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Adapting Growth for Climate Change on Bungulla Farm, 2007-14: Shifting Focus from Yield Productivity to Profit and Minimising the Probability of Loss by Minimising Inputs

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Abstract

Bungulla farm's business philosophy is now concentrated on sustainable margin expansion through efficiency of inputs and a focus on profits relative to risk, rather than yield maximisation that brings with it higher risk in changing conditions. Business decisions are made with respect to their impact on the farm *system's* profitability over time adjusted for the amount of risk associated with those decisions. Minimal possible risk is preferred because of increasingly variable seasonal conditions with a probability distribution that is largely unknown. Soil moisture, not fertiliser application, is seen as the limiting factor to production.

The business employs the well understood strategies of scale economies and adoption of new technology to lower average unit costs and increase profit margins. However, it has augmented its harvest risk strategies (sufficient machinery and labour to strip crops in the shortest possible time) by installing considerable on farm storage; in turn, this has created additional margins from blending widely variable protein levels across the farm, opportunities to capture supply chain efficiencies and self-finance working capital requirements. In addition, it has moved to a liquid fertiliser program in part to enhance operational efficiency, reduce costs and reduce the time taken to seed. Liquids also complement the farm's nutritional program.

Bungulla has higher labour costs per ha compared to other farms in its rainfall zone as it retains a more than an average number of specific skills (e.g. its own plane mechanic/pilot). Its labour depth permits operational flexibility to respond to seasonal changes and business opportunities. A cropping only enterprise also contributes to skill specialisation and the opportunity for greater management capacity that can be spread over more hectares.

The farm's points of departure from common agronomic practice are its scope of soil amelioration practices, its use of liquid fertilisers and its low rates of fertiliser inputs. The purpose of these is to minimise the risk to input expenditure from the advent of a poor season and to increase the uptake of soil moisture and mineralised nutrients. In 2013 the farm achieved 12.56 kg of wheat/mm of rain, which was around the average for the region for that year.

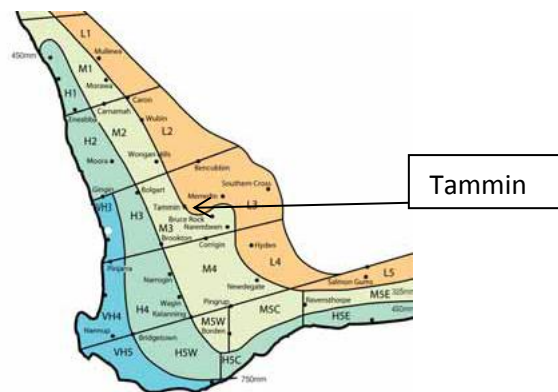
Consequently, target break evens (BE) (including a required return on capital) are set for each paddock, rather than a goal of maximising yields. A combination of scale and operational efficiencies (including marketing) and low inputs has reduced target BE to below average yields for the Medium 3 Rainfall zone. Combined, these strategies have resulted in returns broadly comparable to the Top 25% of growers in the Planfarm/Bankwest (PF/BW) survey.

1. Introduction

According to DAFWA ('A Snapshot of WA Grain Exports', nd, para 1), around 12M tonnes of grain are typically produced from around 4500 rain fed farms over seven million ha in the south west of Western Australia (WA). Around 70% of crops are wheat. Around 90% of grain is exported and grain is WA's largest agricultural export. The south west agricultural area has a Mediterranean climate and is divided into rainfall zones that are depicted in Figure 1. Unitisation (the point in which scale economies from commonly used equipment are largely captured) appears to be around of 4,000-5,000 ha (10,000–12,500 acres), which reflects the PF/BW average farm size for WA.

Bungulla farm is situated at Tammin, which lies in the Medium Rainfall 3 (M3) zone, but very close to the border of the Low Rainfall 3 zone (L3). That is, it lies close to the 325mm rainfall isohyet.

Figure 1: WA Agricultural Rainfall Zones



Bungulla consists of around 11,000 ha of which 10,000 ha is cropped, 7% that is rotationally fallowed. PF/BW data indicates that the average size for M3 and L3 WA wheat belt farms is around 3,600 and 5,800 ha respectively. The farm's previous management was an early adopter of revegetation to control for salinity. Trees have been planted in salt affected and recharge areas. Increasingly plantings have been with mixed species as these have better growth and survival rates than single species. Revegetated and remnant bush now account for 1,000 ha of the farm. 500,000 trees have been planted to link up remnant vegetation and square up paddocks.

