PERSPECTIVES IN PHILIPPINE PASTURES

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ABSTRACT

The improvement and development of pastures, production of quality fodder crops and more efficient utilization of crop residues have been recognized to be the key factors to a viable expansion and development of the ruminant livestock industry particularly of cattle, carabao and goats in the Philippines.

The first ten years of the National Cooperative Pasture Resources Development Program have demonstrated the validity of this view in terms of providing fundamental technologies on the basic forage and pasture production systems. The present state of knowledge is considered peripheral and more in-depth researches are currently being undertaken.

Introduction

Although a few researches had been done on pastures and forages before the 1970s in the Philippines, it was only during the 1970s through the 1980s that formal, organized programs were undertaken to obtain a more comprehensive understanding of Philippine pastures. Three national integrated programs have been launched since 1970, each one lasting for five years, with the third program ending in 1985. The three programs were all nationally-funded through the Ministry of Agriculture coordinated by the Philippine Council of Agriculture and Resources Research and Development (PCARRD) and implemented by the various research institutions of the government.

To appreciate more fully the developments that took place during this period, it is logical to present an appraisal of the industry situation, the programs, identified problem areas, accomplishments and then determine areas or gaps that require further research.

Forage and pasture research situation

Forage crops and crop residues are and will remain the cheapest sources of feeds for ruminants even in the very distant future. Feed grains turn out to be more expensive because their use as feeds for poultry and swine compete with human consumption. The improved management of pastures, production of quality fodder crops and efficient utilization of crop residues would be the key factors to a viable expansion and development of our livestock industry particularly of cattle, carabao and goats.

In general, four types of livestock production exist, namely: (a) commercial or extensive ranch type, (b) pastures under plantation crops, (c) integration with dominant cropping systems and (d) small holder or backyard feedlot. Of the forage resources, it is estimated that the Philippines has 3.5 million hectares of open grasslands and about 400,000 hectares out of the 2.5 million hectares of land under coconuts which are currently utilized for grazing.

There are also about 200,000 hectares of forest plantations which are potentially available for grazing but which are hardly utilized at present. At the small holder level, animals subsist mainly on weeds, crop residues and other by-products derived from 3.6 million hectares of rice land, 3.4 million hectares of corn lands and 533,000 hectares of sugarcane lands (Table 1).

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Table 1 Classification of pasture and forage resources and potential carrying capacities

	Classification	Area (ha)	Carrying capacity (A U/ha)	Total A U
A	Commercial grazing lands			
	Arable area, improved	10,000	2.0	20,000
	Arable area, unimproved	180,000	2.5	90,000
	Non arable area	760,000	0.25	190,000
	Total	950,000		350,000
B	Pastures under coconuts	400,000	1.0	400,000
C	Silvipastures	250,000	0.5	125,000
D	Small holder farms			
	Rice lands	3.6 M	0.5	1.8 M
	Corn lands	3.4 M	2.0	7.8 M
	Sugarcane	0.53M	2.0	1.06M
				11.0M

Program thrusts

The present program has identified several areas of research which are generally classified under (a) small holder or backyard production and (b) commercial production systems. Technical and/or financial support has been distributed equally among the areas, although the urgency and priority ranking depends largely upon the rate of research accomplishments made in these areas. The more specific studies in these areas are as follows:

Small holder or backyard production system. (1) Appropriate schemes integrating fodder crop production with existing cropping patterns. (2) Socio-economic evaluation of integrated crops-livestock farming. (3) Small holder or backyard fodder production. (4) Utilization of crop residues and other agro-industrial by-products.

Commercial production system. (1) Economic evaluation studies on pastures improvement, including seed production, fertilizer use, extensive/intensive pasture development, and different levels of pasture management in existing cattle farms in the Philippines. (2) Micronutrient studies on grassland soils, including improved pastures. (3) Effects of grazing management on hydrology of native pastures. (4) Breeding for low mimosine, high meal, and fast-growing *Leucaena* varieties. (5) Screening for acid and saline tolerance of forage species. (6) Screening for high-intensive-utilization of forage species. (7) Collection and screening of non-conventional plant species for forage purposes. (8) Management and utilization studies of sown grass or legume pastures. (9) Time of grazing in relation to reproductive efficiency, growth rate and marketability of Braham cows and steers in native pastures. (10) Studies of farmer acceptance of backyard forage production schemes.

