Peanut in the Philippine Food System: A Macro Study

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Editor

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FOREWORD

Peanuts are very popular in the Philippines but not much attention has been given to this crop for research and development. It was only in the 80's when USAID, through P-CRSP of the University of Georgia, started a holistic approach to the study of peanut with PCARRD as the coordinating unit.

The P-CRSP program focused on breeding and utilization of peanuts with the Institute of Plant Breeding and the Institute of Food Science and Technology of U.P. as the lead agencies. Through this program, varieties have been developed, recommended and approved by the PSB. Furthermore, products such as peanut butter were improved and new products were developed to expand the uses of peanuts and offer variety to consumers. An enhancement project was also added to the endeavor with ViSCA as the cooperating institution.

Various government and non-government agencies including agricultural colleges and universities have conducted several studies on peanut. The results of these endeavors have been thorough in some areas but sketchy in others. This publication is an attempt by P-CRSP to take a comprehensive look at the situation of peanut R & D in the Philippines today. We expect that our efforts will benefit programs designed in support of the Peanut Program in the Philippines.

Lutgarda S. Palomar
Project Leader
Peanut-CRSP

Acronyms

BAEcon	Bureau of Agricultural Economics
BPI	Bureau of Plant Industry
BAS	Bureau of Agricultural Statistics
CLSU	Central Luzon State University
CMU	Central Mindanao University
CPU	Central Philippines University
CVARRD	Cagayan Valley Agriculture and Resources Research and Development Consortium
DA	Department of Agriculture
DMMSU	Don Mariano Marcos State University
FAO	Food and Agriculture Organization
FDC	Food Development Center
FNRI	Food and Nutrition Research Institute
IFST	Institute of Food Science and Technology
IFT	Institute of Food Technologists
NAPHIRE	National Postharvest Institute for Research and Extension
NCSO	National Census and Statistics Office
P-CRSP	Peanut Collaborative Research Support Program
PAFT	Philippine Association of Food Technologists
PCARR	Philippine Council for Agriculture and Resources Research
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PSB	Philippine Seed Board
TCA	Tarlac College of Agriculture
USAID	United States Agency for International Development
UPCA	University of the Philippines College of Agriculture
UPLB	University of the Philippines at Los Baños
USM	University of Southern Mindanao
ViSCA	Visayas State College of Agriculture

Contents

List of Tables

List of Figures

PEANUT PRODUCTION

Manuel K. Palomar, Ph.D.
Professor

Introduction

Peanut (*Arachis hypogaea* L.) has been a popular crop in the Philippines, its history dating to the Spanish era. It is one of the major field legumes grown by farmers but its production has been low and erratic. Region 8, composed of the provinces of Northern Samar, Eastern Samar, Western Samar, Biliran, Leyte and Southern Leyte, represents a general picture of the peanut production situation in the Philippines (Table 1).

Among the provinces in the Philippines, the top producers by volume and crop hectare in 1995 are Isabela, Pangasinan, La Union, Quirino, Cagayan, Ilocos Norte, Ilocos Sur, Aurora, Albay and Iloilo (**Figure 1**). However, the Cagayan Valley region produced almost half of the country's total peanut production (**Figure 2**) accounting for about 50% of the total peanut production at 14,023 MT/ha, on the average (Table 2).

In terms of crop area, Cagayan Valley led with 21,725 ha or 47% of the total, followed by Ilocos Region, Western Visayas, Southern Tagalog, Bicol and Western Mindanao (Table 3).

Table 1. Peanut production by quantity of production (MT) and area planted (ha), REGION VIII:1981-1990.

PROVINCE / YEAR	PRODUCTION (MT)	AREA PLANTED (ha)
REGION VIII		
1981	787	1,481
1982	973	1,862
1983	718	1,610
1984	836	1,807
1985	857	1,846
1986	831	1,815
1987	959	1,879
1988	984	1,969
1989	938	1,924
1990	543	981
LEYTE*		
1981	596	1,205
1982	632	1,224
1983	554	1,200
1984	518	1,230
1985	555	1,230
1986	546	1,210
1987	717	1,360
1988	701	1,405
1989	615	1,279
1990	301	578
SO. LEYTE		
1981	25	48
1982	130	262
1983	40	121
1984	45	133
1985	50	135
1986	53	135
1987	52	132
1988	53	133
1989	53	147
1990	28	60
SAMAR		
1981	136	176
1982	151	189
1983	65	102
1984	168	207
1985	162	193
1986	140	179
1987	113	145
1988	150	184
1989	192	243
1990	175	113
E. SAMAR		
1981	22	39
1982	53	170
1983	52	170
1984	97	220
1985	82	270
1986	84	275
1987	69	227
1988	70	229
1989	67	234
1990	34	113
N. SAMAR		
1981	8	13
1982	7	17
1983	7	17
1984	8	17
1985	8	18
1986	8	16
1987	8	15
1988	10	18
1989	11	21
1990	5	13

*Includes data for Biliran

Source: Bureau of Agricultural Statistics, Philippines.

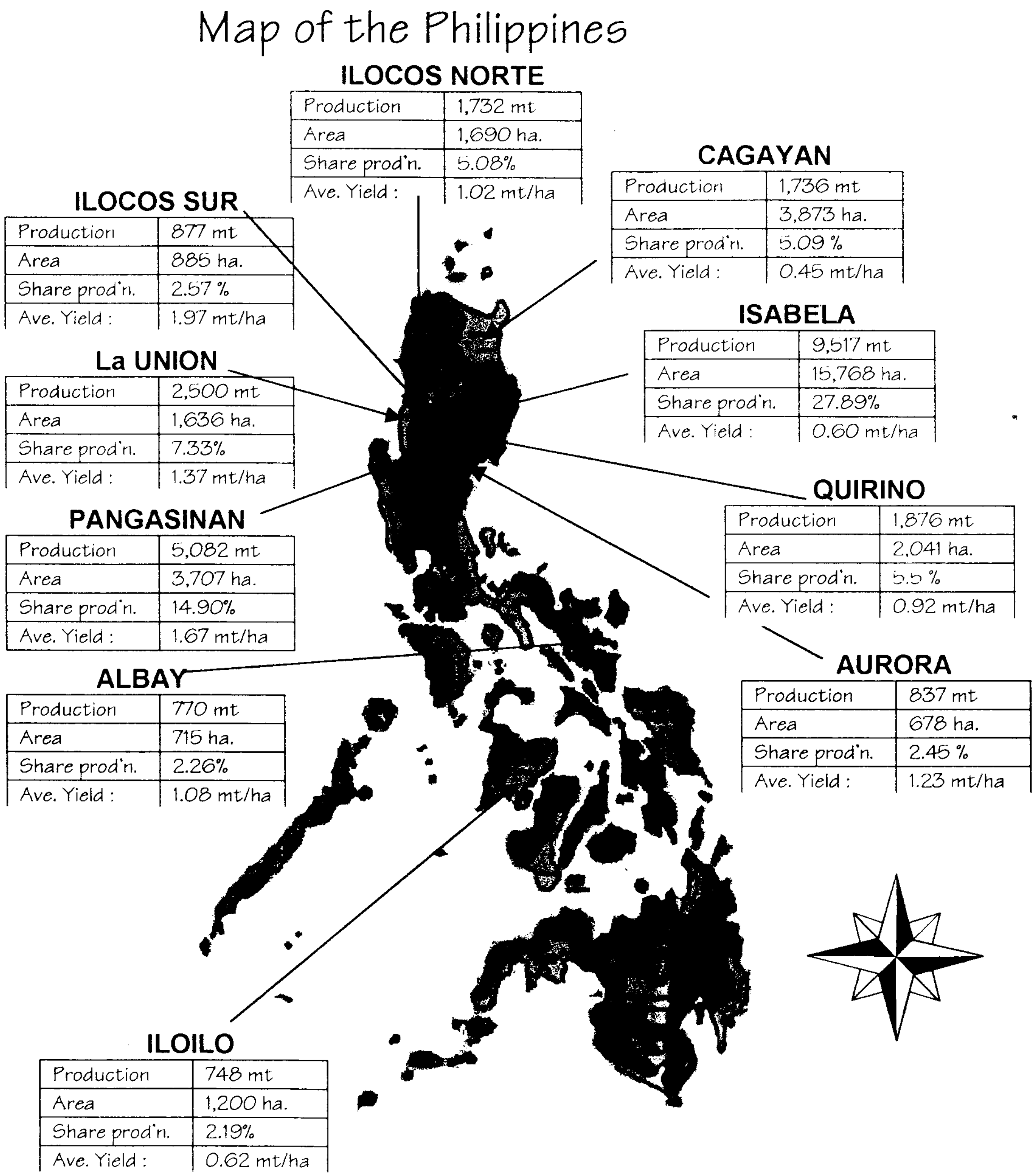

Figure 1. Top ten producers of peanut by province in the Philippines, 1996.

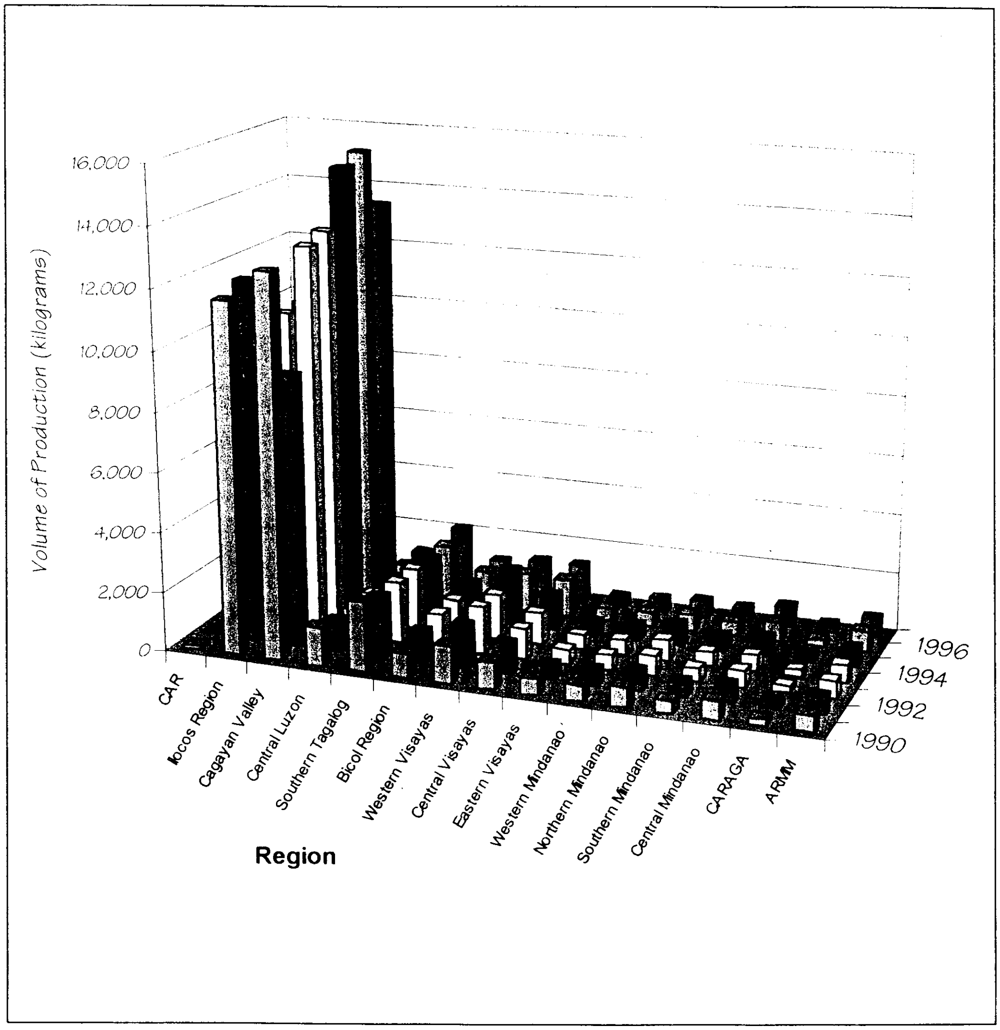

Figure 2. Comparison of volume of production of peanuts by region, 1990-1996.

Table 2. Peanut production (MT) by region in the Philippines, 1992-1996.

Region	1992	1993	1994	1995	1996	Average
CAR	123	125	115	88	81	106
Ilocos Region	10,731	10,400	10,440	10,385	10,192	10,430
Cagayan Valley	13,005	13,244	15,097	15,399	13,370	14,023
Central Luzon	913	1,018	1,100	1,104	1,117	1,050
Southern Tagalog	2,051	2,056	1,967	1,955	2,116	2,029
Bicol	1,155	1,147	1,265	1,216	1,149	1,186
Western Visayas	1,575	1,507	1,916	1,308	1,296	1,520
Central Visayas	1,011	1,055	1,173	1,261	1,305	1,161
Eastern Visayas	493	491	431	419	372	441
Western Mindanao	507	507	433	467	471	477
Northern Mindanao	668	674	709	564	562	635
Southern Mindanao	427	455	465	477	488	462
Central Mindanao	541	549	604	632	708	607
CARAGA	217	220	224	233	254	230
ARMM	575	581	602	690	637	617
Philippines	33,993	34,030	36,574	36,200	34,118	**34,983**

Source: Bureau of Agricultural Statistics, Philippines.

Table 3. Peanut area planted/harvested (ha) by region in the Philippines, 1992-1996.

