

# Seasonal Pasture Production

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## INTRODUCTION

It is well known that pasture production varies considerably with different times of the year and that quality as well as quantity is affected. In nearly all Australian environments production is low in the winter period and this is due to relatively low temperatures in the winter rainfall areas, while in the summer rainfall regions lack of winter moisture is the chief cause. For a few environments, such as the north coast of New South Wales, low winter production may be associated with lack of winter-growing species, because of a dominance of paspalum, rather than unsuitable physical conditions.

There is a flush of production in Southern Australia in the spring period followed by an almost complete cessation of growth in summer, where the climate is typically Mediterranean, whereas in Northern Australia, peak production occurs in the summer, coinciding with monsoonal rains. In most areas autumn growth is variable according to rainfall, but conditions for stock may vary according to the quantity and quality of the carry-over of either the spring or summer production.

The northern tablelands of New South Wales, the part of the New England Region in which Armidale is situated, fits in between the predominantly summer rainfall area of the north and the winter rainfall area of the south. Seasonal pasture production can, therefore, be intermediate between the two types. In actual fact the native pastures are strongly summer productive and winter dormant, somewhat akin to paspalum pastures at Lismore but on a much lower scale. The use of sown pastures tends to correct to some extent the paucity of forage in the winter.

An approximate seasonal production curve for a six-year-old **Phalaris tuberosa** white clover pasture, producing about 10,000 lb. of dry matter per acre in a year, grown at "Chiswick", Armidale, is shown in Figure 1. This mixture is commonly grown on the tablelands and the curve shows the rate of total forage production in pounds of dry matter per acre per day. For short periods in each season, i.e., winter, spring, summer, and autumn, the rate of growth may actually be higher or lower than depicted by the curve. The preponderance of spring growth can be readily seen and also the low productivity in the winter and summer.

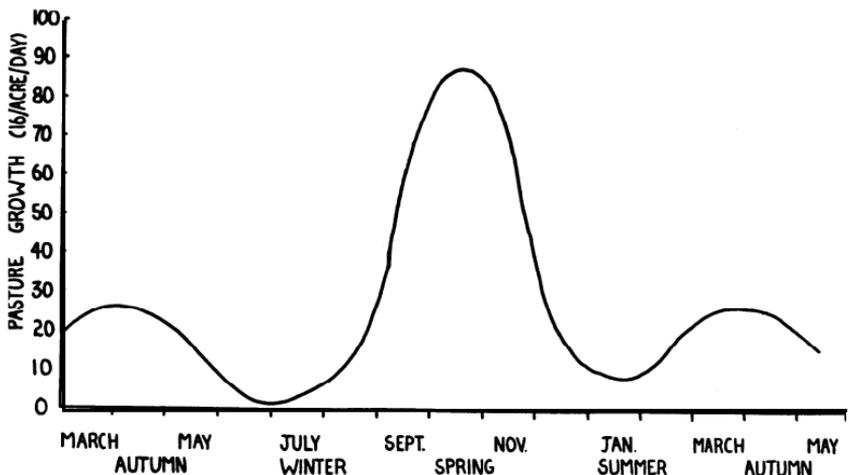


FIGURE 1: Probable average pattern of growth at Armidale of a Phalaris-white clover pasture yielding annually approximately 10,000 lb. dry matter per acre.

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## Factors affecting seasonal pasture production.

Seasonal production is controlled by many factors, the chief of which are climate, soils, pasture species, grazing management, nutrient supply, plant competition, etc.

### 1. Climate

The actual shape of the production curve is largely controlled by climate, although total production may be profoundly altered by the application of deficient nutrients. Species may also cause important minor variations in growth rates, but are in turn controlled by temperature, light, and moisture supply. These three factors will now be considered for Armidale.

