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" SYSTEMS OF ANIMAL PRODUCTION IN
IN THE TROPICS"

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WHAT SYSTEMS OF ANIMAL PRODUCTION ARE JUSTIFIED FOR TROPICAL COUNTRIES?
A J Smith; *University of Edinburgh, Scotland*

Animals are not essential for the survival of man; however in some cultures, for example nomadic ones, people depend almost completely on their animals. In other cultures animals often serve to modify food rather than produce it and in this modification process they reduce the availability of human food from 60 to 95%. The high quality protein produced in this modification process is not needed by man, but he acquires it if he can afford it in order to improve his standard of living.

In the developing world the human population is increasing at an alarming rate and obtaining food for this growing population has been its principal problem. The problem is more acute owing to the fact that the more resources the people have the more animal protein they demand. The system of animal production which would serve to satisfy this demand is very dependant upon the circumstances in developing countries. The developing countries with more economic resources could adopt western systems of intensive animal production if they had the resources to produce or purchase the animal feeds. On the other hand, poor and overpopulated countries can only maintain the type of animal which consumes subproducts and/or carries out a range of other functions such as in the case of draught animals. In arid and semi-arid areas extensive animal production frequently is the only feasible system of agricultural production. In high rainfall zones whenever disease restrictions are not severe, animal production can be integrated with tree crops to increase the overall production of food for humans. All the limitations to production and the population requirements should be analysed completely before the development of new systems. Unfortunately this policy is not always put into practice.

EXTENSIVE OR INTENSIVE IMPROVEMENT OF ANIMAL PRODUCTION SYSTEMS: WHICH IS THE RIGHT MODEL?; J F D Greenhalgh; *University of Aberdeen, Scotland*

The intensification of agriculture involves a change in the balance of the three basic resources: land, labour and capital. Normally it is achieved using capital goods and services to improve the productivity of land and labour. The proportion of the working population of any country which is involved in agriculture is a function of its level of intensification. For the world in general the figure is 45%, for Mexico 36% and for highly developed countries like the United States it is 2%. The chemical processing of forages is an example of the intensification of animal production. It can have the effect of improving liveweight gain from a given forage by a factor greater than 3. Systems of management offer a second example. In Great Britain controlled grazing using electric fences has increased stocking rates and stimulated the use of fertilizer nitrogen. In Europe, however, the principal factor in the intensification of animal production has been the wide use of cereal concentrates. The dangers of intensification are specialisation (lack of flexibility), dependancy on capital loans, and overproduction. Research has been overly preoccupied with the improvement of production through the use of high technology. Whilst developing countries

have many opportunities to intensify their animal production, they must try to avoid the errors committed by countries that are 'over-developed'.

STRATEGIES FOR AGRICULTURAL PRODUCTION IN THE TROPICS: T R Preston ,
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Throughout the world agricultural development has followed three main paths:

(i) Intensification and specialization totally reliant on fossil fuels. Such systems are found in developed countries as for example in Europe, North America and Israel. They are characterized by their high efficiency at crop level (production / unit area) and at animal level (production/ unit animal and /unit of feed).

(ii) Specialized , but extensive systems in which the productivity is low both per animal and per unit area, but in which inputs are minimal. These systems are typical of Latin America, Australia and much of Africa.

(iii) The highly efficient use of land, but with low animal production in mixed and integrated systems . Such systems are the basis of Asian agriculture.

The factors which have contributed to this situation will be discussed in the light of future tendencies, with respect to the demand for crop and animal products, and the role of fossil fuels and their alternatives. It is concluded that mixed systems, in which crop production, energy and animal production are integrated, offer the most appropriate base on which the growing demand for food and energy can be satisfied through the use of natural renewable resources.

CANAVALIA ENSIFORMIS (JACKBEAN) AS A PROTEIN SOURCE TESTED IN YUCATAN ;
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Experiences in Venezuela and the Dominican Republic have indicated that the Jackbean promises to be a valuable source of vegetable protein for animal consumption in the tropics. In order to test the adaptation of this legume in the rocky soils of the henequen zone of the Yucatan, an agronomic trial which tested the effect of different rates of sowing on the grain yield was carried out. A 5 x 5 Latin square design with plots of 400m² was used. The trial was sown at the start of the rainy season (15 June 1981) into land whose sole preparation was weeding. The trial was rain-fed and not fertilised. The seed harvest was started 6 months after sowing (17 December 1981) and a second seed harvest was taken in April 1982. The principal results are presented in the Table. The second harvest yield accounted for only

Plants/m ²	Distance (m)	Seed yield (kg/ha)
5	0.2 x 1.0	1520
2.5	0.4 x 1.0	1840
1.67	0.6 x 1.0	1570
1.25	0.8 x 1.0	1270
1.0	1.0 x 1.0	1280

about 20% of the total. There was a slight tendency ($r=0.40$) for the seed yield to rise as the plant density was increased, with the highest yield 2.5 plants/m² (0.4 x 1.0 m). It is considered that the mean seed yield of 1500 kg/ha under dryland conditions, and without the use of fertilizers on these poor rocky soils is a very promising result for the region.