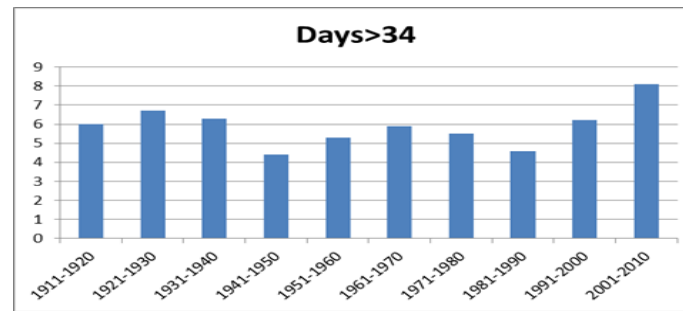
Currently 7% of the farm is chemically fallowed each year. The recent pattern of rotations has typically consisted of fallow, cereal, cereal, canola, hay/legumes. Table 1 presents the farm's pattern of expansion from around 2,800 ha in 2007 when Kate and Brad Jones assumed ownership of the farm.

Tammin is on the edge of the Low Rainfall 3 zone (L3) and its weather is apparently becoming more variable. Brad reports that frosts can typically reduce yields by up to 25% and hot spring days by up to 10%. Early season heavy applications of N are avoided so that crops are not stressed due to possible dry and hot conditions later in the season. If rain has not fallen early enough, then (as in 2010) much of the canola (a heavy water and nutrient user) seeding program is abandoned. The Bureau of Meteorology reports that the farm's average Growing Season Rainfall (GSR, May - October) for the period 2005-14 was 190mm, compared to a 24 year average, 1990 -2014, of 207mm and a five year average, 2009 – 14 of 204mm (BOM, Monthly Rainfall Bungulla, nd). However, the farm has experienced an increase in the incidence of frosts and high temperature spring days in recent years.

Reliable Bureau of Meteorology data for minimum temperatures (to indicate frequency of frost) for the nearest weather station recording temperature (Kellerberrin) do not exist, but Figure 2 suggests that an increasing incidence in recent years of warm spring weather over 34° Celsius (September - November, Figure 2).

Table 1: Bungulla Expansion and Selected Yield Data, 2008-14

Year	Hectares Farmed	Additional Hectares Farmed	Tonnes Produced		Yield (T/Ha)	Growing Season Rainfall (May-Oct)	Kg wheat/mm	Adverse Seasonal Event
			All Grains	Wheat				
			5650	3,960	1.8	133	13.53	Dry
2007	3,373	3,627	5650	3,960	1.8	133	13.53	Dry
2008	7,000		11,498	7,733	2.2	227	9.69	Frost
2009	7,000		12,698	9,458	2.4	236	10.17	2 days hot spring
2010	7,000		4,968	3,318	1.1	122	9.02	Dry
2011	7,000		11,657	7,176	2.3	252	9.13	Late frost
2012	7,000	3,000	9,018	6,361	1.4	157	8.92	Dry
2013	10,000	800	19,600	11,259	2.7	215	12.56	Nil - perfect
2014	10,800		15,000	9,580	2	211	9.48	Dry August; 2 hot days in September
Average	-	-	-	-	1.99	236.5	10.31	

Figure 2: Above 34°Celsius Days at Kellerberrin, Sep - Nov

Source: BOM, Daily Maximum Temperature, Kellerberrin

Table 2: Sept 1 – Oct 7 Temperature Maximums in Degrees Celsius, at Kellerberrin

	> 30°Celsius	> 32°Celsius	> 34°Celsius
1911-20	19	10	4
1921-30	13	3	0
1931-40	6	3	0
1941-50	9	4	1
1951-60	11	2	1
1961-70	14	5	1
1971-80	7	2	1
1981-90	11	3	0
1991-00	5	3	0
2001-10	8	5	1
2005-14	11	9	4
2009-14	7	6	3

Table 3: Comparative Selected Items, Bungulla Farm, Top 25% and Average M2 and L3 Rainfall Zones 2013