Research accomplishments

Technology generation in forage, pasture and grasslands started from fundamental researches cutting across various disciplines, particularly, grassland ecology, soil fertility and legume bacteriology, plant breeding, agronomy, plant pathology, animal utilization and seed production technology. Supportive to the National Livestock Program, the National Cooperative Pasture Resources Development Program was initiated to tackle the feed problems of the livestock industry. The highlights of these programs are summarized as follows:

1 Grassland ecology

1) In contrast to the conventional way of classifying Philippine grasslands as *Cogonales*, pioneering work in ecology identified four dominant grassland types, namely (a) *Imperata* (cogon), (b) *Themeda*, (c) *Capillipedium* and (d) *Chrysopogon*.

Imperata and *Themeda* are the two most useful for grazing among the four types, hence, grazing areas should be confined to these two types.

2) The presence of phenol carboxylic compounds and a high sugar content in *Imperata* had an inhibitory (allelopathic) effect on other plants, thus affecting the introduction of legumes to grasslands (Sajise and Lales, 1975). Evidence was presented to the effect that allelopathic influence of cogon could be attributed more to lowering of soil pH due to high sugar concentration in the rhizomes than from the effect of some secondary metabolites. The sugar exuded from the rhizomes is utilized by microorganisms resulting in decreased soil pH (Fig. 1 and 2) (Sajise and Orlido, 1972).

3) Plant competition studies have shown that Napier and Guinea could effectively compete with and serve as a promising biological control material for the noxious Giant Mimosa that infests pastures (Sajise and Aguilar, 1977).

4) Autecological studies on *Themeda trianda* revealed that the plant produced 7.0-9.

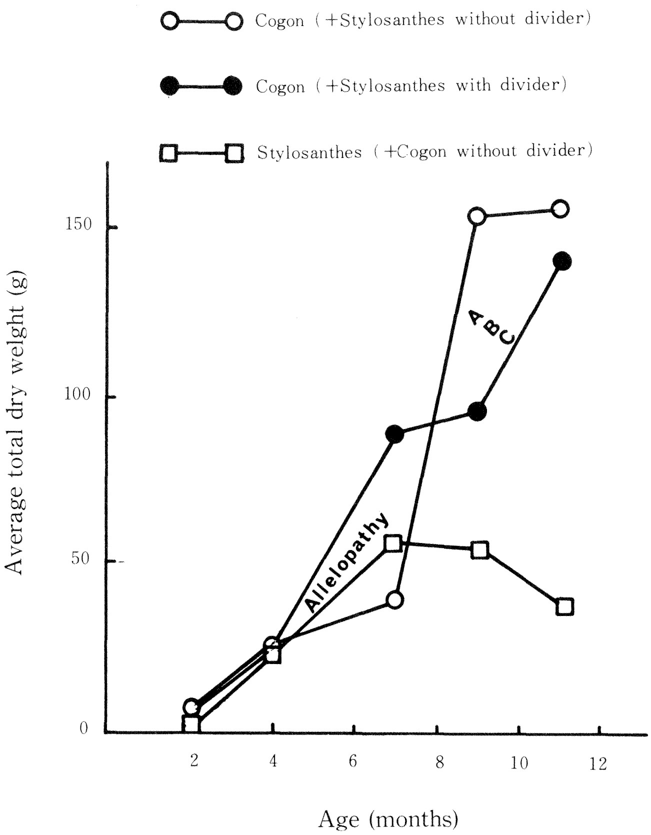

Fig. 1 Growth of *Stylosanthes* grown in mixed culture without root divider and growth of cogon in mixed culture with, without root divider. A, allelopathy; B, root restriction and C, light competition.
From Sajise and Lales, 1975.