THE EFFECT OF CUTTING FREQUENCY ON THE YIELD OF FORAGE AND GRAIN OF *CANAVALIA ENSIFORMIS*: B Pound, G Perlata and F Doñe, CEDIPCA, CEAGANA, Aptd 1256/8, Santo Domingo

See Pound B, Doñe F and Peralta G (1982). Effect of cutting frequency on seed and forage yield of *Canavalia ensiformis* (L) D C (Jack bean). Tropical Animal Production 7:262-266

THE EFFECT OF THE REST PERIOD AND GRAZING PRESSURE ON THE PERFORMANCE OF A NATURALIZED PASTURE: L C Galaviz and G Cubillas, Turrialba, Costa Rica.

Pasture management in the tropics is an unknown element for many producers. Amongst the factors that are considered to have the greatest influence upon the performance of these pastures is the rest period and the grazing pressure. Naturalized pastures of guinea (*Panicum maximum*) and Jaragua (*Hyparrhenia rufa*) were studied from July 1978 until September 1980 with the aim of defining management practices from them. Results showed that the botanical composition was negatively affected by rest periods of less than 35 days and by dry matter availabilities equal to or less than 5 kg/100 kg LW. The growth rate was affected negatively by long rest periods and this was accentuated by larger dry matter availabilities. On the other hand, the dry matter offered and rejected increased with lengthening rest periods and with increasing availability of dry matter per animal. The stocking rate and efficiency of utilization showed an inverse relationship with both factors studied. The quality of the forage did not show any changes caused by the factors evaluated.

PROGRESS IN THE USE OF *LEUCAENA LEUCOCEPHALA* IN MEXICAL ANIMAL PRODUCTION: F J Alvarez, FIRA, Banco de Mexico

A range of studies have been made in Mexico in which *Leucaena leucocephala* (leucaena) was used as a forage protein supplement in a variety of diets for ruminants. In dual-purpose cows grazing African star grass, the restricted grazing of leucaena increased milk production and live weight by 17%. In diets of sugarcane, substitution by leucaena of up to 75% of the protein supplement has been achieved without affecting animal productivity. In steers fattening on chopped cane, grazing leucaena for 6 hr/day increased the weight gains from 280 to 730 g/d. When the basal diet was molasses/urea the weight gain was 650 g/d with 4 hr/d grazing leucaena and a supplement of 500 g/d of rice polishings. In calves from 3-7

months of age with restricted suckling and receiving molasses/urea ad libitum and cut leucaena, the weight gain was 680 g/day.

The most outstanding results were obtained in steers with free access to cane juice preserved with ammonia, which gained 850 g/d with a feed conversion of 5.3 when cut leucaena provided the sole source of forage and protein. Mimosine toxicity does not seem to be a problem when leucaena does not exceed 30% of the diet, and when grazing immature plants is avoided. The principal limitations are agronomic and are concerned with establishment and low production at the producer level under certain ecological conditions.

RECENT ADVANCES IN THE MILK INDUSTRY IN THE UNITED KINGDOM: J F D Greenhalgh, *University of Aberdeen, Scotland*

Milk production contributes 22% of the monetary value of agricultural production in the United Kingdom. The strong position of the milk industry is due in a large part to the activities of selling organizations that were formed about 50 years ago. These organizations buy all the milk from the producers at fixed prices and also provide artificial insemination and administrative services. During the last 20 years the mean herd size has increased to 60 cows and the mean milk yield has reached 5000 kg/cow. National production now covers 85% of the total demand. A specialised milking herd would consist of 100 cows on 50 ha of pasture, which would provide for summer grazing and silage for the winter. Concentrates (1900 kg/cow/year) are fed in complete diets or in self-feeders. Genetic improvement is based on the use of progeny-tested bulls, however, consideration is being given to the use of super-ovulation and embryo-transfer to hasten the selection process as much in females as in males. Tuberculosis and brucellosis have been eradicated, but mastitis, reproductive problems, and metabolic disorders still remain. Any further increase in the size of milking herds will probably bring with it an increase in reproductive problems. However, the principal problem of the future will be overproduction of lactose and insufficient production of the fat necessary for cheese and butter.

GENETIC EVALUATION OF MILK PRODUCTION IN A HOLSTEIN HERD: R D Nuñez, P R Regalado, A Tewolde, *Universidad Autónoma Chapingo, Mexico*

Records of 1082 lactations obtained over 5 years (1973-7) from a Holstein herd in the state of Puebla were analysed in order to study genetic and environmental effects, and estimate the heritability of milk production. The lactations were adjusted to 305 days (PL305). The analysis was by least squares, and the model that was employed included the effects of the cow (V), the cow's father (PV), both as random effects, year of calving (AP), season of calving (EP), the interaction between AP and EP, number of calvings (NP) as fixed effects and number of services/conception (NS) as covariable. The mean of the least squares of PL305 was 5660.3 \pm 135.2 litres. The effects of PV, V, N; AP (all at P < .01) and EP (P < .05) - significantly influenced the variability of PL305. However, the effects of NS and of the interaction between AP and EP were not important. The correlation coefficients (R^2) of the random and fixed effects were 58.03% and 41.95% res-

pectively. The heritability of PL305 turned out to be 0.26 ± 0.11 , hence this work suggests that there exists a moderately high additive genetic variability for an appropriate selection programme to increase the level of milk production in this breed.