Region	1992	1993	1994	1995	1996	Average
CAR	308	311	297	259	247	284
Ilocos Region	9,054	8,700	8,779	8,998	7,918	8,690
Cagayan Valley	20,405	21,037	22,285	22,916	22,982	21,725
Central Luzon	869	101	1,007	1,009	1,032	804
Southern Tagalog	2,919	2,853	2,845	2,843	2,911	2,880
Bicol	1,410	1,406	1,509	1,485	1,404	1,493
Western Visayas	2,782	3,611	3,174	2,739	2,283	2,918
Central Visayas	1,579	1,655	1,774	1,750	1,754	1,702
Eastern Visayas	922	921	914	892	875	905
Western Mindanao	1,162	1,163	1,146	1,222	1,192	1,177
Northern Mindanao	671	675	717	701	701	693
Southern Mindanao	650	689	707	727	728	700
Central Mindanao	638	642	684	728	688	676
CARAGA	414	427	438	470	492	448
ARMM	780	788	815	903	821	821
Philippines	44,563	44,909	47,091	47,642	45,028	**45,847**

Source: Bureau of Agricultural Statistics, Philippines.

Background Information

Planting Season

In the Philippines, peanut can be grown throughout the year provided production inputs, especially the water requirement, are adequately available (PCARR, 1978). In general, the dry season crop (October to early November) gives higher yields and beans of better quality than the rainy season crop. This is because of the season's decreasing rainy days and increasing sunlight, which the crop needs for vegetative growth and reproductive development (Opulencia, 1962; Cadelina, 1964; Lalap, 1972). Peanut planted during the wet season tends to grow viny and vegetative, and produces fewer pods. The pods are generally exposed to adverse weather conditions and may rot and germinate in the field (Lalap, 1972). If supplemental irrigation is available, February is the best month to plant peanut in terms of bean yield and quality (Velasco *et al*., 1972; Cagampang and Lantican, 1975).

In areas where rainfall is evenly distributed (Batanes, northeastern Luzon, western Camarines Norte and Camarines Sur, Albay, eastern Mindoro, Marinduque, western Leyte, northern Negros and most of the central, eastern and southern Mindanao), peanut is planted from September to November and May to June. A third crop can be planted from November to February. In the study conducted by Huelgas and co-workers (1990), the cropping season followed by farmers is shown in Table 4.

Table 4. Peanut cropping season, 204 peanut farmers, Philippines, 1985-86.

Peanut Cropping Season	Number of Farms	Percentage
Aug. 1985 – Jan. 1986	2	0.98
Sept. – Dec. 1985	12	5.88
Sept. 1985 – Jan. 1986	8	3.92
Sept. 1985 - Feb. 1986	9	4.41
Oct. 1985 - Jan. 1986	5	2.45
Oct. 1985 – Feb. 1986	8	3.92
Oct. 1985 – March 1986	9	4.41
Nov. 1985 – Feb. 1986	14	6.86
Nov. 1985 – April 1986	49	24.02
Dec. 1985 – March 1986	35	17.17
Dec. 1985 – April 1986	15	7.35
Dec. 1985 – May 1986	30	14.71
Jan. 1985 – June 1986	8	3.92
Total	204	100.00

Seed Inoculation

Soil bacteria known as rhizobia from the genera *Rhizobium* and *Bradyrhizobium* form symbiotic relationships with peanut root cells and fix atmospheric nitrogen by converting it to organic nitrogen compounds. Inoculation of peanut seeds with the proper culture of rhizobium bacteria is advisable unless inoculated peanuts, cowpea, mungo, lima beans or partridge peas have been grown previously in the soil (Martin *et al*., 1976). The peanut inoculant will provide the plant with rhizobia that can fix nitrogen from the air and thus reduce the nitrogen fertilizer requirements (Clemente, 1979). When the rhizobia die, they are digested by other bacteria and the organic nitrogen compounds are converted to ammonia, nitrites and nitrates that are used by the plants to make proteins.

Artificial inoculation of peanuts results in large increases in the number of marketable pods per hill. Furthermore, inoculated pods consistently yield more marketable pods and seeds per hectare (Santos, 1970; Villones, 1982; Nierras, 1987; Simbajon and Duque, 1987).

Dual inoculation with rhizobia and mycorrhizal fungi did not affect the growth, yield and nutrient uptake of peanut (Quilay, 1994). Meanwhile, Abrea (1996) found that yield of peanut is not affected by distance of planting and rhizobial inoculation.

Classification

The system of peanut classification is based on two considerations: whether the cultivar is a runner or bunch type. The runner type is characterized by prostrate stems and branches, late maturity and large pods and large seeds or kernels produced along the leaf axils of prostrate, side branches above the ground. The bunch type has upright stems, early maturity and small pods and kernels produced mainly in the nodes below the ground. The bunch type matures earlier (90 and 100 days for dry and wet seasons, respectively) than runner types (120 and 140 days for dry and wet seasons, respectively). The runner type varieties are used for hay and for green manuring. They can also be used as "hog off" to fatten hogs.

When the soil is hard and infertile, the farmers grow the bunch type. When the ground is porous and light, the runner type is preferred over that of the bunch type.

Seed Sources

Peanut farmers set aside about 164 kg of unshelled traditional variety for seeds. About 42% of the peanut farmers produce the seeds they use in planting (Huelgas *et al*., 1990).

Seed Production and Certification

The proper selection and handling of seeds are of prime importance in obtaining a uniform plant stand and high yield. Only fully mature seeds from recommended varieties with high germination rate and vigor, that are free of weed seeds and other foreign materials, and free of pest infestation should be used for planting. Seed treatment with Arasan SF at 3 g or with Captan at 5 g/ganta of seeds (about 2 kg) is recommended.

The use of high quality seeds is one of the vital factors leading to increased peanut productivity. High quality seeds are produced from the multiplication of seeds with specific genetic identity and purity approved by the Philippine Seed Board for planting for commercial production. The following seeds must be produced from lands not producing any other variety of the same crop, or an uncertified crop of the variety for a certain length of time and should be free from volunteer plants of the same crop.

Breeder seed - seed directly controlled by the originating or in certain cases, the sponsoring plant breeder or institution. This provides the source for the initial and recurring increase of foundation seed and must be carefully supervised by technical personnel of the experiment station.

Foundation seeds - progeny of the breeder seed and shall be the source of all other certified seed classes either directly or through the registered seed.

Certified seed - progeny of the foundation or registered seed and is so handled as to maintain satisfactory genetic identity and purity and has been approved and certified by the Certifying Agency.

The seed producer aside from accounting the source of his planting seed has to consider uniform and timely application of fertilizer, insecticides and weedicides. Roguing off-types and weeding of noxious weeds are important. Prior to laboratory seed certification, the seed inspector visits the field before harvest to ensure the absence of noxious weed or variety mixtures prior to harvest. Disqualification or rejections may be done if there are evidences of off-types and noxious weeds.

Extent of Use of Improved Seeds

The traditional variety is the popular variety being used by peanut farmers due to the unavailability of improved varieties in the provinces (Huelgas *et al.*, 1990). The farmers will earn more if they switch from native to high yielding varieties but at present the farmers such as in Maddela, Quirino are satisfied with the prices that they are getting from the native varieties (Alvarez, 1981).

Major Varieties

The new and improved varieties of peanuts are high-yielding (1.5 to 2.5 tons per hectare), early maturing (102 to 105 days from seedling emergence, with a purplish seedcoat, resistant to major pests, and of uniform height and maturity. In Table 5, the recommended varieties for peanuts are indicated.

More varieties are constantly being evaluated and developed (Laguna, 1979; Margallo, 1986; Galon, 1985) through conventional methods, the latest of which is PSB Pn-3 (Dia, 1995). PSB Pn-3 matures in 103 days after planting, bears 2 to 3 pods per pod with 64% shelling recovery, and yields 1.8 t/ha, outyielding the check varieties, BPI Pn-2 by 8.3%; PSB Pn-1 (Biyaya 10) by 7%; and PSB Pn-2 (Biyaya 12) by 4%. Other methods that have been explored to improve peanut are mutagenic treatment and mutant selection (Soriano, 1984 &1985), genetic analysis (Redoña and Lantican, 1986), hydroponics culture (Pandey and Pendleton, 1986) and combining ability analysis (Redoña and Lantican, 1985; Lantican and Abilay, 1992). Disease resistance is incorporated in all breeding programs of peanut (Castillo *et al.*, 1971; Paningbatan and Ilag, 1984; Tangonan and Jagolino, 1988).

Table 5. Recommended peanut varieties in the Philippines.

PHILIPPINE SEED BOARD PEANUT VARIETIES (1976-1995)								
VARIETY NAME	AGRONOMIC CHARACTERISTICS						REACTION TO PESTS & DISEASES	OTHER VARIETAL CHARACTERISTICS
	YIELD (t/ha)		MATURITY (days)		PLANT HEIGHT (cm)			
	DS	WS	DS	WS	DS	WS		
UPL Pn-2 (Moket)	1.8-2.0		104-111				Moderately susceptible to cercospora and peanut rust. Resistant to sclerotium leaf spot	Prominently seeded; pinkish seed coat 25% protein, 44% oil, 72% shelling.
UPL Pn-4	2.0-2.5		105-110				Resistant to cercospora leaf spot and peanut rust.	3 to 4 seeded, seeds semi-shrive 1 of medium size.
UPL Pn-6 (Biyaya)	2.42	1.76	101				Moderately resistant to cercospora leaf spot and rust.	It has normal seed shape and is better seed color azale pink that of UPL Pn-4.
UPL Pn-8 (Biyaya 8)	2.17	1.88	100	110	39	51	Moderately resistant to rust, late blight, cercospora leaf spot and sclerotium wilt.	It has shown shade tolerance and suited to be grown under the coconut. It is more suited as a boiling type peanut than table peanut because of its sweet taste. It has high yielding potential with long pods and mostly 3 seeded.
BPI Pn-2 (Mithi)	1.89	1.69	101	97			Moderately resistant to cercospora leaf spot and rust.	Bigger seed size and higher shelling percentage.
UPL Pn-10 (Biyaya 10)	1.66	1.75	100	98	38	65	Resistant to leafhopper and defoliators.	This variety has thin and smooth shell, which makes shelling easy. It is moderately resistant to *Aspergillus flavus* invasion and has high seed storability / viability.
PSB Pn-2 (Biyaya 12)	1.87	1.34	101	103	45	74	Has better resistance to peanut rust and cercospora leaf spot diseases. Has moderate resistance to Aspergillus flavus invasion using dry seed resistance test.	Better suited or more productive tillers during the dry cropping season.
PSB Pn-3	1.80	1.86	104	103	64	41	It has slightly better resistance to peanut rust and cercospora leaf spot.	It has a 3-seeded bunch-type peanut with a light brown seed coat.

DS – dry season; WS – wet season
Source: Bureau of Plant Industry, DA, Philippines

The recommended and acceptable peanut varieties for Region 2 (Cagayan Valley) and their agronomic characteristics are:

1. UPL Pn 2. This variety has a pinkish seed coat, large seeds and two-seeded. It is moderately susceptible to cercospora leaf spot and slightly tolerant to excessive soil moisture. About 165 kg of unshelled pods is required to plant a hectare with 80-100% germination. UPL PN 2 matures in 90 to 100 days with a potential yield of 2.0-2.5 tons/ha-unshelled pods.
2. BPI P9. It has a pinkish seed coat, medium-seeded, moderately susceptible to leaf rust, slightly tolerant to excessive soil moisture and resistant to sclerotium disease. The seeding rate of this variety is 150 kg/ha of unshelled pods at 80-100% germination. Maturity occurs in 90-100 days after planting. A hectare field can give a yield of 1.5-2.0 tons unshelled peanut.
3. UPL Pn 10. This peanut variety has pink medium-sized seeds, two-seeded, moderately resistant to leafhoppers and defoliators. However, it is susceptible to rust and cercospora leaf spot. The seeding rate is 150 kg/ha of unshelled pods at 80-100% germination. UPL Pn 10 matures in 100-110 days from planting and yields about 1.5-2.0 tons/ha-unshelled pods. This variety yields better than the other varieties during the wet season.

Extent of Bunch and Runner Types Grown in the Country

There are no data on the extent of bunch and runner types of peanuts grown in the Philippines. The three general types of peanut in the Philippines – the Virginia, the Spanish, and the Valencia. Of the varieties, the bunch type are Lemery, Tennessee Red, Valencia, African bush, Tirik, Kinoralis, Big Japan and Cagayan No. 3. Examples of the runner type are Virginia Jumbo, Taitan, North Carolina, San Jose and Virginia runner (Galon, 1982).

Production Practices

Land Preparation

Peanut requires a well-prepared field to attain good seed emergence. Thorough land preparation is also necessary for proper development of pods and effective weed control. Plow and harrow the field 2-3 times at an interval of 7 days. Each harrowing consists of 2 passing. However, the frequency of plowing and harrowing depends on soil type, weed population and utilization of the land during the previous season. Clay loam soils and weedy fields require more plowing than light soils and weed-free fields. The field is ready for planting if good soil tilt is attained after the last harrowing.

In dry season planting, straight furrows are made at a distance of 50 cm from the higher elevation of the field going down to the lower elevation. Peanut is planted as soon as the furrows are made, probably early in the morning or late in the afternoon. Ridges are prepared 75-cm apart in rows by plowing straight furrows from the upper to the lower elevation of the field. The plow is passed once; on the second passing, the plow will throw soil clods towards the first ridge. The result is raised beds 10-cm above ground level. Furrowing is done when the soil has the right moisture for planting. This is determined when the soil does not stick to the plow during the operation.