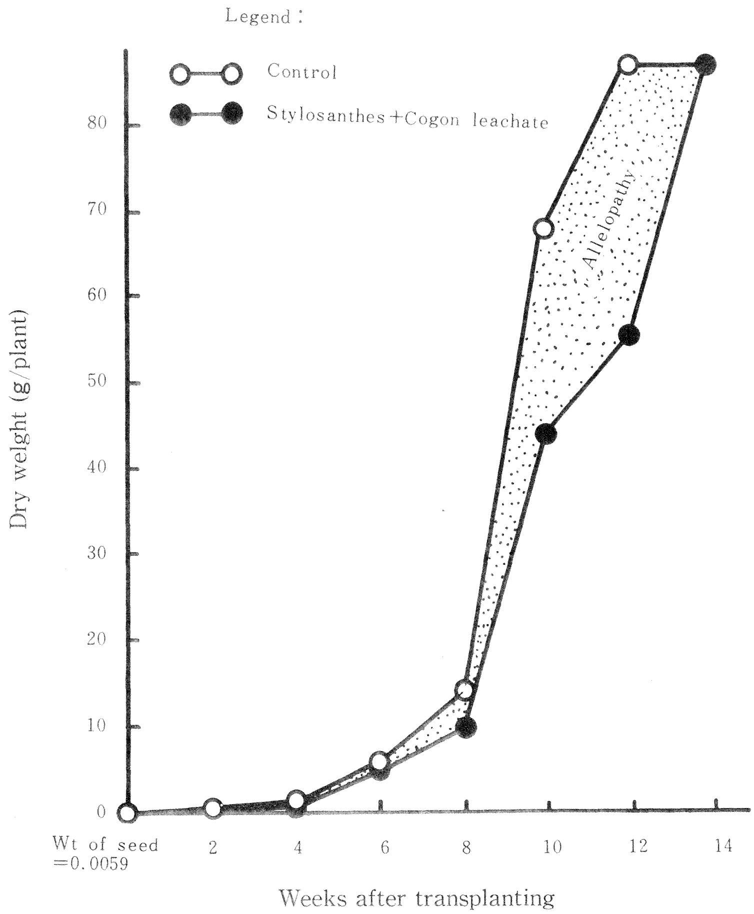

Fig. 2 Growth of *Stylosanthes* plants receiving leachate originating from cogon plants and originating from *Stylosanthes* plants serving as the control.
From Sajise and Lales, 1975.

6x10^5 spikelets/ha. However, filled spikelets and germination percentage were low (2.7 and 2.2%). This low reproductive potential by means of seeds was compensated for by the high tillering capacity and the mechanical ability of the seeds to be buried in the soil for protection against adverse conditions. In overgrazed areas, filled grains increased up to 23% and the ability of the species to persist in a particular area was further enhanced by its wide ecological tolerance to environmental factors such as soil pH (Sajise and Orlido, 1972).

5) Perennial stylo (*Stylosanthes guyanensis*), some *Leucaena* cultivars and *Centrosema* were found to combine well with most grass species owing to their ability to tolerate low pH levels and high acid phophatase enzyme (surface enzyme) activity. The enzyme is found to be able to hydrolyze insoluble phosphate sources present in the soil (Sajise *et al.*, 1975).

2 Soil fertility and legume bacteriology

1) Most grassland soils had been found acidic and deficient in phoshorus and, therefore, a hindrance to grassland improvement through legume introduction. Stylo appeared to be most tolerant to low soil pH while ipil-ipil (*Leucaena*) seemed most sensitive to it. Productivity of these grasslands can, therefore, be improved by liming and phosphorus fertilization