ADDITIVE GENETIC EFFECT OF BREED, AND MATERNAL EFFECTS ON MILK YIELD IN ZEBU AND BROWN SWISS CATTLE: I Mondragón and A Tewolde, *Autonomous University of Chapingo, Mexico*

Data obtained (N=409) over six years (1971-1976) from Zebu (C), Brown Swiss (PS), $1/2$ PS - $1/2$ C (F1), $1/4$ PS - $3/4$ C (C x F1) and $3/4$ PS - $1/4$ C (PS x F1) cows in Yucatan, Mexico were analysed to study additive effects (g^1) and maternal effects (g^M) of the two breeds on the yield of milk adjusted to 135 days of lactation (RL135). Expected values of g^1 and g^M were first derived for each of the two races. For example, an hybrid cow from a PS bull and a C dam had values of 50% and 50% of g^1 of PS and C respectively and values of 0% and 100% for g^M of PS and C respectively. The analysis was by the method of least squares and the mathematical model included effects of years of giving birth, season of birth, the interaction between these two and g^1 and g^M for each breed. Age of the dam and sex of the calf were not included in the model because they were not important in the preliminary analysis. The mean of the least squares of RL135 was 181.68 ± 10.6 litres. Year of birth and the interaction between this and the season of birth had significant ($P < 0.01$) effects on RL135, season of birth alone was not important. Important variations in RL135 owing to g^1 were not observed, however the effect of g^M did have a significant ($P < 0.01$) influence on RL135. The regression of RL135 on g^1 was -0.004 and 0.004 in C and PS respectively. The corresponding values for g^M were -5.66 and 5.66 respectively for C and PS. These results suggest that the Zebu breed is not suitable for growth and milk production although it is adaptable, as is well known, for tropical conditions. On the other hand the Brown Swiss, apart from having good milk production, did show positive potential for growth, however this was not significantly different from zero.

THE INFLUENCE OF COOLING SHOWERS ON THE PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF SPECIALISED AND CROSSED BREEDS IN THE SUB-HUMID TROPICS: J F Hernández and A Castellanos; *INIP/SARH, Centro Experimental Pecuario, Tizimin, Yucatan, México*

One of the ways of increasing milk production in tropical areas is by the creation of new biotypes of cows obtained by crossing, and by using management practices to improve the adaptability of the animals to conditions of high temperature and humidity. The objective of this work was to determine the effect of the use of cooling showers (to ameliorate the environmental conditions) on the milk production and reproductive efficiency of Holstein, Brown Swiss and Holstein x Zebu cows. The experiment used 46 cows in a completely randomized design with a 2×2 factorial arrangement.

The first factor was the type of breed: Specialised (RE) and crossed (RC).

The second factor was exposure or not to cooling showers (BR) for 12 to 13 hours. The animals were grazed at night on a variety of grasses. Milk ing was by hand twice a day. The animals were supplemented with a concen trate with 16% protein at the rate of 1 kg/3 kg of milk produced. There was no significant effect of the factors studied on milk production, calving - first oestrus and the interval between calving and first service.. However, the use of BR allowed an increase in milk production of 7% in RE and 19% in RC in comparison with the control. The fertility percentage was less in the control (RE 20% and RC 37%) than in those cows that re ceived BR (RE 76% and RC 65%). Owing to this the number of services per conception was greater in the control group (RE 4.8 and RC 2.6) than in those exposed to BR (RE 1.3 and RC 1.5). Exposure to BR allowed a signif icant fall in rectal temperature, heart rate and breathing frequency. The animals of the control group showed some symptoms of heat stress .

THE EFFICACY OF SUPPLEMENTING CATTLE AT PASTURE: J G Morris, *Univer sity of California-Davis, U S A*

The supplementation of cattle at pasture is a very common practice, how ever there is a shortage of data on the animal response according to the level of supplementation. Most supplementation trials contain too few levels to be able to derive input-output curves for subsequent economic analysis. Often it is supposed that the nutrients in the supplement will function as additives to those consumed by the supplemented animal. Whilst this thesis might be valid for mineral and vitamin supplementation , it does not necessarily apply to other types of supplement. In confinement, protein supplementation to low nitrogen forages often increases voluntary intake. However, under grazing conditions the responses are almost al ways substantially lower. The use of high energy/low protein supplement depresses the intake of low digestibility/low nitrogen forages. The degree to which such energetic supplements substitute for grazing for grazed pas ture is related to the difference between the supplement and the forage in such factors as digestibility and nitrogen content. The ad libitum provision of a supplement containing an essential nutrient in which the diet may be deficient does not necessarily correct the deficiency. The variation in intake of supplements between individual animals can be wide; some animals consume insufficient quantities whilst others consume lux ury amounts. The specific capacity of the ruminant for sodium has resul ted in salt being used as the common vehicle for mineral supplements. How ever, the individual and seasonal intake of mixtures of salt and mineral salts offered ad libitum has been variable; in many situations the effi ciency of utilization of such supplements has been low. Examples will be presented of selenium and cobalt deficiencies in Florida, and of selenium deficiencies in California; and their corrective measures discussed.