Seed Treatment and Spacing

The proper selection and handling of seeds are of prime importance in obtaining a uniform plant stand and high yield. Only fully mature seeds from recommended varieties with high germination rate and vigor, that are free of weed seeds and other foreign materials, and free of pest infestation should be used for planting. Seed treatment with Arasan SF at 3 g or with Captan at 5 g/ganta of seeds (about 2 kg) is recommended.

Planting shelled peanut seeds is the standard practice. However, ants and other insects before germination often attack the shelled seeds. To prevent insect damage, some farmers sprinkle their seeds sparingly with a solution of equal parts of pine tar and kerosene just prior to planting. Some farmers use the old practice of planting unshelled pods. Unshelled pods take a longer time to germinate and germination percentage is low, therefore producing an uneven crop stand (Rodrigo, 1947).

Cagampang and Marasigan (1971) reported that the 50-cm row spacing for peanut gives the highest bean yield. However, for convenience and relative ease of weeding, cultivation and spraying without significantly affecting yield, the same authors recommend the use of 60-cm row spacing. If possible, the rows should run an east-west direction to allow greater penetration and interception.

Cultural Practices

Intercropping

Intercropping is the growing of two or more crops in the same field at the same time (Herrera *et al*., 1975). It is a method of crop intensification commonly practiced by traditional farmers in many small farms in the Philippines. The benefits that may be derived from intercropping are many, such as maximized land utilization, increased farm profits, better income distribution, better labor use, production of more food crops, reduction of weed growth and cost of weed control and improvement of soil physical characteristics and fertility (Paner, 1975; Mercado *et al*., 1976).

Peanut is a crop that fits well in many multi-cropping schemes. Although researchers agree that the yield of peanuts is reduced when intercropped with other crops due to competition, the overall productivity of intercropping has been found to be higher than that of monoculture stand ((Obordo and Onia, 1970; Nadal and Harwood, 1973; Guantes and Cariaga, 1976).

In the Philippines, the common practice is to intercrop peanut with corn. Peanut is planted between rows of corn at varying spacing (Andrade, 1988). Corn plants spaced at 100 cm apart with one row of peanut intercrop produce the highest grain yield

(Montebon, 1988; Fabroa, 1994); however, one row of peanut in between 2 rows of corn spaced at 75 cm is found to be the best intercropping combination (Escasinas, 1986). In contrast, different intercropping schemes (Pantuan, 1988) seeding rate of corn (Armachuelo, 1987) and timing of planting peanut (Luyahan, 1996) do not affect the yield of corn and peanut. Although the yield of peanut could be reduced by 20-30% when intercropped with corn (Obordo and Onia, 1970), the combined productivity of the two crops is 30-50% higher than their monoculture yields (Herrera *et al*. 1975). However, Sison and Pava (1990) found that in peanut, monoculture is superior than intercropping with corn. The additional corn yield in peanut-corn intercrop cannot compensate for the reduction in peanut yield. Furthermore, the growth performance of the main crop (corn) and the intercrop (peanut) is not improved with increasing levels of nitrogen (Zamora, 1988). On the other hand, the incidence of corn borer infestation is significantly reduced in the corn-peanut intercropping scheme. Paner (1975) observed that peanut provides a hiding place for spiders that prey on the larvae of the corn borer.

Similar results were obtained when sorghum is intercropped with peanut (Tandang, 1959). Shading by sorghum reduces the yield, leaves and root nodules but increases the height of peanut intercrops (Ochieng, 1988). Intercropping peanut with sugarcane or other annual crops (mungbean, soybean or upland rice) is highly profitable. The peanut intercrop does not adversely affect cane and sugar yields provided the intercrops are fertilized and recommended spacing is used (Mercado *et al*., 1976). Two rows of peanut, 35-50 cm apart are planted within a week after the main sugarcane crop is planted or after ratooning. The peanut is harvested before the sugarcane canopy closes in completely. At P3.35/kg of unshelled peanut, the net income from the intercrop alone is P976.00/ha or a P2.31 return per peso invested (Dosado, 1979).

Elemo (1980) observed that rice-peanut intercrops (1:1), planted simultaneously early during the season (June-December), give a 21%-yield advantage based on the land equivalent ratio. Varying levels of nitrogen (Bodonia, 1995) and different population (Sinahon, 1993) applied to upland rice and peanut intercrop affect some of the growth characteristics and yield parameters of both crops. Optimum yield of both crops are obtained when peanut is planted one week after the upland rice and when they are planted simultaneously (Martinez, 1996). Borong (1989) found that higher grain yield of rice (1.02 t/ha) and the highest seed yield of peanut (1.45 t/ha) are realized when rice is planted in single rows and intercropped with 2 rows of peanut. Transplanted rice can also be followed by corn intercropped with peanut in Pangasinan (Marra and Aquino, 1993).

Guantes and Cariaga (1976) reported that weed growth is greatly suppressed when sunflower and peanut were grown together within the rows, resulting in higher yields per unit area of land. However, handweeding is necessary to obtain the optimum yield.

Peanuts may also be intercropped with cassava, okra, and may be planted between rows of coffee (Anonymous, 1992), coconut (Baliad, 1986), papaya and citrus trees that have not yet closed in (PCARR, 1978). Intercropping peanut with dwarf coconut is advantageous to the coconut. A study conducted by Carcallas in 1981 showed that nitrogen concentrations found in leaves of intercropped dwarf coconuts is higher than in those without intercrop. However, the yield of the peanut intercrop is not influenced by NPK fertilization (Palconit, 1977). Intercropping taro with 2-4 rows of peanut increases total land productivity by 30-65% and attains higher net income compared to the monoculture of either taro or peanut (Mangyao, 1986). In contrast, the agronomic characters and yield and yield components of peanuts are not significantly affected by the different nitrogen levels applied to sweetpotato except for the number of seeds per pod. More seeds per pod are developed by peanut grown in plots where sweetpotato is applied with 40 kg N, with 30 kg/ha each of P_2O_5 and K_2O (Davis, 1989). Intercropping with peanut planted 3 weeks ahead of sweetpotato results in higher net income of both crops (Abella, 1987; Misa, 1985).

Other Cropping System

Relay cropping significantly affects the number of days from planting to heading, maturity and straw yield of rice. Upland rice relay planted 2 weeks and 1 week before the harvest of peanut produces the highest grain yields (Prejula, 1989). However, contour strip cropping markedly decreases pod yield of peanut (Paraiso, 1987) while no significant differences due to hedgerows are observed on agronomic and yield and yield components except in number of pods and number of seeds per pod of peanut (Florentino, 1997).

Shading

Light is a limiting factor of peanut yield in intercropping systems which suggests the need to improve adaptation of peanut under a low light environment. Shading reduces kernel yield by reduced photosynthesis (Gonzales, 1991). Partial shade decreases the pod and seed yields, specific leaf weight and nodule count (Abilay *et al*., 1988). It also reduces nitrogen fixation by 37%, total nodule number by 35% and nodule dry weight by 36% (Fernandez *et al.,* 1988). Correlation and path coefficient analyses show that harvest index, number of pods per plant, leaf area index, leaf protein content and plant height are desirable characters for predicting high yield of peanut grown under 40% shading (Abilay and Lantican, 1982). Peanut cultivars have been screened for shade tolerance (Magpantay *et al.,* 1991; Abilay and Magpantay, 1992).

Seedbed Preparation

Thorough seed preparation is needed for good seed germination, seedling emergence and establishment. A well-cultivated soil allows easy penetration of the peg and development of the pods. Plowing the field 15-20 cm deep will completely cover the plant residues and reduce losses from stem and pod disease caused by *Sclerotium rolfsii* (Martin *et al*., 1976). About two to three alternate plowings and harrowing will be sufficient to put the soil in good tilt for planting. Monzon (1979) reported that NPK uptake of both peanut seeds and hay is not affected by the size of clods formed by harrowing once, three and five times.

Planting Materials and Planting

Peanut is commercially propagated through seeds. However, it can also be grown from cuttings (Rodrigo, 1927), although asexual propagation through cuttings may be used in breeding studies to expedite production of F_2 seeds from F_1 planting (Rachie and Roberts, 1974).

Planting is done early in the morning or late in the afternoon while the soil is still moist. During the rainy season, planting is made on ridges but during the dry season, furrow planting may be resorted. To ridge-plant, holes are dibbled on the ridges at desired distances by means of a pointed stake. The seeds are dropped on the holes and covered with fine soil 2 to 3 cm thick. As a general rule, the thickness of soil cover at planting is 2 to 4 times the diameter of the seeds.

Planting may be done mechanically or manually. Manual planting is accomplished either by the drill method (sowing of the seed singly and evenly on shallow laid-out furrows) or by the hill method (sowing 2-3 seeds/hill spaced 20-25 cm apart on the laid-out furrows) (PCARR, 1978; Galvez, 1991; Alas, 1995). In both methods of planting, the seeds are covered with a thin layer of fine moist soil and firmed up slightly with the feet. The depth of planting varies from about 3-6 cm. Sowing on shallower furrows is done in heavy soils and/or soils with high moisture content and deeper furrows are recommended in light soil and/or less moist soils (Rodrigo, 1947).

Comparing the two planting methods, Leboon (1967) obtained significantly higher bean yield from the drill than from the hill method. The highest yield came from the 40 cm-row spacing with 20 evenly spaced plants per linear meter (about 500,000 plant density/ha). In the hill method, Alonzo (1961) obtained the highest bean yield using 20 x 80 cm spacing. Three seeds per hill is the best seeding rate in terms of yield (Andaya, 1968; Tabunar, 1969).

Cagampang and Lantican (1975) reported that a density stand of 200,000-400,000 plants/ha shows little variation in pod yield of the Virginia bunch type peanut. They recommend a plant population of 200,000 plants/ha for the wet season and 250,000-300,000 plants/ha for the dry season.

A guide on the recommended population densities for specific row spacings and the seed requirement for each planting method is presented in the Philippines Recommends for Peanut (1978).

Because of the time consuming nature of manual planting, Rosal (1982) designed, constructed and evaluated a hand-pushed peanut seeder (**Figure 3**) that is 2.64 times more efficient than hand seeding. The seeder is composed of three main parts, namely: whellbarrow frame, metering mechanism, and driving wheel. The machine, however, causes clogging of seeds in the seed cell resulting in delay in operation. Meanwhile, Duldulao and co-workers (1993) designed another mechanical peanut seeder (**Figure 4**) consisting of a drum hopper (with a center diameter of 18 cm and an end diameter of 23.87 cm) that rottes about about the main axle shaft (with a length of 85 cm)

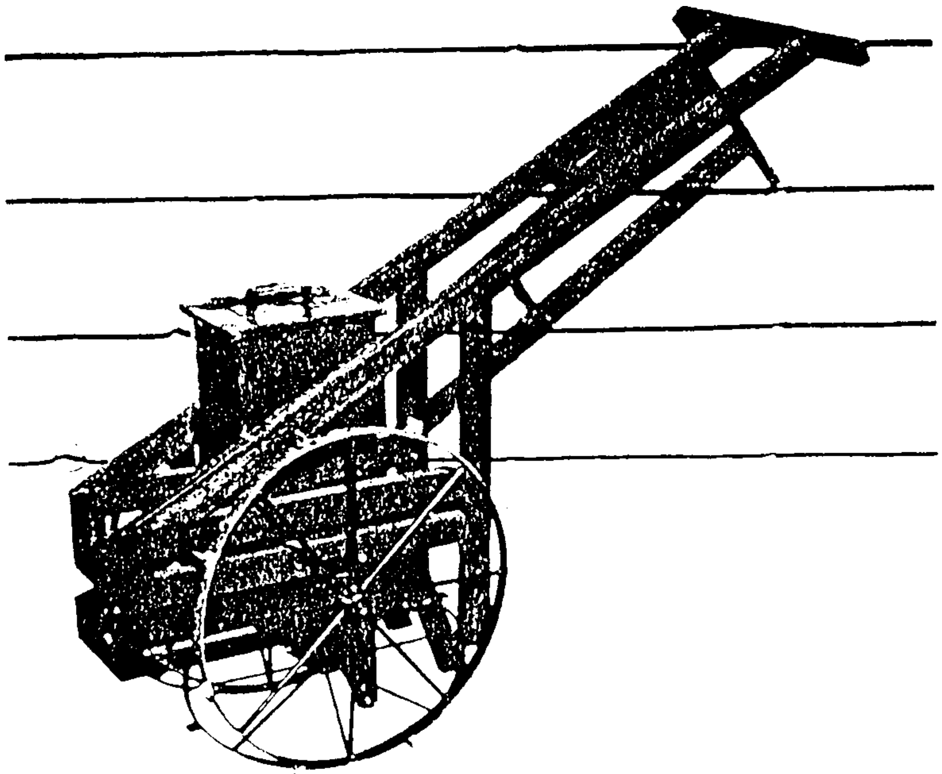

Figure 3. Rosal hand-pushed peanut seeder.