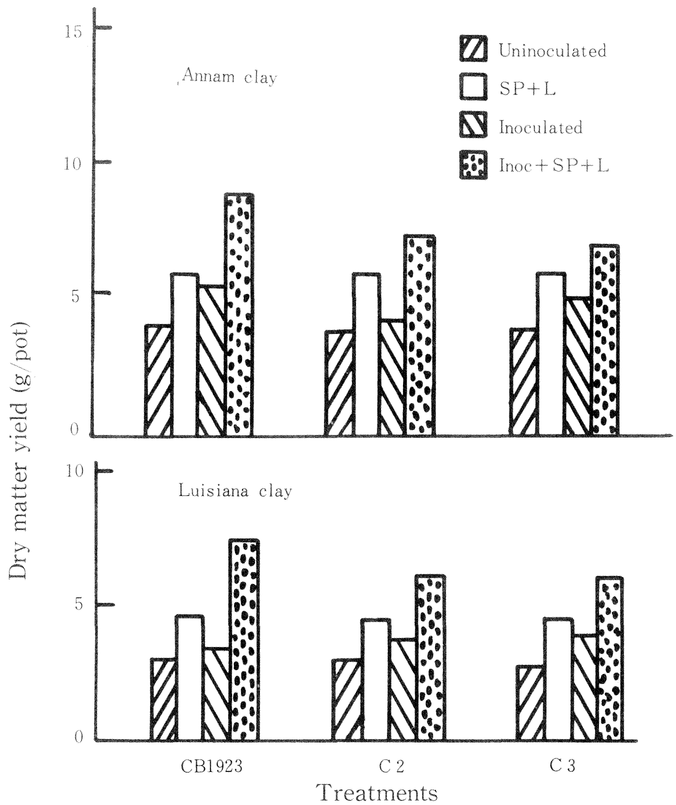

Fig. 3 Dry matter yield of *Centrosema pubescens* as affected by inoculation and P application.
From Paterno and Espiritu, 1978.

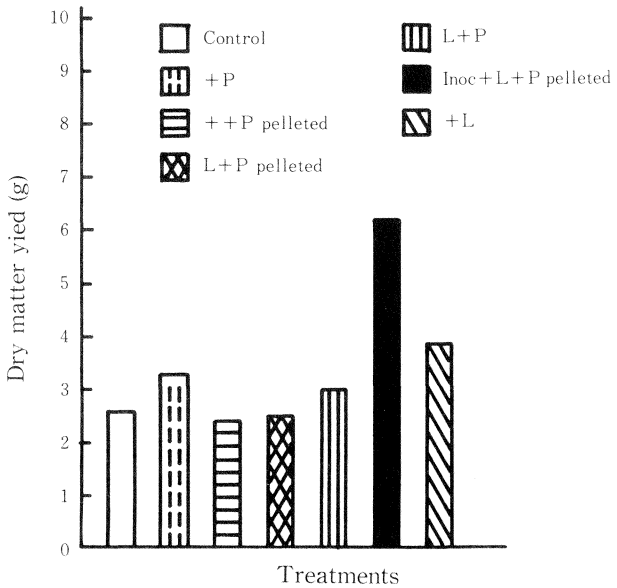

Fig. 4 Effect of treatments on the dry matter yield of ipil-ipil.
From Tilo, 1975.

(Fig. 3 and 4) (Paterno and Espiritu, 1978; Tilo, 1975).

2) Although there appeared to be an effective indigenous rhizobial population for most pasture legumes overseeded in grasslands, nitrogen input can be minimized by rhizobial inoculation.

3 Agronomy

1) Legume establishment and increase in carrying capacity

(a) Overseeding legumes on *Imperata*-dominated grasslands which are mostly rolling hills and steep slopes in inaccessible areas on generally poor soil had been shown to offer the quickest and most practical approach to large-scale improvement of native grasslands. This can be done by either burning or heavy grazing non-accessible areas or by disking the more accessible areas. (Table 2 and 3) (Javier and Marasigan, 1974).

(b) Oversowing legumes on native pasture increased its productivity and provided adequate forage for animals during the dry season. Experiments at Masbate showed that

Table 2 Legume contribution to herbage yield four months from sowing, June sowing (%)

	Burned	Grazed	Disked	Average
Centrosema	2.4	3.5	16.9	7.6
Siratro	1.5	1.2	13.1	5.3
Schofield stylo	32.8	22.7	66.8	40.8
Townsville stylo	4.5	3.1	29.7	12.4
Average	10.3	7.6	31.6	16.5
Comparisons: 5% level				
Seedbed preparation		Disked>Burned, Grazed		
Species		Schofield>Townsville, Centrosema, Siratro		

From Javier and Marasigan, 1974.

Table 3 Legume contribution to herbage yield four months from sowing, November sowing per cent

	Burned	Grazed	Disked	Average
Centrosema	9.9	3.7	51.2	21.6
Siratro	8.6	0.4	49.8	19.6
Schofield stylo	34.0	9.3	84.4	42.6
Average	17.5	4.5	61.8	28.8
Comparisons: 5% level				
Disked>Burned>Grazed				
Schofield stylo>Centrosema, Siratro				
Significant seedbed x species interaction				

From Javier and Marasigan, 1974.