Item	Unit	Bungulla, 2013	M3 Top 25%	M3 Avg.	L3 Top 25%	L3 Avg.
Wheat yields	T/ha	2.9	3.26	2.69	2.14	1.72
Wheat: water use efficiency	kg/mm	12.56	16.20	13.34	13.12	10.45
Permanent labour	persons	6	1.8	2.1	2.3	2.1
Effective area permanent labour	ha	1667	1408	1533	2293	2384
N used on <i>cereals</i>	Kg/ha	8**	43	32	20	16
Labour costs	\$/eff. ha*	19.70	12.80	10.10	10	8.10
Fertiliser costs	\$/eff. ha*	42	94	57	36	31
Herbicide costs	\$/eff. ha*	90	72	60	57	48
Plant investment	\$/eff. ha*	438	508	400	341	349
Operating costs	\$/eff. ha*	335	389	299	228	185

* Effective ha are ha used for production.

** Low application due to soil tests indicating high levels of mineralised N from summer rain. Year 2014's average was 15 units.

Furthermore, Table 2 indicates an increasingly number of warm days during the most vulnerable period for the crops (nominated as September 1 – Oct 8). Note that the recent increase in over 32° and 34° days during the most vulnerable period appears to be the similar to a spike a century ago, but is not associated with a large number of over 30° days as in the 1911-20 period. That is, there appears to be an increase in temperature variability.

The Plan farm/Bankwest (PF/BW) Benchmark data top 25% of growers are selected on the basis of farm operating surplus¹/mm GSR, as it indicates how effectively rainfall received during the growing season has been employed. Table 3 presents Bungulla's, the M3 and L3 Top 25% and average growers' figures on selected variables.

PF/BW Benchmark data indicates that the Top 25% across WA achieved better results than the average of the 600 farm sample for 2008-13. These results stem from the three key variables of wheat yield, operating costs and prices received. The Top 25% in the combined L3, 4 and 5 cohort had a higher average wheat yield of 0.04 T/ha, no difference in average operating costs and a \$4/T higher average wheat price received than the sample average over the five year period. The Top 25% in the combined M3, 4 and 5 cohort had a higher average wheat yield of 0.08 T/ha, a lower average operating cost of \$3/ha and a \$4/T higher average wheat price received than the sample average over the five year period.

The Plan farm Bankwest Benchmark data for 2013/14 indicate that fertiliser is the top input cost at around 20%, with chemicals the next largest expense at around 15%. Index Mundi (Fertiliser Price Indices, nd) indicates that the price of key fertilisers (DAP, Urea, Rock Phosphate, Superphosphate and Potassium Chloride) have increased by between 50–100% since 2007. The post 2007 period's prices have also been more variable compared to previous periods.⁴ Farmers' Glyphosate Price Review (2010) indicates price volatility in this key chemical input to cropping.

The difference between the rise in farmers' costs and the prices they receive for their products (the 'cost – price squeeze'²) means farmers are generally commodity producers

¹ Operating surplus is calculated before interest, depreciation and tax.

² Cost-price squeeze refers to a period of increasing costs and simultaneous decreasing or stable prices. Within agriculture, a typical scenario involves commodity crop farmers facing increasing costs of inputs (fertilizer,

that must focus on productivity to reduce their costs per unit of production in order to maintain profits. Table 4, from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES, 2014) indicates the extent of the decline in Australian farmers' terms of trade³ in the 30 years from 1972. Increasing scale to reduce fixed costs per unit of production has been a key farmer strategy, as has the adoption of technologies such as variable applications of fertilisers and chemicals to reduce unnecessary use.

Table 4: Australian Farmers' Terms of Trade (1997-98 = 100)

Year	Terms of Trade
1972–73	219.9
1982–83	128.6
1992–93	104.7
2002–03	101.1
2012–13	95.8

Source: ABARES, Farm Inputs Tables (2014)

The Jones' are pushing this strategy further and, in essence, their business strategy consists of three key elements. First, there is a focus on total factor productivity⁴ which not only includes scale and the application of new technology as described above, but also the addition of other technology (e.g. on farm storage and handling) and the creation of a very high level of labour engagement.

Second, there is a focus on margin rather than on yield as its proxy. This refocuses on the difference between input costs and output revenue rather than increasing outputs as a means to lower the unit costs of inputs. While this is a strategy to mitigate the cost part of the cost price squeeze, attention is also paid to lifting the price part of the marginal revenue product calculation by a combination of on-farm blending and online quality optimisation. Blending, and the silos and other technology used to achieve it, also permits capture of supply chain efficiencies.