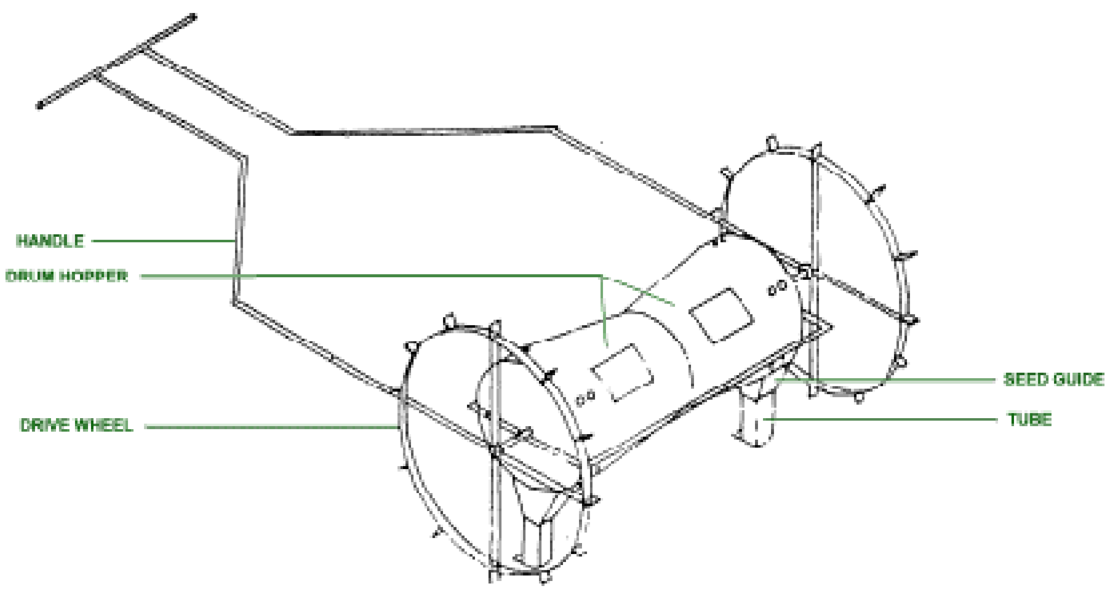

Figure 4. TCA hand-pushed peanut seeder.

that is directly connected to two driving wheels. In hoppers A and B, two rows of 1.4 cm and 1.7 cm diameter holes are punched at an interval of 12.5 cm around the preiphery of the rotating hopper. The handle, made of iron pipe, is attached to both ends of the amin axle by bearings and are used to transmit the power from the operator to the driving members of the machine. The seeder gives the highest seeding rate of 287.1 kg/ha and a field capacity of 0.023 ha/hr with the hopper one-fourth full.

Method and Time of Cultivation

Cultivation not only loosens up the soil for better root and peg development of peanut but also controls the growth of weeds. Tests have shown that the growth of peanut did not vary when subjected to different cultivation practices (flat, combination of flat and off-barring, combination of off-barring and hilling-up and no cultivation). However, yield is greatly influenced by the combination of off-barring and hilling up (Sinampaga, 1968). This confirms the previous findings of Rodrigo (1927) that hilling up is better than flat cultivation because the former provides loose soil around the base of the plant for the developing pegs.

The hilling-up operation should be done with extra care to prevent unnecessary damage to the blooms and developing pegs. Hilling up done 35-40 days after plant emergence or just before flowering results in higher yield than hilling up after flowering (Rabang, 1968).

Water Management

Peanut is relatively drought tolerant although like most field legumes, its critical periods of water need are during germination, flowering, pod development and pod filling stages. The water requirement of the crop grown on dry lands is estimated at 500-600 mm/crop per season (Rachie and Roberts, 1974).

When peanut is planted during the rainy season, irrigation is generally not needed. On the other hand, drainage may be a problem on poorly drained or waterlogged peanut fields. When planted duirng the dry season, especially in early October, supplemental irrigation is not needed in most instances. Normally, there is still residual soil moisture sufficient to support the vegetative and reproductive process of the crop from October to December.

However, the late dry season planting in February needs supplemental irrigation. Three to four applications may be enough: the first application is at planting for seed germination; the second two weeks after planting; the third at midbloom stage; and the fourth at pod filling stage. Depending on a number of factors, the average amount of irrigation water ranges from 40-50 mm per application. This is enough to wet the soil down to a depth of 30 cm (PCARR, 1978).

On the other hand, Galvez (1968) reported that the various levels of available soil moisture ranging from 20-80% do not affect the growth of peanut, but the range from 50-80% significantly increases pod yield of the crop.

Harvesting

Harvesting is one of the most important phases of peanut production because it affects the quantity and quality of yield. Peanut should be harvested at the right stage of maturity. Pre-mature harvesting results in shriveled and poor quality beans while delayed harvesting causes rotting or germination of seeds right in the field especially in soils with high moisture as is common during the wet season planting (Cagampang and Lantican, 1975).

The maturity of peanut can be determined by the following indications (PCARR, 1978):

- Gradual withering and yellowing of the leaves of majority of the plants (not to be confused with withering and yellowing caused by diseases) which are more noticeable during the dry season planting.
- The expected maturity date of the variety being grown based on the maturity period that ranges from 90-110 days, depending on the planting season.
- From random sampling of about 10-12 plants/ha, maturity is indicated by hardness of most of the pods, darkened veins of the inner portion of the shell, vascular strands on the shell becoming more distinct and plump pinkish full-grown kernels.

In small-scale production, harvesting is done manually by pulling the entire plant or passing a native animal-drawn plow or both sides of the row to loosen the soil.

Fertilization

In the absence of soil analysis, a 30-40-40-fertilizer recommendation is practical. This is equivalent to 1.33 bags of urea (4-0-0) or 3 bags of ammosul (21-0-0), 4 bags of solophos (0-20-0) and 1.33 bags of muriate of potash (0-60-0). If soil inoculant is used, only one-half of the recommended fertilizer is needed.

Peanuts are usually grown in leached sandy soil of relatively low fertility. They have a marked ability to use fertilizer residues not utilized by a previous crop and they sometimes do not respond to additional fertilizer on very fertile soil (Martin *et al*., 1976). The response of peanuts to fertilizer application appears to be quite unpredictable when compared with other field crops.

Although several studies indicate that the application of complete fertilizer does not significantly increase yield (Documus, 1964; Perez *et al*., 1970; Pacia, 1971; Lalap, 1973), other investigation showed that peanut yield is markedly increased with the application of 30 kg nitrogen (N), 30 kg P_2O_5 and 60 kg K_2O/ha (Pava, 1971). According to Silayan (1918), application of complete fertilizer increases the actual yield of marketable pods of peanut.

Results of different investigations have led many workers to conclude that peanuts do not respond to nitrogen fertilization. This is probably due to the plants' ability to fix nitrogen in their root nodules (Martinez, 1980). Marasigan (1970), Perez *et al*. (1970), Gloria (1971), Gloria and Cagampang (1971), Testado *et al.* (1978) and Sumalinog (1992) indicated that application of nitrogen does not substantially increase yield. Gloria (1971) and Daisog (1987) noted it only increases the number of nodules formed per plant.

Phosphorus (P) and calcium (Ca) are found to be particularly important in the growth of peanuts. Phosphorus stimulates root growth, thus, affecting directly the density of root nodules. Dressing with phosphates greatly increases the fixation of nitrogen. It is also essential for the production of protein in the seeds of peanuts.

Application of 30 kg P (Pava, 1971) and 40 kg P (De Jesus and Riñon, 1968) or a higher rate of superphosphate (Dagami, 1985; Reyes, 1987) results in an appreciably high yield of pods. However, use of phosphorus together with other practices such as mulching (Villamor, 1997), weed control (Salares, 1983) and mycorrhiza (Lasquite, 1997) have no significant effect on yield. Juan *et al.* (1986) indicated higher percentage germination, higher speed of germination, longer root length, higher dry matter yield and best quality of seeds in peanut fertilized with 60 kg P. Coloma (1970) and Corre (1987) had shown further that the application of P and lime significantly increases the number of filled pods. Peanuts treated with the lime alone and those treated with P + lime had higher yield values than peanuts treated with either K + lime or K + P + lime (Documus, 1964). Application of calcium carbonate up to 3 t/ha does not affect the growth and yield of peanut (Acebedo, 1987; Salinas, 1993; Tabes, 1997). A more detailed study (Serohijos, 1993; Serohijos and Samonte, 1993) found that liming using up to 10 tons of calcium carbonate significantly affected dry matter, pod and seed yields of Maasin clay and Dolongan peat.

Calcium also neutralizes soil acidity for the survival and growth of the rhizobia. Lime application at the rate of 1,000-2,500 kg/ha has been recommended for slightly acid soils (Rodrigo, 1947). The lime, if applied, should not be mixed with commercial fertilizers and manure but should be spread after plowing and then harrowed into the soil. Lime application is influenced by rainfall since moisture is needed to dissolve the lime material (Bales, 1989).

Results of several experiments suggest that peanuts do not respond to potassium (K) fertilization. However, when K is applied in combination with lime and P, peanut yield markedly increased. Leal (1967) reported that 0.5-kg muriate of potash applied in combination with 1.5-kg super phosphate and 10-kg agricultural lime had the greatest positive effect on the growth of peanuts. This is supported by the observations of Tilusan and Cajigal (1967) on the Kinorales variety of peanut. The application of 200 kg of mixed super-phosphate and muriate of potash per hectare gave the best response in both hay and pod production. These studies seem to verify the role of potassium in the nutrition of peanuts. It is suggested that the fixation of nitrogen is stimulated by phosphorus in the presence of potassium.

Extent of Use of Organic and Inorganic Fertilizers

Although peanut is a legume, it also requires a reasonable amount of organic matter for its full development and production. However, inorganic fertilization is not commonly practiced by farmers in different provinces in Luzon (Huelgas *et al.*, 1990). Only about 20% of the peanut farmers applied fertilizer through basal method during planting. The kinds of inorganic fertilizer used by farmers are shown in Table 6.

Table 6. Kinds of fertilizers used by 41 peanut farmers, Philippines, 1985-86.

Kind of Fertilizer	Number of Farmers Who Used Fertilizer	Percentage
Urea (45-0-0)	22	55.00
Complete (14-14-14)	11	26.83
Urea and complete	1	2.50
Ammonium phosphate (16-20-0)	1	2.50
Ammonium sulfate		
(21-0-0)	5	12.50
(18-46-0)	1	2.50
Total	41	100.00

Magaliglaw fertilizer of 12-12-12 mixture has been found to increase pod yield (Balleza, 1955). Organic fertilizers (Bolo, 1983) such as hog manure (Bonilla and Verzosa, 1980), cow manure (Aniceto, 1996) and chicken manure combined with PK (Pelayo *et al.*, 1984) have been tried on peanut to a limited extent. Chicken manure appears to be a better fertilizer than carabao or hog manure (Manzano, 1950) but wood ashes are considered the best (Magracia, 1965) on account of their high potash and calcium content (Rodrigo, 1947).

Application of commercial fertilizers especially phosphate (P_2O_5) and potassium (K_2O) and a little amount of nitrogen (N) at the rate of 300-500 kg/ha is generally profitable (Rodrigo, 1947; Tangonan, 1979). The root of peanut does not spread widely so that the fertilizer is best applied along the rows (Rodrigo, 1947), 5 cm below the seed (Onia and Molinyawe, 1968; Perez *et al*. 1970) at planting time.

Role of Gypsum in Peanut Cultivation

One of the primary functions of calcium in peanut nutrition is to improve the quality of the nuts. Several studies have shown that calcium sulfate improves peanut pod formation. The better quality of nuts grown in soil properly supplied with calcium is shown by white firm hull, well-developed kernels and an increase in weight. An adequate supply of calcium in the soil results in solid pods while a deficiency produces a large number of unfilled pods. Calcium content of the peanut plant is highest in the leaves, followed by the stem and the root, both in flowering and at maturity (Monte and Bagaoisan, 1966).

Gypsum is not normally used by farmers in the cultivation of peanut unless the soil pH is below 4.0 especially since peanut cultivars tolerant to acid soil conditions have been identified (Samonte and Ocampo, 1989). Studies have shown that application of calcium from gypsum did not significantly affect the nutrient uptake and yield of peanut (Barrera, 1998). However, calcium sulfate application up to 300 kg/ha significantly influences the number and weight of pods, and yield of Spanish red and UPL Pn-2 peanut cultivars (Inson and Alcala, 1981).

Pests and Diseases

Diseases

Leaf spots (Paningbatan, 1980; 1988)

1. Black spot [caused by *Cercosporidium personatum* (Berk. and Curt.) Deighton]
2. Brown spot [caused by *Cercospora arachidicola* Hori]

The initial symptoms caused by the isolates appear 13 to 17 days after inoculation. Lesions caused by *C. arachidicola* are generally brownish on the abaxial leaflet surfaces while those caused by *C. personatum* are blackish. Lesions caused by *C. arachidicola* are bigger and produce spores earlier than those caused by *C. personatum*. *C. arachidicola* lesions have about three times more spores than the lesions from *C. personatum* (Paningbatan and Ilag, 1981). Spotting may also be found in the petioles. Infected and defoliated leaves could serve as sources of inoculum (Paningbatan and Opina, 1995) and contribute to the epidemic development of the disease (Paningbatan, 1988) during the cropping season. Leaf spot is a destructive fungal disease common during warm and humid weather.

Leaf rust (caused by *Puccinia arachidis* Speg.)

The first symptoms of rust infection are pinprick spots on the under surface of the leaves which later become visible on the upper surface as yellowish spots. Later on, the epidermis of the spots ruptures with orange-red pustules appearing on the surface. Pustules are larger and more numerous on the undersurface with older leaves showing the symptoms earlier than the younger ones. Individual pustules are circular and often surrounded by a dull green, yellowish or chlorotic zone of leaf tissue. The pustules later turn dark brown and coalesce. The leaf tissues around the pustule eventually turn necrotic in irregular patches (Estrada and Palomar, 1981).

