Some Agronomic and Nutritional Characteristics of *Canavalia* sp.[1]

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ABSTRACT

A collection of 26 cultivars of *Canavalia* sp. was analyzed for protein and selected amino acids. The samples were also used to obtain information on yield components and the effect of date of planting. In the original samples, moisture content varied from 9.9 to 13.6 g/100 g; protein, from 21.6 to 23.6 g/100 g; lysine from 1.30 to 2.35 g/100 g; methionine from 0.18 to 0.24 g/100 g; and tryptophan from 0.14 to 0.27 g/100 g. Lysine and tryptophan, but not methionine, were correlated to protein content. Multiple regression analysis of the agronomic data of the seed harvested from the 26 cultivars indicated seed weight, seed per pod, and pods per plant, in that order, to be the main yield contributors. In the agronomic trial, protein quality of the 26 cultivars harvested and cooked, varied from protein efficiency ratio (PER) of 0.93 to 1.61. Percent protein was negatively related, although not statistically significant, to protein quality. Date of planting did not influence yield or protein quality, although flowering was significantly effected, and there was some influence on protein content. The results obtained suggest *Canavalia* to have a good yield potential. Further studies are thus suggested to find uses as human food or animal feed.

COMPENDIO

Se analizó una colección de 26 cultivares de *Canavalia* sp. por su contenido en proteína, lisina, metionina y triptófano. Asimismo se evaluó el rendimiento de la semilla y se estudió el efecto de la época de siembra. En muestras originales la humedad varió de 9.9 g/100 g a 13.6 g/100 g; la proteína, de 21.6 g/100 g a 23.6 g/100 g; la lisina, de 1.30 g/100 g a 2.35 g/100 g; la metionina, de 0.18 g/100 g a 0.24 g/100 g; y el triptófano, de 0.14 g/100 g a 0.27 gramos por cada 100 gramos. La lisina y el tripófano, pero no el contenido de metionina, se correlacionaron con el de proteína. Análisis estadístico de regresión múltiple de los datos agronómicos de la semilla cosechada de los 26 cultivares, indicó que el peso de semilla, el número de semillas por vaina y el de vainas por planta fueron componentes de rendimiento más importantes, en ese orden. En la prueba de producción, la calidad de la proteína de los 26 cultivares cosechados y cocidos, varió de un índice de eficiencia de proteína (PER) de 0.93 a 1.61. El porcentaje de proteína se correlacionó negativamente con la calidad, aunque la fecha de floración fue afectada significativamente y hubo influencia sobre el contenido de proteína. De los resultados observados, *Canavalia* sp. tiene un potencial de rendimiento atractivo, por lo que se sugieren estudios para su uso en alimentación humana o animal.

INTRODUCTION

In Central America although there are a number of non-conventional grain legumes that may some value as food or feed, they have not been extensively studied. Such is the case of Canavalia (*Canavalia* sp.), which are grown in a limited way, mainly as a cover crop. When seeds are harvested, they are roasted to prepare water infusions to be used as coffee. Good descriptions of *Canavalia* sp. are found in the Tropical Products Institute (TPI) literature (9), National Academy of Science (NAS) (12), and others (1). Previous reports from the Institute of Nutrition of Central America and Panama (INCAP) dealt with basic chemical and nutritional data on *Canavalia* (5) and on seed protein and starch extraction (11). These studies have suggested *Canavalia* seeds to have economic potential if systematically studied. This paper presents some

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agronomic characteristics and chemical and nutritional data for 26 cultivars. The results of studies on date of planting, yield, and nutritive value are also reported.

MATERIALS AND METHODS

Around 100 g of each of 26 cultivars of *Canavalia* sp. were collected from various sources in Central America and Colombia, and a subsample of each was taken for chemical analysis. The rest was used for agronomic studies and to produce enough seeds for nutritional evaluation.

All 26 cultivars, 25 of which were *Canavalia ensiformis* and one *Canavalia gladiata,* were planted at an experimental site located at 266 masl in the Pacific area of Guatemala. The seeds of each cultivar were planted in rectangular experimetal plots 0.80 x 2.40 m, planting one seed at 80 cm apart in the rows and between rows, for a total of eight plants per experimental plot. Each plant was taken as a replication. A discard trip 2 m wide was provided between plots.

