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Short-term high-performance pastures in temperate eastern Australia

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Key words: ryegrass; chicory; plantain; beef; sheep; rain-fed; grass-fed; gibberellic acid

Abstract

In exclusively rain-fed/grass-fed grazing systems, Short Term High-Performance Pastures (HPP) are used in specialised finishing paddocks to produce high-quality feed, enabling livestock to maximise their genetic production potential and meet market carcass specifications at the youngest age possible. This strategy not only achieves premium prices but also requires just 8% of a breeding enterprise's land to finish animals. Described are the range of species choices and combinations used in different environments of the Australian Eastern high rainfall zone, the reasons these species are used and the options available to meet animal requirements strategically. Instead of a monoculture of fodder crops, combinations of short-term hybrid ryegrasses with annual clover species and forage herbs are utilised to ensure animals gain weight every day of the year. Details are given of the tools used to optimise plant production such as the timing of synthetic fertilizer, use of recycled organic material to reduce metabolic stress on animals, and plant growth regulators to boost plant growth. Explanations are given on how the HPP system is used to enhance grazing enterprises in the erratic climate of eastern Australia and to boost recovery from the catastrophic economic consequences of drought. Key performance indicators include weight gain per 100 mm rainfall and dry matter per unit of nitrogen. These measurements have caused a paradigm shift in managers' thinking on what is important in profitable livestock enterprises and widening their focus beyond animal and plant genetics. Evidence and examples are given on the use of HPP to ensure that farm operators not only survive but thrive, taking profitable control of their livestock finishing enterprises.

Introduction

In eastern Australia, pasture types ranging from degraded native pastures, semi-improved pastures, sown and fertilized pastures, fodder crops and grain are utilised for meat production from grazing livestock, predominantly sheep and cattle. The evolution and use of short-term, high-performance pastures (HPP) to produce high-quality feed and livestock is described. The HPP system refers to a tailored mix of productive pasture species that replace traditional fodder crops such as oats, hybrid sorghum and brassicas in the temperate high rainfall zone (650-1350 mm rainfall per year) of Australia. The species used are fast establishing, can be successfully zero-till planted and respond quickly to high fertilizer inputs even from a low soil fertility starting point. The system commonly starts on a small area of a farm, but it can be scaled up rapidly as producers gain confidence, skill and income. Intensifying the inputs into pastures on a small area of a farm facilitates adoption and develops the management skills of producers. The advantages of HPP allow farms enterprises to recover from adversity caused by poor management, drought and periods of low commodity prices. HPP promote adoption, fill the normal autumn-winter and summer feed gaps, yield high weight gains, finish livestock to meet target specifications, and switch producer attitudes from a 'survive' to a 'thrive' mentality.

History and Methods of HPP

When Plant Breeder Rights came to Australasia in 1987, it enabled plant breeding companies to market many new pasture forage cultivars and species in Australia's beef/sheep region, with a potential to improve animal performance. Two examples were hybrid tetraploid Italian ryegrass and chicory. These species provided many new traits to a farm operation including an extended range of seasonal maturity, robustness, beneficial symbiotic *Epichloë* endophytes, low aftermath heading, improved digestibility, a lower bloat hazard and many more possibilities for seed mix combinations.

By the mid-1990s, a limited number of commercial agronomists in the lower altitude slopes and tablelands of Northern NSW started to use these new pasture species as substitutes for cereal forages and lucerne (alfalfa) pastures. Through interacting with R&D based commercial seed companies, these new options were developed for use as backgrounding for beef feedlots and finishing weaned animals. These became known as "Short-term High-Performance Pastures", an alternative to the only other real options of a forage crop or a long-term perennial pasture. These regions of NSW were warm enough in winter and cool enough in summer to utilise these HPP, thereby offering additional months of pasture growth each year and improved rates of liveweight gains over traditional winter cereals and summer forages.

The HPP system was quickly adopted by those graziers who ran their farms as a business. The advantages were a non-bloating feed system that gave high daily weight gains with a superior period of feed supply which enabled them to realise their animals' productive genetic potential to meet market specifications at a younger age without any setback periods of weight loss. They were able to take control of which market to target their animals' sale and were among the first farmers to consistently meet tighter carcass traits over the last 30 years. For many of them there was a financial advantage in being classified as "preferred suppliers" enabling them to sell directly to customers.

