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STUDIES ON THE PRODUCTION AND UTILIZATION OF OILSEEDS IN BELIZE

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ABSTRACT

To conserve foreign exchange and increase income of farmers, studies for oilseed production and utilization were started in 1981. The limitations to annual crop production were: high rainfall during crop growth especially at harvesttime for the June planted crop; difficulty of land preparation and less and erratic rainfall for the November to January planted crop. These difficulties have been overcome to a great extent by forming land into raised beds, minimum tillage technology and selection of crops and their varieties. Soybean varieties yielding up to 3.5 tons per ha have been identified. High yielding sesame varieties have been selected. Low erucic varieties of mustard have been tested.

Yield of sunflower was considered low for commercialization. To keep the capital and recurring expenses of oil mill low, and to get high protein and high energy feed, oilseeds should be mechanically pressed rather than solvent-extracted. Results of a trial indicated that broilers could be raised on whole fat soybean. Whole fat soybean is being mixed with corn by a tortilla factory, for improved human nutrition.

INTRODUCTION

Diversification of monoculture economies is of importance not only because of fluctuations in the price of the commodities exported, but also to provide increased income to farmers and to conserve foreign exchange by import substitution. Belize imports food worth $45 million dollars per annum. Simultaneously, conventional crops like corn and bean tended to be over produced and could not be sold. Cultivation of oilseeds and extraction of oil would provide oils and fats for human consumption and feed for livestock. Oils and fats and feed were imported at a cost of about $9 million annually (Table 1). Further, additional amounts of proteinaceous feed would be required for shrimp culture for export and to produce milk and milk products and meat, imported to the tune of $14 million annually. Thus, cultivation of oilseeds is pivotal for improvement of an agrarian economy. With the increased use of broilers, globally, the vegetable oils have become a by-product of the feed industry. Thus quality of feed produced must be considered while selecting oilseed crops.

Existing vegetable oil processing facilities in the CARICOM region were importing more and more soybean, to keep the plants running and to be competitive with the extra-regional oil as the regional price of copra was 2-3 times the world price. CARICOM countries imported soybean, and soybean oil and cake worth $44 million annually (Table 2). Further, other vegetable oils and ready made feed were imported into the CARICOM countries.

Table 1. Quantities and value of edible oils and fats and feed imported into Belize

Item	1982		1983		1984		1985	
	a[1/]	b	a	b	a	b	a	b
			A. Oils and Fats					
Lard	1,384	3,182	1,801	3,412	1,570	3,680	1,291	2,774
Margarine	487	1,371	376	1,127	379	1,236	467	1,400
Oils	248	310	486	417	89	343	93	341
Sub total	2,119	4,863	2,663	4,956	2,038	5,529	1,851	4,515
		B. Feed (Protein Concentrate)						
For poultry	3,580	2,249	4,401	3,977	4,226	4,450	4,552	3,186
For cattle	193	107	204	176	371	273	791	284
For pigs	16	11	58	44	38	41	96	35
Sub total	3,789	3,367	4,663	4,197	4,635	4,764	5,439	3,505
Grand total		8,230		9,153		10,023		8,020

1/ a = Quantity in tons; b = Belize dollars in thousands.

Table 2. Import of soybean and soybean products into CARICOM countries[1/]

Country	Quantity (MT)			Value (US $'000)			Value (US$/MT)
	1982	1983	1984	1982	1983	1984	1984
		Soybean					
Jamaica	54,859	94,194	50,813	14,455	19,577	15,312	301
		Soybean cake					
Barbados	10,276	10,000	8,500	3,052	3,100	2,550	300
Trinidad	42,058	30,402	33,901	16,466	8,903	8,228	243
Guyana	5,303	3,000	4,100	2,968	1,800	2,400	585
		Soybean oil					
Barbados	3,681	2,600	1,500	1,568	1,800	1,050	700
Jamaica	2,778	3,549	4,962	2,091	2,853	4,393	885
St. Lucia	519	8		350	7		
Trinidad, etc.	7,603	7,811	8,196	5,169	5,678	7,549	921
Total	127,077	151,609	111,972	46,119	43,718	41,482	

1/ Source: FAO Trade Year Book, 1984.