Third, there is lowering the risk to margin from increased seasonal variability from a largely unknown probability distribution. This is done by avoiding the risk from a high input system as adverse weather events become increasingly more likely. It is predicated on the notion that the generally accepted idea of 'yield potential' may be inaccurately measured because it only takes into account available moisture (stored and opening rains) and the historical likelihood of rainfall. This conventional approach may not take into account crop damage from an increasing likelihood of hot days, frosts or collapses in growing season rainfall. The effects of these events are compounded by the potential for input losses (fertiliser may carry over; diesel, labour and sprays etc. don't) in a high input system, and from quality downgrades for no offsetting increase in yield over a low input system.

These strategies are examined in more detail in the following sections.

2. Factors driving ability to rapidly expand

2.1. Harvest and field operational efficiencies

2.1.1 Crop specialisation and scale:

After assuming ownership of the 2800 ha farm in 2007, Brad and Kate decided to swap from a mixed enterprise to all-cropping. The switch lowered the per ha cost of machinery,

seeds, etc.) and decreasing crop prices. The farmers become squeezed between costs and prices, moving towards paying out more than they take in.

³ The ratio of what farmers are paid to what it costs to produce.

⁴Total Factor Productivity: is the growth in output not explained by the growth in inputs used in production.

as more ha were cropped using the same machines. Subsequent expansions in farm size have had the same effect, of lowering the per hectare cost of machinery even though more machinery has been added to farm additional hectares. Greater scale has also justified the use of aerial fertiliser, herbicide and fungicide spraying. The following table lists the machinery presently used to farm 10,800 ha at Bungulla. It is essentially the same combination that was used to farm 7,000 ha in 2008 (with the exception of the liquid fertiliser rig). This combination could be used to farm another 1,200 ha in the future.

Table 5: Machinery Used to Crop Bungulla's 10K Ha in 2014

Machine	Type and Year
Harvester 1 (60% of crop) owned	John Deer, 2014
Harvester 2 (35% of crop) contracted	John Deer, 2011
Harvester 3 (peas only – 5% of crop)	Ancient
Track machine 1 (475 hp – low hours, for air seeder and 100T field bin; technology retrofitted into cab)	2003
Track machine 2 (360 hp)	2009
Front wheel assist tractor (235 hp – high hours, pulls weed seeker and spreader)	
40 and 60 footair seeders	
Boom spray / weed seeker (weeds / fungicide)	
Plane	
Variable (prescription) (granular and lime) fertiliser spreader...	
Mostly replaced by liquid fertiliser rig	

Importantly, the move to specialise in grain and expand production also resulted in a deepening of skills and a simplification of management systems (discussed further in section 4). Both are conducive to further scale of operations.

2.1.2 Financing of land purchases to gain scale

Bank financing of land purchases has been augmented by the Jones' consistent pattern of lease and follow on purchasing. This model of land acquisition has allowed the Jones to immediately incorporate parcels of neighbours' land into Bungulla to gain immediate machinery and management scale advantages. Over a defined period (say three years) the proportion of leased land is reduced as the proportion of purchased land increases. Thus, the efficiencies of contiguous land ownership help to finance the purchase of that land. That is, average fixed costs not only drop across the entire operation, but contiguous holdings imply additional benefits such as reduced scope for conflicting land uses, ease of machinery movement and provisioning, reduced weed and disease incursion from poor external control⁵ and gaining more of the benefits from salt control measures. Larger machinery works best in large square paddocks and Bungulla's paddocks have been enlarged and squared to permit easier machinery operation, including aerial spraying of fertiliser and herbicides. Paddock enlargement is limited by landscape features (roads, remnant bush, hills, etc.). The enlargement process has been continual as new land has been added.

Investments to improve the productivity of introduced paddocks are expensive in the short term, but important in lifting total factor productivity over time. This highlights the importance of leasing to preserve cashflow until these paddocks have been managed into full productivity.

Bank financing requires a very clear business plan to demonstrate an ability to generate the necessary returns and repay loans. A track record of success is important in securing bank support. This is reflected in the smaller scale of the farm's first acquisition which laid the foundation of bank support for subsequent larger acquisitions.

⁵ This results from a reduced length of boundary as a proportion of land area.