Short-term diploid Italian ryegrasses were initially used in pure swards in HPP for easy weed control and simplicity. By the year 2000, additional species were being used such as herbs like chicory and plantain plus clovers, along with a broader range of short-rotation hybrid ryegrasses. Thus, HPP was evolving into formulating tailored-made mixes to best suit a farm's particular location and microclimates. Further tailoring allowed each paddock's performance to be observed and measured to give specific feedback on weight gain potential now that most farms owned scales to weigh livestock. This strategy provided better individual animal performance, achieved more animal product per hectare annually and gave the ability to finish stock nearly every month of the year. Hence the name "Short-term High-Performance Pasture".

Currently, a selection from a range of species and cultivars is used in formulating each HPP pasture mix. In the Tableland regions, regular components are short-term rotation grasses ranging from the earlier seasonal maturity of Italian ryegrass up to late flowering hybrids from the combined crossing of Italian ryegrass, late flowering Spanish perennial ryegrass ecotypes and meadow fescue. These are typically high in metabolisable energy and protein with high palatability leading to high daily animal intake. In softer environments, tetraploid versions of these cultivars are used. Chicory, well known for exceptional animal performance, is usually included for additional quality and summer production. Plantain is added to mixes in drier climates and for its winter activity. Legumes are generally added mostly for their contribution to feed quality and they offer some limited nitrogen fixation. These legumes are white and red clovers in cooler climates or in the hotter, drier climates annual clover species such as berseem, balansa, arrowleaf, subterranean and Persian clovers. One example of a sowing mix would be 20 kg/ha late flowering diploid hybrid ryegrass x meadow fescue cross, 5 kg/ha late flowering tetraploid Italian ryegrass, 1 kg/ha each of chicory and plantain, 2 kg/ha diploid red clover, and 1 kg each of white, balansa and Persian clovers.

Results/Benchmarks/Guidelines

By 2005, approximately 300 farmers had sown typically 5 to 20% of their farms to HPP. From the experience gained, a range of benchmarks were developed to incentivise and guide producers towards achievable targets. ***Fertilizer Inputs.*** Fertilizer inputs are key to the successful performance of these pastures (Table 1). It is essential to match fertilizer inputs in advance of expected nutrient removal, as a plan to replace nutrients later results in a premature failure of a HPP. Often a paddock's fertility when these programs start is not adequate and requires a capital application of fertilizer. Many first-time users do not recognise and understand that HPP are producing so much more dry matter (DM) than their regular pastures, and therefore need high rates of fertilisation. Failure to provide HPP with adequate fertility is the most common reason farmers choose not to repeat planting further HPP areas due to their early failure. Diligent attentive advice from agronomists is essential to prevent this happening.

Table 1. Expected DM production per mm of rainfall determined by fertilizer inputs.

Level of fertilizer	DM produced/ha/mm rainfall
Zero	2-3 kg
Low or erratic	3-5 kg
High inputs	11-14 kg

Comprehensive soil testing is essential to understand the starting point of major nutrients, to anticipate secondary and trace nutrients deficiencies that appear once extra demand is placed on soil, and to ensure that soil pH is adjusted by liming if necessary, to $pH_{Ca}5.5$. The secondary elements of calcium and magnesium should be generally corrected as indicated via soil tests. This aids in animal performance, soil structure and correcting the pH. Usually, the species are not too sensitive to pH, provided soils range between $pH_{Ca}5.0$-7.0. *Phosphorus (P)* is commonly applied at a rate double a district's standard practice on regular pastures. Base *potassium (K)* requirements are high, with HPP programs highlighting hidden soil deficiencies. Annual *sulphur (S)* requirements are 15-25 kg/ha. *Trace element* deficiencies are specific to soil types. The higher the productivity per hectare, the more often shortages occur. Typically, boron and zinc deficiencies are seen in the

plants. In the livestock, deficiencies occur in selenium, zinc, cobalt and copper. Finally, for soil health, cobalt and molybdenum have been found to be of benefit to symbiotic microbes.