PERFORMANCE OF STEERS UNDER THREE SUMMER FEEDING REGIMES: J Wadsworth,¹ *Escuela Centroamericana de Ganaderia, Atenas, Alajuela, Costa Rica, CA.*

1. *Animal Production:* Animal Production from natural pastures in margin al zones is characterized by periods of dry weather with a low availabil -

ity of nutrients followed by a rainy season and consequent pasture growth.. Traditional animal production systems are not sufficiently flexible to balance the supply and demand of nutrients through the year; this results in a poor degree of exploitation of the pasture and low animal production. To investigate the commercial potential of adjusting the stocking rate of natural pastures according to the season of the year the following experiment was carried out. 30 Brahman steers with an average age of 22 ± 0.2 months (liveweight 324 ± 4.3 kg) and 30 steers with an average age of 10 ± 0.15 months (liveweight 198 ± 3.6 kg) were allocated to the 3 following feeding regimes during the summer of 1982: T₁) Molasses + 3% (fresh weight basis) urea and chicken droppings ad libitum, 0.5 kg meat meal and 4 hours grazing per head per day; T₂) Chopped sugarcane + 1% (fresh weight basis) urea ad libitum, 1.0 kg rice polishings per head per day; T₃) Grazing on pastures of *Hyparrhenia rufa* at 0.5 livestock units/ha. Growth during the 88 days was: T₁) 0.69; T₂) 0.66 and T₃) -0.11 kg per head per day for the 22 month steers and T₁) 0.39; T₂) 0.44 and T₃) 0.01 kg per head per day for the 10 month steers. The effect of age on daily gain was significantly different for T₁ and T₂ ($P < 0.01$). In the case of T₃ the 22 month steers lost more weight than the 10 month group but this was not significant. There was no significant difference between T₁ and T₂ with respect to daily gain, however both were superior to T₃ ($P < 0.01$). It is concluded that in the attempt to balance the summer and winter stocking rate that there is an advantage in feeding 22 month old steers whilst those of 10 months are left at pasture.

2. *Financial analysis:* Financial analysis of the above results showed that for the 22 month steers the net benefit per head per day was \$(US): T₁) 0.11; T₂) 0.10 and T₃) -0.13; and for the 10 month group: T₁) 0.05; T₂) 0.07 and T₃) -0.05. These results were used to compare the potential to improve production per hectare following a model for beef production. Three systems were examined on a whole-farm basis; S₁) winter pasture 2.0 livestock units /ha, summer pasture 1.0 LU/ha and the rest of the animals on molasses and restricted grazing; S₂) winter pasture 2 LU/ha, summer pasture 1.0 LU / ha and the rest of the animals fed with chopped sugarcane; S₃) traditional , grazing all the year at 1.3 LU/ha. The animal production realized by these three systems was S₁) 286; S₂) 315 and S₃) 160 kg liveweight/ha/year and the gross margin was : S₁) 103; S₂) 119 and S₃) 50 \$US/ha/year. The analysis shows that the attempt to balance the stocking rate at pasture according to the time of year, and the use of the appropriate feeds was great potential for improving animal production from and profitability of natural pastures in the marginal zones.

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PRODUCTIVITY OF LAYING HENS IN HIGH ENVIRONMENTAL TEMPERATURES: A J Smith, *University of Edinburgh, Scotland, Great Britain.*

Although laying hens evolved in humid tropical forests their commercial exploitation has reached its optimal level in temperate regions. As a result of this the majority of the experiments with laying hens have taken place in temperate environments. During the last 20 years a great deal of inter-

est has been shown in the effect of environmental temperature on the performance of laying hens. In the first place the growing price of feeds has stimulated livestock specialists in developed countries to examine methods to save food and in the second place the poultry industry has increased recently in third world countries. A great part of this work was carried out at constant temperatures with the results indicating that the voluntary feed consumption is reduced at high temperatures; this response is curvilinear.

Egg production was reduced and egg weight and shell quality were depressed when the constant temperature exceeded 26°C. The effect of temperature stress on the first 2 parameters is progressive. The most recent studies also show that fluctuating temperatures could cause less stress than constant temperatures when there exists a recuperation period during the day when the temperatures are lower than the critical point of dyspnoea. There exist considerable differences between individual birds in their response to constant and varying temperatures. This indicates that it should be possible to carry out selection of types that can produce well at high environmental temperatures. The interactions between day length and specifically days longer than 24 hours, and environmental temperature were also discussed.

THE USE OF POULTRY OFFAL SILAGE: C Mauricio, D H Machin¹ & W Thorpe,² FMUZ, Universidad de Yucatán, Mérida, México.