2.1.3. Extensive on-farm storage

The farm currently has 6,500T of storage (40% of the 2013 crop). 4,000T are aerated silos, installed in 2013, and these provide opportunities for blending, storage, the extraction of supply chain efficiencies and tax advantages. Whenever possible, harvesting is a 24 hour operation. Storage removes the harvest constraint of CBH opening times and removes the need to invest in a second harvester as harvest is almost continuous (note, second harvester is contracted in). If the weather is wet, moist grain can be harvested and blended and aerated to reduce moisture levels. If there is a harvest ban due to extreme heat, grain can be carted from the silos in preparation for the lifting of the ban.

The silos are very technologically advanced with an electronic weighbridge, grid, garner bin and sampling hut. Loads can be analysed and blended to meet the possible quality grades. This is very important to the overall strategy of the farm. Low nitrogen application rates imply lower protein, but high rates of mineralised N and stored soil moisture from fallowing imply high protein. Blending high and lower protein grain can lift the overall return to the farm. In 2014, much of the wheat crop was blended to produce APW, a 10.5 % protein wheat; this was important in meeting contracts. The Calingiri noodle wheat was also blended to meet an ASWN 9.5 – 10.5% protein range. Deliveries are further optimised online within the CBH system. Furthermore, low nitrogen rates imply a lower risk of general purpose or feed grade quality from very hot days causing the crop to 'burn' from water stress.

Grain can also be stored for delivery later in the year and these deliveries create the opportunity to backfreight fertiliser or lime for the farm or surrounding farms. The automated handling also solves operational difficulties; for instance, an incorrectly loaded truck that can trigger overweight transport penalties can be reloaded easily using the garner bin.

The silos' aerators are set to maintain sub 16°Celsius temperature for insect control. Blending solves falling numbers and other quality downgrade issues. Importantly, a very quick harvest reduces the risk of weather damage to the crop; this means that only half of previous levels of insurance has to be taken. It also means the family and farm workers can relax and enjoy their Christmas break rather than be involved in further harvesting at this time.

2.1.4 Adoption of latest technology

Table 6 below lists machinery and examples of new technologies that have been incorporated into machinery at turnover.

Table 6: Selected Machinery and Examples of Incorporated Technology

Machine	Technology example
Harvester	GPS
	Auto steering (Greenstar)
	Yield data collection (Greenstar)
Tractor	Auto steering
	GPS
Boom spray (weeds)	Weedseeker (camera) Bracket kits (2013)
Plane	GPS
Variable (prescription) fertiliser spreader	Mostly replaced by liquid fertiliser rig (2013)

The incorporation of new technologies increases the farm's operational efficiencies. Variable costs cannot only be reduced as inputs can be. This provides an important rationale for the rapid turnover of machinery with embedded new technology, particularly harvesters and tractors. In addition, new machinery minimises the costs of repairs and maintenance, especially in a complex machine like a harvester and the high use (and thus critical) sprayer. Spraying, seeding and harvesting are activities where delays increase the exposure to weather-related risks.

Greatly increased operational efficiency from new technology is clearly illustrated by the farm's move to a nearly all liquid fertiliser system in 2014 after adopting liquid P application in 2013 following farm trials in 2012. (Granular solids are largely reserved for hay as it better tolerates acidity.) The cost was \$20K. The greater efficiency is because the crop can be put in much faster in an all liquid system as liquid fertilisers are much easier to apply compared to spreading granular fertilisers. The farm can spread liquid fertilisers in 100ha loads and this means returning to base less often to refill compared to the previous system. Seeding up to 600 ha a day can be achieved which cuts the time needed for seeding 10,000ha to around 15 days (with no rain delays). Previously, 500 ha a day could be achieved with an all granular operation.

The switch to liquid fertiliser application has eased the machinery constraint on operations, such that the farm has now the capacity to absorb a further 1,200ha should it become available. That is, seeding and harvesting another 1,200 ha of crop could still be carried out in optimum time frames with the same equipment.

Greater scale of production also means falling average fixed costs in adopting systems such as Global Positioning System (GPS) which was installed in 2005 and further refined with Real Time Kinematic (RTK) installation in 2008. It is GPS in conjunction with proximal soil mapping and grain yield mapping that provides efficiencies such as prescription fertiliser application. More soil types will be found in larger paddocks, so the use of a combination of GPS, proximal soil and yield mapping and camera recognition technology is pivotal in identifying optimal rates of fertiliser and chemical applications.