New seeds were planted four days later to replace those that had not germinated, so that measurements were taken of all eight plants per experimental plot per cultivar. At the time of planting, 30 g of 15 N, 15 P and 15 K fertilizer was applied per seed covered with soil, and had the *Canavalia* seed placed on top.

At harvest, data were collected on number of pods per plant, and number and weight of seeds per pod.

In a second agronomic study, a local cultivar of *C. ensiformis* (No. 24872) was used to determine the effect of date of planting on yield, protein content, and protein quality. Experimental plots measured 34 m^2 (5.4 x 6.3 m) where 56 seeds were sown at a distance in rows and between rows of 90 cm, at montly intervals from June 4 to October 22; each plot was replicated twice. Data were obtained on flowering and yield per experimental plot. Seed weight was also obtained by weighing four replicates each of 25 seeds.

Moisture and protein content (N x 6.25) of seed from the 26 cultivars and from the second study were determined by the ADAC procedures (2). Lysine and methionine content of the 26 cultivars were determined using microbiological assays with Difco media and *Leuconostoc mesenteroides* as the test organism (16), and tryptophan by the Opienska-Blauth *et al.* (13) method, and modified by Hernández and Bates (8).

For the biological assays of protein quality, protein efficiency (PER) (2) and net protein (NPR) ratios (3) were determined in the grain samples used in both experiments. Samples of seeds (1 kg) were soaked overnight in four liters of water. The soaking water was discarded and fresh water added (three liters) before cooking in the autoclave, at 15 lb pressure for 50 minutes. After cooking, the water was discarded and the wet seeds were ground and dried in a convection oven at 60°C. This process was carried out to eliminate, as far as possible, the toxic substances present in *Canavalia*. After drying, the samples were further ground, passed through a 60-mesh sieve and analyzed for total nitrogen (2). For the protein efficiency assays, diets were prepared to provide 100 g kg^{-1} protein (N x 6.25) from *Canavalia* seeds. They were supplemented with 40 g kg^{-1} mineral mixture (7), 50 g kg^{-1} refined cotton-seed oil, and 10 g kg^{-1} cod liver oil. The diets were supplemented with a complete B-vitamin mixture (10) and 50 ml kg^{-1} added. Feed and water were provided *ad libitum* to six 22-day-old rats (Wistar strain) assigned to each experimental group, and the assay was carried out for 28 days. Feed intake and weight changes were measured every seven days. The values at 14 days were used to estimate NPR. A casein diet at 100 g kg^{-1} protein level was used as reference, and a nitrogen-free diet was used for the NPR assay.

RESULTS AND DISCUSION

Results on protein (N x 6.25) lysine methionine and tryptophan content of the original 26 cultivars samples are presented in Table 1. Protein content averaged 25.5 g/100 g with values ranging from 21.6 to 32.6 g/100 g, a variability which is also found in other grain legumes (4). Average values of lysine, methionine tryptophan and were 1.78, 0.20 and 0.20 g/100 g. There was little variability in methonine content with no correlation to protein content; while protein and lysine, and protein and tryptophan were positively correlated. These relationships are similar to those which have been reported for other grain legumes (4).

Table 1. Moisture, protein, lysine, methionine, and tryptophan percentage (g/100 g), in seeds from 26 *Canavalia* cultivars.