- (a) **Rainfall:** The mean annual rainfall for Armidale is nearly 31 inches with a variability of between 25 and 30 per cent.; 60 per cent. of the rain falls in the summer six months and 40 per cent. in winter, but because of lower temperatures and their consequent effect on evaporation the winter rains are more effective. If the average monthly rainfall totals were received, soil moisture might be nearly adequate for growth of some species at all times of the year. In practice there are variable periods of moisture stress, particularly under sown pastures, during the summer and sometimes in the autumn.
- (b) **Temperature:** With an elevation of over 3,000 feet the tablelands are naturally fairly cool. The mean temperature for January is 68.7° F. (maximum 81.4° F. and minimum 56° F.), and for July it is 43° F. (maximum 53.6° F. and minimum 32.4° F.). If 41° F. is the lower threshold for growth of many temperate pasture species, then growth in winter is restricted to only a few hours per day. On the other hand, the summer temperatures are probably only a little above the optimum for many species. The importance of temperature to growth rate of pasture species may be realised from the fact that a van't Hoff coefficient of between 2 and 3 has been found to apply, (Prescott, 1948), i.e., growth rate doubles or trebles itself for each 10° C. rise in temperature.
- (c) **Light:** Both length of day and light intensity are of importance. Because of latitude the length of day in summer at Armidale is shorter than for the original habitats of the pasture species in use and in winter it is longer. Thus the rate of growth could be slightly lower in summer and slightly greater in winter than in places of higher latitudes but with similar temperatures. The elevation results in greater light intensity than for most Australian environments.

### 2. Soil moisture supply.

Soil moisture is a reflection of the moisture intake, losses through drainage and evapo-transpiration, and the water-holding capacity. Briefly most soils of the northern tablelands of New South Wales are adequate for moisture in winter, while in summer there are periods when moisture is insufficient for growth (J. E. Begg, personal communication). The light sandy soils tend to fluctuate between wet and dry much more than the heavier clays, resulting in lower summer production on the lighter types. When summer dry periods become sufficiently severe as on soils derived from granites, with low moisture-holding capacity, a change to winter growing annuals may be necessary, thus still further reducing summer production. On the heavy basaltic soils, on the other hand, white clover stands have carried through severe droughts although production itself was curtailed.

### 3. Species.

Species can play an important part in seasonal production. A strong effect accrues from the alternative use of annual species or perennials. For the tablelands area pastures may consist of both annuals and perennials or entirely of perennials. The annuals, such as subterranean clover and wimmera ryegrass, which are quite commonly grown on the New England tablelands and western slopes especially on the lighter soils, make for marked seasonality in production, accentuating the spring peaks and the summer troughs in growth.

With perennial species the seasonal growth pattern is largely under the control of temperature and moisture. When moisture is limiting the ability of a species to continue, growth will depend on depth and habit of rooting and on depth of soil. However, when the supply is severely restricted the plant must be able to survive until conditions again become favourable. For survival when soil moisture availability is decreasing, plants that continue to grow because temperature is satisfactory are probably at a disadvantage with those that are naturally dormant.

**Phalaris tuberosa** is an interesting species in this regard. Its rate of growth in the hottest part of the summer appears to be low even when moisture is plentiful and it seems that temperature is the controlling factor. As it originated in the Mediterranean area and environment, temperature control might be essential to ensure that growth did not occur in the summer from chance storms, thus resulting in a dissipation of root reserves. Instead resumption of growth tends to occur with the lower temperatures of autumn, when the chances of rain are high.

Individual species differ in their temperature and light requirements for best growth. The effect of temperature and light on growth has recently been demonstrated by Mitchell (1955) for perennial ryegrass, cocksfoot and paspalum. At temperatures of 59° F. cocksfoot and perennial ryegrass were more productive than paspalum, but at 83° F., without any marked change in the rates for the two temperature species, paspalum was greatly superior. This could be the basis for a separation into winter and summer-growing species.

In selecting pasture species, to fit the seasonal temperature curve, two possibilities exist:

- (a) A species may be obtained suited to the whole temperature range and thus capable of giving both reasonable winter and summer production, or
- (b) Species may be selected to grow at only parts of the temperature range, e.g., summer-growing species and winter-growing ones, suited to mean temperatures of 69° F. and 43° F. respectively.

These two considerations would involve a choice between either general purpose pastures or use of special seasonal pastures. In both cases the species would be required to endure extremes of at least 15° F. for the coldest winter night to about 95° F. for the hottest summer day. Where species with different temperature optima were used then a combination of species might be required to overcome the dearth of growth in the off season of the main species. In this way a combination of a grass and legume with different growth phases has proved practical, as at Lismore with paspalum, where subterranean clover fills in the winter trough. (H. V. Jenkins, personal communication).