Imperata pasture overseeded successfully with stylo can easily carry 1 AU per hectare with a beef production of 150 kg liveweight gain per hectare per year. Residual herbage after grazing could still support additional 0.5-1.0 AU per hectare. On the other hand, a pure *Imperata* pasture with a carrying capacity of 0.5 AU resulted in only about 14 kg of beef per hectare per year. Animals lost weight during the dry season.

In Zambales, similar results were obtained using Townsville stylo. The annual stylo dried off during summer, but animals still relished the dry herbage, resulting in weight gain even during the dry season.

Perennial stylo, a recommended forage legume is sensitive to cutting treatments. For this species to persist and maintain productivity, cutting height should allow the plant to retain some leaves. This would be about 20 cm from ground level. Severe and untimely cutting was the main reason for the short duration of perennial stylo that many farmers were complaining about.

(c) Ipil-ipil yielded more edible herbage when suitable height of at least one meter was maintained. The usual recommended cutting height was 15 cm to 30 cm. This height is still the most convenient for mechanized harvesting (Tables 4 and 5) (Mendoza *et al.,* 1976).

2) Integration of fodder production with existing cropping system

(a) A model upland-farming system built around ipil-ipil grown in hedgerows and intercropped with corn or upland rice was initially shown to be a potentially productive approach to integrated crop-livestock farming. Ipil-ipil could substitute for the expensive oil-

Table 4 Dry matter yields of ipil-ipil (*L. latisiliqua*) harvested at different cutting heights and frequencies (ton DM/ha/year)

Height	Frequency (weeks)			Mean[1]
	8	12	16	
6 inch	11.00	9.54	11.49	10.68
1.5 meter	17.82	14.34	15.18	15.78
3.0 meter	24.07	22.80	23.97	23.61
Mean[2]	17.62	15.56	16.88	16.69

1 Means are significantly different from each other at 1% level.
2 No significant differences among frequency means.
From Mendoza *et al.,* 1976.

Table 5 Crude protein content of ipil-ipil (*L. latisiliqua*) harvested at different cutting heights and frequencies (% DM).

Height	Frequency (weeks)			Mean[1]
	8	12	16	
6 inch	22.72	20.95	13.48	19.05
1.5 meter	23.45	19.90	18.34	20.56
3.0 meter	21.86	18.88	20.07	20.27
Mean[2]	22.68a	19.91ab	17.30b	19.96

1 No significant differences among height means.
2 Means with similar letters are not significantly different at 5% level.
From Mendoza *et al.*, 1976.

Table 6 Comparative yields of fertilizer N and herbage (*Leucaena*) N-treated corn crop

Parameters	Trial I	
	Leucaena fertilized plot	Check plots
Herbage applied (ton/ha)	9.44	0
N-equivalent* (kg/ha)	70.85	0
Corn/fodder yield (ton DM/ha)	8.24	3.59
Green corn yield (ton/ha)	4.06	1.48

Parameters	Trial II			
	Leucaena intercropping plots		Pure corn plots	
	3 meter	4.5 meter	45-30-30	90-30-30
Herbage applied (ton/ha)	9.85	7.84	—	—
N-equivalent (kg/ha)	73.94	58.8	45.0	90.0
Corn fodder yield (ton/ha)	11.02	9.94	14.59	14.44
Marketable corn ears (ton/ha)	8.99	7.58	9.07	8.11
Non-marketable corn ears (ton/ha)	1.32	1.20	1.09	1.18

*At approximately 1.5% mineralization rate. Yields from the *Leucaena* fertilized plots are expected to go up in time due to organic matter build-up.
From Mendoza *et al.*, 1981.

based inorganic fertilizer for corn or upland rice and could also be a high-protein supplement feed for backyard goats or cattle utilizing crop residues (Table 6) (Mendoza *et al.*, 1981).

(b) Fodder species such as forage soybean and kadyos, if intercropped with corn or upland rice offer a cheap source of high quality forage without reducing grain yield of corn or rice.

(c) Growing corn at twice the level of the recommended planting density per hectare is a means of providing fodder for backyard cattle in the form of excess corn plants thinned within 40 days from sowing.