The disease usually occurs in the later stage of growth of peanuts and is common during the dry season planting (PCARR, 1978).

Bacterial wilt (caused by *Pseudomonas solanacearum* L.)

Sudden wilting and collapse of the plants characterize the disease. Wilted plants usually recover during the night but shrivel and become dry within a few days. The plants finally die with leaves still attached to the plant (CVLMROS, 1998).

Mottle (caused by peanut mottle virus)

The initial symptom of infection is the presence of dark-green dots on the unopened youngest leaf. The infected leaves become mottled later which usually start from the margin as small, irregularly shaped and dark green islands on a light green background. As infection advances, the infected leaf curls and become smaller with distinct differentiation of light and dark green areas (Estrada and Palomar, 1981).

Ringspot (caused by peanut ringspot virus)

The leaf develops dark green spots measuring about 3-5 mm in diameter surrounded by a chlorotic or yellow ring. This symptom is very similar to the mottle disease except for the presence of the yellow zone surrounding the dark green circular spot. Like mottle, leaf size and plant height is not markedly affected (Benigno, Quebral and Pua, 1975).

Rosette (caused by peanut rosette virus)

The earliest symptoms of artificially infected plants are the presence of numerous irregularly circular minute yellowish spots on the inoculated leaves. Succeeding leaves thereafter exhibit spindle-shaped chlorotic spots. In the advanced stage of infection, peanut plants have stunted growth with numerous closed tufts of small leaves and little or no pods.

Stripe (caused by peanut stripe virus)

The disease appears as green islands or blotches, oakleaf pattern or stripes along the lateral veins of infected plant leaves. Infection can cause significant reduction in the number of pods per plant, yield, weight of seeds and percent germination (Mangaban, 1989).

Damping-off (caused by several soilborne fungi such as *Pythium, Phytophthora, Sclerotium, Rhizoctonia, Rhizopus* and *Fusarium*)

If infected before emergence, the seeds may rot or the sprouts decay in the soil. The decay may either be soft and watery or dry in appearance. After emergence, the stem of the affected seedlings may rot at the soil level resulting in a condition called stem-rot and then fall over while the leaves are still green and turgid. Humid atmosphere, wet seedbed and thick stand of seedlings are conditions that favor the development of damping-off (PCARR, 1978).

Insect Pests (PCARR, 1978)

Leafminer (*Stomopteryx subsecivella* Zeller)

The damage of leafminer may be mistaken for that of bean fly except that the mines enlarge as the larva develops and pupates inside the leaf tunnel. The reddish caterpillar remains inside the mine and feeds on the parenchyma of the leaves. As a result of the feeding only the silvery membrane remains and the larva is visible externally. Heavy infestation causes premature leaf drop.

Common cutworm (*Spodoptera litura* Fabricius)

The adult moth is dark brown with white streaks on the wings and is generally active at night. The eggs are laid in clusters on the leaves. The larvae vary in color but small orange, half-moon spots along the dorsum slightly at the side are common characteristics, regardless of general coloration. The are primarily leaf feeders, consuming the interveinal portion of the leaf, leaving the veins intact.

Bean aphid (*Aphis craccivora* Koch)

These are tiny lice-like insects with colors ranging from yellowish or brown to black. They tend to congregate at the growing points of plants. A colony may consist of both winged and wingless individuals. Most of the time, they stay in one place on the plant sucking the sap. Aside from the direct damage due to withdrawal of sap, aphids also transmit virus diseases.

Bean leaf roller (*Lamprosema indicata* Fabr.)

The adult is a medium-sized moth, yellow orange with three black waxy bands across the forewings and two on the hindwings. The larva is foliage green with light brown head. It spends its feeding and development inside rolled leaves. Heavy infestation is noticeable from a distance, as rolled leaves are prominent and generally silvery in appearance due to the larvae feeding on the internal portion of the rolled foliage, leaving only the external membrane.

Coffee leaf folder (*Homona coffearia* Nietner)

The adult when in repose is bell-shaped. It is brown and has an undulating dark brown crossband on the forewings. The larvae gather several leaves, fold them together and spend most of the feeding stages inside. The feeding characteristics resemble that of the Pyralid leaf roller as the coffee leaf folder may also roll or fold in a single leaf. The larva of the coffee leaf folder is rather distinct with the prominent black head. The damage is identical to Pyralid leaf roller and may occur throughout the year.

Corn earworm (*Helicoverpa armigera* Hubner)

The adult is a reddish brown moth with a prominent brown dot near the middle of the forewings. The caterpillars have variable colors ranging from green, brown to yellow. They feed on the leaves, buds, and flowers and exposed pods.

Corn semi-looper (*Chrysodeixis chalcites* Esper*)*

The adult has grayish brown hindwings. The forewings are prominently marked with Y-shaped brownish yellow spots. The larva is greenish with stripes along the back and side and moves with a characteristic looping motion. It often conceals itself at the base of the plant during the hotter period of the day. The feeding damage is characterized by consumption of the entire lamina in contrast to that of cutworm where the veins remain. Excessive infestation may defoliate the plants.

Bean lycaenid (*Catochrysops cnejus* Fabr.)

The adult female is pale ash-gray with purplish tinge and has a prominent dot in the apical region of the hind wings. The white eggs are laid on the surface of the pod, flower, stem or leaf. The ovate larva is covered with white stout hairs and is light green with dark or reddish dorso-medium line extending the entire length of the body. It feeds on flowers, young buds and exposed pods but the body remains outside while feeding on succulent tissue.

Leafhopper (*Empoasca biguttula* Ishida)

The adult leafhopper is triangular in shape, and yellowish green with light yellow forewings. A small black spot is prominent on each forewing. The adults and the nymphs generally found on the undersurface of the leaves suck the plant sap. The females insert the eggs into the veins and petioles by the ovipositor. The nymphs are identical to the adults in appearance but are wingless. Damage is severe if heavy infestation occurs during the early vegetative stage.

June beetle (*Leucopholis irrorata* Chev.)

The adults are cylindrical in shape, 2.5 to 3.0 cm in length, glossy and blackish with reddish tinge. During the day they are found clinging on the leaves and twigs of trees. The females lay their eggs before flying to neighboring plants. The pale yellow grubs are fleshy, wrinkled or corrugated and normally curved. They stay in the soil and feed mainly on the roots of corn, mungbean, peas and peanut.

Tiger moth caterpillar (*Dasychira mendosa* Hubner)

The adult moths have light brown forewing with jagged dark cross bands but the hind wings are pale yellow to brown. The yellowish egg masses are generally covered with hair-like materials. The larvae are defoliators, stripping the leaves heavily under severe infestation. They are black but appear orange pink at a distance due to yellow orange stiff tufts of hair on the 4^{th} and 7^{th} segments and the short and erect bristles along both sides of the body. They pupate in egg-shaped silky cocoons.

Weeds

Weeds, if left uncontrolled, reduce the yield of peanut by 50-95% (Punzalan, 1971). Weeds associated with peanut that are most troublesome and difficult to control are *Rottboellia exaltata* L.F., *Eleusine indica* L., *Cyperus rotundus*, and *Ipomoea triloba* L. (PCARR, 1978).

In some major peanut producing areas in the Philippines, the traditional method of weed control is still done. This is a combination of cultivation and manual weeding Nierva, 1973: Hermoso, 1990). Punzalan (1971) reported that the greatest increment on yield in the peanut-weed competition results from controlling weeds between 4 and 6 weeks after planting. He recommends that weeding should start as early as 2 weeks and not later than 6 weeks to maximize bean yield. Cagasan (1990) found the same results and added that rice straw appears to be the best mulching material in suppressing weed growth. Lalap (1972) obtained the highest bean yield from 300,000 plants/ha when the field is kept weed-free until 30 days after planting. Row cultivation and row weeding should be done with care so as not to injure the roots of the plants, as root injury increases *Sclerotium rolfsii* Sacc. infection (Wood, 1969). Mechanical methods of weed control also become impractical after peanuts have begun pegging, as these injure developing pods (Hill and Satilomann, 1969). The use of conventional (off-barring and hilling-up) and chemical methods of weed control do not differ from hand-weeding in terms of seed yield (Pepito, 1982).

Integrated Pest Management

One of the many reasons for the low yield of peanut in the Philippines is the problem posed by weeds, insects and diseases. Peanut at the early growth development stage is vulnerable to weeds. Weeds are effective competitors of plants for light, nutrient and water. Some weeds, insects and diseases are interrelated through their alternate host-vector relationship, spread of viruses or by predisposing the plant to other parasites. Several insect pests and diseases attack peanut at all growth stages.

Insect pests and diseases have not occurred in epidemic proportions probably because of the presence of natural control agents which are responsible for maintaining a delicate and fluctuating balance of their hosts (Uichanco, 1926). However, they are a potential threat to commercial production. Therefore, it is imperative that a pest management scheme for peanut is developed. Meanwhile, the nature of resistance of peanut cultivars to a few diseases (Paningbatan and Ilag, 1984) and the potential economic importance of minor diseases have been reported (Bajet and Castillo, 1974; Estrada, 1981).

Types and Usage of Chemical Plant Protection

Disease Control

Peanut leaf spot and leaf rust may infect peanut simultaneously during the wet and dry seasons. In general, however, leaf spot is more prevalent during the wet season while leaf rust usually attacks during the dry season planting. Quebral (1973) and Quebral and Garcia (1974) reported that leaf spot can be effectively controlled by spraying the plants with any of the following: Benlate at 0.4 lb/100 gal of water; Carbendazol at 0.33 lb/100 gal of water; or Daconil 2787 at 1 lb/100 gal of water four times during the growing season at approximately 14-day intervals. The same authors reported that peanut leaf rust can be effectively checked with Plantvax 75w at 0.9 lb/100 gal of water and Dithane M-45 at 2.0 lb/100 gal of water sprayed four times during the growing season at approximately 14-day intervals (Anonymous, 1974; Jader, 1978). Rust-protected plants showed an increase in yield ranging from 44.1% to 52.3% over the unprotected plants. Laranang and Pizarro (1996) likewise reported that Sweep 70 WP and Dithane M-45 effectively and economically controlled leaf spot infection in peanut. *Sclerotium rolfsii* and *Rhizoctonia solani* can be effectively controlled by spraying with Chlorothalonil, Mancozeb and Thiophanate methyl (Sabarez, 1991) although *S. rolfsii* can also be controlled with the use of a biocontrol agent (Fernandez, 1988). Broadcasting *Trichoderma aureoviride* controlled stem-rot of peanut caused by *S. rolfsii* similar to the control provided by Brassicol applied as soil treatment under greenhouse and field conditions.

Benigno *et al*. (1974) advised against the use of seed obtained from virus-infected plants for planting and recommended spraying with insecticides to control bean aphid, the vector of the disease.

Insect Control

Peanut has been observed to be susceptible to a number of insect species at all stages of growth (Gabriel, 1974). The more important pests are: (1) leaf feeders-leafminer, common cutworm, bean leaf folders, semilooper, tiger moth caterpillar, slant grasshopper, common Katydid, sphinx moth or horn-worm; (2) blossom, foliage or exposed pod feeders-corn earworm, bean lycaenid, corn borer: (3) sap feeders-green stink bug, leaf hoppers, bean aphid; (4) root feeder-June beetle. The damage of these pests is generally tolerable. Therefore, most farmers apply very little or no input to protect the plant from these insects. So far, the only documented study is at the Department of Entomology, University of the Philippines at Los Baños, which dealt on chemical control. Out of 47 commercially available insecticides that have been screened, 8-10 is found effective against the more important pests of peanut as well as of mungbean and soybean. These insecticides are monocrotophos, phosphamidon, carbofuran, MIPC, malathion, endosulfan, diazinon, carbaryl), disulfoton and gusathion A (Rejesus, 1974). Carbofuran is found effective against beanfly, the prime pest of legumes. In addition to the above-mentioned pests, spider mites are also observed to be a serious problem. However, the effect of spider mite damage on the yield has not been assessed.

Only 7.35% of the farmers surveyed applied insecticides to eliminate insect pests attacking the plants (Huelgas *et al.*, 1990). The chemicals used for insect control are synthetic insecticides (Table 7).

Weed Control

Studies on the use of herbicide in peanut production are still few. So far, Nitrofen at 3.0 kg/ha and Trifluralin at 1.0-kg a.i./ha are most promising in trials at College Laguna and Ilagan, Isabela, respectively (Punzalan and Vega, 1972). Prometryn at 2.0 kg a.i./ha and TOK at 3.0 kg a.i./ha are rated satisfactory to excellent while Amiben at 5.0 kg a.i./ha is fair in weed control during the wet season. Linuron at 2.0 kg a.i./ha, although effective in controlling weeds, s highly phytotoxic to peanut (Punzalan, 1971). PCARR in 1978 listed Butralin, Bentazon and Trifluralin (including their trade names, rates and chemical actions) as suitable for weed control in peanut production. A preemergence herbicide, pendimethalin (Fabro and Robles, 1981), and a postemergence herbicide, cloproxydim (Robles and Fabro, 1985), have been found effective for control of *Rottboellia exaltata* in peanut.

Table 7. Kinds of chemicals used by 15 farmers, Philippines, 1985-86.