### Seasonal production of species at Armidale.

Attempts have been made to measure the rate of production at Armidale of a number of different grasses in association with white clover. After about four years, when the swards had settled down to approximately equal percentages of clover and grass, seasonal production was measured by determining the difference between two successive yield samples, separated by a period of about seven to nine weeks of no grazing. The rate of growth per day was determined by dividing the growth increment in the grazing-free period by the number of days in the period. Contributions of grass, clover, and weed were recorded but only the total forage of all these constituents will be considered.

In general it was found that most of the species examined tended to follow fairly closely the curve shown in Figure 1. At certain periods, notably winter, there could be differences of as much as 100 per cent. between two different grass mixtures, but because this was during a trough in production when yields were low the effect on the curve was slight. Among the large number of species used most had a peak in spring, a minor peak in autumn, and troughs in summer and winter. The species included **Phalaris tuberosa**, two tall fescue strains, perennial ryegrass, cocksfoot, and smooth brome grass, all sown in association with white clover.

For winter production a Moroccan fescue-white clover mixture was nearly twice as good as the phalaris mixture, and this was chiefly due to the excellence of the grass and not the clover. Some of the other grasses were similar to phalaris in production and others considerably poorer, but the white clover tended to compensate for any major grass differences.

In spring the production of all grass mixtures was very similar in one year, but was a little divergent in the following one when the first part of the spring was dry and the latter part wet; the break coincided with the time that phalaris normally comes away. However, in both years a brome grass-white clover mixture was the best, especially in the earlier year when it was 25 per cent. more productive than phalaris. This was due more to the growth of clover than of grass.

In summer, an Oregon fescue was about 15 per cent. better than phalaris in both years. The Moroccan fescue was also better in one year but poorer in

the other which was drier. Brome grass and Oregon fescue were some 12 per cent. better than phalaris in the autumn.

From the results there does not appear to be very much in favour of the use of seasonal pastures, at least from the species selected for trial. Although some produced more in summer and winter than others, the total levels at those seasons was so low that the increase is probably of little consequence. However, these small differences may have depended on the original selection of the range of species for general suitability to Armidale conditions. Much more divergent species like *paspalum* were omitted.

Another factor of importance is that forage produced by some species in one season could carry well into a succeeding season as standing forage, e.g., as autumn-saved pasture. In this regard phalaris was found to be poor for autumn saving, because of a marked tendency for yellowing after the first frosts, whereas the Moroccan fescue was quite good. Cocksfoot and perennial ryegrass were intermediate between these two. Differences were also noted in the summer period for the spring carry-over.

#### 4. Size and condition of plants.

The forage production of a pasture is to some extent dependent on height and size of the species in it. When plants are very small their relative growth rate may be high, but their contribution in pounds of forage per acre will actually be low. Similarly, when plants are left to grow very large, growth rates again fall off. These two facts are reflected in the sigmoid nature of growth curves.

It would appear that there might be an optimum height for the plant to achieve maximum production and this height could vary with, the time of the year, perhaps depending on differences in the angle of incidence of the sun's rays from winter to summer, availability of moisture in the different soil horizons, etc. New Zealand workers appear to favour a pasture from 4-5 inches high.

In practice the tendency is for the pastures when at a set stocking rate to become short in winter because consumption generally is greater than production. This still further reduces the rate of winter production and may result in even heavier overgrazing unless supplementary feeding is provided.

To illustrate the effect of size of plants on winter growth rate it was found at Chiswick in a time of sowing trial that large subterranean clover plants at June 26 compared with small plants at the same date, had produced by August 25 over 7 times as much forage (Hilder, unpublished data). Other examples could also be quoted. Thus higher winter production might be obtained by late autumn spelling of pastures, with supplementary feeding of stock if necessary or by fertilising and other cultural treatments, to increase the later autumn size of plants.

