Grazing cattle on dual purpose crops - managing health risks

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Key words

ruminal acidosis, bloat, polioencephalomalacia, buffers, fibre

Take home message

- Cattle grazing dual purpose crops can be a highly profitable option
- Cattle are more susceptible than sheep to livestock forage disorders, including; nitrate toxicity, acidosis, bloat and polioencephalomalcia (induced thiamine deficiency)
- Cattle grazing dual purpose wheat should be supplemented with minerals
- Cattle grazing dual purpose canola should be adapted onto the crop to ensure that rumen adaptation occurs.

Opportunities for cattle on dual purpose crops

The use of dual purpose crops has been well established across the mixed farming zone for more than a decade. Commonly, grazing has occurred with sheep enterprises and has dramatically changed the feed budget on mixed farms, significantly reducing the winter feed gap. Research and uptake of dual purpose crops has occurred primarily with sheep. In the mixed farming zone, sheep are the dominant livestock enterprise. Greater use of dual purpose crops on farms by sheep is unlikely and therefore growers are missing out on utilising the potential of large amounts of forage production. This is because at the time of grazing (May-July) it is common that ewes are pregnant or have recently lambed. There is limited market for young sheep for a grower to expand and respond to large amounts of feed that might be available. In comparison, at that time of year there are often a significant number of young cattle requiring feed either in the saleyards or being hand fed on grazing properties. Research conducted on dual purpose crops with cattle grazing has demonstrated high cattle liveweight gains, with the practice generally safe to livestock. Commercially, cattle have been grazed on wheat and canola dual purpose crops, but there have been some examples of poor cattle health outcomes.

Cattle production from dual-purpose crops

The potential for producing very large amounts of forage from dual purpose crops is high due to the large area for producing these crops. Currently within the mixed farming zone in southern Australia only 10-20% of crop land is utilised as dual purpose. If this area was increased by another 10% in the wheat sheep zone and 50% in the high rainfall zone then approximately 2.2 M head of cattle could be grazed across southern Australia.

Available feed is the driving force behind cattle production on dual purpose crops. Experiments conducted with yearling cattle grazing wheat and canola dual purpose crops have regularly exceeded growth rates of 2 kg/hd/day (McCormick et al., 2020). There is an opportunity to produce large amounts of forage during winter by increasing the area of dual purpose crops sown on a mixed farm leading to an opportunity to either agist or trade in cattle. Calculating a simple gross margin for trading young cattle that includes costs such as transport, agent fees and death rates, indicates that a gross margin per hectare could be $342-$945/ha with a buy/sell price of 350 c/kg liveweight just for the cattle enterprise.

Dual purpose crop agronomy for forage and grain production.

Achieving high forage production in dual purpose crops relies on good agronomic planning and management including:

- Paddock selection. Select paddocks with low weed pressure as weeds in dual purpose crops can be difficult to manage.
- Control summer weeds. Maintain weed free fallows over summer which will conserve soil water and nitrogen and enable early sowing.
- Select appropriate cultivars. Early sowing of dual purpose crops requires the selection of cultivars with true winter requirement.
- Sow early. Sowing of dual purpose canola can commence from February whereas wheat can start from March depending on soil moisture. Need to be ready to sow when the opportunity is available. Increase sowing rate to ensure good density of plants (>150 plants/m^2 for wheat and >40 plants/m^2 canola)
- Fertiliser use. Dual purpose crops require nitrogen to produce forage. Total nitrogen supply available at sowing for dual purpose wheat and canola should be 100-150 kgN/ha.
- Starting grazing. Grazing can be initiated when the crops will not be pulled from the ground by the cattle commonly this is when wheat has 4-5 leaves and canola has 6-8 leaves. This can occur anywhere from March to June depending on the season with canola commonly grazed before wheat.
- Finishing grazing. The completion of grazing depends on crop growth stage (up to commencement of stem elongation) and is affected by location and cultivar. Winter canola types tend to elongate the stem from mid-late July, while winter wheats tend to elongate during August. Crops can be grazed for longer periods but the residual crop after grazing needs to keep increasing the later the grazing period.
- Stocking rate. Young cattle (approx. 200kg/head) can be grazed at 2-3 head/hectare depending on forage availability. This means that crops could be grazed from 60-90 days with 2-3 young cattle (120-270 cattle grazing days per hectare).
- Nitrogen top-dressing. It is beneficial to top-dress nitrogen after the grazing period to aid in crop recovery and grain yield. Top-dressing before or during grazing is not recommended due to nitrate toxicity.