Kind of Chemical	**Number of Farmers Who Used Chemical**	**Percentage**
Azodrin 202-R	2	15.38
Bionex	1	7.69
Decis	1	7.69
Folidol	4	66.66
Lannate	3	23.08
Lannate/Thiodan	1	7.69
Lannate/Gusathion	1	7.69
Thiodan/Azodrin 202-R	1	7.69
Total	15	100.00

Aflatoxin in Peanut

Aflatoxin is a potent carcinogen of the liver that causes aflatoxicosis among domestic animals in the order of susceptibility depending upon the dose, duration, and age of the following animals: ducklings, turkey poults, chickens, piglets, pregnant sows, calves, fattening pig, and mature cattle. The two aflatoxin-forming fungi, *Aspergillus flavus* and *A. parasiticus*, are common molds that grow over a wide range of environmental conditions. They can grow at temperatures ranging from 6 to 46 C with optimum from 28 to 38 C, depending on the strain of the fungus and can seriously contaminate peanut (PCARR, 1978).

Seeds damaged physically or by insects or the presence of foreign matter in the stored seeds are other conditions favorable to mold development. Mold-contaminated peanuts usually exhibit some of the following characteristics: darker skin coloring before and/or after roasting; darker flesh after blanching before and/or after roasting; and resistance to splitting and/or blanching.

Aflatoxin has already been shown to produce primary cancer of the liver in experimental animals tested. Although no toxic effects have yet been reported in humans, the potential danger cannot be ignored. The hazard is not only confined to the direct consumption of foods processed from peanuts containing aflatoxin. The earliest signs of aflatoxicosis are lack of appetite and decrease in weight. The general symptoms of the disease are dullness, restlessness and weakness of the afflicted animals before death. Sensitive and reliable tests have shown that aflatoxin is present in the edible tissues and milk of animals fed large amounts of aflatoxin-infected feeds. There are epidemiologic studies associating liver cancer in humans with a diet of allegedly moldy foods (PCARR, 1978; P-CRSP, 1993). These findings point to the potential health hazard of contaminated peanuts. Therefore, there is a need to properly harvest, dry and store peanuts. Furthermore, adequate and careful sorting of moldy, discolored, shriveled and damaged raw peanuts should be done before processing.

The importance of the aflatoxin problem was recognized in early 1967. The Food and Nutrition Research Institute, National Science Development Board initiated studies to determine the presence of aflatoxin in some raw and locally processed peanut products that were contaminated with aflatoxin beyond the permissible level of 20 parts per billion (ppb). The Institute of Food Science and Technology, University of the Philippines at Los Banos through the United States Assistance for International Development (USAID-Peanut Collaborative Research Support Program (P-CRSP) conducted aflatoxin surveillance among different brands of peanut butter and other peanut products from 12 outlets in the Philippines (P-CRSP, 1993).

Aflatoxin contamination is mainly attributed to delays in drying and improper postharvest practices (NAPHIRE, 1991) and is shown in Table 8. It can be produced with minimum temperature of 15 C at 98 percent relative humidity to as high as 40 C, with optimum temperature falling at near 30 C. This is an environment that favors mold growth and toxin production. The response to temperature is influenced by moisture, amount of aeration, nutrition, genetic composition, and other factors. Since the fruiting bodies of these fungi are constantly present in the air and soil, there is difficulty eradicating them. Once they produce aflatoxin on a particular substrate, they are very hard to remove or detoxify. It is thereby necessary to prevent their formation on grains and oilseed (PCARR, 1978).

The Philippine Bureau of Food and Drug (BFAD) surveyed 69 brands of peanut butter manufactured by 23 licensed Metro Manila firms and showed three brands as having aflatoxin levels greater than 100 ppm. The allowable level of aflatoxin set byinternational authorities is 20 ppm. Food authorities ordered the firms manufacturing these brands to withdraw their products from the market. The peanut butter-eating public was also warned against unlabeled peanut butter sold in local markets as they are likely to be prepared by unlicensed manufacturers and thus may not have been subjected to BFAD tests for aflatoxin using the chick embryo bioassay that suppress germination that show no harmful constituents. Levels of metabolite could be attained as evidenced by minimal hyphal growth and development. This inhibition of hyphal development shows the absence of *A. parasiticus* growth and hence negative aflatoxin formation. This technology has potential for worldwide impact in the control of aspergillus-aflatoxin contamination not only in peanut but also among foods susceptible to this health-safety hazard.

Table 8. *Aspergillus flavus* infection and aflatoxin content of peanut samples from Manila, Northern Luzon.

Sample Description	**No. of Units Plated**	**% of Units Yielding *A. flavus***	**Aflatoxin *B1* (ppb)***
Freshly dug peanut	20	5	14
Farmer stock peanut of commerce, in bulk, in bulk storage, dry	20	1.4	257
Shelled peanut from farmer stock	20	45	964
Whole peanut in shell	20	25	0
Large segregated peanut segregated from smaller discards, used for peanut products	20	90	114

Better quality peanuts are used in foods processed in Manila while poorer quality peanut appears in food products including candies. Bitter taste has been related to microbial contamination. A study to analyze peanut at various processing stages for aflatoxin, including water washing to remove the seed coat, boiling for boiled peanut and sodium bicarbonate cooking for peanut brittle products showed that this contaminant was significantly reduced. Values noted were less than 20 ppb, hence, processing conditions reduce aflatoxin in foods, except where grossly contaminated. Findings also showed that homemade peanut butter is less likely to be contaminated with aflatoxins because the housewife carefully picks only the quality peanut during homemaking (P-CRSP, 1993).

Philippine traders and the key players in the purchase, drying, handling and sale of peanut actually grade for quality (P-CRSP, 1993). The good quality peanut is then sold in Manila and other larger city markets and those of poor quality go to the local buyers of peanut. This supports the concern that local market entrepreneurs may be selling highly aflatoxin contaminated peanut products.

Prevention

Earlier studies (Fandialan, 1972; Santamaria *et al*., 1972) included work on aflatoxin in peanut and peanut food products. Escueta (1984) also found that shelled peanut can be stored safely free from *Aspergillus* at room temperature for one year if packed in 60% CO_2 atmosphere. Molds during storage can be prevented in many ways as indicated below:

1. The peanut should be initially high in quality and should be free from molds, insects and rancidity which can be done by good growing practices such as:
    a. using good quality seed
    b. fertilizing properly
    c. controlling insect pests and diseases
    d. inverting peanut plants after digging to prevent pods from touching the ground.

2. The storage conditions inhibiting mold production include
    a. observing sanitation in the storage and on drying areas by keeping free from debris, insects and rodents.
    b. separating new and old seed stocks or lots having different moisture content.
    c. keeping the storage temperature low for long storage life.
    d. maintaining a low relative humidity (65 to 70%)
    e. having a well -circulated and odor-free ambient air

One solution to control of aflatoxins is educating the farmer, trader, processor and homemaker in handling-storage of peanut for the prevention of contamination. The Philippine Department of Agriculture's extension service is working with farmers in helping them to understand the importance of drying peanut. The Institute of Food Science and Technology, UPLB serves as an information resource for workshops. These scientists have developed brochures and a training module on how to select and maintain quality peanut for the marketplace.

Natural Control

A biological or microbial control or preventative method that is safe, inexpensive and practical (Mabesa *et al.*, 1993) has been shown to inhibit or inactivate aspergilli growth, and or aflatoxin contamination of peanut seed. This approach replaces the use of vapor-proof containers, storage compartments and chemical treatments. The method involves the use of *Cladosporium fulvum* to inhibit the growth of toxicogenic aspergilli (*A. parasiticus*) in peanut, rice and corn and thus prevents possible toxin formation. Experiments on the mechanism of inhibition show that the culture filtrate and pigment fractions from *C. fulvum* are responsible for the inhibition of *A. parasiticus*. These substances cause the thinning and deformation of mycelium and lessen the number and size of the spores produced. Toxicological studies (P-CRSP, 1993) on effect of processing of aflatoxin content of naturally contaminated peanut showed a decrease in aflatoxin concentration upon processing into sugar-coated peanut, peanut brittle, peanut bar, “pastillas de mani”, “masapan de mani”, and peanut candy. The effect of dilution is minimal compared to the destruction due to processing. This finding may explain the non-occurrence of localized incidence of abnormally high rates of human disorders associated with aflatoxin in peanuts in the Philippines, despite the fact that peanut is consumed extensively (P-CRSP, 1993).

Delays in drying and the continued use of poor postharvest practices predispose peanuts to mold infection leading to aflatoxin contamination. Paguerigan (1971) reported that *A. flavus* infestation is more common on dried than on fresh peanut kernels. Fortunately, not all strains of *A. flavus* produce aflatoxin.

Control Measures Used by Farmers Against Aflatoxin

Farmers dry peanut immediately to reduce its aflatoxin content. The postproduction handling practices needed in the maintenance of peanut after harvest vary depending upon the season of harvest. For the dry season harvest, peanuts can be windrowed for days in the field until the peanuts are easily pulled from the plant. After windrowing, stripping is done immediately to facilitate thorough drying of the nuts. However, windrowing the peanuts after harvest during the rainy season favors the growth and development of *Aspergillus flavus* that can lead to aflatoxin contamination. Thus, peanuts must be stripped immediately after harvest during the rainy season. Drying should also be done within three days after harvest to prevent aflatoxin build-up ((NAPHIRE, 1991).

Varieties found resistant to the invasion of *A. flavus* are: ICGS (E), ICGS 50, JL 24, BPI-Pu-9 and ISU Pu-9 (NAPHIRE, 1991).

Production Yield and Cost

The national average yield of peanut from 1992 to 1996 was 0.76 MT/ha, with the highest coming from the Ilocos Region (Table 9).

Using 1996 prices, a hectare of peanut has a production cost of P16,193.31 (Table 10), of which about 49% would go for labor inputs while 45% would go to material inputs. Seeds incur the single biggest expense amounting to about 32% of the total cost. An estimated yield of 1,800 kg/ha and at a farm gate price of P13.00/kg of unshelled peanut will realize a gross return of P23,400 and net return of P7,206.05. A return of investment of about 44% can be realized which shows that peanut production is highly profitable provided that the necessary inputs like the use of recommended varieties is adopted.

Table 9. Peanut average yields per hectare (MT) by region in the Philippines, 1992-1996.

Region	1992	1993	1994	1995	1996	Average
CAR	0.40	0.40	0.43	0.39	0.33	0.39
Ilocos Region	1.19	1.20	1.20	1.19	1.29	1.21
Cagayan Valley	0.64	0.63	0.67	0.68	0.61	0.65
Central Luzon	1.05	1.02	1.01	1.09	1.08	1.05
Southern Tagalog	0.70	0.71	0.71	0.69	0.73	0.71
Bicol	0.82	0.82	0.82	0.82	0.82	0.82
Western Visayas	0.57	0.58	0.47	0.48	0.57	0.53
Central Visayas	0.64	0.64	0.66	0.72	0.74	0.68
Eastern Visayas	0.53	0.53	0.53	0.47	0.43	0.50
Western Mindanao	0.44	0.44	0.42	0.38	0.10	0.36
Northern Mindanao	1.00	1.00	1.00	0.80	0.80	0.92
Southern Mindanao	0.66	0.66	0.64	0.66	0.67	0.66
Central Mindanao	0.85	0.86	0.86	0.87	1.03	0.89
CARAGA	0.52	0.52	0.51	0.50	0.52	0.51
ARMM	0.74	0.74	0.74	0.76	0.78	0.75
Philippines	0.76	0.76	0.76	0.78	0.76	**0.76**

Source: Bureau of Agricultural Statistics, Philippines.

Table 10. Production cost of peanut per hectare in the Philippines, 1996.

Material	**Quantity**	**Cost (P)**	**Amount (P)**
Seeds (kg unshelled)	150	35.00	5,250.00
Inoculants (200 g/pack)	2	20.00	40.00
Fertilizers (14-14-14/ bag)	3	323.29	969.87
Insecticides (liter)	2	234.00	468.00
Fungicide (kg)	1	300.00	300.00
Sacks (pcs)	100	3.00	300.00
Subtotal			7,327.87
Labor	**MD(P80)**	**MAD(P120)**	**Amount (P)**
Plowing (1x)		8	960.00
Harrowing (2x)		8	960.00
Furrowing		2	240.00
Shelling	2		160.00
Inoculation, planting and fertilizing	8		640.00
Off-barring/cultivation		3	360.00
Weeding	15		1,200.00
Application of $CaSO_4$	2		160.00
Hilling-up		2	240.00
Irrigation	2		160.00
Pesticide spraying (3x)	6		480.00
Harvesting	9		720.00
Picking, hauling of pods	20		1,600.00
Cleaning, drying, and bagging			
Sub-total			7,880.00
Others			
Irrigation fee			
Interest on capital (60% of material			500.00
and labor inputs x 1.133% per mo. X 4 mos.)			485.44
Sub-total			985.44
Total Cost of Production			16,193.31

Source: Agribusiness Investment Profile, Philippines, Series of 1996-1997.

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POSTPRODUCTION OPERATIONS OF PEANUTS

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Introduction

Related technologies for field production of peanuts are in place but postproduction operations from harvesting to storing of peanuts are generally taken for granted. This results in the lack of appropriate technologies and facilities, thus causing the production of inferior peanuts and high postproduction losses. The postproduction operations of peanuts consist of harvesting, field drying, stripping, pod drying, pod storage and shelling (**Figure 5**).

