MILK PRODUCTION FROM TROPICAL PASTURES

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As Wollongbar is located in an environment which can be described as humid subtropical only (Holder, 1960) it is perhaps unwise of me to quote data achieved at and from The Station in the context of the title of my address. However we have been dealing with the performance of tropical pastures species in this environment for some time (as indeed we have with some temperate species) so in view of the almost complete absence of reports in the world literature on milk production from tropical pasture species I may be doing a service in providing some of the results we have.

I intend to provide information on the nutritive value of tropical legume and grass species and the relation to milk production, then complete my address with reference to some of the commercial studies we have made in the Richmond-Tweed area of N.S.W.

NUTRITIVE VALUE AND MILK PRODUCTION

General considerations

Payne in 1963 expressed the opinion that "it should be possible on good humid tropical pastures to 'Carry' two milking cows per acre, each producing 6-800 gallons of milk or a total production of milk per acre approaching that obtained on the best temperate zone pastures". Glover and Dougall (1961) after a theoretical consideration of the relationship between nutritive value of Kenya pastures and milk production, also felt that such pastures were "very similar to good temperate zone pastures in their ability to supply similar amounts of nutriments for milk production at similar levels of appetite, although it may be for shorter periods of time because of more rapid maturation in warmer climates".

On the other hand Hardison (1966), after an examination of much of the published data on composition and digestibility of fresh tropical herbage, concluded that "if grazed rotationally at intervals of 20 to 30 days and ignoring the ability of the animal to graze selectively, most of the grasses examined would supply sufficient amounts of digestible crude protein (D.C.P.) for maintenance and production of about 10 kg of milk daily. However the total digestible nutrients (T.D.N.) content of the grasses would limit milk output to not more than 5 kg per day". The term of this production was not discussed.

Can we reconcile these obviously diverse opinions? If we can I am sure it will be on the basis that the pasture species under consideration, the fertilizer programme, the management of the pastures, the environment in which the pastures are growing and the cattle used to graze the pastures will all have to be clearly defined.

Tropical pasture productivity, nutritive value and milk production at Wollongbar

The situation at Wollongbar is as follows, using as examples Kikuyu grass *(Pennisetum clandestinum)* and Clarence glycine *(Glycine javanica)*, the tropical grass and legume species most adapted to the "red basaltic" soil type and our environment.

All of the evidence gathered over the years has indicated that the grasses originally introduced to the area, but now "adapted", have been declining in

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productivity. As evidence of that decline the following table illustrates the production of spring-calving dairy cows* grazing a mixed Kikuyu grass, paspalum *(Paspalum dilatatum)* and carpet grass *(Axonopus affinis)* pasture (approximately one-third each species) on a year round basis at Wollongbar since 1958. No fertilizer is applied to this pasture and the small white clover *(Trifolium repens)* component is variable in production and most ephemeral. The cows are rotationally grazed on the pasture.

TABLE 1.

Milk production from a mixed Kikuyu, paspalum and mat grass pasture at Wollongbar.

Year	Stocking Rate (Acres/Cow)	Butterfat Production (lb)		Rainfall (points)		
		Per Cow	Per Acre	July-Dec.	Jan.-June	Total
1958-59	2.4	311	129	2445	5477	7922
1959-60	2.4	320	133	4254	2154	6408
1960-61	2.4	182	76	1123	3728	4851
1961-62	2.4	231	96	2666	5305	7971
1962-63	2.4	215	90	4580	7466	11946
1963-64	2.0	168	84	2065	4173	6238
1964-65	2.0	148	74	1834	2756	4590
1965-66	2.4	184	77	3597	3113	6710
1966-67	2.4	190	80	1528	7140	8668

After the first two years, when the cows were obviously taking advantage of a feed build-up which had occurred through years of relative understocking and concentrate feeding on the Station, production fell until it now appears to have stabilised slightly above the average production of commercial properties around Wollongbar.