4 Seed production

The economic feasibility of producing seeds from important pasture legumes has been explored. The cost of producing a kilogram of seed is about 2 to 3 times lower than that of locally produced seeds, and 5 to 8 times lower than that of imported seeds. For a livestock farmer it would be better to grow his own seeds for pasture improvement. For seed producers, the lack of a stable and established market makes seed production risky (Table 7) (PCARRD, 1983).

Some pasture grasses such as Alabang X and Guinea grass can be propagated effectively by seeds. Under natural conditions of the seeds, germinability is low. Germination can be enhanced considerably by treating the seed with 0.2% KNO_3.

In legumes such as stylo and ipil-ipil, germination can be enhanced by acid treatment (concentrated sulfuric acid) for five to ten minutes or hot water treatment (80°F) for 1 minute.

5 Animal utilization

1) *Controsema, Siratro*, perennial stylo and ipil-ipil were successfully overseeded on established Guinea pastures. Legumes were better maintained by phosphorous fertilization.

2) Napier or Centro pasture fertilized with 65-45-45 NPK produced 128 to 148 tons of

Table 7 **Comparison of seed yield, price and returns between corn and seven pasture seed crops (1981–1982 prices)**

Crop	Seed yield (kg/ha)	Suggested selling price (ha)	Imported seed price (kg)	Establishment cost (ha)	Return after establishment cost (ha)
Corn, flint	2,500	6.00	-	2,750	12,250
Siratro	700	60.00	100.00 160.00	2,000	40,500
Schofield stylo	200	60.00	150.00 250.00	2,000	10,000
Townsville stylo	100	45.00	25.00 60.00	2,000	2,500
Guinea grass	200	45.00	60.00 80.00	2,500	6,500
Alabang X	250	40.00	None	2,500	7,500
Setaria	150	45.00	60.00 80.00	2,500	4,250
Centro	700	12.00	None	2,000	6,400

From PCARRD, 1983.

fresh herbage per yer year in a study conducted at ANSA Farms. This pasture safely carried three animals per ha with beef production of 475 kg liveweight gain per ha per year. With four animals, the pasture gave 806 kg liveweight gain per hectare but ran out of grass for 37 days when corn-stover supplementation was resorted to.

In another study conducted at Bukidnon, beef production on Para pastures showed that on mixed Para grass/Centro pastures fertilized with 50 kg P_2O_5/ha/yr and stocked with 2 AUs, 305 kg of beef liveweight gain resulted. Pure Para grass fertilized with 100 kg N/ha/yr produced only 200.4 kg of beef liveweight gain (Tables 8-11) (PCARRD, 1983).

6 Breeding

1) Variety and adaptability trials of improved pasture grasses and legumes have resulted in recommended interim pasture grasses and legumes.

2) Hawaiian K-lines and the Peruvian variety were introduced and became popular not only with livestock farmers but also with crop farmers. The high nitrogen content and high herbage yield made ipil-ipil a living protein-supplement factory for livestock feed and promising organic fertilizer to increase crop yield. Today breeding is geared towards the development of low-mimosine varieties. Several *Leucaena* lines that are tolerant of acid soil conditions with high Al content have also been isolated (Table 12) (Mendoza *et al.*, 1982; Mendoza, 1983).

Table 8 Liveweight gain on native grass/legume pastures

Location	Stocking rate (AU/ha)	Average daily gain kg	Liveweight gain		Botanical composition End of grazing trial	
			Per head kg	Per ha kg	Grasses %	Weeds %
CMU	1.0	0.212	77.46	77.46	89.6	10.4
	1.0	0.274	100.20	100.20	36.5	63.5
Masbate	0.5	0.120	43.25	21.63		
	1.0	0.070	26.64	26.64		

From PCARRD, 1983.

Table 9 Liveweight gain on native grass/legume pastures

Pasture	Location	Stocking rate A U/ha	ADG kg	LWG/hd kg	LWG/ha kg
Cogon/Stylo	Masbate	1.0	0.32	116.62	116.62
Cogon/Centro	Masbate	1.0	0.25	91.80	91.80
Cogon/Centro	C M U (Bukidnon)	1.0	0.26	94.12	94.12
Native/Townsville stylo	Zambales	0.5	0.28	202.1	101.0
Native/Townsville stylo	Zambales	1.0	0.18	128.9	128.9
Native/Townsville stylo	Zambales	1.5	0.17	119.6	179.1

From PCARRD, 1983.