Table 3. Rainfall data for various districts

Month	Corozal San Andrez		o/Walk San Pablo		Belize Lemonal		Cayo				Stann Creek				Toledo P G
							Roaring Creek		San Ignacio		Pomona		Middle Sex		
	a[1/]	b	a	b	a	b	a	b	a	b	a	b	a	b	a
January	64	7	43	7	78	6	101	9	107	10	150	13	167	15	227
February	33	5	64	3	41	3	78	5	50	6	86	9	89	9	129
March	18	2	20	2	39	2	56	3	40	5	62	6	58	6	99
April	41	3	25	2	51	2	51	3	39	4	86	6	75	6	99
May	122	5	80	4	104	4	79	4	104	6	152	10	176	10	249
June	232	10	242	9	264	9	221	12	199	12	320	18	425	18	619
July	174	11	63	4	193	9	256	14	186	15	332	20	435	24	710
August	150	10	135	6	210	11	201	12	136	11	257	19	316	20	633
September	237	12	181	10	275	12	220	12	175	14	339	19	369	18	567
October	164	10	179	9	189	9	228	13	182	13	314	17	322	17	363
November	100	7	46	5	125	8	162	10	148	11	216	14	200	15	256
December	71	6	71	6	151	8	169	9	139	11	177	13	190	15	229
Total	1,406	88	1,149	67	1,720	83	1,822	106	1,505	118	2,491	164	2,822	173	4,140

1/ a = Rainfall in mm. b = Number of days with more than 1 mm rainfall.

CLIMATIC CONDITIONS IN BELIZE FOR OILSEED PRODUCTION

Because of the rainfall pattern, about 11,500 and 5,400 ha are planted to annual crops in June and in November to December, respectively. Thus 53 per cent of the area planted in June remains fallow during the second planting season. The weed load on fallow land increases and cultivation of even one crop per year becomes difficult and expensive.

June Planting Season

At the beginning of the rainy season it is possible to prepare land and plant crops in the first half of June, in the Corozal, Orange Walk, Belize and Cayo Districts. In the Stann Creek District, June has more rainfall (Table 3), and land preparation and planting have to be done earlier. Similarly in the Toledo District, though in soı : years dry land preparation is not possible because of no dry period. June planted crops are not expected to experience shortage of water. On the other hand, the success of a crop depends on its ability to withstand high rainfall especially at harvest. A 120-day duration crop, planted in Mid-June, should be ready for harvest in mid-October. Because of the amount of rainfall and number of rainy days in October, the best chances of successful harvest of a 120 days crop are in the Corozal and Orange Walk districts, followed by Belize and Cayo, and the least in the Stann Creek and Toledo districts.

November to January Planting Season

Rainfall data for San Ignacio, Cayo District, for 1966 to 1979 were subjected to pentagonal probabilities to determine the chances of land preparation. When any five days received less than 2.5 cm rainfall, that period was considered dry. A period of five dry days preceeded by another five dry days was considered suitable for land preparation. The probatilities thus worked out are presented in Table 4.

Table 4. Probability of land preparation in Cayo

Dates	November	December	January
1 - 5	0.2449	0.4082	xxx
5 - 10	0.2143	0.1224	0.1837
11 - 15	0.3367	0.1633	0.2755
16 - 20	0.1224	0.3061	0.4490
21 - 25	0.2006	0.4490	0.5510
26 - 30	0.3214	0.7857	0.6122
Mean	0.2401	0.3727	0.4143

The probability of land preparation was low in November and early December, but was good from December 16 to December 30, and again from January 16. Corozal, Orange Walk and Belize Districts received less while Stann Creek and Toledo Districts received more rainfall than Cayo and thus chances of land preparation would either be more or less, respectively, over the same period.

The data on the amount of rainfall received by various growth stages of a 95 day soybean crop, presented in Table 5, indicated that, as planting is delayed from November to January, the crop receives less rainfall. Based on the water requirement of various crops, the time of planting can be determined. It should be mentioned that rainfall from November onwards is erratic. For assured success of crops irrigation is necessary.