A strong *nitrogen* input is essential to the success of a HPP. It must be supplemented as the N fixed by the legume component of a mix is insufficient to cope with demand. The optimal amount of N to apply is a consideration of the total amount of DM produced each year, the current season, and how much N is likely to be returned through animal excretion. In a typical HPP, the annual minimum should be 150 kg N/ha, applied as small, split applications over each year for efficiency, continuity and animal health reasons. Since most HPP pastures are producing in excess of 12,000 kg DM/ha/yr with protein levels ranging from 15 to 28%, the strategic use of N applications has the following management principles:

- As HPP are generally first planted into a poor fertility base, sow with a fertilizer blend containing N as well as P, S and often K.
- Once the pasture has germinated and established, apply ~50 kg N/ha. As HPP are often zero-till planted into old pasture, N fertilizer must also compensate for the process of decaying organic matter.
- Apply N in late autumn, late winter, mid-late spring and the end of summer. This practice is continued until 8 weeks before the HPP is terminated.
- Apply 25 kg N/ha for every anticipated tonne of DM produced until the first spring and then reduce this to 15 kg N/ha thereafter due to N recycling.
- As the grass base comprises short rotation grasses, the mid-spring N application is essential for development of vegetative daughter tillers for these grasses to persist after each summer. Failure to do this risks an early end for the HPP due to the grasses producing predominately reproductive tillers which do not meet livestock feed demands so summer target carcass weights are not achieved.

Plant Growth Regulators. Response rates of 20-23 kg of DM for every additional kg of N applied can be achieved, except for winter when the response is only 12 kg and overall growth is slow. By applying gibberellic acid twice @ 12 g/ha 6 weeks apart or three times @ 8 g/ha 4 weeks apart during winter, results in pasture growth rates are similar to those achieved in early spring. Daily winter DM production is increased from 15-25 kg/ha to 65-90 kg/ha.

Animal Production. It is preferrable to use the New Zealand approach of focusing on performance per hectare rather than that of individual animals. Simple comparative DM measurements do not truly reflect the effects of various pasture systems' performance on animal feeding behaviour, feed conversion and utilisation of the feed on offer. Live weight gain per 100 mm of rainfall (Table 2) is a better benchmark.

Table 2. Typical beef weight gains.

Pasture type and fertilizer policy	Live weight gain/ha/100 mm rainfall
Native/natural pasture, zero inputs	5-15 kg
Native/natural pastures, superphosphate and legumes, low inputs	10-25 kg
Improved pasture, poorly managed, low inputs	20-35 kg
High input/improved pasture, well managed, optimal inputs	50-80 kg
High performance pasture (HPP system), optimal inputs	75-120 kg

These benchmarks work well with temperate species in rainfall between 700 and 1,500 mm/yr in the High Rainfall Zone of eastern Australia and worldwide. Based on data collected by more than 100 graziers, the HPP beef production of 75-120 kg live weight/ha/yr for every 100 mm of rainfall is superior to other pasture options. The range in HPP performance is due primarily to variations in regular rainfall and what type of short rotation grass the climate allows. The typical weight gain performance from pasture in the high rainfall zone of NSW is 29 kg/ha/yr for every 100 mm of rainfall, or 230 kg/ha/yr when receiving 800 mm/yr. In contrast, a HPP system in the same rainfall will achieve 760 kg/ha/yr. This comparison highlights its strategic value in a grazing enterprise.

Studies conducted on animal performance have generated typical outcomes in eastern Australia from well managed HPP systems of:

Beef weight gain

- 0.5-1.0 kg/head/day winter
- 1.5-2.0 kg/head/day spring and autumn
- 1.0-1.5 kg/head/day summer

Prime lamb weight gain

- 250-300 g/head/day – less lamb enterprises have used the system so no seasonal figures are available.

These typical weight gains illustrate that not only is the pasture productivity high, but also individual animal performance is high. HPP enable animals to fulfil their genetic potential and to reach market specifications at a younger age. The system aligns with the signals from Meat Standards Australia (MSA) that grades meat based on eating quality, permitting access to higher paying markets.

Animal Health

Before entering HPP finishing systems, the animal health treatments for the livestock are like any other new animal arrivals to farms or induction for feedlots. They are supplemented for trace element deficiencies, vaccinated and treated for internal and external parasites. These improve animal wellbeing giving the benefits of improved performance and a reduction in unwanted deaths.

Livestock can suffer metabolic disorders and sudden death when HHP's are driven very hard with synthetic fertilizer inputs. There was a situation one year where a few farmers in one district were losing more than 5% of their animals over just a few months. An investigation showed high fertilizer N inputs lead to excessive crude protein, putting animals into an energy crisis as they tried to convert it into urea to excrete in their urine. Research showed that ryegrass species uptake of N is very rapid. Within 2 weeks of an application, it is mostly all in the plant tissue. On these farms, crude protein spiked as high as 33% in tissue tests during cloudy weather, leading to a significant drop in daily weight gain and the occasional death. Under the same conditions, the natural cyanide levels spiked in clovers leading to sudden animal deaths from heart failure. The solution to keeping to the required annual N input was to apply lesser amounts of N more frequently. Further improvements in animal performance and safety came when substituting synthetic fertilizer with animal manures and other recycled organic material such as composted food waste. These recycled organics are available at a reasonable cost in eastern Australia. They slowly release plant available nutrients to the HPP species and assist as a buffer for any later synthetic fertilizer applications. Using this strategy virtually ended any animal metabolic-related problems. Trials showed setting the recycled organics application rate to the annual P requirement satisfied all the annual major, secondary and trace nutrient demands except for N. As a bonus, it took the guesswork out of supplementing trace elements. Farmers still needed to apply 50% of the N demand as synthetics, but relative feed value tissue testing showed the danger had disappeared.

