Grazing and grain recovery of the soybean variety Hayman(b)

Nathan Jennings
Senior Land Services Officer Agricultural Advice
NSW North Coast Local Land Services

Natalie Moore
Research Agronomist
NSW Department of Primary Industries

Introduction

The soybean variety Hayman(b) was bred by the Australian Soybean Breeding Program and released in 2014. This variety produces a lot of vegetative matter and is also slow to mature, making it ideal for hay or silage production. The potential for this variety to be grazed by beef cattle, and the potential for grain recovery after one grazing, was investigated in a replicated trial by North Coast LLS and NSW DPI at Grafton Primary Industries Institute in 2017-18. Economic analysis of the beef and grain production from this trial was also conducted. The forage potential of this variety was initially observed in demonstrations in 2014-15 at NSW DPI Grafton and in 2016-17 on a commercial farm located near Tabulam, NSW.

The information in this document relates to the use of soybean variety Hayman(b) for the purpose of grazing, and to measure the grain recovery potential after one grazing. Some of the concepts presented are different to those that would be involved in grazing a failed silage or grain crop, which requires specialist advice.

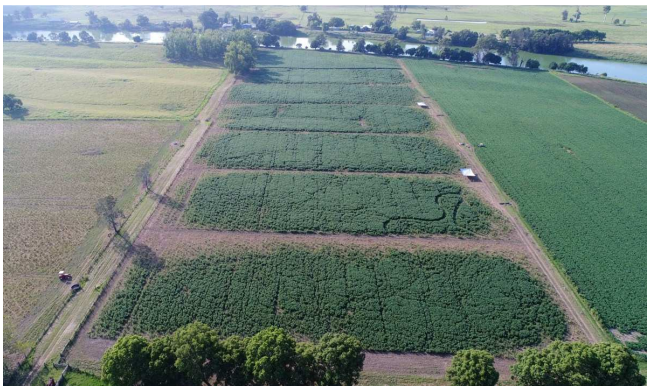

Figure 1. Soybean grazing and grain recovery trial, NSW DPI Grafton, February 2018. Photo: S. Blanch, NSW DPI.

Animal performance

Average daily weight gains based on the findings of the trial and the demonstration sites suggest that weaners 180 – 250 kg live weight can achieve 0.8 – 1.2 kg/head/day and yearlings 300 – 380 kg live weight can achieve weight gains in the range of 0.9 – 1.7 kg /head/day when grazing this crop. Kilograms of beef produced per hectare is the most important calculation, as this reflects the combination of stocking rate and animal performance.

The 2017-18 replicated trial at Grafton (Figures 1 and 2) utilised 46 crossbred yearling steers with an average live weight of 341 kg at the start of grazing. The six trial plots were 0.9 ha each in size (Figure 1) and eight steers were allocated to each plot, which resulted in a stocking rate of 8.8 head per ha and produced 192 kg/beef/ha over a 14 day period. During this study three day sickness (Bovine ephemeral fever) was widespread in the Grafton region and the steers in this trial were all affected to varying degrees, which likely reduced the recorded weight gains.

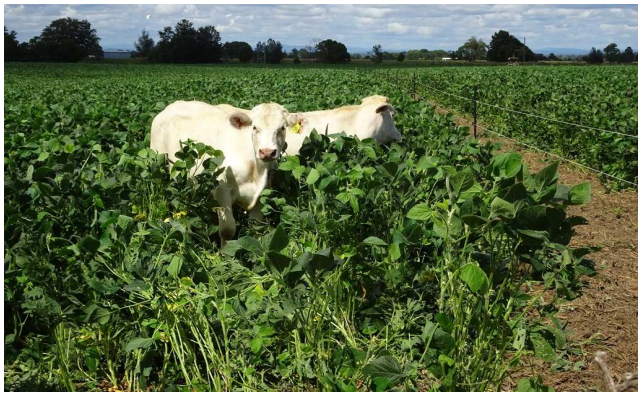

Figure 2. Soybean grazing and grain recovery trial, NSW DPI Grafton, February 2018. Photo: N. Moore, NSW DPI.