The use of organic acids for the ensilage of animal wastes is a technology very appropriate for the conditions of tropical developing countries. The object of the following work was to evaluate the factors affecting the use of formic acid, sulphuric acid and hydrochloric acid in the preparation of silages made from broiler slaughter house offal. Formic, sulphuric and hydrochloric acids were used over a range of levels between 1.5-4.0, 0.75-1.75 and 1.5-4.0% respectively. The raw materials studied consisted of a mixture of feet, heads and viscera in biological preparations or only the viscera. Although all the acids were satisfactory in reducing the pHs to levels less than pH 3.0, only formic acid at higher concentrations than 2.0% was adequate to make good quality silage, the silages made using mineral acids or less than 2.0% formic acid being contaminated with fungus. Silages made from the viscera and the mixture of heads, feet and viscera were incorporated after drying into sorghum in the diets of broiler chicks substituting whole or half of the fish meal of the control diet. There was no significant difference between the rate of gain, voluntary consumption or food conversion efficiency of the broilers on the different diets. Neither were there health problems nor changes in the liver or pancreas of the birds fed the different diets.

Metabolizable energy determinations carried out on the diets indicated that these were within the values calculated from literature values in the initial phase but were lower than calculated for the final phase. It is concluded that broiler slaughter house wastes ensile easily with formic acid at concentrations more than 2.0% and that these may be substituted to provide up to 6% of the protein in the diets of broilers.

¹ On secondment from Tropical Products Institute, England

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SUGAR CANE JUICE OR MOLASSES IN THE FEEDING OF GROWING AND FATTENING PIGS: D Fermin¹, R Fermin² & A Mena³ *Santo Domingo, Dominican Republic*

Sixteen Yorkshire x Landrace pigs were used in a randomized block design experiment to investigate the use of sugarcane juice or molasses as energy sources in growing and finishing pig diets. The juice was fed ad libitum and the molasses by restriction at 20-40%, depending on the weight of the pigs to avoid toxicity problems. In both cases a protein concentrate was offered (soya meal), to meet the requirements for protein. In the case of diets with molasses, maize was also supplied to meet the optimal energy level.

The initial mean weight of the pigs was 43.2 kg. At 49 days the group consuming juice had achieved a mean weight of 91.3 kg having a daily live weight gain of 969 g/day with a food conversion efficiency of 3.37. The data corresponding to the group with molasses were: weight at 49 days 87.0 kg with a daily live weight gain of 909 g/day and a food conversion efficiency of 4.08.

These are preliminary data, but they show the great potential of sugar cane juice in the feeding of pigs.

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A NUTRITIONAL AND ECONOMIC EVALUATION OF THREE SYSTEMS OF FEEDING PIGS DURING GROWTH AND FINISHING: A Garcia, D H Machin¹ & W Thorpe¹, *FMVZ, Universidad de Yucatán, Mérida, México.*

Feeding of pigs represents up to 80% of the cost of production. Because of this, a method to improve the economic efficiency of the pig industry could be to increase the efficiency of food utilization. In the majority of American countries, including Mexico, fattening pigs are fed ad libitum whilst in Europe they are fed by restriction by which saving in food utilization and improved carcass quality has been achieved.

The object of this work was to carry out an economic and technical comparison between these two systems in the tropical Yucatan. The treatments consisted of the ad libitum feeding system of the National Research Council of the United States (AA) and the restricted feeding system of the Industry of Agriculture, Fisheries and Food of the United Kingdom (RR). These systems of initiation and finishing are shown in the table below. 84 cross bred Yorkshire-Hampshire-Duroc pigs were used, including 14 male castrates and 14 females per treatment. The two phases of the study consisted of initiation (28 - 50 kg liveweight) and finishing (50 - 90 kg liveweight). For the principal production parameters summarized in the Table below there were shown to be significant differences between groups AA(ad libitum all the study) compared with the other treatments AR and RR. Where the pigs were fed ad libitum all their lives the daily liveweight gain was superior to other treatments but the feed conversion efficiency, Longissimus dorsi muscle area and back fat thickness were poorer than in the other treatments.

It was concluded that the restricted feeding system offers greatest econo-

conomic advantages due to the greater value of the carcass (more lean meat) and the saving in feed due to a superior food conversion efficiency.

	AA	AR	AR	SE diff.
28 - 50 kg	Ad lib.	Ad lib	Restr	
50 - 90 kg	Ad lib	Restr	Restr	
Daily live Wt. Gain (91 day)	724	629	623	+ 20
Food Conversion Eff.	3.53	3.29	3.15	+ 0.087
Area L. Dorsi (cm ²)	30.6	34.9	36.1	+ 0.98
Back fat (mm)	25.5	21.3	19.9	+ 1.5

¹ On secondment from the Tropical Products Institute, England

² Technical Cooperation Officer, Overseas Development Administration, London

AN EVALUATION OF SOME NON-TRADITIONAL FEEDSTUFFS FOR PIG FEEDING IN SRI LANKA: V Ravindram, Department of Animal Science, The University of Sri-Lanka.