Average monthly maximum temperatures fro Cayo District from January to December were 28, 29, 30, 31, 32, 31, 30, 30, 30, 29, 28, and 30ºC, and average monthly minimum were 17, 18, 18, 20, 20, 22, 21, 21, 21, 18, 18, and 20ºC. The "absolute" minimum temperatures recorded in January, February and March were 4, 4, and 8ºC. Similar temperature conditions prevail in all the other districts. These data suggested that some semi-tropical crops could be planted in November and December.

Thus, major limitations to the production of annual crops are high rainfall during crop growth and at harvest time for the June planted crop and difficulties of land preparation, and less and erratic rainfall for November to January planted crops. A system of farming on raised beds developed at ICRISAT, India, using animal power, has been adapted for tractor use at CARDI's Field Station, Belmopan, Belize. For the last few years, crops of corn, soybean, peanut and some vegetables have been successfully raised on the beds by planting in June.

Manual tools and specialized harvesting equipment are needed to harvest crops in October so that the beds are not damaged. Crops are planted from November to January, on the same beds without land preparation, using minimum tillage. Crops that have been successfully raised on beds from November to January are: corn, soybean, peanut, sesame, chickpea, dry pea, pigeon pea, sunflower, mustard, and some vegetables.

OILSEED CROPS AND THEIR VARIETIES

Since 1981, work has been in progress on oilseed crops such as soybean **(Glycine max)**, sesame **(Sesamum indicum)**, rape and mustard **(Brassica spp.)**, sunflower **(Helianthus annuus)**, peanut **(Arachis hypogea)**, safflower **(Carthamus tinctorius)**, and castor **(Ricinus communis)**. Five varieties of safflower failed to grow when planted in November and January. Safflower requires drier conditions than those prevailing in Belize, and work on safflower was suspended in 1982. Peanut production systems have been developed, and varieties with various characteristics have been identified, but the cost of production is high for use as oil and feed. Work on castor was initiated in 1986. Work on soybean, sesame, mustard and sunflower is discussed in this paper.

Soybean

Variety selection: From 1982 to the present, 188 varieties from INTSOY (USA), AVROC (Taiwan), IITA (Nigeria) and from Colombia were test-planted in June and in November to December. Selection criteria included yield, plant and lowest pod height, and grain quality.

Based on previous tests, four varieties were tested in a thrice replicated trial planted in June, 1985. Establishment was uneven because of low rainfall immediately after planting. IPB 213-81 yielded the most (3,586 kg ha^{-1}) but had 27 per cent discoloured grains (Table 5). PR 140 (11) yielded 2,384 kg per ha, with 12 per cent discoloured grains, but apparently healthy and discoloured grains germinated 97 and 65 per cent, respectively. Varieties AGS-29 and TAC 23-1385 yielded less than PR 140 (11), had higher percentages of discoloured grains and that germinated poorly. In 1984, apparently healthy and discoloured grains of AGS-29 were analyzed for aflatoxin but none was found. The effect of discolouration on quality of oil needs to be determined. As the quality of seed obtained from the June planted crop was poor, except for PR 140 (11), the effect of planting in November was tested. IPB 213-81, PR 140 (11) and IAC 73-1385, along with UFV-1, another variety selected for planting in June 1985, were planted in November, 1985. The data presented in Table 6 indicate that the plants were very short in height, and that per cent discoloured grains and seed germination ranged from 5 to 18 and 92 to 95, respectively. Yield per unit area could not be assessed as the plant stand was not uniform due to poor quality seed from the June planted crop. Four of these five varieties hadbeen planted in November 1984 when yield varied from 1.6 to 2.1 ton per ha.

The seed harvested in March could be used for planting a commercial crop in June and a seed crop in November. Such a system would reduce expenses on cold storage of seed. Seeds of varieties IPB 213-81, PR 140 (11), AGS-29, and IAC 73-1185 were analyzed and the results were 19, 23, 18, and 21 per cent, respectively, of oil; and 37, 34, 40, and 37, respectively, of protein.