#### 5. Nutrient supply.

With the general deficiency in most soils of nitrogen, phosphorous, and sulphur, the application of corrective fertilisers, such as superphosphate, may have two effects:

- (a) increase greatly the production for the year;
- (b) change, to some extent, the shape of the production curve.

Fertilising may well increase the potential stocking rate and when this is achieved the winter and summer shortages of available forage from the pasture could be accentuated. Alternatively if fewer stock are carried there would be a lower relative utilization in the spring.

In the early stages of pasture improvement some of the differences in seasonal production caused by fertilising are due to changes in botanical composition. Clover dominance is a common feature in young pastures and Willoughby (1954) has shown that subterranean clover was much less productive in winter than some grasses. However, unfortunately little is known of the general effects of superphosphate on seasonal production in New England as most of the fertiliser trials have been concerned, with measurement of soil deficiencies and yields were mostly measured in the spring.

At least the importance of time of early fertilising is realised because January applications of superphosphate to a previously well fertilised phalaris-subterranean clover pasture resulted in 25 per cent. more growth at the beginning of winter than an April application (Hilder, unpublished data). Due to uniform

mowing of all treatments immediately after sampling there were no further winter differences, but without mowing, yields would probably have been in favour of the early fertilising treatment owing to greater plant size.

The use of nitrogenous fertiliser for increasing winter production has not yet received much attention at Armidale, although in one year a 300 per cent. increase was obtained during the winter, on a highly productive pasture, with the use of 2 cwt. of sodium nitrate per acre (Hilder and Spencer, unpublished data). Overseas work suggest that production in both the early spring and the autumn periods could be increased considerably, but present cost of nitrogenous fertilisers in Australia is a deterrent to their use.

#### 6. Plant competition.

A pasture might be compounded of several species each capable of growing at different times of the year. Short rotation ryegrass has been used in this way in New Zealand for improving the winter production of perennial ryegrass-white clover pastures. The principle could be extended to include paspalum and reed canary grass to lift summer production at Armidale. In practice it becomes difficult to maintain all the species in their original proportions because of plant competition effects.

High seasonal productivity of one species is often detrimental to subsequent production of an associated species capable of growth in the next season. Strong autumn growth of a grass can greatly depress the winter yield of subterranean clover due to competition in this vital autumn period. A further effect of plant competition is to reduce plant numbers in a pasture when the growth is very tall, as in a flush period. When this pasture is eventually eaten short, production is then lowered because the bare ground between plants is not utilizing available sunlight. This emphasizes the importance of keeping pastures in control during spring.

### **Some suggested methods of overcoming seasonal production effects.**

#### 1. Fodder conservation.

Obviously one way of overcoming seasonal differences in production is to conserve fodder in the flush periods and feed it back when the pastures are short. By this method much greater utilization of the forage produced in the year could be obtained. However, fodder conservation on the northern tablelands of New South Wales is often attended by some losses due to inclement weather at hay-making periods.

#### 2. Seasonal pastures.

By this is meant special purpose pastures to meet the periods of low productivity. Here the aim might be to produce:

- (a) early spring and late spring pastures in order to extend the hay-making period as much as possible and to reduce late winter shortages;
- (b) a special summer-growing pasture consisting of species like paspalum or **Phalaris arundinacea**, preferably under irrigation, and
- (c) autumn pastures for saving into the winter.

It is thought that a greater range of species than has been used at Chiswick so far might suit the above purposes.

#### 3. Grazing techniques.

Briefly this would consist of grazing heavily in autumn and spring those pastures that do not carry over well into the following season and spelling those that do. To further economize on the autumn and winter saved pastures, fodder might be fed out to stock while they are on the pastures that do not keep well.

#### 4. Use of fertilizers.

This has already been dealt with earlier in this paper. Suffice to say that there does seem to be some scope for the use of nitrogenous fertilizers to improve the late autumn and early spring production. The effect of type of fertilizer and their time of application on summer production is unknown, but their use might be limited because of possible shortages of soil moisture.