The 2016-17 demonstration site at Tabulam (Figure 3) utilised 50 mixed sex Angus weaners with an average liveweight of 227 kg at the start of grazing. This unreplicated demonstration site had two blocks, each approximately 3 ha in size, a stocking rate of 16 head per ha and produced 113 kg of beef/ha over 21 days.

Studies have not yet been performed using cows and calves or adult dry stock, however, based on the recorded feed quality, grazing soybean crops offers a very high quality diet for these classes of cattle. The most profitable use of such high quality feed will depend on the farming system and business position of the enterprise.

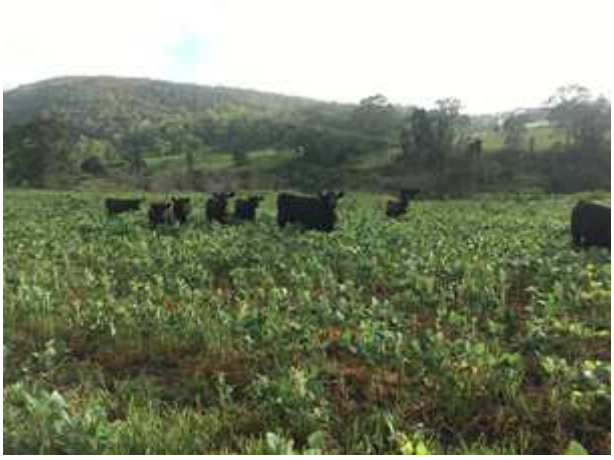

Figure 3. Angus weaners grazing soybean variety Hayman(b) at the Dowley family's property, Tabulam, NSW. Photo N. Jennings, NSW LLS.

Feed quality

Feed quality samples were taken from each of the 2017-18 trial plots and from the demonstration sites prior to cattle entering. The feed samples were 'grab samples' of mainly leaf and some branch material but no stem as it was intended to contain the parts of the plant that cattle would consume. The range in feed quality is presented in Table 1.

Table 1. Feed quality analysis of soybean variety Hayman(b) forage crops at grazing, Grafton and Tabulam, NSW .

Feed quality attribute	Unit	Range of values
Neutral Detergent Fibre	%	25 – 37
Acid Detergent Fibre	%	14 – 19
Crude Protein	%	31.4 – 41.4
Metabolisable Energy	MJ/ME	11.6 – 13.4
Digestibility	%	77 – 87

The feed quality was consistently high across the trial site, and whilst this is beneficial from a cattle feeding perspective, there are some important aspects to understand in relation to animal performance.

Firstly, the energy level of the foraged soybean crop is similar to most cereal grains and the protein level is comparable to cottonseed meal, however, it isn't formulated as a balanced ration. For cattle grazing a soybean crop there is an imbalance in the ratio of protein to energy (too much protein). Protein in excess to a cow's requirement is converted to ammonia and excreted. This takes energy, thus reducing the amount of energy available for beef production. Practically there is little that can be done to address the protein to energy imbalance on farm without impacting the Neutral Detergent Fibre (NDF) component of the animal's diet. Based on the weight gains observed in this trial, it suggests that weight gains were not excessively impacted.

The second important consideration is the NDF value. The recommended NDF level for grazing beef cattle is 25 to 30 percent. Within this range, the daily Dry Matter (DM) intakes are considered optimal. An NDF value below 25% can upset the function of the rumen as there isn't enough fibre in the diet to stimulate chewing (rumination) and saliva production, which when swallowed, stops the rumen from becoming too acidic (acidosis).

Issues associated with acidosis were not observed in the cattle grazing the soybean crops at the trial site or the demonstration sites, however, all the cattle actively sought and grazed summer grasses within and around the edges of the crop. It is likely that the cattle self-balanced their diet satisfactorily in terms of NDF. Access to grasses or other fibre is an important consideration prior to grazing soybean crops. Producers should be aware that a soybean crop with limited summer grasses present in or around the crop may require the addition of hay or a run off area with summer grasses available to enable cattle to balance their fibre intake requirement. Chewing of bark on trees can indicate that cattle require additional fibre.