Risks for cattle on dual purpose crops

Some cattle have died from a range of livestock diseases as a result of feeding on dual purpose crops. Cattle are more susceptible than sheep to many forage induced diseases, so it is critical that the grower understands and manages the risks associated with grazing dual purpose crops.

Nitrate toxicity

Nitrate toxicity can occur in ruminants when cattle consume plants that have accumulated nitrate. Within the rumen, nitrate is converted to nitrite and then to ammonia. High nitrate levels in the plant lead to a high conversion of nitrite, which results in it being directly absorbed into the bloodstream. Here it binds with haemoglobin preventing oxygen from binding and being transported around the body which in turn starves the animal of oxygen.

Within the plant, nitrate is transported within the vascular network and is converted to amino acids in the plant cells. Nitrate can start to accumulate to high levels within the vascular network when the conversion from nitrate to amino acids slows. Nitrate toxicity can be a particular concern in broadleaf leaf crops like dual purpose canola. It has been demonstrated that the stem and petiole have much higher levels of nitrate than the leaf lamina. McCormick et al., (2020) measured nitrate levels of 4465 and 13847 mg/kg in the stem and petiole respectively, compared to 1155 mg/kg in the leaf lamina. A critical value for nitrate where the risk of nitrate toxicity greatly increases has been determined at 5000 mg/kg dry matter (Hibbard et al., 1998).

The use of high levels of nitrogen fertiliser can exacerbate nitrate accumulation as can climate conditions that limit photosynthesis, such as drought stress, cloudy days or cold temperatures. In these situations, nitrate accumulates in the plants vascular network which can lead to higher levels of nitrate intake by livestock. Practices that reduce the risk of nitrate toxicity include not applying high levels of nitrogen fertiliser and delaying grazing until the plant is more mature, as nitrate tends to dilute in plants as they develop. Undertaking a period of adaptation reduces cattle's sensitivity to nitrate levels. In canola crops, having high forage availability and a lower stocking rate will enable livestock to select the leaf lamina and therefore reduce the risk of nitrate toxicity.

Acidosis

Acidosis is a cause of major health problems and production losses that occur in ruminants grazing cereals or canola. It is related to rumen pH depression. The rumen is a large microbial fermentation vat which produces a range of volatile fatty acids (VFA). VFAs are absorbed through the rumen wall and are the main source of energy for cattle. The rumen microbial population is sensitive to pH. Changes in pH result in changes to the VFA profile. Ruminal acidosis can occur with any dietary intake high in rapidly fermentable carbohydrate and low in fibre. Forage with high crude protein concentrations, which result in high rumen ammonia concentrations, can prevent the pH depression that would otherwise occur with a poorly buffered, low fibre intake that is high in water soluble carbohydrates. However, feed with lots of rapidly fermentable carbohydrate that lack sufficient roughage to generate a substantial flow of salivary bicarbonate, can overwhelm the alkalinising effect of the elevated rumen ammonia, leading to acidification. This combination of forage characteristics is a potent stimulant for lactic acidosis. Sub-acute ruminal acidosis can occur simply due to the rapid production of volatile fatty acids (VFA) in excess of rumen absorptive capacity, particularly in cattle newly introduced to a greater availability of lush forage. There is a strong inverse relationship between VFA concentration and rumen pH (Figure 1) – i.e. as rumen pH decreases, total rumen VFA concentration increases.