The high cost and scarcity of coconut meal, which is the principle protein supplement of pig feeding in Sri-Lanka, has limited the expansion of the pig industry in recent years. The studies reported here were carried out to evaluate the potential of two non-traditional feedstuffs, cassava leaf meal and rubber seed meal, in growing and finishing pig diets. In the first trial 20 pigs of 13.1 kg mean live weight were allocated at random to 4 diets in which cassava leaf meal was substituted for 0, 10, 20 and 30% of coconut meal. The liveweight gain and feed conversion efficiency was improved significantly by the substitution of cassava leaf meal at the 20 and 30% levels. This response can be attributed to the high content of lysine in the cassava leaf meal. The second trial was a repetition of the first except that finishing pigs were used of 43.8 kg mean live weight. The liveweight gain and the feed conversion efficiency did not differ significantly between treatments. The data indicates that it is possible to use successfully up to 30% of cassava leaf meal in fattening pig diets. In the third trial 32 cross bred pigs of 18.1 kg mean live weight were allocated to 4 dietary treatments including 0, 10, 20 and 30% rubber seed meal. The liveweight gain and the feed conversion efficiency were significantly reduced where more than 10% of rubber seed meal was used in the diet; this effect was attributed more to the deficiencies in lysine and sulphur amino acids than the presence of cyanogenic glucosides in the rubber seed meal.

THE USE OF FISH SILAGE (FROM FISH BY-CATCH) TREATED WITH FORMIC ACID IN DIETS FOR FATTENING PIGS: D H Machin¹, R H Young¹ and K Crean¹, Escuela de Ciencias Maritimas y Alimentarias, Guaymas, Sonora, México.

Crossbred Duroc - Yorkshire pigs were fed with diets containing fish silage or locally made fish meal. The silage was produced from fish separated from shrimp by-catch. The fish was minced through a 10 mm screen and mixed with formic acid (90%) to achieve a concentration of 3.5% (volume /

weight) of minced fish. The mixture was stirred regularly during the following 24 hours during which time the mixture liquefied. The material was considered suitable for feeding after 4 days. Three levels of silage were studied (supplying 5, 10 and 15% dry matter) and the control diet included fish meal supplying the same level of protein as the 10% silage diet. All the diets were balanced to satisfy the pigs nutritional requirements, using sorghum, soya, wheat feed, limestone, orthophosphate, salt and a commercial pre-mix of trace minerals and vitamins. Each diet was fed to a group of 5 castrate and 5 female pigs of approximately 20 kg. mean live weight. The experiment terminated as the mean live weight of each group reached 90 kg. The principle results are shown in the following table.

Treatments	Weight gain (g/day)		Food conversion efficiency (kg consumed/kg gain)	
	Castrates	Females	Castrates	Females
Control	519	515	4.82	4.15
5% Silage (DM)	603	621	3.85	3.64
10% Silage (DM)	615	608	3.61	3.61
15% Silage (DM)	615	632	3.56	3.27

As the level of silage increased in the diets the liveweight gain of pigs increased logarithmically ($r^2 = 0.97$) and the food conversion efficiency increased linearly ($r^2 = 0.84$).

At the end of the study the pigs were slaughtered, carcass characteristics measured and samples of meat were taken to determine the presence of any unacceptable flavours. It was concluded from this study that all the carcasses were acceptable standard and that there were no unacceptable effects due to the experimental diets.

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A COMPARATIVE STUDY OF TECHNIQUES USED TO DETERMINE DIGESTIBILITIES OF RUMINANT AND MONOGASTRIC FEEDSTUFFS: A Aguilar, L Chel & A Castellanos, Centro Experimental Pecuario, Tizimin, Yucatán, México.

Digestibility determinations of materials suitable to be incorporated into animal diets is an important aspect of their better use. The in vivo method requiring the total collection of faeces produced was until recent years the most used. This is a laborious and slow method and other methods have been developed to replace it. Very little information has been generated within Mexico comparing the different techniques and this work was carried out with this objective in mind.

Two experiments were carried out to try to compare different methods for determining the apparent digestibilities of feedstuffs for use by ruminants and monogastrics. In the first experiment the digestibility of *Panicum maximum* (var. Trichoglume) was determined for ruminants comparing the in vivo technique, the acid insoluble ash technique (AIA) as indigestible marker and the in vitro technique (IVDDM). For the in vivo technique six male Pelibuey sheep were housed in metabolic cages.

The faeces collection period was 7 days and the determination of acid insoluble ash of both faeces and feedstuffs was carried out using 2N hydrochloric acid. In the in vitro technique two different pepsin digest times were used; 12 and 24 hours. A digestion period of 48 hours was used as a control.

The coefficient of digestibility obtained by the total collection method was $57.7 \pm 3.1\%$ and that using the AIA technique $48.3 \pm 0.5\%$. The difference between the two techniques being highly significant ($P < 0.01$). In the case of the in vitro technique, only between the control ($57.1 \pm 1.3\%$) and the in vivo technique was no significant difference noted ($P < 0.05$).