Twenty varieties were tested in a thrice replicated trial planted in November 1985. Ten varieties were rejected because of susceptibility to diseases, grain quality, lodging, shattering, green leaves at harvest stage or 10 percentile plant height less than 45 cm. There were no significant differences in yield of the ten varieties not rejected (Table 7). Longer duration and greater plant height have been considered important characters (Spehar et al., 1983). Greater height of lowest pod was an advantage for a crop to be combined.

Seed longevity: Seed longevity during storage, especially under high ambient temperatures and relative humidity (RH), is important for good establishement. The International Institute of Tropical Agriculture (IITA), Nigeria, has developed techniques to test varieties for this character and has developed varieties with good seed longevity. Dr. E. A. Keuneman, during a visit to CARDI-Belize, suggested that while testing varieties for adaptability, seed longevity should also be considered. Dried seeds of 15 varieties harvested in February/March were exposed to 40ºC and 60 per cent RH in a cabinet. At various time intervals, 100 seeds of each variety were planted to determine seed viability. Corrected per cent viability was calculated uisng the modified Abbot's formula. Variety TGX 814-230 developed at IITA was the most viable (Table 8).

Time of Planting: Data presented in Table 6 indicate that the same varieties planted in June yield more than when planted in November. Further, yields decreased on planting delayed from November to January (Table 9).

Table 5. Rainfall received by various growth stages of a 95-day duration crop when planted at various times

District	Date of Planting	Amount of rainfall (mm)			
		Seedling (0-10 dys)	Vegetative growth (11-50 dys)	Pod formation (51-80 dys)	Grain hardening (81-95 dys)
Corozal	Nov. 1	68	132	78	33
	Dec. 1	48	107	51	17
	Jan. 1	39	74	31	15
Orange Walk	Nov. 1	62	120	85	38
	Dec. 1	45	114	63	22
	Jan. 1	42	90	36	16
Big Falls,	Nov. 1	79	149	91	45
Belize	Dec. 1	61	119	79	38
District	Jan. 1	45	109	85	37
San Ignacio,	Nov. 1	81	185	115	47
Cayo District	Dec. 1	68	158	74	24
	Jan. 1	67	107	44	20
Stan Creek	Nov. 1	134	298	168	68
	Dec. 1	108	235	109	37
	Jan. 1	83	157	62	27

Table 6. Performance of varieties selected for planting in June

Variety	No. plants ha^{-1} ('000)	No. days to harvest	Plant height (cm)	Yield ($kg\ ha^{-1}$)	Percent dis-coloured grains	% germination	
						Heal-thy	Dis-coloured
		Planted on June 11, 1985					
IPB 213-81	217	125	79	3,586	27	38	35
PR 140(11)	200	130	73	2,384	12	97	65
AGS-29	242	98	69	2,115	20	97	30
IAC 73-1385	115	135	75	1,892	50	48	18
		Planted on November 20, 1985					
IPB 213-81			26	2,169 1/	18	92	
PR 140(11)			54	1,737	11	93	
AGS-29			60	1,974	15	92	
IAC 73-1385			34	1,643	13	93	
UFV-1			28		5	95	

1/ Yield data in this case were obtained from a November 1985 planting.

Table 7. Data on ten soybean varieties planted in November

Days to harvest	Plant	Lowest pod	Lodging score	Percent grain discoloured	Variety	Yield (kg ha^{-1})
97	49-77	10-19	1	0	TGX 814-230	2,159
	52-75	10-19	1	9	Jupiter-R	1,812
104	55-85	10-20	2	14	M-98	2,045
110-	65-75	10-20	3	11	IPB 189-81	2,056
111	69-80	10-20	3	12	IAC 73-5115	1,899
	65-90	10-19	2	17	PR 21-35-2x4	2,078
	72-90	13-20	2	15	ICAL-139	2,259
	66-100	13-25	2	13	PR 30-38-3x8	1,918
	76-97	10-25	2	9	PR 15-100-4B8	2,157
	70-105	15-24	1	9	PR 30-38-3x3	1,926

Table 8. Comparative seed viability of soybean varieties exposed to high temperatures and relative humidity