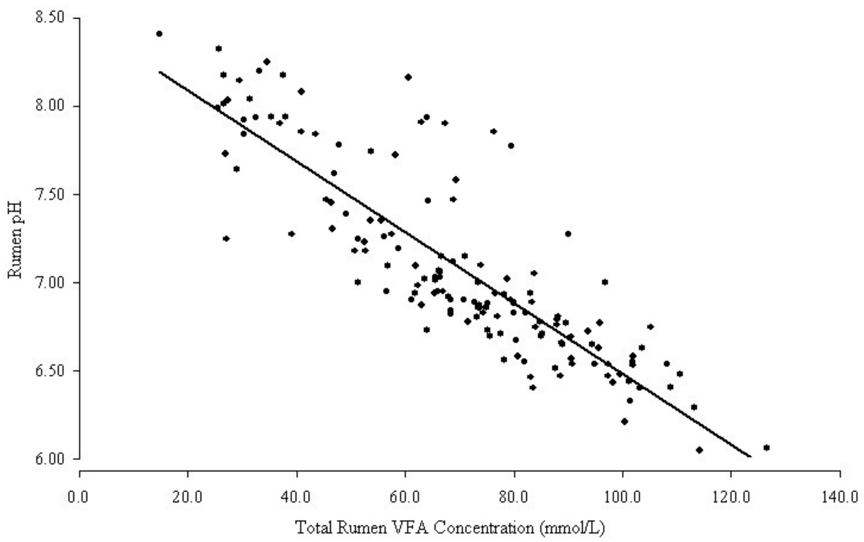

Figure 1. Relationship between total concentration of rumen VFA and rumen pH ($r^2 = 0.742$, $P<0.001$; Packer 2010).

Further research is required with cattle, but growth rate has been increased in lambs grazing cereals that were supplemented with a rumen buffer and an alkalinising agent (MgO and $CaCO_3$; Grain and Graze projects, Dove and Kelman 2015). This suggests that rumen pH might drop sufficiently in forage ruminal acidosis to reduce fermentation efficiency i.e. below 5.6 where the molar proportion of propionate starts to decline (Figure 2). The use of therapeutic agents, such as the ionophores (monensin, salinomycin or lasalocid), that select against lactate producers. If we can reduce this pH drop without significantly diluting dietary nutrient density, we might achieve cost effective increases in growth rate with cattle, as was observed with lambs.

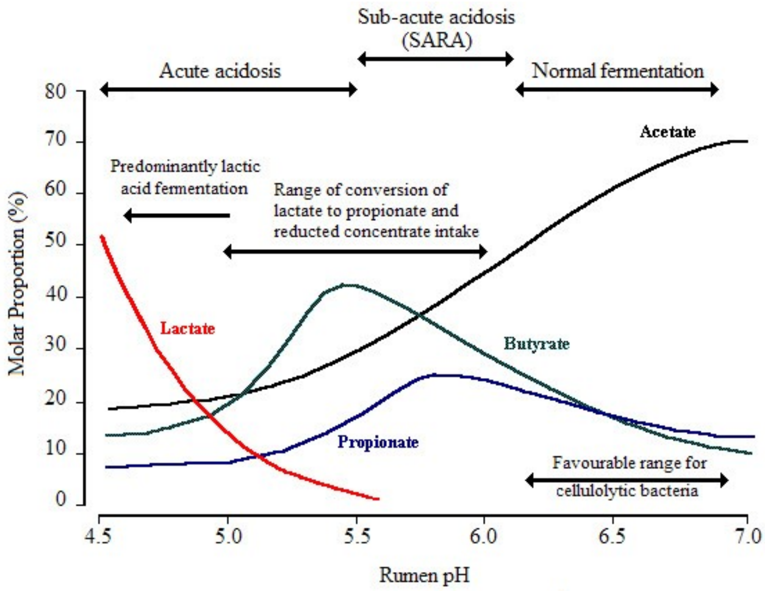

Figure 2. Changes in molar proportions of VFA at with changing pH as presented by Packer (2010) BVSc honours thesis.