In the second experiment the digestibility of a balanced pig feed was determined using 8 castrated Mexican Pelon pigs. In this experiment two techniques using indigestible markers were compared ie. using acid insoluble ash (AIA) and chromic oxide (Cr_2O_3).

The chromic oxide was added at a level of 1% of the diet. The experiment used a crossover design with two collection periods of 4 days each. The apparent digestibility estimated was $68.6 \pm 6.1\%$ and $71.5 \pm 2.7\%$ for the AIA and Cr_2O_3 techniques respectively. No significant differences ($P < 0.05$) with respect to the method used or individuals were noted.

SEASONAL FLUCTUATIONS IN THE CONCENTRATIONS OF VITAMIN A AND CAROTENE IN THE LIVER AND PLASMA OF GRAZING COWS: T Iglesias and J G Morris, *Department of Animal Science, University of California-Davis, USA*

The supplementation of cattle with vitamin A is a common practice owing to its relatively low cost. Ruminants convert the carotene contained in green forage to vitamin A which is stored in the liver as a reserve during the dry season. This study was made in order to analyse the need to supplement cattle at pasture with vitamin A. On 10 occasions during one year the concentrations of vitamin A and carotene in the liver and plasma were measured in 12 adult Hereford or Hereford x Angus cows. The experimental herd was maintained grazing natural pasture and was supplemented with cotton seed meal during part of the summer and autumn. The mean (\pm SE) annual concentration of vitamin A and carotene in the liver and plasma was from $151(\pm 6.3)\mu\text{g/g}$ and $22(\pm 0.6)\mu\text{g}/100\text{ ml}$, to $10.2(\pm 0.5)\mu\text{g/g}$ and $374.9(\pm 33.4)\mu\text{g}/100\text{ ml}$ respectively. There was a significant ($P < 0.1$) seasonal variation in the concentrations of vitamin A in plasma and liver and of carotene in plasma. A high correlation existed between the level of carotene in plasma and the annual rainfall ($r^2=0.70$). The concentration of vitamin A in the liver reached its lowest level immediately after the beginning of the rainy season and was $101.5(\pm 8.2)\mu\text{g/g}$. At no time during the experiment were vitamin deficiency symptoms detected in the cattle; this suggests that vitamin A supplementation of cattle at pasture in the zone is not necessary.

THE USE OF HENEQUEN (SISAL) PULP IN MAINTENANCE RATIONS FOR PELIBUEY SHEEP: R Bores, J N Romano and A Castellanos, *INIP/SAR, Centro Experimental Pecuario, Mococho, Yucatán, México.*

An experiment was carried out in order to establish a feeding system based on henequen pulp for the maintenance of weight in Pelibuey sheep. 72 uncas

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trated males with a mean weight of 19.0 ± 2.2 kg and one year of age were used. The experiment was a totally randomized design with a 3 x 3 factorial arrangement and 2 replicates of 4 animals per treatment. The factors were 3 levels of energetic supplement by molasses (0.0, 0.19 and 0.38% of liveweight per day) and 3 levels of protein supplement: (0 and 8 g urea, and 122 g of chicken droppings per day). Measurements were made over 70 days. Afterwards the animals were supplemented with 1.14% of their live-weight by soya bean meal for 56 days. Finally the animals were measured over another 28 day period as in the first one. The provision of energy and protein supplements had a significant effect on the voluntary intake of henequen pulp. The addition of molasses depressed consumption, however nitrogen supplementation stimulated it. During the first period of measurements the addition of molasses allowed the animals to maintain weight. There was no beneficial effect found that was attributable to the addition of nitrogen. During the last period of measurements, all the animals lost weight except those fed molasses at 0.19% and those supplemented with chicken droppings. It is concluded that supplementation of henequen pulp with molasses (0.19% live weight) permits the maintenance of liveweight in the Pelibuey sheep. The response to nitrogen supplementation will depend on the physical state of the animals.

SUPPLEMENTATION OF ENSILED HENEQUEN (SISAL) PULP FOR SHEEP: A Rodríguez, FMVZ, University of Yucatán, México.

The aim of this work was to relate the known response in performance to the addition of forage and/or bypass protein supplements to ensiled henequen pulp, with the physiology of the animal. 32 uncastrated, 7th month old male Pelibuey sheep were distributed amongst the 8 treatments of a 2 x 2 x 2 factorial design with 4 animals in each sub-treatment. The diets were: with and without minerals (up to 150% of requirements); with and without forage (chopped fresh ramon (*Brosimum alicastrum*) at 25% of the dry matter); and with and without soya meal at 9% of the dry matter. The experiment lasted 98 days.