Harvesting

Cagampang and Lantican (1975) pointed out that harvesting is an important phase in peanut production since timing greatly affects its yield and quality. They emphasized that peanut should be harvested at the right stage of maturity; premature harvesting results to shrivel and poor quality beans. Delayed harvesting causes rotting or germination of seeds right in the field, especially in soils with high moisture content, which is common during the wet season planting.

Harvesting is normally a very manual and labor intensive operation which varies from 6 man-days/hectare (Gamboa, 1979) to 15-23 man-days/hectare (Sarmiento, 1985). PCARR (1978) reported that harvesting peanut can be done by pulling the plants using a spading fork, pitch fork or any other digging tool. Another method is by passing a plow on both sides of the row followed by hand pulling. The first method is very time consuming and laborious while the second method is inefficient in exposing the peanut pods.

To overcome the drawbacks of the conventional methods of harvesting peanut, Diamante (1983) designed, constructed and evaluated a carabao-drawn peanut digger (**Figure 6**). He found that the mean rate of pod exposure of the designed implement was 1.85 kg pods/min which was significantly higher than that of the common turn plow (1.20 kg/min) and the spading fork (0.36 kg/min). Consequently, the designed implement was 1.54 and 4.10 times more efficient than the common turn plow and spading fork, respectively. The designed implement and the spading fork had comparable values of 96.73% and 95.99% of percent exposed pods, respectively. The common turns plow had significantly lower percentage of pods exposed (85.45%). The designed implement therefore has higher rate of pod exposure and percentage of pods exposed.

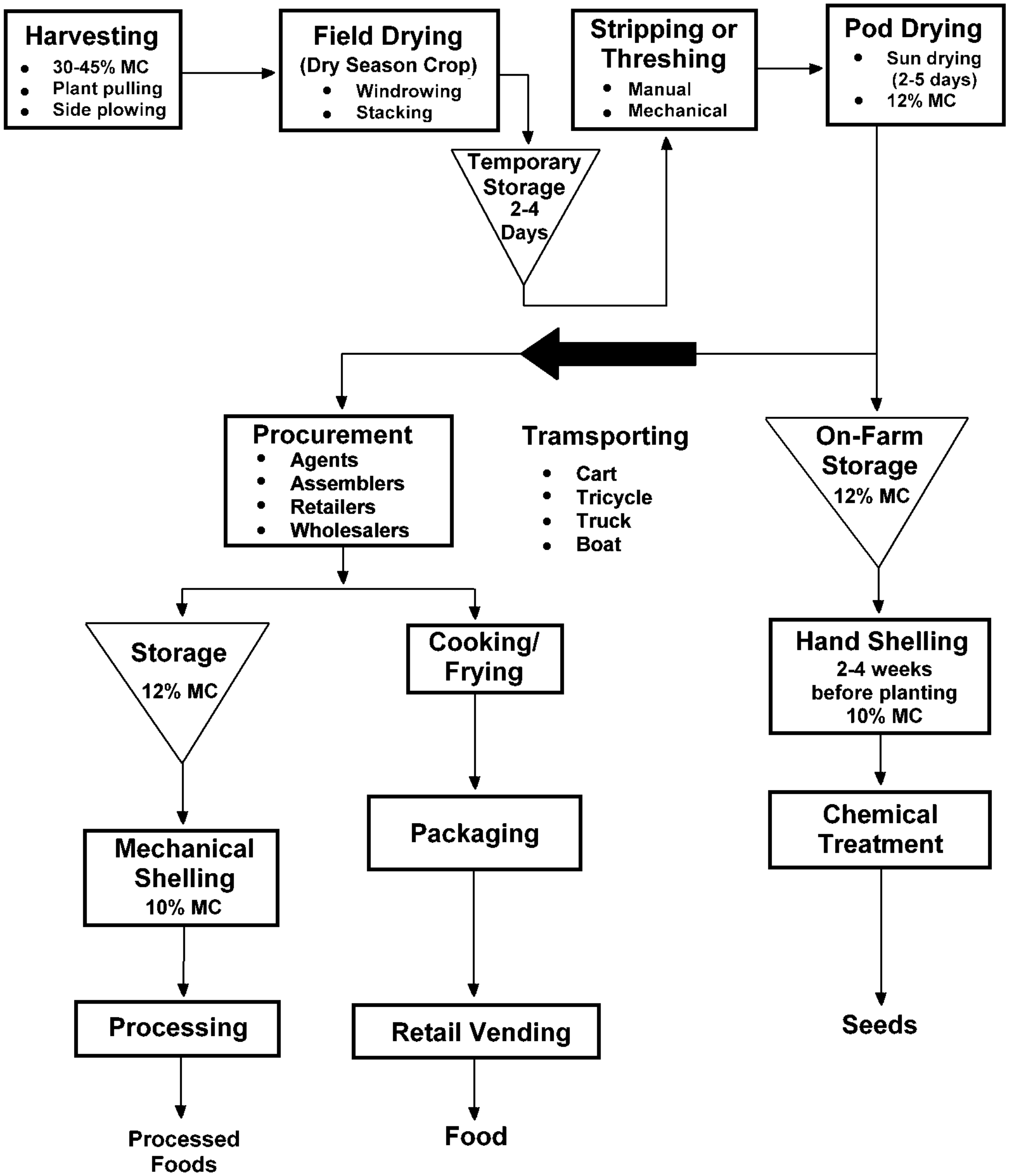

Figure 5. Peanut postproduction system (After PCARRD, 1991).

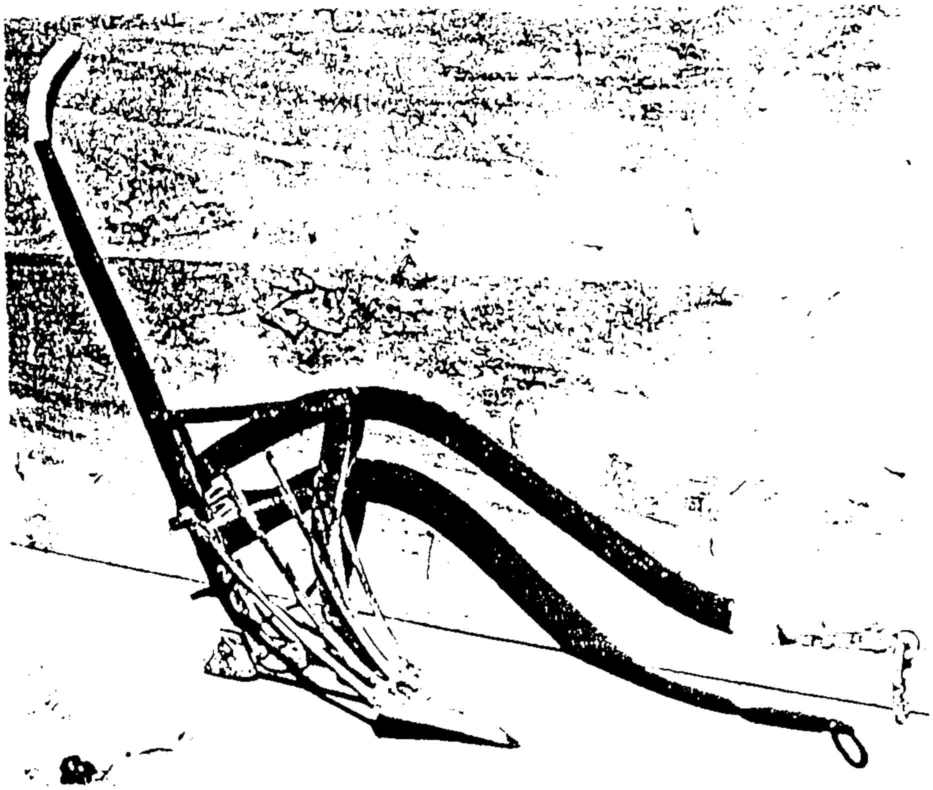

Figure 6. Carabao-drawn peanut digger (After Diamante, 1983).

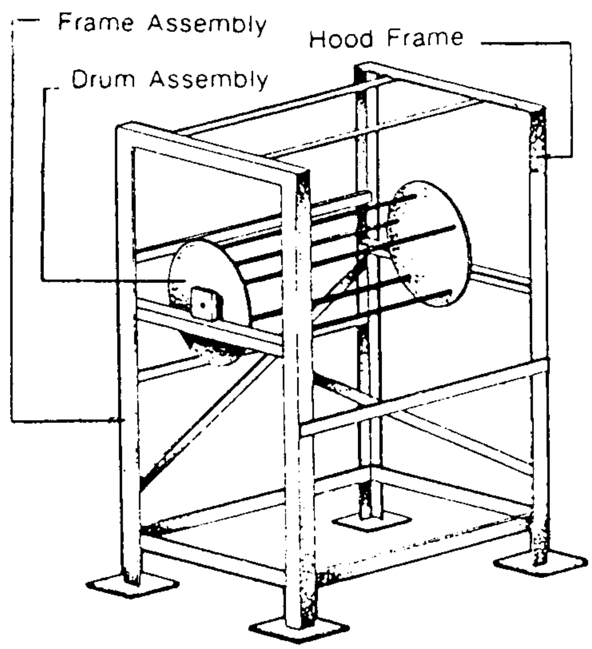

Figure 7. Indian groundnut stripper (After Sarmiento, 1985).

Stripping/Threshing

Farmers aerate and dry newly harvested crops in the field. They either hand pick or strip/thresh the pods from the vine by beating. To shake off pods from the vines, farmers repeatedly strike pods against a hard surface. Threshing takes an average of 4.6 man-days per hectare. During inclement weather, farmers thresh pods immediately after harvest. However, this practice produces shriveled kernels (Sarmiento, 1985). Gamboa (1979) reported that manual threshing of wet peanuts is accomplished at the rate of 11 kg/hour per person while that of half-dried peanuts at the rate of 30 kg/hour per person.

For wet-season crops, farmers usually strip/thresh the pods immediately after harvest so that they can be immediately dried to the desired moisture content to prevent deterioration. For dry-season crops, stripping is delayed because farmers windrow the plants in the field to reduce plant and pod moisture content. Partially dried plants are stacked in a strategic area in the field for the stripping operation (PCARRD, 1991).

Picking is done in such a way that the peduncle does not go with the pod. The pods are then washed and the inferior, immature ones are separated from the mature and sound pods. The parent plant or vines are usually either left in the field to decompose and fertilize the vines, or kept and used as animal fodder (Picar and de Padua, 1983).

To speed up the threshing operations, Rosario and Bautista (1983) as quoted by Sarmiento (1985) evaluated the performance of three threshers, namely: Indian ground nut stripper (**Figure 7**); modified pedal-operated rice thresher (**Figure 8**); and twin rotor peanut picker from North Carolina (**Figure 9**). They found that the modified pedal rice thresher showed promising results for use in the country. Its capacity is 66.7 kg/hr; stripping efficiency, 98%; nut damage, 8.2%; output purity, 69.6%; and nuts with thread, 18.3%.

Drying

The traditional and most widely used drying method is still direct sun drying. This is a cheap method but is very dependent on climatic conditions (PCARR, 1978). The crop left in the field to dry under the sun will take 2-5 days depending upon the weather. In general, it is done twice within the chain of postharvest operations, i.e. if weather permits, initial drying prior to threshing and final drying before shelling (Picar and de Padua, 1983). After pulling the plant from the earth, some farmers handpick the pods from the vine and immediately dry them in the sun. This practice generally results in the production of many shriveled kernels because of too rapid drying (Rodrigo, 1947).

In the Cagayan Valley region where peanuts are grown as second crop, windrow drying in the field is sometimes followed by aeration in small shaded huts prior to threshing and final drying. On the other hand, final drying is usually accomplished on concrete outdoor pavements of trader and processor's warehouses (Picar and de Padua, 1983).

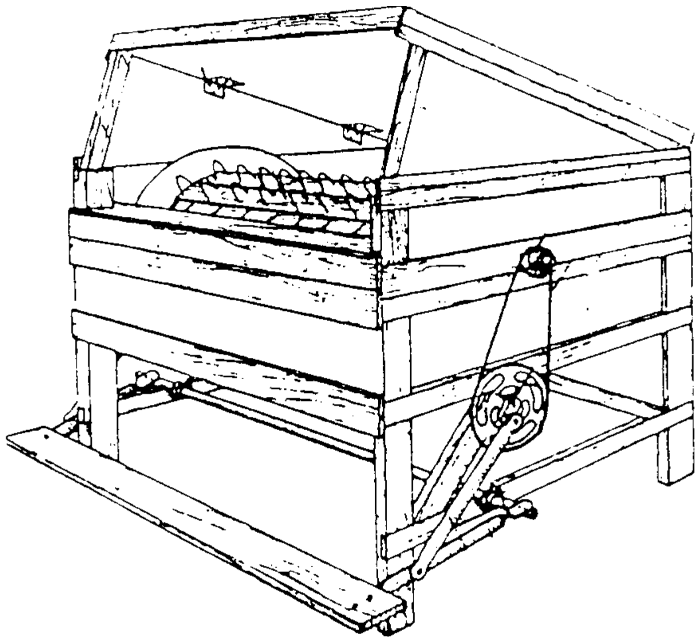

Figure 8. Modified rice pedal thresher (After Sarmiento, 1985).