Cultivar No.	Moisture	Protein (N x 6.25)	Lysine	Methionine	Tryptophan
24969 (1)	13.6	25.6	1.82	0.21	0.20
24870 (2)	11.0	28.5	1.87	0.21	0.27
24871 (3)	11.9	24.5	1.60	0.24	0.23
24872 (4)	12.5	28.5	1.89	0.20	0.22
24873 (5)	10.9	32.6	2.00	0.22	0.22
24874 (6)	11.8	22.3	2.01	0.20	0.21
24875 (7)	11.0	26.6	1.85	0.21	0.22
24876 (8)	11.4	22.6	1.59	0.20	0.21
24877 (9)	10.8	21.7	1.41	0.19	0.14
24878 (10)	11.2	25.1	1.72	0.20	0.20
24879 (11)	11.1	27.8	2.01	0.22	0.19
24880 (12)	11.3	25.9	2.35	0.20	0.18
24881 (13)	10.8	25.8	2.01	0.21	0.20
24882 (14)	10.9	24.3	2.02	0.21	0.19
24883 (15)	10.8	24.1	1.95	0.19	0.21
24884 (16)	10.9	24.3	1.79	0.21	0.22
24885 (17)	10.6	31.0	1.92	0.22	0.21
24886 (18)	11.0	26.0	1.79	0.21	0.22
24887 (19)	11.0	26.1	1.69	0.22	0.18
24888 (20)	11.4	26.6	1.54	0.20	0.22
24889 (21)	10.8	26.4	1.49	0.20	0.23
24890 (22)	10.8	24.7	1.77	0.20	0.20
24891 (23)	9.9	21.6	1.30	0.18	0.16
24892 (24)	11.3	22.9	1.55	0.19	0.18
24893 (25)	10.6	24.5	1.65	0.20	0.17
24894 (26)	10.8	23.6	1.78	0.20	0.20
$\bar{X}$	11.16	25.5	1.78	0.20	0.20
S.D.	0.697	2.64	0.23	0.01	0.02

Information on some yield components of the 26 *Canavalia* cultivars is presented in Table 2. The number of pods per plant shows high variability, ranging from 5.6 to 20.6 among all cultivars, with a high coefficient of variation. A high variability among cultivars was also evident in the average seed yield per plant (field dry weight), which varied from 109.5 to 408.5 g per plant. However, the variability in the number of seeds per pod was lower, ranging from 5.8 to 12.3, as well as the average seed weight which varied from 1.53 to 2.86 grammes. Statistical analysis of the data showed highly significant differences in pods per plant, number of seeds, total seed weight, seeds per pod, and weight per seed. With these data, multiple regression was calculated in which yield (total seed weight per plant) = -417.87 ± 11.48 (pods per plant) ± 0.7929 (No. of seeds per plant) ± 21.97 (seeds per pod) ± 96.79 (weight per seed). This equation suggests that seed weight, seeds per pod and pods per plant are important components for yield. Table 3 presents the coefficient of correlation between some agronomic variables. A high significant correlation ($r = 0.985$) was found between number of pods and number of seeds; and a negative relationship, although not significant, between number of pods and seeds per pod, as well as between seeds per pod, and seed weight. Total seed weight was highly correlated with number of pods ($r = 0.8781$), with number of seeds ($r = 0.9695$) but not with seeds per pod ($r = 0.0371$) or with weight per seed ($r = 0.3495$).

These results suggest that there is sufficient genetic variation in *Canavalia* to select cultivars that have a high yield potential.

Table 4 presents the protein (N x 6.25) content of the raw samples obtained from the field experiment. These values differed from some cultivars when compared to the protein content of the original samples. The table also shows the protein of the processed samples, as well as the dried matter yield after processing, obtained from a weight of 825 g of

Table 2. Yield components of *Canavalia* sp.