The main results are shown in the Table. Supplementation with ramon and soya increased the voluntary intake of ensiled pulp and the total dry matter of the diet, which in turn was closely related to the liveweight

	Control	Ramon	Soya	Ramon/Soya	SE ± (P)
Intake DM/g/d:					
Pulp	403	512	642	627	+ 41(.06)
Total	442	798	775	1048	+ 32(.01)
Gain, g/d	-35	39	56	109	+ 14(.01)
Blood:					
Haematocrit %	43	37	35	38	+1.6(.01)
Urine:					
Acid/base meq/litre	2	26	21	74	+9.6(.04)
pH	7.36	7.70	7.79	8.23	+ .13(.06)

change which was improved from less than 35 to 109 g/day between the control diet and the forage and protein combination. There were no significant effects of the minerals on these parameters. All the supplements (including the minerals) lowered the level of haematocrit in the blood, however all the values were above the normal range. Apparently these high values were due to high mean globular volumes. It seems that there was a compensated metabolic acidosis in all the animals and that the effect was least marked in treatments with supplements of ramon and soya meal.

ACID BASE BALANCE AND THE EFFECTS OF NEUTRALISATION WITH SODIUM HYDROXIDE ON METABOLIC PARAMETERS IN CATTLE RECEIVING DIETS OF SISAL BAGASSE:
R. Belmar & Judith A Riley,¹ FMVZ, University of Yucatán, México.

An experiment was carried out to study acid-base balance in bulls given diets of ensiled sisal (*Agave fourcroydes*) bagasse with urea + minerals, and the effect of neutralisation of supplementation with elephant grass (*Pennisetum purpureum*).

19 bulls with an initial mean weight of 202.9 kg were used. They were arranged in a 2 x 2 factorial design, the treatments being neutralisation with 1.1% NaOH (w/w) and supplementation with elephant grass (20% of voluntary intake). An additional control group was given only grass, (ad libitum). The experimental period was 35 days. Blood parameters (pH, pCO₂, HCO₃ and tCO₂) and urine parameters (net acid base, pH) were measured periodically (0, 7, 15 and 30 days) as were voluntary consumption of DM and changes in liveweight. Changes in liveweight were negative with all dietary treatments with the exception of the control group (grass), being -.188, -.96, -.100, -.062, +.102 kg/d/100 kg LW for bagasse, neutralised bagasse, bagasse + grass and control respectively. Differences between animals with and without grass supplementation were significant (P < 0.01), as was the difference between the control group (grass) and the groups consuming bagasse (both neutralised and supplemented) (P < 0.01).

Voluntary consumption was 17% and 13% higher for animals receiving grass supplement, compared with those consuming bagasse and neutralised bagasses respectively. Mean urine pH after 29 days was 7.4, 8.4, 7.9, 8.4, 8.1 for bagasse, neutralised bagasse, bagasse with grass supplement, neutralised bagasses with grass and grass respectively. At 29 days net acid-base in urine was +10, +108, +33, +128 and +81 meq/l for bagasse, neutralised bagasse, supplemented bagasse, neutralised supplemented bagasse and grass respectively, resulting in significant differences (P < 0.01) between treatments with and without neutralisation. After 30 days mean blood pH was 7.477, 7.513, 7.462, 7.452 and 7.450, mean HCO₃ 31.5, 32.5, 28.0, 28.0 and 28.3 mmol/l, mean tCO₂ 33, 33.5, 28.0, 29 and 29.5 mmol/l and mean PCO₂ 40.7, 42.4, 40.1, 39.3 and 40.3 mmHg for bagasse, neutralised bagasse, bagasse supplemented with grass, neutralised bagasse with supplement and control (grass) respectively. There were significant differences (P < 0.01, P < 0.05 and P < 0.05) for pH, tCO₂ and HCO₃ respectively between animals receiving grass supplement and those without supplement, there were no significant differences in PCO₂ values.

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A STUDY OF THE POSSIBLE METABOLIC CAUSES OF MOLASSES TOXICITY: A Santana & J A Riley¹, FMVZ, University of Yucatán, México.

Two experiments were carried out to determine changes in physiological parameters in blood and in the rumen of animals intoxicated with molasses with the objective of determining metabolic changes and to try to elucidate the cause of the condition.

Samples of blood and rumen fluid were taken from 4 fistulated bulls, consuming a basal diet of ad libitum molasses/urea with 3% of liveweight fresh grass. The animals were again sampled and the grass was removed from the diet of two animals to try to induce toxicity. No signs of toxicity were presented after two months and the grass was withheld from the two remaining animals. After a further month without symptoms a state of subclinical toxicity was assumed and each animal was injected with 200 mg of thiamine on three occasions at intervals of 7 days. Blood samples were taken during a period of 24 hrs following injection. Animals consuming molasses presented a rumen fermentation pattern typical of this diet ie. high levels of butyric acid and high concentrations of glucose and acetone in plasma. Thiamine injections had no effect on any of the measured parameters.

In a second experiment samples of venous blood were taken from 3 bulls consuming grass for a period of 24 hours. Toxicity was induced by giving an oral dose of 23 g molasses/kg LW and the sampling repeated for another 24h. During the presentation of toxicity symptoms the following factors were observed:

- i) low blood pH
- ii) high blood glucose concentration
- iii) slight increase in pyruvate and lactate concentrations.

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