Variety	Viability of seed at 0 day exposure	Corrected per cent viability after No. of days of exposure			
		23	28	33	36
Varieties November planting					
TGX 814-230	92	95	80	39	36
M-98	92	93	69	15	18
ICAL-139	96	64	72	12	10
IAC 73-5115	88	59	45	4	12
AGS-29	96	62	54	2	0
PR 21-35-2x4	96	52	52	16	0
Tulumayo-2	92	58	34	0	0
PR 15-100-4B8	94	46	42	0	0
TGX 239-520	100	32	24	0	0
PR 30-38-3x3	92	28	15	0	0
IPB 189-81	94	23	19	0	0
PR 30-38-3x8	92	15	13	0	0
Varieties for June planting					
IPB 213-81	88	68	59	9	8
UFV-1	96	70	56	0	0
PR-140(11)	92	39	28	4	0
IAC 73-1385	98	20	16	0	0

Plant spacing: A spacing trial indicated that at closer spacing there was a greater reduction in plant number from germination to harvest, the lowest pod height tended to increase, but there was no signficant difference in yield (Table 10).

Fertilizer trials: Two rates of basal fertilizer applied at planting and three rates of fertilizer application at R_5 stage of growth were tested on three varieties. One variety (Baru) lodged, and data on the other two are presented in Table 11.

There was no significant difference between basal fertilizer application rates, nor did side dressing or foliar application of fertilizer increase yields over the control.

Sesame

Cultivation of sesame was the least capital intensive but was labour intensive, and is thus suited to the 5,000 or so slash and burn farmers in Belize. Some farmers already grow a few plants for use in confectionery. In 1983, a large number of varieties were imported from FAO, Mexico, Brazil, Panama, Nicaragua, Guatemala, Colombia and Venezuela, and some were collected locally. In all,80 varieties were screened for suitability. The varieties found suitable, up to 1985, are Yuamar, Acarigua, Aceitera, Local I, Chino Rojo, Phultil No. 1 and FAO 59.833 (Table 12). However, duirng multiplication of these varieties in 1986, Aceitera was observed to suffer from a physiological condition and was rejected. In a variety trial harvested in March 1986, the other varieties which have been observed to be promising are Glauca, Inamar and Venezuela 52.

Young sesame plants grow slowly and compete poorly with weeds. Successful production will require development of an effective herbicide treatment. Schroder and Newson (1984) tested pre- and post-emergence herbicides in a series of experiments in Queensland. Alachlor at 2.25 kg a.i. ha^{-1} was the most effective treatment. Alachlor at three different rates was tested pre-emergence and its effectiveness observed up to 30 days after application. Control plots were hand weeded 16 days after planting. Three fixed 1 m^2 quadrats per plot, were counted for numbers of monocot and dicot weeds. Up to 30 days, weed size in treated plots was small.

Alachlor at 3.33 a.i.ha^{-1} resulted in the least numbers of weeds (Table 13). Fatty acid composition of the Yuamar variety of sesame grown in Belize was determined using a New Port Analyzer MK IIIA at the Oilseeds Laboratory, Agriculture Canada, Saskatoon, with the assistance of Dr. D. Woods. On the basis of poly-unsaturated fatty acid content, sesame oil was next to safflower, sunflower, and corn oil and better than soybean, cotton, and peanut oil.

Mustard

Rape and mustard seeds were obtained from Canada, England, Sweden, France, Federal Republic of Germany, and India, between 1981 and 1985. The species of **Brassica** tested were **B. napus** (15 varieties), **B. campestris** (4 varieties), **B. juncea** (15 varieties), **B. carinata** (2 varieties) and

Table 9. Data on varieties of soybeans planted at different times

Variety	Plant height (cm)			Yield (kg/ha^{-1})		
	Date of planting			Date of planting		
	1	2	3	1	2	3
			1983-84			
AGS-29	66	60	48	2,708	2,182	1,284
AGS-129	67	53	40	2,735	2,161	932
AGS-17	65	58	50	2,409	2,280	687
			1984-8_			
AGS-29	68	50	64	1,972	1,665	1,555
AGS-129	62	43	50	1,958	1,504	1,380
AGS-17	64	30	56	1,742	1,211	1,286

1/ 1, 2, and 3 are November, December and January, respectively.