#### 5. Forage crops.

There appears to be considerable scope for using forage crops to augment the poor forage supply of winter and summer. Forage crops have long been used in New England, but they have preceded sown pastures rather than followed them. Much greater yields might be expected on soils whose fertility has been

lifted considerably by improved pasture, and, in fact, forage crops represent one of the few ways in New England in which it is possible at present to cash in on the stored fertility. To fulfil this purpose they might best be used as catch crops in the process of renovating old pastures and preparing to sow a new one in its place.

Gains by forage crops may accrue from two important factors, both concomitant with the cultivation necessary for sowing. These factors are:

- (a) cultivation enables some storage of moisture against a subsequent dry period; and
- (b) it allows the accumulation of available soil nitrogen also for subsequent use.

On the basis of these two facts, both summer and winter forage crops could be grown. For both crops the cultivation could be performed in the spring when forage is normally abundant and this operation, together with hay-making, would allow for the better control of excess spring growth. The storage of moisture and nitrates under fallow should allow some growth even in relatively dry summers, especially if adequate plant spacing or row cultivation were practised. For the winter forage crop, success would depend on whether the greater availability of soil moisture and nitrates could lead to autumn growth great enough for carrying into the winter as standing forage. Provided the forage crops were grown on soils where fertility had been built-up, then their use might almost be similar to an irrigation and heavy application of bagged nitrogen to a sown pasture.

#### REFERENCES:

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#### DISCUSSION

Mr. JOHNSTONE: Provided these pastures are stocked at a level equivalent to the dry matter available, what difference in weight gains could be expected throughout the year?

ANS.: I am not sure as we have not stocked pastures in this way. I did not indicate the protein values of the pastures. Phalaris contains 4 per cent. nitrogen (25 per cent. protein) in early winter and this drops to 1.5 per cent. nitrogen (9.4 per cent. protein) by the end of the spring. In addition the water content of the pasture at certain times might also be a factor limiting intake.

Dr. FRANKLIN: Isn't it more a question of digestibility?

ANS.: Yes, that is so. If protein is an indication of digestibility then we might expect the pastures to be more digestible in winter than in summer.

Mr. MURPHY: What were the methods of assessing pasture dry matter yield per acre per day during the various seasons of the year?

ANS.: Plots of one hundredth of an acre were grazed, shut up, sampled to measure the residue and then left for 7 to 8 weeks ungrazed and sampled again. From the difference between successive samplings we obtained the average growth rate in pounds per acre per day. Sometimes a negative growth was observed, that is, the yield was higher after grazing than some 7 or 8 weeks later owing to the pastures drying off.

Mr. WRIGHT: One graph showed the low nutrient value of summer pastures, yet it is the general experience in New England that stock do better on summer native pastures and to some extent summer improved pastures than they do on spring growth. What is the explanation of this?

ANS.: I don't really know as our limited results don't show this. Possibly the water content of the spring pastures is sometimes too high and may affect intake. In improved pastures the fibre is roughly inversely proportional to the protein content, that is, in winter protein is high and fibre is low, whereas in mid-summer protein is low and fibre is high. This may not apply to native pastures, which do not grow over winter.

Mr. BLOMFIELD: What effect has spring management on winter production, for example, letting pasture grow right away in spring or grazing it right off?

ANS.: I couldn't really say as we have not tested this experimentally. I have often thought that by letting it grow up well in spring in order to build up root reserves this should make for good winter production. Under this

type of management one could also get more clover and so more nitrogen, but if the grasses progress too far the clover might be depressed and nitrogen levels would then fall.

Mr. DUN: What would be the value of sheep dealing, for example, purchase of merino weaners to utilize spring growth?

ANS.: It should be a good idea. Grazing the pasture and keeping it relatively short should improve the pasture quality and soil fertility. Clover, kept at a height of 4 to 6 inches, probably produces most and hence should give higher soil fertility.

Mr. COTSELL: Have cattle been used to help utilize spring and early summer excess pasture growth?

ANS.: We haven't done anything with cattle to utilize this pasture excess. Instead we have used a large number of sheep to stock our small areas heavily when necessary.

Mr. BOLT: As a contribution to the discussion I would like to stress the importance of fibre to cattle in endeavouring to control spring flush of irrigated pasture in northern Victoria. On small areas, even with intensive stocking, we have had to feed straw to get the best performance from the stock.