Table 10 Liveweight gain on grass/legume pastures

Type of pasture	Location	Fertilizer rate (kg/ha/yr)	Stocking rate A U/ha	ADG kg	LWG/hd kg	LWG/ha kg
Para grass/Centro	CMU	0-50-0	2.0	0.427	155.87	311.75
Para grass/Centro	CMU	0-50-0	2.0	0.419	152.90	305.80
Napier/Centro	ANSA farm	65-45-45	2.0	0.428	156.50	313.00
Napier/Centro	ANSA farm	65-45-45	3.0	0.431	158.00	474.00

From PCARRD, 1983.

Table 11 Liveweight gain on pure grass*

Type of pasture	Fertilizer rate (kg/ha/yr)	Stocking rate A U/ha	ADG kg	LWG/hd kg	LWG/ha kg
Para grass	100-50-0	2.0	0.419	153.08	306.17
Para grass	200-50-0	3.0	0.429	156.58	469.75
Para grass	100-50-0	2.0	0.357	130.20	260.40
Para grass	200-50-0	3.0	0.285	104.00	312.00

*Taken from experiments conducted in Central Mindanao University (CMU).
From PCARRD, 1983.

Table 12 Screening for *Leucaena leucocephala* tolerant to Luisiana soil* (acid type)

Rank	Acc. No.	Height class	Noninoculated		Inoculated	
			Dry weight (mg)	Growth rate (mg/wk)	Dry weight (mg)	Growth rate (mg/wk)
1	68	I	91.6	12.3	242.0	35.2
2	19	T	249.9	35.6	220.0	30.2
3	55	S	162.9	18.4	202.0	27.4
4	30	T	111.4	9.4	198.0	23.8
5	71	T	183.5	28.6	195.0	25.8
6	65	T	120.3	18.4	183.0	23.4
7	70	I	197.5	33.2	183.0	25.0
8	69	I	124.4	20.4	172.0	25.4
9	119	I	125.8	15.8	171.0	23.8
10	105	T	183.9	23.8	150.0	17.2
11	78	S	138.3	16.2	146.0	19.8
12	64	T	124.4	11.6	143.4	19.8
13	5	T	126.9	15.0	141.0	18.4
14	86	I	191.4	26.4	140.0	20.0
15	95	T	123.2	14.6	140.0	16.8
16	42	T	235.6	31.8	139.0	17.0
17	62	T	184.3	21.2	139.0	13.2
18	7	S	126.86	15.0	138.3	19.2
19	76	S	100.0	10.8	134.0	17.4
20	72	T	75.9	6.6	130.0	15.8
21	44	S	98.1	12.6	129.1	17.8
22	75	T	124.0	15.4	129.0	16.0
23	77	S	138.8	18.0	127.0	16.4
24	22	S	127.0	12.6	127.0	17.6
25	80	T	119.0	10.4	126.0	16.4
26	12	I	106.3	10.4	125.7	15.4
27	79	T	98.4	15.4	124.0	15.2
28	24	S	92.6	9.0	120.0	18.0
29	92	S	82.4	8.8	120.0	12.2
30	66	T	96.7	16.2	112.0	15.8
31	100	T	214.1	29.0	110.0	13.4
32	98	T	80.2	4.4	110.0	14.0
33	87	S	171.6	24.6	110.0	14.6
34	96	T	114.1	13.6	110.0	14.6
35	88	S	97.1	11.4	110.0	13.6
36	74	T	71.4	7.2	106.0	14.2
37	89	S	120.3	15.8	100.0	12.2
38	103	T	78.7	6.6	100.0	12.8
39	91	S	77.8	8.8	100.0	12.0
40	113	T	105.2	13.0	95.0	11.8
41	11	S	91.4	6.4	91.0	12.6
42	90	S	98.1	12.8	90.0	10.8
43	85	S	84.7	9.0	90.0	8.2
44	21	I	128.5	17.5	90.0	10.6
45	108	T	142.9	17.6	90.0	9.0
46	43	S	55.5	1.4	84.0	11.2
47	8	S	123.8	15.2	80.0	12.6
48	83	I	86.6	9.6	80.0	12.6
49	117	T	73.9	7.4	74.0	9.8
50	52	S	132.2	18.2	72.0	9.6
51	101	T	82.5	64.0	71.0	7.2
52	99	T	111.1	9.6	70.0	6.0
53	111	T	63.8	2.8	60.0	6.2
54	109	T	153.9	24.2	67.0	5.2