Table 10. Soybean spacing trial planted in November 1983

Variety	No. plants/ ha at harvest ('000)	Per cent reduction in no. plants up to harvest	Plant height (cm)	Height of lowest pod (cm)	Yield kg/ha
AGS-29	386	18	61	15	2,647
	368	7	58	14	2,630
	306	2	53	13	2,644
AGS-2	392	19	110	15	2,418
	380	5	119	15	2,168
	311	0	109	14	2,372

Table 11. Data on fertilizer trial (soybeans)

Variety	Fertilizer rate at R5 growth[1/] stage	Yield (kg ha^{-1})		
		Basal fertilizer rates[2/]		
		F1	F2	Mean
IAC 73-5115	A	2,499	2,436	2,468
	B	2,295	2,380	2,338
	C	2,400	2,334	2,367
	D	2,239	2,013	2,126
AGS-29	A	2,103	2,120	2,111
	B	1,902	2,000	1,951
	C	2,065	2,015	2,040
	D	2,036	2,207	2,122
Mean		2,192	2,188	

1/ A = nil; B = ammonium sulphate sidedressed (150 gk ha^{-1}); C = urea (70 kg ha^{-1}) and Emgeo (80 kg ha^{-1}) sidedressed; D = Nitrophoska (4.5 l ha^{-1}) as foliar spray.

2/ F_1 = 18.46.0 + K-Mag + micronutrient mixture at, respectively, 100, 100 and 10 kg ha^{-1}. F_2 = as F_1 plus triple superphosphate and potassium sulphate both at 50 kg ha^{-1}. Applied at planting.

Table 12. Data on selected varieties of sesame

Variety	Yield (kg/ha)					Mean yield	Per cent oil content
	1983		1984		1985		
	Nov.	Dec.	Jan.	Dec.	Jan.		
Yuamar	-	-	-	1,261	-	1,261	51
Aceitera	-	-	719	1,169	1,520	1,136	52
Acarigua	-	-	-	1,055	-	1,055	50
Local I	1,238	1,346	569	655	-	955	51
Chino Rojo	813	-	-	828	870	837	53
Phultil No. 1	-	-	664	709	898	757	52
FAO 59.833	290	1,219	263	622	949	599	55

Table 13. Effectiveness of alachlor applied post-plant to sesame

Rate of alachlor (kg a.i. ha^{-1})	No. days after sowing					
	16		23		30	
	a1/	b	a	b	a	b
3.33	22	1	21	1	24	4
2.66	52	3	50	3	38	22
2.00	45	5	34	6	33	15
0.00	104	17	Hand weeded weekly			

1/ a and b are number of dicot and monocot weeds respesting m^{-2}.

B. hirta (1 variety). All except **B. juncea** performed poorly. Some varieties of **B. juncea** yielded up to 1.5 ton/ha^{-1}, but all were high in erucic acid and glucosinolates. The FAO/WHO Joint Expert Consultation on Dietary Fats and Oils in Human Nutrition, in 1980, suggested: "In view of the present knowledge from animal studies, it seems prudent to recommend for populations in which fat constitutes a high proportion of dietary energy (a) the reduciton of erucic acid in **Brassica** oils and/or (b) the blending or use of **Brassica** oils with other fats and oils". However, high erucic acid **Brassica** oils have been consumed for centuries on the Indian sub-continent, China and Japan, with no apparent adverse effects.

During a visit to Agriculture Canada, Saskatoon, Canada, Dr. R. K. Sowney and Dr. Don L. Woods indicated that they were breeding varieties of **B. juncea** with low erucic acid. In November 1985, two such varieties were received and planted (Table 14).

Table 14. Data on two mustard varieties

Variety	Days to 50% flowering	Days to harvest	Planr height (cm)	Seed colour	Yield
T 931 R70	43	105	180	yellow + brown	Well
T 931 R139	89	145	210	yellow	Well

Plant breeding has not yet met with success in breeding varieties low in glucosinolates. Some varieties predominantly contain allyl-, others butenyl-glucosinolates. McGregor et al. (1963) have demonstrated that allyl-glucosinolates could be detoxified by ammoniation, but not butenyl-glucosinolates. Ammoniated mustard meal contains 21 per cent less available lysine, about 3 per cent more digestible energy and 8 per cent more digestible crude protein than the low glucosinolate canola meal (Bell et al., 1984). In view of this, emphasis is now being placed on selecting varieties containing low amounts of erucic acid and predominantly allyl glucosinolates.