Weed Control and Insect Control

Generally, weeds are not a major concern providing the established pasture populations are high. After establishment, weeds usually are absent from HPP pastures due to thick vigorous plant growth and grazing management. Species used in HPP are generally tolerant of insect attack. Usually, the insect pest problems are the same known ones specific to all pastures in a particular region, so weed and pest husbandry practises are as for other pastures.

Grazing Management

During establishment, grazing as early as possible without pulling the grass is critical. Early grazing firstly allows companion species to compete with the ryegrass and will assist in weed control.

A management area for each animal mob is created using some form of "pulse grazing" strategy. Ideally, there are at least four fenced grazing units exclusive to each mob. This can be four paddocks, or a single paddock subdivided into four by portable electric fencing. The short rotation grasses in a HPP can then be grazed for 1 week followed by 3 weeks of rest. This practice optimises DM production and allows enough sunlight for the other pasture species to flourish.

Grazing pressure will influence the persistence of these pastures. As the base short rotation grasses are usually hybridised ryegrasses in some form, the aims of grazing should be:

- Aim for a maximum pasture height of 15 cm (2800 kg DM/ha). Higher than this diminishes the digestibility and daily feed intake steadily.
- Ensure pasture post-grazing heights are always >5 cm (1200 kg DM/ha).
- De-stocking or reduced stocking is ideal at certain times when there is moisture stress – usually in summer. The simple goal is to not allow the grass to be grazed shorter than 5 cm or plant death will occur.
- Higher stocking rates, mulching or haymaking is required to maintain quality at certain times of the year – usually in the spring.

General Management for Best Results

- Monitor weed and insect pests and control when necessary.
- Monitor stock performance and health.
- Fertilize at strategic times. For example, apply nitrogen in mid-spring and late summer.
- Ensure the choice of animals grazing these pastures can gain weight.
- Ensure there is a clean water supply and not muddy dams or saline water.

- Fence where necessary to realise the full potential of the pasture. Electric break fencing is usually sufficient.
- Keep in close contact with a competent pasture technologist/agronomist for the day-to-day management and general advice.

Summary of the Disadvantages

- Graziers require a high degree of competency and quality advice in both grazing management and general agronomy.
- Animal performance is pushed hard and can lead to metabolic disorders and deaths.
- Although the seed sowing costs are only $20-$40 higher than a typical perennial-based pasture, the fertilizer inputs are considerably higher.
- The increased rate of animals achieving market specification requires adjustment in stock policy which can lead to greater capitalisation to purchase additional stock and the need to development new skills.

Summary of the Advantages

- Animals continually gain weight in all months of the year, including winter.
- Provides the opportunity to finish livestock out-of-season resulting in access to a broader range of markets and ability to capture price premiums.
- Only 8% of a breeding farm's land area is required.
- Species used are easy to establish and are suitable for planting using zero-tillage.
- Species used are tolerant of moderate soil acidity and salinity.
- The combined formulation of the species reduces the possibility of bloat.
- After only 6 months, net returns are made and not the 6 years often quoted for long-term perennial grass-based pastures.
- Compared to long term pasture options, HPP produce twice the DM/ha, and due to their higher quality and higher utilisation, they produce three times the typical meat production/ha.
- They earn three times the typical gross margin/ha.
- They give higher cash-flows and faster turnover of traded livestock.
- They provide higher rainfall use efficiency.

Discussion

The Short-term High Performance Pasture system is achieving very high animal performance. The strategic advantage the HPP approach offers to a grazing operation is compelling. It supports the expectations and satisfaction of both the producers (setting and achieving production, economic and social goals) and consumers (improved supply, improved quality). As more is learnt about the compatibility of the commonly used species and cultivars in the system, there will be an increase in the range of climates these pastures can be utilised in and improvements in their productivity and longevity. There are good prospects for greater application of this strategy in Australia.

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