Rumen pH depression not only results in direct mortalities and sub-clinical reduction in growth rate and feed efficiency, but it also predisposes ruminants grazing lush forages to bloat and polioencephalomalcia (PEM).

Bloat

The bloat seen when grazing dual purpose canola and cereal crops differs from bloat seen when grazing legumes. The bloat that occurs when grazing dual purpose canola and cereals, does not involve the specific chloroplast proteins that contribute to the formation of a stable foam in legume bloat, although intake of a legume (with these proteins), in addition to the lush forage of a canola/cereal crop could exacerbate the condition. Bloat on lush canola/cereal forages occurs as a result of the rumen contents being more viscous at lower pH, and the contribution of the slimy capsule of *Streptococcus bovis* to the formation of a stable foam. *Streptococcus bovis* overgrows at the expense of its neighbours in the rumen microbial ecosystem when rumen pH is low enough (< 5.6) for long enough, and it produces lactic acid, which is a 10 x stronger acid than the VFA's.

Polioencephalomalacia

Polioencephalomalacia (PEM) occurs due to an induced thiamine (vitamin B1) deficiency. A healthy rumen microbial ecosystem provides the ruminant's requirements for thiamine. However, when there is a high dietary intake of sulphur and when rumen pH is depressed, the rate at which thiamine is destroyed can exceed production and lead to a deficiency in thiamine and PEM. PEM can cause symptoms such as blindness, seizures or holding their head in an unusual position (stargazing). An acidic rumen increases the likelihood of PEM by increasing the release of a thiaminase exoenzyme through acid shocking of certain species of rumen bacteria. An acidic rumen also increases the rate of thiamine destruction by sulphite which is produced from the bacterial reduction of sulphate. Rumen bacteria also reduce sulphate to sulphite, therefore high dietary intakes of sulphate (e.g. from grazing brassicas) can have thiamine-antagonistic activities. Canola crops are often fertilised with sulphur. It is likely that this could increase the risk of PEM as the plants would have higher sulphur levels, although this has not been demonstrated with research.

Management practices to reduce forage disorders

Managing cattle grazing dual purpose crops requires an understanding of the animal health risks and regular observations to ensure a successful outcome. General rules regarding the introduction of a new feed source to cattle should always ensure that the cattle are always full. Hungry cattle are highly susceptible to changes in diet and gorging themselves on unfamiliar forage. One way to enable this is to introduce the livestock to a new forage mid-morning. Cattle will tend to eat a large proportion of their daily intake early in the morning. Care should be taken if cattle are grazing very short pastures prior to introduction as they are likely to still be hungry. The supplementation of hay will enable this transition. There is no requirement to adapt cattle to dual purpose wheat over time. In comparison it is still recommended to adapt cattle to canola over a period of at least 4-6 days. This is because cattle have been known to avoid canola initially leading to hungry cattle. When they finally do start to eat the crop they are likely to gorge themselves leading to health problems. To adapt cattle onto canola it is worth introducing them initially for 2-3 hours and increase the time by 2-3 hours each day. It is critical to observe that the cattle are eating significant amounts of canola before allowing them to be on the crop full time.

Mineral supplementation in wheat

Supplementation of sheep on dual purpose wheat is standard practice. Wheat is deficient in sodium (Na) and magnesium (Mg) for ruminant livestock production. Lime has also showed benefit through supplying calcium (Ca) to the livestock. While there are only limited studies in beef cattle, McCormick et al., (2021) demonstrated a cattle response to mineral supplementation in two out of three experiments, with liveweight gains of up to 27%. The supplement cost 4.5c/hd/day for a cattle liveweight increase of 0.5 kg/hd/day. It is recommended that cattle grazing wheat should be supplied with a loose-lick mineral supplement consisting of salt (NaCl), Causmag® (MgO) and lime ($CaCO_3$) (1:1:1 by weight, as-fed), offered *ad libitum* (at all times). Mineral supplementation with cattle grazing canola has not been tested, but previous research in sheep demonstrated a decrease in liveweight gain.

