$320	**$5,218**	
Graz/fodder crop	0 ha	@	$0 /ha		$0	
			B. Total Variable Costs:		**$46,928**	

	excl. fodder	incl. fodder	
GROSS MARGIN (A-B)	**$63,102.71**	**$57,884.23**	
GROSS MARGIN /WETHER	**$63.10**	**$57.88**	
GROSS MARGIN /DSE	**$53.48**	**$49.05**	
GROSS MARGIN /HA	**$534.77**	**$490.54**	

This budget should be used as a GUIDE ONLY and should be changed by the grower to take account of movements in commodity and input prices, changes in seasonal conditions and individual farm characteristics. Estimated prices are GST exclusive.

ASSUMPTIONS MERINO WETHERS (20 micron)

1. Flock Parameters

Cull age	6.5 years	Adult mortality	2%
Replacement age	1.5 years	Body weight	59 kg
Productive life	5.0 years	DSE rating	1.2
Stocking rate/ha	10 dse's		

Sheep and wool prices thanks to MLA market reporting, AuctionsPlus and AWEX. Wool cuts based on wether trial data

Pasture maintenance = 90kg/ha single super @ $3450t + $6.00/ha application

2. Flock Structure

Sheep numbers are modified to reflect mortality throughout the year.

Age	No. of wethers
0.5	174
1.5	172
2.5	169
3.5	165
4.5	162
5.5	159
6.5	0
Total	**1000**

174 **replacements bought**

156 **CFA's sold**

3. Wool Prices

Merino Wether	**Micron**	**AWEX Type**	**Clean price**	**Yield**	**Greasy price**	**Specifications (all 35n/ktex)**	**Proportion of Clip**
- Fleece GTM	20	MF5B.	$22.12	65%	$14.42	1%VMB, 90mm	80%
- Skirtings/bellies	19	MP5B.	$17.87	56%	$9.97	4.8%VMB, 80mm	15%
- Cardings	20	MZ2B.	$11.07	52%	$5.75	2.9%VMB.	5%
					$13.32		used in budget

4. Sensitivity Tables - Changes in Gross Margin $/DSE (includes fodder)

Wool Cut kg/hd	**Wether Greasy Wool Price $/Kg greasy**				
	$7.99	$10.66	**$13.32**	$15.98	$18.65
3.64 kg	$6.82	$14.87	$22.92	$30.97	$39.02
4.85 kg	$14.55	$25.28	$36.02	$46.75	$57.49
6.06 kg	$22.22	$35.64	**$49.05**	$62.47	$75.89
7.28 kg	$29.89	$45.99	$62.09	$78.20	$94.30
8.49 kg	$37.56	$56.35	$75.13	$93.92	$112.70

Wool Cut kg/hd	**Wether weaners Wool Price $/Kg greasy**				
	$3.57	$4.77	**$5.96**	$7.15	$8.34
0.76 kg	$48.36	$48.49	$48.62	$48.75	$48.88
1.01 kg	$48.49	$48.66	$48.84	$49.01	$49.18
1.26 kg	$48.62	$48.84	**$49.05**	$49.27	$49.49
1.52 kg	$48.75	$49.01	$49.27	$49.53	$49.79
1.77 kg	$48.83	$49.13	$49.44	$49.74	$50.04

CFA wethers $/hd	**Replacement wethers $/Hd**				
	$51.00	$68.00	**$85.00**	$102.00	$119.00
$74.43	$47.85	$45.34	$42.83	$40.33	$37.82
$99.24	$50.96	$48.45	$45.94	$43.44	$40.93
$124.05	$54.07	$51.56	**$49.05**	$46.55	$44.04
$148.86	$57.18	$54.67	$52.16	$49.66	$47.15
$173.67	$60.29	$57.78	$55.28	$52.77	$50.26

Note: The above sensitivity tables vary price and quantities by +/- 20% and +/- 40%.

M.Weth. Wean. kg/Hd/wk	**Feeding Adult Wethers kg/Hd/week**				
	1.73 kg	2.60 kg	**3.46 kg**	4.33 kg	5.19 kg
1.4 kg	$51.27	$50.49	$49.72	$48.94	$48.16
2.1 kg	$50.94	$50.16	$49.38	$48.61	$47.83
2.8 kg	$50.61	$49.83	**$49.05**	$48.28	$47.50
3.5 kg	$50.27	$49.50	$48.72	$47.95	$47.17
4.2 kg	$49.94	$49.17	$48.39	$47.62	$46.84

Adult Wethers kg/hd/wk	**Grain price $/Tonne**				
	$160.00	$240.00	**$320.00**	$400.00	$480.00
1.7 kg	$52.04	$51.32	$50.61	$49.89	$49.17
2.6 kg	$51.65	$50.74	$49.83	$48.92	$48.01
3.5 kg	$51.27	$50.16	**$49.05**	$47.95	$46.84
4.3 kg	$50.88	$49.58	$48.28	$46.98	$45.68
5.2 kg	$50.49	$49.00	$47.50	$46.01	$44.52

Note: The feeding sensitivity tables vary quantities/cost by +/- 25% and +/- 50%.

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