These data are in accord with our knowledge of the productivity of the three grasses on Wollongbar where, with no fertilizer applied, average annual yields of dry matter (D.M.) per acre are for Kikuyu, paspalum and carpet grasses approximately 4000, 3000 and 1000 lb respectively. At this level of pasture production, I have estimated that there is approximately 4500 lb digestible organic matter (D.O.M.) available per cow annually on the pasture at the stocking rate of approximately 2½ acres per cow. The energy available appears to match the requirement of a 700 lb cow producing about 180 lb fat annually (Wallace, 1956), approximately the productive level on our unimproved grass pasture.

Can the productivity of these pastures be improved? The answer is an incontestable yes.

Examining Kikuyu grass first; Colman (1966) has shown that when nitrogen fertilizer is applied to the grass in addition to a basal superphosphate (2 cwt per acre) and potash (1 cwt muriate per acre) dressing, response is almost linear up to 800 lb nitrogen applied per acre. He estimated that with 300 lb N. applied, annual production would be approximately 10,000 lb D.M. per acre. Depending on the way in which the nitrogen was applied (number of split dressings), Colman found that significant growth occurred in our environment over a ten month period of September to June. In fact, when 600 lb N. was applied per acre, growth exceeded 30 lb D.M. per day over those 10 months (total production 18,000 lb per acre).

* All dairy cows used in the Wollongbar studies are either purebred or grade British breed type, predominantly Guernsey.

The performance of Clarence glycine has been examined over a number of soil types in the Richmond-Tweed (Murtagh and Mears, 1964). On Wollongbar, yields of legume dry matter measured in a grazed glycine-Kikuyu pasture have been as high as 4000 lb D.M. per acre and over a three year period averaged 3500 lb (Colman, Holder and Swain, 1966). On this same pasture the total yield of grass and legume was 7040 lb D.M. per acre with the period of measurement from January to June.

Holder (1965) has measured the digestibility of the two species at different stages of growth both singly and in combination. Material was cut and fed green daily to penned wether sheep. Selected data are given for the two species in Table 2.

TABLE 2
Digestibility of *Glycine javanica* and Kikuyu grass

Species	Stage of growth	Crude Protein %	Digestibility %	
			D.M.	C.P.
Glycine javanica	February—leafy	18.9	61.7	80.3
	May—flowering	20.2	59.6	79.3
	June—post flower	14.9	55.7	72.2
	July—seeded and frosted	12.9	56.2	66.6
Kikuyu +	January—leafy	14.1	68.6	70.0
	June—leafy	13.8	70.8	72.6
	November—winter carryover	6.3	53.3	25.9
Kikuyu *	March—36 days	12.9	60.4	58.8
	May—36 days	18.8	73.9	70.6
	August—69 days	19.5	68.3	67.2
	September—99 days	14.8	71.3	68.8
	October—45 days	14.7	64.3	61.5

* Fertilized with cal-ammonium nitrate (100 lb N/acre) after mowing to 2" high.
+ No fertilizer nitrogen.

It is clear that the digestibility of organic matter can vary widely depending on a number of factors, with, undoubtedly, age of the pasture and the moisture regime under which the pastures are grown playing major roles in determining digestibility. Intake has varied widely without a clear pattern relating to digestibility developing (Holder 1965). As a general statement I would not be far from the truth in saying that digestibility of the organic matter in glycine will be about 10 units lower than a temperate legume like subterranean clover **at an equivalent stage of growth.** Kikuyu grass can, if maintained in an actively growing and vegetative stage of growth, retain relatively high digestibility coefficients, of the order 70-72% digestibility of organic matter.

Based on these data the pasture mentioned above, yielding in excess of 7000 lb D.M. per acre, could provide approximately 4300 lb D.O.M. per acre over a 6 month period.

Does milk production reflect this sort of yield?