*Data taken at 5 weeks after germination. Tabulated according to decreasing dry weight of inoculated plants.
From Mendoza *et al.*, 1982.

Present commodity industry situation

The series of trials conducted during the last decade basically have led to a better understanding of the following: (a) population dynamics of the dominant grassland species as affected by the major environmental and cultural factors, (b) the contribution of legumes towards increasing and maintaining pasture productivity, (c) better grazing and stocking management to maintain pasture productivity and persistence, and (d) utilization of farm by-products and crop residues.

It should not be construed however that nothing more has to be done. In fact, the present technologies are only peripheral. More in-depth researches should be undertaken. However, in view of what has been accomplished, it can now be confidently claimed that of the total forage and pasture resources we have, an animal population of over 11 million can easily be supported in small feedlots and commercial farms. In 1979, 4.2 million head of cattle and carabaos were reported to have been raised in backyards and apparently there is still a lot of excess of unutilized feed resources.

Research gaps

The following have been identified as research gaps which limit the availability of technology for packaging:

1) Valid evaluation studies in management and economics for pasture crops, fertilization, cutting regimes, integration of crops-fodder-livestock production, and the different levels of pasture management.

2) Intensive evaluation of the different schemes of integration of fodder production with existing cropping systems.

3) Exhaustive studies on various low-quality farm residues and other agro-industrial by-products in combination with high-quality forage and feedstuffs.

4) Extensive studies on management of native and improved pastures.

5) Valid studies on effective pasture-extension strategies.

Research thrusts

To achieve production self-sufficiency in livestock products, the following research thrusts have been identified.

1) Pasture improvement and production of good quality forage crops, and development of efficient utilization schemes for crop residues and agro-industrial by-products.

2) Technical constraints to pasture development through applied research.

While in the past, our main livestock feedstuffs had been derived from commercial or extensive type of production, the conversion of some of these areas to crops brought about by population pressure has shifted the emphasis to a more intensive system of forage production. But since the two systems complement each other, the present program recognizes the need to attain a more productive balance between the two.

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Discussion

Jayawardana, A.B.P. (Sri Lanka): Did you use mineral licks in the trials when you obtained 0.2kg/head liveweight per day?

Answer: No the cattle were continuously grazed on grass without any supplement. During the dry season the liveweight decreased. In other trials including legume supplements the liveweight increased to 0.4kg/head/day.

Kitamura, Y. (Japan): How did you identify plant allelopathy in the case of *Imperata* inhibiting the growth of *Stylosanthes*?

Answer: We found phenocarboxylic compounds. The rhizome of *Imperata* contains a very high concentration of sugar which causes a decrease in the soil pH which in turn hampers legume establishment. *Stylosanthes guyanensis* as well as some accessions of *Leucaena* has an active acid phosphatase enzyme system which enables it to compete with *Imperata*. It is mostly a phenomenon that involves the inhibition of root development of the legume which is brought about by the decrease in pH. In addition there is a problem of light competition since in a plant with restricted root function, growth is often stunted.

Kawanabe, S. (Japan): 1. What is the acreage of *Leucaena*? 2. You referred to a system of rice-corn, corn-*Leucaena* intercropping. Are these systems well accepted by the farmers?

Answer: 1. My estimate which includes both private and public plantations is 50,000 hectares. 2. These systems are attractive to the farmers, particularly in the highlands, who depend on rainfed agriculture, to secure feed during thy dry season. Also, in the lowland areas, the integration with *Echinochloa crusgalli* is profitable since the farmers harvest this weed manually and feed it to the cattle, instead of applying chemical herbicides. When the price of *Leucaena* leaf meal increases, the farmers sell the leaves as leaf meal and do not apply them to corn as fertilizer.