High energy supplements such as grains or molasses are also low in NDF, so the addition of these energy sources in an attempt to balance the protein to energy imbalance could also cause acidosis, and requires specialist advice.

Grazing behavior

The cattle that were used in the trial had not previously grazed soybean crops. At each of the trial sites the cattle

initially grazed the soybean crop lightly but after five to seven days they were actively grazing the crop.

The demonstration site at Tabulam was planted according to the producer's farming system with an 80 cm row spacing (Figure 4). The plant population established at the Tabulam site was 210,000 plants per hectare. The wide row spacing proved to be beneficial for cattle movement and grazing behavior in the crop. The cattle walked along the crop rows in preference to across the rows, which greatly reduced the amount of plants knocked down and also assisted in maintaining green leaf in the crop (Figure 4). This row configuration also helped the crop to recover and produce new growth after grazing.

In comparison to the Tabulam demonstration crop, the trial at NSW DPI Grafton was planted at a row spacing of 19 cm. The plant population in the Grafton trial was lower than intended (150,000 plants were established per hectare instead of the target of 180,000).

The narrow row configuration used in the trial at Grafton resulted in more damage to the crop from cattle knocking over plants as they moved through the crop, compared with the Tabulam demonstration that used a wider row spacing (80 cm).

The cattle in the Grafton trial grazed the crop from the outside edges toward the middle, which increased the amount of crop loss, particularly on the outer edges.

At both sites the cattle preferred grazing the leaf material and seldom ate the main stem of the soybean plants (Figure 5). This grazing behavior resulted in little to no damage to the nodes of the soybean plant (the junction of the lateral branches and the main stem), which is where flowers and pods develop. As the nodes were largely intact after grazing, the plants were able to re-grow leaves, and flowers and pods subsequently developed.

There was little to no evidence of entire plants being pulled out of the ground due to cattle grazing. Some plants were trodden down or knocked over but remained alive. Plants that were knocked over and remained alive developed lateral stems that later flowered and produced pods.

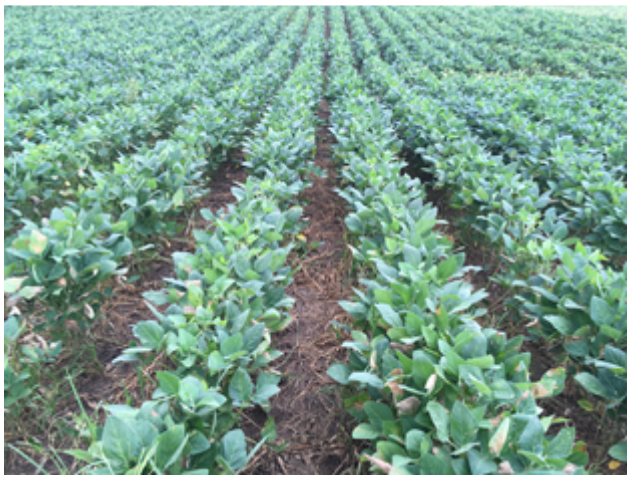

Figure 4. A row spacing of 80 cm was used in the demonstration crop at Tabulam. Photo taken at the commencement of grazing. Photo N. Jennings, NSW LLS

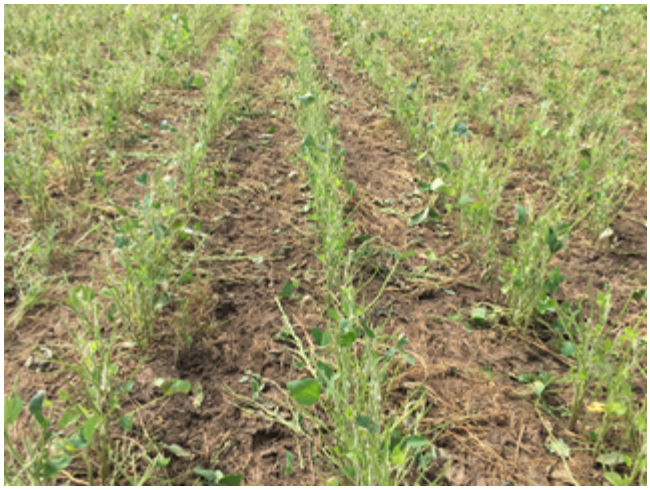

Figure 5. Cattle were removed from the demonstration crop at the Tabulam site as soon as they had eaten the green leaf. Photo N. Jennings, NSW LLS.