Milk production from a Kikuyu-glycine pasture

Stall feeding studies

Dale and Holder (to be published) over a 9 week period, January to March, 1966, offered such a pasture, cut twice daily and fed green, *ad libitum* to three stall fed monozygous twin cows which had calved at the end of December, 1965. The three co-twins were offered lucerne hay *ad libitum* plus a concentrate mix fed at a rate of 4 lb per 10 lb of 4% fat corrected milk (F.C.M.) produced. The objective was to secure production from the latter, close to their potential over the period of the study. The dietary intake and milk production are shown in Table 3.

TABLE 3
Intake of digestible organic matter and milk production of cows fed glycine-Kikuyu or Lucerne plus concentrate.

Week	Glycine-Grass Diet			Lucerne Hay-Concentrate Diet*	
	Digestibility O.M. %	DOM I lb/day	FCM lb/day	DOM I lb/day	FCM lb/day
1	64.8	13.6	25.5	23.1	43.4
2	65.9	16.1	21.7	22.0	44.0
3	66.6	14.1	20.1	22.7	41.6
4	60.5	14.7	17.4	21.8	41.3
5	57.0	13.9	15.2	22.9	40.3
6	63.3	15.6	15.5	22.4	38.5
7	62.5	13.6	13.9	21.8	39.4
8	70.1	17.2	14.5	22.4	35.9
9	72.1	20.6	17.8	22.7	35.4
Mean		15.4	18.0	22.4	40.0

* Mean digestibility O.M. % = 70.4 ± 0.7.

A number of points can be made:

(a) The potential for milk production of these grade twin cows was apparently quite high.

(b) The pasture-fed cows were not able to ingest sufficient digestible energy (protein was not limiting) to reach this potential. (Strenuous efforts were made to provide pasture in a fresh state but despite this, overnight "heating" of the greenchop material occurred and may have limited intake slightly).

(c) The difference in D.O.M. intake between the dietary groups (7.0 lb/day) would explain completely the difference in milk yield, agreeing quite closely with the data of Wallace (1961) who found that 0.33 lb D.O.M. was required to produce 1 lb F.C.M.

(d) Milk production achieved from the pasture was approximately 60% higher than the potential indicated by Hardison (1966).

Grazing Studies

Attempts to measure production from a fully improved glycine — Kikuyu pasture grazed on a year round basis by dairy cows have just commenced at Wollongbar.

On 24 acres of such a pasture, established in December 1965, 18 cows have been grazing full time since September 1966 at a stocking rate of 1.33 acres/cow. Half of these cows receive an oat grain supplement daily. The cows calved over the December 1966-January 1967 period. Production to date of writing is as follows:

Supplement (lb/day)	No days in milk	lb F.C.M. (TOTAL)	lb F.C.M./day
4.5	219	5850	26.8
Nil	209	4250	20.3

Two points can be made; firstly, that again production from the pasture is well in excess of that predicted by Hardison (1966) and second that an energy supplement has increased production although, as usual, not to the extent expected on the basis of the energy supplied by the supplement. Production per acre achieved to date is 152 lb butterfat (3800 lb F.C.M.).

Milk production from a nitrogen fertilized Kikuyu grass pasture

Colman and Holder have over the past two years measured milk production from a predominantly Kikuyu grass pasture, receiving 300 lb N. per acre annually (as sulphate of ammonia) in six split dressings in addition to a basal 2 cwt superphosphate and 1 cwt muriate of potash. Cows are grazed year round on the pasture at three stocking rates 0.66, 1.00 and 1.33 cows per acre (low, medium high). Results for the 1966/67 lactation (all heifers) are shown in table 4.

TABLE 4

Milk production from a nitrogen fertilised Kikuyu pasture.

Stocking Rate (cows/acre)	Body Wt. at Calving (lb)	Body Weight Gain (lb) During Lactation	FCM Production (lb)		Butterfat (lb)	
			Per Cow	Per Acre	Per Cow	Per Acre
0.66	606	203	6525	4075	261	163
1.00	525	205	6100	6100	244	244
1.33	600	220	5475	7300	219	292

A number of points can be made:

(a) The obvious influence of stocking rate in the production response.