The farm has been proximally soil mapped using Gamma ray (γ -ray for K, U, Th and total γ) spectrometry and electromagnetic induction (EMI) in 2007 and a 240ha paddock was extensively soil tested, as proximal soil sensing can be limited at depths of more than 30cm (Lefroy, 2013). EMI 'measures the apparent soil electrical conductivity (ECa), which may be used to estimate soil properties such as plant available soil water storage capacity (PAWC), clay content, salt concentration and soil depth to hardpan at high spatial resolution. γ -ray spectrometry measures emissions from naturally occurring radioisotopes of potassium (K), uranium (U), and thorium (Th) found in the soil. It has been used to estimate contents of clay, potassium organic carbon, iron, soil depth and soil pH where relationships exist' (Lefroy, 2013, p.5, para 2). The value of these maps comes from overlaying them with yield data to identify the limiting factor to yield e.g. high acidity that limits nutrient uptake indicating a need for liming and the need for a specific fertiliser application. Brad rates soil survey maps as the 'best investment we ever made as we learn from them every year'.

Liquid fertilisers are mixed by the computer at the particular soil location logged by GPS, meaning a much tighter prescription (variation) application. For 2014, the first year of almost complete liquid application, prescriptions were not applied to create a set of benchmark background data against which to calibrate subsequent yield data. (The exception to uniform paddock application was the extensive strip trialling undertaken across the farm.)

GPS also allows for 24 hour seeding, spraying and harvesting operations. It also permits the farm to operate its machinery on 'tramlines' (Controlled Traffic Farming – CTF) so soil is not compacted where plants grow. CTF is loosely applied at Bungulla, as the smaller tractor's wheels do not align with the rest of the equipment. CTF is particularly useful in deep sandy soils which consist of only 800 ha of Bungulla. CTF will be introduced when the small tractor is replaced.

The key question with regard to prescription is identification of the areas of the farm that will respond *most profitably* to prescription and thus most justify the investment. For instance, the boom spray has been equipped with weedseeker technology which is also a prescription technology via camera. Its use on fallow land cuts spray usage to as little as 10% of former levels due to infra-red location of weeds. It appears that camera development will soon permit identification of specific weeds and this will further reduce costs as the most cost-effective sprays will be applied to particular weeds. Developments in drone technology also promise more efficient identification of problems and delivery of prescription solutions.

The increasing use of IT on the farm also helps to streamline management; indeed, the current development of a range of standalone and web-based IT management systems indicates that their integration is an important new field of productivity gains for grain farming.

2.2 Paddock Management

2.2.1. Incorporation and remediation of new paddocks into the system

Chemical fallows were introduced on new land most needing soil and weed remediation. On average, 8% of the farm is currently fallowed and this is planned to rise to 20% because of a number of advantages that have been observed from the practice.

A chemical fallow year can be used to apply a *range* of broad-scale herbicides to remove herbicide resistant weeds, which are a major risk in an all cropping enterprise. Consequently, the weed-free paddock can be dry seeded when brought back into production. Dry seeding allows for more efficient use of seeding machinery (because dry seeding can start earlier on a set date) and greater management flexibility in seeding other parts of the farm (because seeding these parts can be held off to wait for emergent weeds to be sprayed at seeding; this takes advantage of warm soil temperatures and rain to bring on weeds). The reduction in straw residues also increases the amount of herbicide that comes in contact with weeds, increases the effectiveness of residual herbicides and increases the speed of seeding.

In 2013, 2 areas of new land (800 ha) were deep ripped with great results. Deep ripping allows deep soil moisture to be accessed by plants, breaks up compact layers and turns over weeds. Soil compaction, caused by animal traffic and heavy machinery, retards plant growth as plant roots are restricted in accessing deeper moisture and nutrients. Removing animals from the system helped to reduce soil compaction (and the spread of weeds). Deep ripping is well suited to a chemical fallow as it complements the use of herbicides in controlling weeds and applying liming to lower acidity.

Acidity is corrected by the addition of lime, particularly in the forms of limestone or dolomite. Liming (including the use of gypsum) adds calcium which improves the structure of clay soils, helps plants better absorb nutrients, helps bind organic matter to clay and may decrease the sodium content in soil. Liming is also well suited to a chemical fallow as it can be incorporated into ripping and mouldboarding to raise pH in deeper soils. From 2013 low rates of liquid calcium, phosphorus, potassium and micro nutrients are applied at seeding to help correct the immediate pH surrounding the germinating plant and provide readily available nutrients to encourage the development of root mass. This was initially targeted at addressing aluminium levels in root zones as it appears that aluminium levels are less of an issue when the root mass is large. Liquid N is also now provided to better provide an optimal growing environment for the germinating seed.