Animal health

Soybean crops are known to have a low risk of bloat for cattle. The cattle in the trial and demonstration sites did not receive any preventative measure for bloat and there were no signs of any animals experiencing bloat.

Prior to grazing soybean crops a vaccination with '5 in 1' or '7 in 1' vaccine for pulpy kidney is strongly recommended especially for cattle coming from a low quality feed source.

Grazing management

For optimum recovery of the crop after grazing, it is important not to graze the crop too early. Soybean variety Hayman(b) can be grazed from six to eight weeks after planting depending on the conditions for growth. The crop

at Tabulam was grazed when it was approximately 65 cm high and at least seven branches had developed per plant (Figure 6). The main stem diameter was >5 mm. Seasonal conditions and planting times may vary the time to grazing.

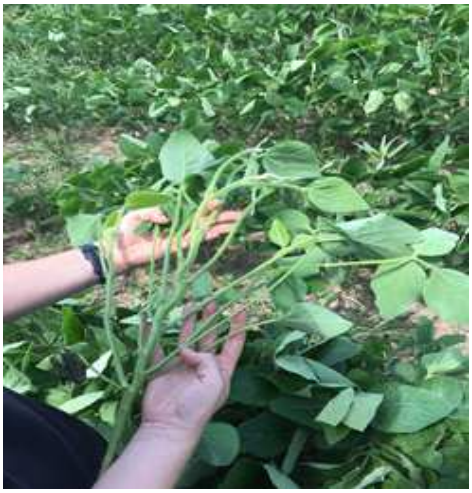

Figure 6. Soybean variety Hayman(b) ready for grazing at 65 cm height and with at least seven branches developed from the main stem. Photo N. Jennings, NSW DPI.

Strip grazing with the use of a rear fence offers optimal grazing control and the ability to adjust stocking rates relative to crop growth rates. Most importantly, it prevents overgrazing of some areas of the crop.

Heavy, prolonged grazing should be avoided. Remove cattle as soon as the leafy portion of the plants have been eaten. Provided the main stem and branches of the plants are intact, the Hayman(b) variety of soybean has the potential to recover for a second and possibly third grazing (Figures 7 and 8). The capacity to recover after grazing is an exceptional characteristic of the soybean variety Hayman(b). It is influenced by seasonal conditions and soil moisture, as well as crop management factors including choice of paddock, sowing time, crop nutrition, row configuration, length of grazing, and stage of plant growth at the commencement and completion of grazing.

If grain recovery is being considered, then the cattle should be removed from the Hayman(b) crop by early to mid-flowering stage, with no further opportunity for grazing.

If the crop is not required for grain, Hayman(b) variety soybean can be grazed through flowering into early pod set. Caution is required if grazing during pod-fill, as the high oil content of the grain can disturb rumen function.

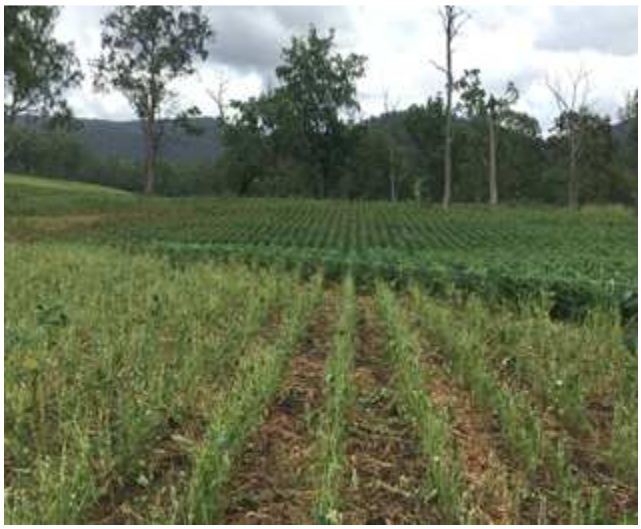

Figure 7. Soybean variety Hayman(b) recovering after grazing. The background section is two weeks into recovery, and the foreground section is immediately after grazing. Photo N. Jennings NSW LLS.