Cultivar No.*	Pods/plant	Seeds/plant	(g) Seed yield/plant**	No. seeds/pod**	Av. seed weight (g)
24869 (1)	13.9 ± 2.7	139.2 ± 31.7	237.5 ± 56.0	10.0 ± 0.9	1.71 ± 0.09
24870 (2)	13.7 ± 1.7	146.9 ± 29.7	247.1 ± 51.9	10.6 ± 1.3	1.68 ± 0.10
24871 (3)	20.6 ± 10.9	227.7 ± 128.9	408.5 ± 219.7	9.6 ± 1.1	1.81 ± 0.16
24872 (4)	14.6 ± 6.3	158.9 ± 68.1	313.5 ± 144.3	11.0 ± 1.2	1.94 ± 0.13
24873 (5)	18.6 ± 6.4	192.5 ± 61.4	366.4 ± 117.9	10.4 ± 1.2	1.91 ± 0.14
24874 (6)	16.6 ± 6.9	158.4 ± 62.9	279.7 ± 102.2	9.8 ± 1.4	1.78 ± 0.17
24875 (7)	13.5 ± 2.9	144.5 ± 39.9	305.4 ± 70.4	11.5 ± 1.2	1.97 ± 0.06
24876 (8)	12.4 ± 5.4	143.1 ± 69.9	259.0 ± 113.1	11.1 ± 4.1	1.86 ± 0.32
24877 (9)	10.2 ± 5.2	86.2 ± 45.1	218.1 ± 97.5	8.3 ± 1.0	2.86 ± 0.19
24878 (10)	5.9 ± 1.8	64.5 ± 22.7	110.0 ± 38.7	10.8 ± 1.1	1.72 ± 0.34
24879 (11)	9.1 ± 4.2	91.5 ± 38.2	143.0 ± 71.5	10.4 ± 2.6	1.57 ± 0.34
24880 (12)	6.4 ± 2.2	79.0 ± 34.3	130.4 ± 63.9	12.0 ± 1.5	1.83 ± 0.13
24881 (13)	5.6 ± 2.3	64.1 ± 25.3	120.6 ± 43.3	11.2 ± 1.3	1.91 ± 0.15
24882 (14)	5.9 ± 1.9	66.6 ± 23.8	113.2 ± 45.6	12.0 ± 1.6	1.61 ± 0.08
24883 (15)	10.2 ± 1.7	122.7 ± 23.8	197.9 ± 41.8	11.2 ± 1.6	1.69 ± 0.48
24884 (16)	8.6 ± 4.3	95.9 ± 50.0	169.0 ± 106.5	11.2 ± 1.3	1.89 ± 0.11
24885 (17)	9.5 ± 2.1	106.0 ± 26.3	212.9 ± 49.8	10.8 ± 1.8	1.73 ± 0.32
24886 (18)	14.9 ± 4.8	164.4 ± 57.3	285.0 ± 104.8	12.3 ± 0.0	1.87 ± 0.11
24887 (19)	13.9 ± 4.0	170.2 ± 48.4	316.5 ± 85.7	10.6 ± 1.5	1.87 ± 0.26
24888 (20)	19.5 ± 7.0	204.9 ± 71.4	388.4 ± 157.6	10.6 ± 1.5	1.87 ± 0.26
24889 (21)	20.4 ± 11.0	113.6 ± 60.3	211.1 ± 120.7	5.8 ± 1.3	1.86 ± 0.22
24890 (22)	15.2 ± 3.9	183.6 ± 70.0	341.4 ± 117.4	12.0 ± 1.7	1.84 ± 0.22
24891 (23)	15.9 ± 4.1	178.0 ± 87.7	395.9 ± 165.2	11.2 ± 2.1	2.42 ± 1.77
24892 (24)	6.7 ± 5.8	72.2 ± 64.2	114.7 ± 106.6	10.8 ± 1.4	1.53 ± 0.28
24893 (25)	5.6 ± 2.7	63.0 ± 29.5	109.5 ± 55.6	11.2 ± 2.1	1.73 ± 0.31
24894 (26)	8.4 ± 3.2	92.3 ± 30.5	178.7 ± 56.9	10.9 ± 1.7	1.97 ± 0.20

* All entries were *C. ensiformis* with the exception of No. 9 which was *C. gladiata*.

** Average of eight replications.

Table 3. Correlation coefficients for some agronomic variables in *Canavalia* sp.

	No. of seeds	Seeds per pod	Mean seed weight (g)	Total seed weight (g)
No. of pods	0.895	−0.355	0.199	0.878
No. of seeds	–	0.077	0.133	0.969
Seeds per pod	–	–	−0.307	0.037
Mean seed weight	–	–	–	0.349

raw seed. With respect to protein, the processed samples had a higher protein content, in all cases except for samples 24871 and 24879. This may be due to greater losses in carbohydrates and minerals rather than losses in nitrogen compound, as well as to possible differences in moisture content. The recovery of dried matter due to the cooking process used ranged from 72.7% (24869) to 85.8% (24893). Similar observations have been made with common beans (*Phaseolus vulgaris*) (6).