Indeed, the farm's guiding approach is that the dominant limiting factor is *available moisture, rather than nutrient application* and this results in a focus on creating as much root mass as possible to utilise available water. A fallow year provides for the incorporation of rain to soil moisture during the 16 months of fallow (November/December harvest year 1, to April seeding year 3). Very importantly, little water is transpired and evaporated during the fallow year so that much more is available to the plant the following year. Water harvesting in this manner is very important in a dry year and may result in the farm adopting canola following fallow as a more typical practice, as canola is a relatively big water (and nutrient) user. Rotting root mass and straw over the fallow is also an important source of mineralised N.

2.2.2 Management of existing paddocks

Overlaying yield data with soil maps in 2007 indicated a potential variety of subsoil constraints on yields, including boron toxicity, sodium impact and high aluminium. The next step in the process was to devise management strategies for these problems. This process led to considering whether it was worthwhile taking the risk of heavy fertiliser application – in pursuit of yield – when the processes surrounding these problems were judged by Brad to be often not that well understood. It was concluded that further high

applications of fertiliser may not only exacerbate these issues, but that the risk of increasing crop failure was real as seasonal conditions have become more variable.

A number of techniques are used to improve soil structures and lower total soil profile acidity, as well as acidity around emerging plants, as these greatly affect the growing conditions for the plant. For instance, beginning in 2012, the farm has increasingly incorporated a big range of liquid calcium and micro nutrients at seeding to provide the best pH and nutrients for the germinating seed, reasoning that a healthier soil is a better medium for plant growth and root zone development. 'Doubling the root zone means doubling the country we are farming.' Larger root zone development implies a great volume of soil organic matter to cycle (decompose) and subsequent increases in mineralised nutrients, particularly nitrogen. Deeper root penetration into sub soil layers implies plants will be more resilient to stress. An abundance of micronutrients is applied to also encourage soil microorganisms that increase the decomposition of organic matter associated with high soil nitrogen supply. The incorporation of legumes into the typical cereal, cereal, canola, legume/hay, chemical fallow rotation also is important in fixing further nitrogen into the system.

As noted above, chemical fallowing was initially introduced into the rotation to deal with weed problems when incorporating new land into the farm. Over time, a number of additional benefits were observed in addition to those listed earlier. These are that: root diseases are extinguished (note that these can transfer across break crops); fungal diseases are greatly reduced; observed plant vigour is greater, so plants are more resistant to diseases. As noted, larger root masses imply greater levels of mineralised nutrients.

Collectively, these measures have resulted in a comparatively low application rate of N (an average of 15 units across the farm in 2014) and in a year following fallow, N application can be low as 0 units. As indicated in Table 3, this is much lower than the average in the M3 region. Much higher applications of N will be applied to, say, a cereal on cereal crop as the store of mineralised N will be much lower. Little is also applied of other nutrients. Rather it is the timing, form (liquids), balance between nutrients applied and tight monitoring of nutrition that is undertaken, with the aims of promoting root mass growth for subsequent mineralisation and ensuring over application is avoided, so that it is neither wasted nor places the crop at risk from additional stress. Accordingly, soil testing at the beginning of the season is conducted to provide a nutrition audit of available nutrients and potential nutrients available from mineralisation during the season. Subsequently, constant monitoring of rainfall (actual and predicted) effects on mineralisation, backed up with sap and tissue tests, are used to monitor for any deficiencies. To repeat, the focus is not to maximise yields per se, but to achieve a yield with a cost structure that provides a break-even yield that includes a target return on capital.

3. Labour efficiency:

Table 1 indicates that the farm's per ha cost of labour is high compared to the average PB/BW sample of farms in the L3 and M3 rainfall zones, but is comparable to growers in the top 25%. The farm contracts out for add-on services such as seed provision, but importantly it performs all core key activities internally, including seeding, spraying and harvest. Conceptually, this could be thought of as purchasing from the market lower risk/lower cost of failure activities whereas high risk/high cost of failure activities are kept under management's co-ordination and control⁶. This is very much in keeping with the business philosophy focus of minimising risk, particularly as the operating environment becomes more variable. The adoption of technology, incorporating GPS for instance, greatly reduces the costs of labour monitoring, thus increasing the area and range of activities over which labour can be deployed efficiently.