Figure 8. Soybean variety Hayman(b) recovering after grazing. The background section is five weeks into recovery and the foreground section is three weeks after grazing. Photo N. Jennings NSW LLS.

Crop management

For detailed information on sowing and managing soybean crops for grain production refer to the NSW DPI Summer Crop Production guide at

www.dpi.nsw.gov.au/agriculture/broadacrecrops/guides/publications/summer-crop-production-guide

Some of the critical factors for establishment of a successful soybean crop are as follows.

Sowing time

If the soybean crop is intended for grazing, sowing in northern NSW can occur from late October to mid-December. Sowing later than this will reduce the amount of vegetative growth that can be produced before the crop begins to flower and fill pods. An early sowing date allows more time for the plants to produce vegetative material (stems, branches and leaves), which increases the amount of feed and the opportunity for multiple grazings.

Sowing rate

For grazing purposes aim to establish a plant population of 18 – 22 plants/m^2 (180 – 220,000 plants/ha) This sowing rate is lower than recommended for grain only crops and is designed to encourage branching of the plants, which increases the leaf material available for grazing and the ability of the crop to recover after grazing.

Use the below formula to calculate the required sowing rate using these example values:

- target plant population (e.g. 18/m^2)
- germination % (e.g. 90 % germination = 0.9 in formula)
- establishment % : usually 80 % (80 % = 0.8 in formula). Reduce this value when sowing into adverse conditions
- number of seeds/kilogram (e.g. 4150)

Worked example of the formula

Sowing rate (kg/ha) =

$$\frac{\text{target plant population/m}^2 \times 10{,}000}{\text{germ. \% X estab. \% X seeds/kg}}$$

$$\frac{18 \text{ X } 10{,}000}{0.9 \text{ X } 0.8 \text{ X } 4150}$$

$$\frac{180{,}000}{2988}$$

= sowing rate of 60 kg/ha

Sowing depth and row spacing

Seed should be planted into moist soil to a depth of no more than 5 cm.

Observations reported in this publication were based on a row spacing of 80 cm compared to a row spacing of 19 cm. The wider row spacing resulted in less crop damage and encouraged a more even grazing pattern.

Inoculation

To capture maximum crop growth, grain yield and benefits of residual soil nitrogen from soybean crops, inoculate planting seed with Group H soybean inoculant (strain CB 1809) every time a soybean crop is sown.

When purchasing inoculant check the expiry date and look for the 'Green Tick' logo that indicates quality assurance and independent testing by the Australian Inoculants Research Group.

Soybean inoculant contains live bacteria that will be killed by excessively hot or dry conditions. Manage inoculum to ensure the greatest numbers of live bacteria are available to the seed. Store inoculant in a cool but not frozen location until required. If using a peat slurry or liquid inoculant to coat planting seed, inoculate small batches of seed and sow immediately. Do not lime coat the seed after inoculating and do not tank-mix liquid inoculants with pesticide, fertiliser or any other product unless the inoculant label expressly states that it is safe to do so.

Fertiliser

Well nodulated soybean crops fix more nitrogen than is required for their needs and rarely require the addition of fertiliser nitrogen. In most situations, a high rate of fertiliser nitrogen (e.g. greater than 25 kg N/ha) is not recommended at sowing as it can have a negative impact on root nodule numbers and function later in the crop.