Table 5 summarizes the protein quality of the 26 cultivars with a PER variation of 0.93 to 1.64 and a NPR varying from 1.88 to 2.45, which is important. Although this could be attributed to the amino acid level present in the protein, particularly methionine, it could also be due to residual levels of the toxic substances in *Canavalia* after processing, information on which is not yet readily available. The correlation between percentage protein and protein quality was negative ($r = -0.31$), but not statistically significant for all *C. ensiformis* cultivars. In this correlation the values for *C. gladiata* were not included.

These data suggest it is thus possible to select material with a higher protein quality. In this series of tests, unlike previous trials with unprocessed grains (4, 15), there were no deaths and the animals used showed no obvious signs of ill-health or growth impediments.

Data on the effect of date of planting are presented in Table 6. Differences in yield, seed weight, and protein content were not statistically significant; however, days to flower was statistically significant, and it decreased from June to October, without affecting yield. However, protein content of the grains from plants sown on October 22 was lower than that of seeds sown on previous dates. Protein quality of the seed harvested in this study is shown in Table 7. The values are similar to those reported for the 26 cultivars, and there is no tendency for PER to vary with date of planting. However, as presented in Table 8, grouping the samples on the basis of their average protein content indicates that higher quality is obtained with the sample with lower protein content, as shown for the correlation with the 25 *C. ensiformis* cultivars. This observation has also been reported for other grain crops, whether cereals or grain legumes, and is due to their higher concentration of essential amino acids per gramme of protein in samples with lower levels of total protein. Higher protein represents an accumulation of nitrogen, not necessarily a greater richness in essential amino acids, particularly the one limiting protein quality, such as methionine in the case of grain legumes (4).

Results of this research show the high yield of *Canavalia*, and efforts should be made to select and improve cultivars if further research proves it to have a place in feeding systems.

Table 4. Effect of *Canavalia* processing on protein content (N x 6.25) and dried matter recovered.

Cultivar No.	Protein percentaje (N x 6.25) raw*	cooked	Recovery of dried matter after cooking (%)
24869 (1)	23.8	25.9	72.7
24870 (2)	22.8	26.1	81.8
24871 (3)	26.4	26.7	83.0
24872 (4)	24.4	26.3	83.6
24873 (5)	29.7	30.6	83.0
24874 (6)	22.6	26.5	82.4
24875 (7)	26.6	29.3	82.4
24876 (8)	23.9	26.9	83.6
24877 (9)	21.0	22.7	81.2
24878 (10)	22.2	25.5	82.4
24879 (11)	28.8	28.1	83.6
24880 (12)	24.4	25.9	84.0
24881 (13)	26.6	29.1	82.4
24882 (14)	25.2	27.4	83.2
24883 (15)	25.8	27.6	81.8
24884 (16)	26.0	27.8	78.2
24885 (17)	26.3	28.3	82.4
24886 (18)	27.1	28.7	74.5
24887 (19)	26.5	29.1	84.2
24888 (20)	26.3	29.0	74.5
24889 (21)	28.7	30.8	83.6
24890 (22)	26.8	28.6	84.8
24891 (23)	26.2	29.6	84.2
24892 (24)	23.5	24.6	83.4
24893 (25)	27.5	28.2	85.8
24894 (26)	25.6	26.8	83.0
Ave ± SD	25.6 ± 2.1	27.5 ± 1.8	81.9 ± 3.3

* Air dried basis.

Table 5. Protein quality of processed seeds from 26 *Canavalia* cultivars.