Bungulla also utilises a plane and retains a training pilot capable of maintaining the plane. Although around 20,000 ha of cropping is required to efficiently run a plane, the plane is hired out to surrounding farms so that it is efficiently utilised. This essentially means that

⁶ This is the Coasian problem of whether to make or buy as the boundary issue for the scope of the firm (Coase, 1960).

the unit cost of aerial spraying to Bungulla is competitive with ground applications. Aerial applications are not only timely (i.e. more can be applied in response to weather conditions) they also do no crop damage, which is particularly important in a maturing canola crop. Brad is keen to further grow this business and provide further opportunities for his pilot and trainee pilot.

Indeed, providing opportunities for staff development and a high level of engagement is critical to the smooth running of the farm. The farm employs 5 permanent employees and 1 periodic employee (the pilot) that blends his work around opportunities elsewhere. That staff engagement is high is reflected by the very low turnover (the current exiting manager gave two years notice to provide for succession training). A low turnover is conducive to investment in skills formation, as the farm can reap the benefits. Specialisation means that each worker can spend much of their time engaged in activities that interest them. For instance, one staff member is primarily a maintenance/workshop operator, another focusses on civil works and operation of some of the most technologically advanced silos in the central wheatbelt while another focuses on machine operation. A highly proficient, multi-skilled workforce is also flexible and able to be redeployed in periods of peak activity at seeding and harvest. Staff who are capable and focused are far less likely to damage expensive machinery at critical periods of operation.

The farm provides two further sets of incentives for high staff engagement. First, soft incentives build a cohesive culture and a sense of team belonging. For instance, all members participate in much of the decision making as strategy and tactics are openly discussed on a daily basis. This daily end of work socialising not only creates a comfortable atmosphere, it is also an important and efficient planning session for the following day's activities. Co-formulation of objectives implies a higher level of personal identification and assumption of responsibility for their achievement. Crucially, it also creates an informal and supportive atmosphere for staff to contribute their insights to the working of the business. Further, part of the business' objectives is to be family friendly and a flexible, sizable workforce implies that personal circumstances can be accommodated. This leads to a second set of incentives, which are tailored to each individual's preferences. For instance, for one staff member, this means flexibility to participate in sporting events, even in peak activity periods. Flexibility also underpins the objective of creating a family-friendly culture and opportunities for training.

Sharper economic incentives also selectively exist. Wages are comparatively high for the sector and production-linked incentives exist for some employees to more tightly align residual decision making with that of the owners. Most staff has a farm house as part of their package and these are refurbished with the occupants in mind. The key point, however, is that all incentives are not only fitted to the level of decision making, but are also carefully crafted to reflect the circumstances of individuals.

4. Marketing

Predominantly, the farm relies solely on Australian dollar swaps (derivatives) to manage price risk as entering into forward contracts before assured production introduces production risk. Swaps allow the farm to lock in price spikes earlier in the season for a portion of the crop; this portion can be increased if production becomes more assured through the season and the price spike persists. A lower target yield associated with a target BE which is based on a lower cost structure implies that more of the BE target can be met with a locked-in price with lower risk.

Once grain is stored, further marketing opportunities can be explored and exploited. Transport efficiencies are available as freighting grain to domestic users permits backfreighting of fertiliser and lime for the farm and neighbours and CBH charges (and transport to the bin) are avoided. As the grain is forward sold domestically – that is, it is at full carry – storage charges after October are avoided and cash flow is available to fund operations, lowering the cost of working capital.

5. Conclusion

The combination of scale that lowers average fixed costs, new technology and management practices that lower variable costs and marketing that lifts prices and exploits supply chain opportunities results in lower break evens. The projected BE for

wheat (2014) at an expected yield of 1.8T/ha and at a price of \$275/T was 1.3T/ha to cover all costs including a return to capital and 0.7T/ha to cover operational costs. (Note, the cost of the 7% of the farm under fallow management has not been added into this BE calculation.) Low BEs further reduce the need for working capital. In turn, generated surpluses have funded the farm's expansion. The actual wheat yield for 2014 was an average of 1.96T/ha across the farm.

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