(b) Production of milk was well in excess of that suggested by Hardison.

(c) It was possible for the heifers to make large liveweight gains during lactation.

(d) Feed shortages tended to occur during the late spring early summer at the high stocking rate.

(e) Despite the latter point, it is our intention to increase stocking rate to 2 cows per acre at the same rate of nitrogen input.

In summary, therefore, our experience with a tropical legume and a grass on the research station is as follows:

(a) Kikuyu grass is an outstanding pasture species, very responsive to nitrogen input either from legume or as fertilizer, capable of withstanding heavy grazing pressure. It is known to be susceptible to certain insect attack and a not yet clearly defined "yellow disease" (Allen, private communication).

(b) Clarence glycine is well adapted to our environment. Generally it is easy to establish and if individual plants are allowed time to develop over a 2-3 month period in the planting season it is capable of withstanding reasonably heavy stocking rate. In our experience this is up to 1 cow to 1¼ acre under a rotational grazing system. We have no knowledge of the plant's reaction to set stocking.

(c) Nutritive value, and thus milk production, are likely to be higher under grazing conditions than the literature would suggest.

(d) However it is doubtful if in our environment a tropical legume-grass pasture would reach the productive levels of which a temperate legume-grass is capable in a suitable environment.

(e) Tropical *grass* pasture adequately fertilized may allow stocking rates and production up to those of a similarly fertilized temperate *grass* pasture.

EXPERIENCES UNDER COMMERCIAL CONDITIONS IN THE RICHMOND-TWEED REGION

Time prevents my describing in detail the projects developed under commercial conditions on eight properties in the region. The objectives of the study have been

outlined by Bird and Swain (1964) and by Hudson *et al* (1965). An early progress report has been given by Swain (1964). Briefly the general pasture programme is the same on all properties in that research officers responsible have sought to establish the **combination** of temperate and tropical legume and grass species best suited to the particular farm environment. The pasture establishment programme has been relatively slow on each property, with one exception (Farm 8), and designed to meet the capacity of the individual farmer to perform the physical work involved. On Farm 8, the project examines the effect of a rapid development programme secured by capital injection and via some contract working, on a low production base. The production gains made to date are shown in Table 5.

TABLE 5

Production of farms adopting the pasture development programme.

Farm No.	Soil Type	Year Development Started	Farm Size* (acres)	Butterfat Production (lb)	
				Base	1966/67
1	Red Basalt	1962/63	156	8992	10,813
2	Red Basalt	1962/63	100	7355	10,064
3	Red Basalt	1962/63	117	5073	8,111
4	Alluvial	1964/65	134	7081	12,374
5	Alluvial	1964/65	156	6390	11,586
6	Choc. basalt	1964/65	132	6736	13,838
7	Choc. basalt	1964/65	200	10,060	14,474
8	Tweed podsol.	1965	360	6075	10,215

* Area developed on each farm varies.

A number of problems, not least the dry spring-summer in both 1964 and 1965, has been met but general progress has been most satisfactory to all concerned. Certainly, research officers at Wollongbar, as befits the members of a regional research group, are very much aware of the problems which the new technology they seek to implement poses for farmers. There is absolutely no doubt that the farming community is aware of our presence!

SUMMARY

Experience at Wollongbar with tropical legume-grass species is that in our environment far greater production of milk can be achieved from the most suitable species we have, than had hitherto been thought possible. It is doubtful however if production achieved will reach the optimistic predictions of some enthusiasts, and match the potential production of legume-grass pastures in temperate areas.

There appears to be considerable scope for the use of tropical **grass** pastures adequately fertilized and heavily stocked, thus taking advantage of those environmental features favourable to grass growth in the subtropics and tropics, viz, rainfall and high temperatures.

An economic assessment, such as is being undertaken at Wollongbar, will be necessary to determine which technology, if any, should be used.

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