Cultivar No.	Average weight gain (g)	Average diet intake (g)	PER*	NPR**
24869 (1)	43 ± 6.4	267 ± 28.0	1.64 ± 0.37	2.28 ± 0.18
24870 (2)	39 ± 10.9	261 ± 55.0	1.44 ± 0.18	2.24 ± 0.29
24871 (3)	42 ± 9.4	267 ± 42.6	1.59 ± 0.11	2.45 ± 0.08
24872 (4)	29 ± 8.5	219 ± 42.9	1.33 ± 0.19	2.31 ± 0.26
24873 (5)	31 ± 11.8	240 ± 43.5	1.23 ± 0.28	2.10 ± 0.35
24874 (6)	44 ± 7.8	289 ± 30.6	1.50 ± 0.21	2.29 ± 0.32
24875 (7)	35 ± 7.9	245 ± 21.6	1.36 ± 0.25	2.29 ± 0.24
24876 (8)	39 ± 6.2	264 ± 34.0	1.45 ± 0.11	2.29 ± 0.25
24877 (9)	22 ± 3.4	217 ± 25.5	1.02 ± 0.10	2.23 ± 0.33
24878 (10)	37 ± 3.8	260 ± 11.1	1.38 ± 0.13	1.89 ± 0.33
24879 (11)	34 ± 8.6	256 ± 35.9	1.27 ± 0.20	2.15 ± 0.18
24880 (12)	29 ± 5.4	228 ± 26.6	1.27 ± 0.16	2.11 ± 0.17
24881 (13)	37 ± 12.5	259 ± 48.2	1.30 ± 0.22	2.07 ± 0.30
24882 (14)	34 ± 8.6	255 ± 43.2	1.23 ± 0.17	2.26 ± 0.31
24883 (15)	29 ± 5.4	258 ± 25.7	1.48 ± 0.22	2.18 ± 0.25
24884 (16)	37 ± 12.5	283 ± 34.0	1.50 ± 0.10	2.30 ± 0.29
24885 (17)	31 ± 5.9	262 ± 24.9	1.31 ± 0.18	2.37 ± 0.23
24886 (18)	37 ± 7.3	258 ± 33.3	1.37 ± 0.16	2.14 ± 0.33
24887 (19)	45 ± 6.8	245 ± 47.1	1.21 ± 0.34	2.29 ± 0.14
24888 (20)	35 ± 7.2	233 ± 26.9	1.24 ± 0.30	2.10 ± 0.35
24889 (21)	21 ± 5.3	213 ± 15.3	0.93 ± 0.17	2.00 ± 0.44
24890 (22)	25 ± 7.8	239 ± 35.1	1.00 ± 0.20	1.89 ± 0.36
24891 (23)	34 ± 6.6	252 ± 34.8	1.25 ± 0.16	1.88 ± 0.22
24892 (24)	33 ± 6.6	211 ± 28.2	1.44 ± 0.30	2.24 ± 0.25
24893 (25)	35 ± 12.3	254 ± 50.3	1.35 ± 0.25	2.24 ± 0.26
24894 (26)	43 ± 5.9	283 ± 18.1	1.50 ± 0.14	2.39 ± 0.24
Casein	127 ± 13.4	441 ± 23.9	2.83 ± 0.17	3.81 ± 0.22

* PER = Protein efficiency ratio.
** NPR = Net protein ratio

Table 6. Effect of planting date on some plant characteristics.

Planting date	Replicate No.	Days to flower	Germinated seeds	Yield g/plot	Yield g/plant	Yield g/56 plants	Seed weight (g)	Moisture (%)	Protein (%)
June 4	1	81	51	10 503	205.9	11 533	1.58	13.4	25.5
	2	76	42	6 900	164.3	9 200	1.42	13.3	25.5
June 2	1	80	47	8 205	174.6	9 776	1.59	12.8	25.3
	2	68	52	10 764	207.0	11 592	1.71	13.7	24.0
July 31	1	62	51	7 786	152.7	8 549	1.76	13.1	25.5
	2	62	56	8 492	151.6	8 492	1.81	13.2	24.4
August 27	1	60	55	9 053	164.6	9 218	1.76	13.4	25.1
	2	59	53	8 181	154.4	8 644	1.80	13.6	25.1
September 24	1	56	55	8 350	151.8	8 502	1.73	13.0	25.6
	2	62	52	7 606	146.3	8 191	1.62	13.4	25.0
October 22	1	55	56	9 224	164.7	9 224	1.73	13.2	23.4
	2	58	51	8 890	176.1	9 860	1.67	13.3	22.7

Experimental plots: 32 square meters.