Soybean crops have a high demand for phosphorus and potassium. When deciding how much fertiliser to apply to a soybean crop it is important to know the nutrient status of the soil and the critical level of soil nutrients, particularly phosphorus and potassium that are needed to give the maximum economic yield. The addition of sulfur is required on some coastal soils in northern NSW, especially for high biomass crops. A soil test is the only reliable way to determine soil nutrient status. Consult your local agronomist for a soil test and crop nutrient budget.

Weed and insect pest management

Weed and insect pest management will vary depending on seasonal pressures and whether the producer intends to harvest grain from the crop. If grain harvest is intended,

weed and pest management is advisable to improve both yield potential and grain quality. Green weeds can cause difficulty at harvest, and lead to staining and degradation of the quality of the grain. Desiccation of green weeds may be required before grain is harvested.

Weed control is likely to differ markedly when there is no intention to harvest the grain. For example, grasses may not to be controlled as they provide an option for the cattle to balance the NDF level of their diet.

In the demonstration crops reported in this publication, insect pest treatments were not required.

Important: Many of the herbicides and pesticides used in soybean production have Grazing Withholding Periods (WHP), which must be complied with. The WHP may reduce the number of grazing opportunities available.

Grain recovery potential

The soybean variety Hayman(ᵬ) produces large seed (4000 – 5000 seed/kg) with a clear hilum and high protein content (40 – 45 % dry matter basis), making it suitable for the human consumption markets such as soymilk, tofu and flour. It is also suitable for crushing markets.

The demonstration site at Tabulam in 2016-17 was grazed once, and cattle removed at the mid-flowering stage of the crop. The two blocks produced a grain yield of 1.6 and 1.7 tonne/ha respectively.
The Grafton trial in 2017-18 produced a grain yield of 1.2 tonne/ha from the plots that were grazed once for 14 days from the end of February. This was a surprisingly positive result given the lower than intended plant population, lateness of grazing in the crop cycle, and crop damage.

The more times a crop is grazed, or the later in the season, the lower the grain yield is likely to be. Rainfall or irrigation immediately after grazing will support crop recovery.

Economic analysis

Based on the beef and grain yield data obtained in the Grafton trial in 2017-18, a gross margin analysis was performed by Fiona Scott, Senior Economist with NSW DPI. All prices and costs were on an ex-GST basis. At the time of the trial, the price received for soybean grain was $609/tonne, the purchase price of the cattle was $996/head and the sale price of the cattle was $1088/head. The growing cost of the soybean crop was $481.74/ha, including pre-sowing cultivation, seed, fertilizer and in-crop herbicides. The grain recovery treatment received one desiccation spray prior to harvest. Cattle costs included drench and vaccination, $10/head freight, MLA sale levy and 4% sale commission.

Based on these figures, grain recovery after one grazing returned a positive gross margin of $191.14 per hectare. The high purchase price of cattle and the short (14 day) period of the trial contributed to a negative gross margin (Table 2) for the grazing without grain recovery treatment. The margin from the cattle alone was not enough to cover the soybean and livestock costs for the period of the trial.

Additionally, as the sensitivity table (Table 2) shows, the difference between the cattle purchase and sale prices can markedly impact the gross margin outcome.

Table 2. Sensitivity table comparing gross margin returns for cattle pricing scenarios for grazing without grain recovery, NSW DPI Grafton, 2017-18.

Cattle purchase price ($/head)	**Cattle sale price ($/head)**				
	988	1038	**1088**	1138	1188
937	-615	-170	274	718	1163
957	-793	-348	96	541	985
977	-970	-526	-82	363	807
997	-1148	-704	**-259**	185	630
1017	-1326	-882	-437	7	452
1037	-1504	-1059	-615	-170	274

Actual prices at the time of the trial are highlighted in bold.

Acknowledgements The authors would like to acknowledge the Dowley family for their enthusiasm in testing this system on their farm. The NSW DPI Research Services and Northern Cropping Systems teams at Grafton are gratefully acknowledged for their efforts in conducting this trial with investment from GRDC Grower Solutions. Economic analysis by Fiona Scott, Senior Economist, NSW DPI Tamworth is also gratefully acknowledged