Sunflower

Thirty nine hybrid varieties of sunflower from commercial firms in the USA, from FAO, and from the Research Institute for Cereals and Industrial Crops in Romania, were tested between 1982 and 1985. Varieties were planted in June/July 1982, in Cayo and Corozal districts. The plants grew well, flowered, set seed, but flower heads rotted at both locations due to high rainfall at maturity. Trials planted in November and January indicated that the higher yielding varieties were RO-29, RO-130 and Ag-S49, but the maximum yield obtained was only 2,048 kg per ha. The shelling percentage of high yield varieties was 70. The yield was considered too low to warrant commercialization.

UTILIZATION OF OILSEEDS

Trial to Raise Broilers on Whole Fat Soybean

Whole fat soybean was roasted to destroy urease and trypsin inhibitors. Composition of various rations used is given in Table 15. Starter ration was given for the first 42 days. The trial was started on March 19, 1986 with one day old chicks and the birds were processed on May 18, 1986.

Table 15. Composition of broiler rations

Ingredient	Starter Ration (g) Ration No.			Finisher (g) Ration No.		
	1	2	3	1	2	3
Dicalcium phosphate	750	-	-	-	-	-
Limestone	750	-	-	-	-	-
d L methionene	100	100	-	100	100	-
Mineral and vit. mix	120	120	-	120	120	
Common salt	200	200	-	200	200	-
Meat and bone meal 1/	-	5,000	-	-	5,000	-
Roasted soybean	23,000	15,580	-	18,480	14,480	-
48% protein commercial feed	-	-	16,666	-	-	14,280
Corn	25,000	26,000	33,334	30,200	30,500	35,720
Total	50,000	50,000	50,000	50,000	50,000	50,000
Per cent protein in feed	22	22	22	20	20	20
Per cent fat in feed	10	10	3	8	9	3

1/ Per cent content in meat and bone meal, roasted soybean, corn and 48% protein feed were: 35, 37.6, 9, and 48, respectively, crude protein, and 17, 17, 3.5, and 2.5, respectively.

Water and feed were provided **ad libitum**. Data on live and dressed birds and feed consumed, are presented in Table 16, indicated that 2.72 kg and 2.34 to 2.36 kg feed were consumed per kg dressed bird weight when feed was prepared from 48 per cent crude protein (CP) content imported feed and 41 per cent CP content whole fat soybean, respectively. The birds raised on whole fat soybean had slightly more body fat. Thus ration prepared from whole fat soybean should be mixed with ration prepared from seed containing 48 per cent CP, in a proportion, so that the mixture contained about 5 per cent fat. It has been calculated that by following this system, about 700 ha of soybean could be produced and utilized, without having an oil mill in the country.

Table 16. Data on broiler production

Ration No.	No. birds ♂	No. birds ♀	Live weight (kg) ♂	Live weight (kg) ♀	Dressing per cent ge ♂	Dressing per cent ge ♀	Kg feed consumed	kg feed consumed per kg of wt. Live	kg feed consumed per kg of wt. dressed
1	16	24	41.4	54.5	84	86	190	1.99	2.34
2	17	18	47.3	42.3	83	85	177	1.98	2.36
3	11	27	30.6	62.6	82	81	207	2.22	2.72

Cheaper mechanical press oil mill was preferable to capital and high technology intensive solvent extraction mill, as the meal would contain about 7 per cent fat so very necessary for better growth of livestock. The meal obtained from solvent extraction method contained almost no fat.

Improved Human Nutrition

Soybean is being mixed with corn, 12 per cent by weight, by one tortilla making factory in Belize for improved corn protein efficiency ratio, increased protein content, and better texture. Another entrepreneur is considering production of soy milk.

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