Table 7. Protein quality of *Canavalia* seed harvested from different planting date (cultivar 24872).

Planting date	Protein in diet (%)	Average weight gain (g)	Average diet consumed (g)	PER*
June 4	10.3	28 ± 7.0	217 ± 37.5	1.26 ± 0.16
July 2	10.1	32 ± 9.3	237 ± 46.0	1.33 ± 0.21
July 31	10.2	27 ± 6.5	211 ± 30.5	1.21 ± 0.20
August 27	10.1	27 ± 5.3	227 ± 25.6	1.19 ± 0.17
September 24	10.1	26 ± 7.4	202 ± 29.3	1.28 ± 0.30
October 22	10.2	31 ± 8.8	220 ± 31.0	1.39 ± 0.20
Casein	10.2	110 ± 15.3	393 ± 28.5	2.74 ± 0.32

Average initial weight: 45 g
Experimental period: 28 days
8 animals/group
* PER = Protein efficiency ratio

Table 8. Effect of protein level in seed on protein efficiency ratio.

Level of protein in seed	Average weight gain (g)*	Average food consumed (g)	PER
25.5	28 ± 7.3	225 ± 35.4	1.24 ± 0.19
25.0	27 ± 7.0	209 ± 32.9	1.27 ± 0.22
24.2	28 ± 4.4	211 ± 25.3	1.32 ± 0.13
23.0	34 ± 9.7	227 ± 31.8	1.45 ± 0.25

* On 10% protein diets

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RESEÑA DE LIBROS

BEETS, W.C. 1990. Raising and sustaining productivity of smallholder farming systems in the tropics. Alkmaar, Holland. AgBé Publishing, 738 p.

En este documento se presentan en forma balanceada los aspectos físicos, económicos y sociales que determinan el nivel de producción y su sostenibilidad en fincas de pequeños agricultores en las regiones tropicales. En él se resumen veintidós años de experiencia del autor en el tema, principalmente en Africa y Asia.

Como mecanismos para elevar y mantener la productividad de los sistemas utilizados en las fincas de pequeños agricultores, se recomiendan la diversificación del sistema y la optimización de la mano de obra e insumos disponibles en la finca. Se critica fuertemente la dependencia de recursos externos al sistema, fenómeno que se asocia con la revolución verde y que funciona con cierto grado de sostenibilidad cuando las condiciones del sistema son buenas (por ejemplo, suelos fértiles, fincas grandes, disponibilidad de capital, otros). El autor enfatiza la necesidad de lograr rendimientos sostenidos en el tiempo, lo cual implica que el sistema debe ser ambientalmente balanceado, aunque sea económicamente marginal a corto plazo.

La multitud de ejemplos presentados en el libro muestra la enorme influencia que tienen ciertas agencias internacionales y organismos financieros en la toma de decisiones en los países en desarrollo. La "Revolución Verde" y la Alianza para el Progreso de los años cincuenta y sesenta, las ISI impulsadas por la Comisión Económica para América Latina y el Caribe (CEPAL) en los años setenta, el desarrollo rural integrado de la década pasada y el neoliberalismo propuesto en los años noventa por el Banco Interamericano de Desarrollo (BID), el Fondo Monetario Internacional (FMI) y el Banco Mundial (BM), son claros ejemplos. No es de extrañar, entonces, que los problemas que atañen a los pequeños agricultores no hayan sido considerados, debido a la poca importancia política de ellos.

El libro es valioso para estudiantes y profesionales que tengan que lidear con el desarrollo agrícola del Tercer Mundo, pues se resumen numerosas publicaciones poco asequibles para personas que no cuentan con tiempo suficiente para buscarlas. La experiencia narrada por Beets deberá ser documentada a corto plazo con ejemplos de América Latina. El libro puede ordenarse a Agbé Publishing, P.O. Box 9125, 1800 E.C. Alkamaar, The Netherlands (US$65 + costo de envío).

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