Liveweight lag period in canola

It has been identified that both sheep and cattle undergo a lag phase of liveweight gain for 1-2 weeks after introduction to dual purpose canola (McCormick et al., 2021). This can occur from cattle avoiding the canola crop, as many cattle in Australian grazing systems are not familiar with brassica grazing crops, or due to rumen adjustment. If cattle avoid eating the crop, this can increase the risk of other conditions such as bloat, as they are not adapted to the crop. The lag phase occurs even when cattle are adapted to the crop over a period of time. Practically this means that cattle should be grazed on canola for at least a month to enable weight gain to catch up.

Use of roughage

The use of roughage is a common risk management strategy to avoid animal health problems in cattle. No research has been conducted on the requirement of roughage when cattle graze dual purpose crops. From experience, there is generally no need to add roughage to cattle grazing dual purpose cereal crops. Due to the higher risk of forage disorders in cattle grazing canola, roughage has generally been recommended as a risk management strategy. Growers should be aware that a potential outcome of using roughage during grazing is that liveweight gains can be reduced. This is due to the reduced forage crop intake as the roughage can part fill the rumen. This effectively dilutes the nutrient intake of the livestock.

Best management practice for cattle on dual purpose crops

To minimise the risk of cattle health problems grazing dual purpose crops it is suggested to:

- Ensure stock are not introduced to a new paddock when hungry. Fill them with a fibre source before introduction – we seek a compromise between quality and fibre, therefore good quality cereal hay is recommended
- Introducing cattle to the crop mid-late morning during the adaptation period will reduce the risk of cattle gorging themselves
- Cattle should be adapted onto dual purpose canola to ensure they are eating the crop and to allow time for rumen adjustment
- Supply mineral supplements for cattle grazing dual purpose wheat
- Reduce pre-sowing sulphur fertilisers for dual purpose canola to reduce the risk of PEM
- Research has found low nitrate levels in the canola leaf, so ensuring that that there are high forage levels available will allow animals to select the leaf and reduce the risk of nitrate toxicity
- Provide hay in the paddock for dual purpose canola to allow cattle to select different forage. This will enable cattle to substitute hay for canola in the diet and increase dietary fibre levels. Be aware that this may result in nutrient dilution
- During the adjustment period the cattle need to eat the crop. If they are grazing fence lines or any other non-crop areas during the adjustment period, it is unlikely the animals have been adjusted
- Supplementation with palatable buffers, alkalinising agents or therapeutic agents can be used to reduce acidosis although limited research has occurred with cattle on dual purpose crops

References

Bramley, L., I.J. Lean, W. Fulkerson, Stevenson, M., Rabiee, A., Costa, N. 2008. The definition of acidosis in dairy herds predominantly fed on pasture and concentrates. J. Dairy Sci. 91:308-321.

Dove, H., Kelman, W. M. (2015). Liveweight gains of young sheep grazing dual-purpose wheat with sodium and magnesium supplied as direct supplement, or with magnesium supplied as fertiliser. Animal Production Science, 55(10), 1217-1229.

Hibbard, C. A., Rehberger, T. G., Swartzlander, J., & Parrott, T. (1998). Utilization of high nitrate forages by beef cows, dairy cows and stocker calves. In: Management of High Nitrate Forages for Beef and Dairy Cattle. In C. D., F. R., K. M., & W. D. (Eds.), *Nitrate toxicity of montana forages*. Oklahoma Agricultural Experiment Station Conference Proceedings.

McCormick, J. I., Paulet, J.W., Bell, L.W., Seymour, M., Ryan, M.P., McGrath, S.R. (2021). Dual-purpose crops – the potential to increase cattle liveweight gains in winter across southern Australia. Animal Production Science. In Press.

Packer, E. 2010. Rumen fermentation and body weight gain in grazing beef cattle treated with monensin. BVSc. Honours Thesis. Charles Sturt University, Wagga Wagga, Australia.

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