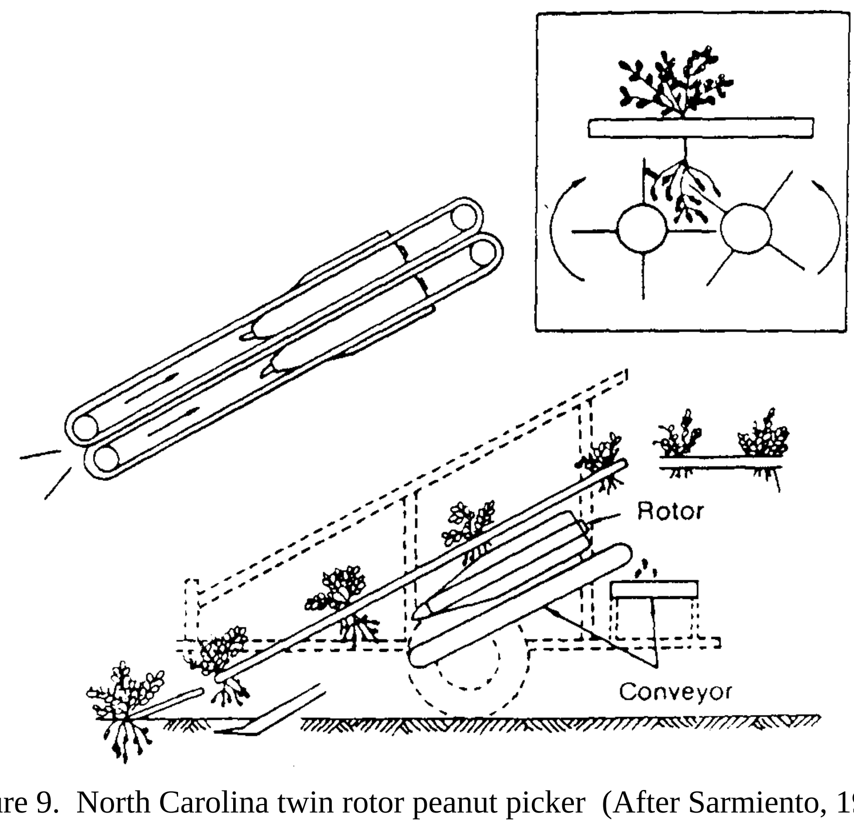

Figure 9. North Carolina twin rotor peanut picker (After Sarmiento, 1985).

During rainy days when sun drying is not possible before threshing, the unthreshed, fresh peanuts are spread out under the houses of farmers or trader's storehouses to allow aeration (Picar and de Padua, 1983). This practice, to a limited extent, minimizes heating and blackening of the crop.

Mendoza *et al*. (1981) reported the use of coarse-weave sacks where peanuts are loaded and exposed to the sun. They found no serious disadvantages of the practice except for improperly dried products. Moreover, the use of bamboo baskets was found substantially acceptable as long as the products are kept dry during the whole storage period.

The moisture content of peanut pods at harvest (49.3% w.b.) was reduced to 33.9% (w.b.), 29.6% (w.b). and 23.2% (w.b). after 1, 2 and 4 days of windrowing or field drying (Lagunda, 1991). He further added that the moisture content of one day windrowed and stripped peanut pods (33.9% w.b.) can be reduced to 9.35% (w.b.) after 3 days of sundrying. Gamboa (1979) reported that sundrying has an average recovery of 63% from an initial moisture content of 35% (w.b.) to a final moisture content of 6% (w.b.).

Due to unpredictable weather conditions in the Philippines, artificial dryers have been recommended. Various dryer designs have been field-tested before. The new technology on artificial drying presents two modes of providing heat, i.e., by natural and by forced convection. In natural convection drying, a heat source like burning charcoal is placed underneath a bed of samples. On the other hand, forced convection drying is accomplished by using hot air, which is passed through the bed with the help of a fan and an air heater. The UPLB multicrop dryer (**Figure 10**) is a natural convection dryer that has been successfully used for peanuts. The dryer consists of a shallow drying bin with bamboo flooring, a tapered plenum chamber and a charcoal stove furnace. The grain flatbed dryer (**Figure 11**) is an example of a forced convection dryer used for peanuts. The dryer is made up of a rice hull furnace, a blower and a grain bin (PCARRD, 1991). Gamboa (1979) reported that flatbed drying has an average recovery of 58% from an initial moisture content of 32% (w. b.) to a final moisture content of 6% (w.b.).

Diamante and Chinnan (1996) published a handbook for the design of fixed deep bed dryers for peanut pods in the Philippines and other tropical countries. This handbook illustrates the use of a simplified deep bed drying model for grains based on the Hukill's Analysis in the design of a deep bed peanut dryer. Basic data on peanut pods and centrifugal fan performance data for use in the design procedure are also included. They reported that a 680 kg capacity peanut dryer requires a drying chamber of 2.973 m^2 area and 0.853 m deep, a 0.181 m^2 minimum duct area, a 26.67 cm centrifugal fan wheel diameter, 1.12 kW motor, 6.60 cm pitch diameter fan pulley, 11.94 cm pitch diameter motor pulley and a heat requirement of about 11.72 kJ/s. With this dryer, the peanut pods with an initial moisture content of 25% (w.b.) will be dried to an average final moisture content of 11% (w.b.) in about 15 hours using a drying temperature of 35^oC and an airflow of 0.305 m^3/s per square meter drying area.

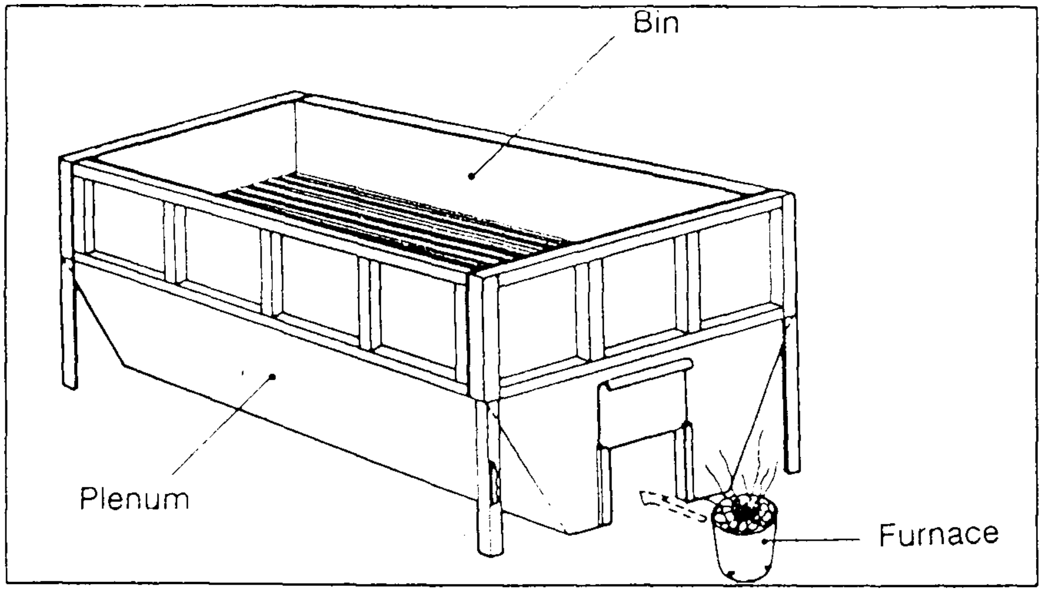

Figure 10. UPLB multicrop dryer (natural convection dryer) (After PCARRD, 1991).

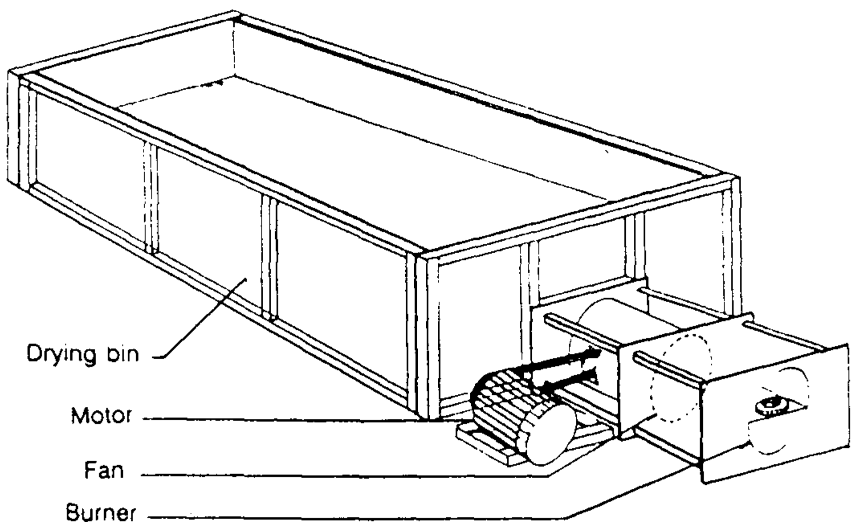

Figure 11. Grain flatbed dryer (forced convection dryer) (After PCARRD, 1991).

In order to efficiently dry peanuts in artificial dryers, fundamental studies in drying of peanuts need to be done. A number of studies have been reported on the drying of peanuts in artificial dryers (Bulilan and Lozada, 1979; Mendoza *et al*., 1981; Diamante *et al*., 1998).

Bulilan and Lozada (1979) observed large temperature and moisture content gradients between upper and lower levels of peanut in the bin during the first 20 hours of drying after which these gradients gradually decreased. They also mentioned that under specific drying conditions, the rate of drying decreased with an increase in the height of the peanut column. Lastly, they recommended an optimum depth of 182.85 cm for drying unshelled peanuts from 40% (w.b.) to 13% (w.b.) using an air temperature of 43.3^{o}C and an air flow rate of 11 cfm per cubic ft. of load which would have a drying time of about 48 hours.

Mendoza *et al*. (1981) studied the fundamental and optimum drying characteristics of peanuts specific for Philippine conditions. In choosing the optimum drying condition, both quality and cost factors were considered and on these bases, they found that the best drying temperature for peanuts was 37.8^{o}C. At this temperature, germination was 100%, drying time 10 hours and kernels exhibited very slight physical alterations such as splitting and wrinkling. They also studied the effect of drying temperature on the drying time, germination and wrinkling of peanuts. They found that as drying temperature increased, drying time decreased (for drying temperature of 32.2^{o}C, drying time is 18 hours while for drying temperature of 60.0^{o}C, drying time is 6.6 hours). They also reported that peanut seeds will had 100% germination and will not show significant wrinkling when dried up to a drying temperature of 43.3^{o}C.

Diamante *et al.* (1998) reported the use of the Hukill's Analysis for deep bed peanut drying simulation. The model was evaluated using the peanut deep bed drying data of Bulilan (1978) and actual drying experiments. They found that the simulation model could adequately describe the deep bed drying of peanuts. Using the simulation model, they evaluated the effects of bed average initial and final moisture contents, drying temperature, air humidity, airflow and bed depth on the drying time and moisture content in various layers within the bed of peanut pods. They found that drying temperature had the most significant effect on drying time followed by bed initial moisture content, bed final moisture content, air humidity, airflow and bed depth, respectively. In addition the drying time decreased when the drying temperature, bed final moisture content and airflow increased. Increase in the bed initial moisture content, air humidity and bed depth also increased the drying time. Furthermore, the bed final moisture content had the major effect on the bottom, middle and top layer moisture of peanut pods among the six factors studied. Also, the bed final moisture content, drying temperature, bed initial moisture content, bed depth and air humidity vary directly with the moisture content difference between the bottom and top layers, however, this was not observed with airflow.

Shelling

Peanuts should be shelled carefully to avoid scratching, splitting, and rupturing of the seed coat, breaking of the cotyledon, or separating one or both of the cotyledons from the embryonic axis. Any form of injury to the seed coat is harmful. Likewise, breaking or splitting of the kernels will render them useless for planting purposes. A break in the seed coat will cause decay and allow storage fungi especially the toxin-producing microorganisms (*Aspergillus flavus*) to attack the exposed tissues and rapidly destroy the seed. When the scratch on the seed coat is deep, some oil is freed, rendering the seed rancid. This condition reduces the quality and viability of the seed (PCARR, 1978).

Traditionally, farmers shell peanut manually. This practice is labor intensive, takes time and the output is low. Hand shelling is the preferred method of obtaining peanut seeds which protects seeds from being broken (Sarmiento, 1985). Manual shelling of sundried and flatbed dried peanuts gave similar average recoveries of 68% (Gamboa, 1979).

To cope with increased demands for seeds and shelled peanuts, the peanut shelling rate of the manual method needs to be increased. As a result, numerous peanut sheller designs have been reported (Rosario and Sison, 1971; Labiano, 1972; Balbiran *et al*., 1978; Orias, 1980; Orge, 1982; Cortes, 1983; Caballero and Tangonan, 1985; Sarmiento, 1985; Ancheta, 1990).

Rosario and Sison (1971) developed a reciprocating screen peanut sheller that crushes and shears the peanut by means of an oscillating screen and a stationary base. The rated efficiency of the sheller per kilogram sample is (a) 2.2% kernel damage, (b) within 3.2 minute shelling time and (c) 8.5% unshelled pods.

A combined peanut thresher-sheller was designed, constructed, and tested by Labiano (1972). It has seven main parts, namely: the threshing mechanism, hopper, shelling mechanism, blower, and grader, power transmission system and the frame. Although the machine's shelling capacity is great (391.76 g/min for an average speed of 1,296 rpm), the cost of operation is high and proper maintenance is needed since it is driven by a motor.

Balbiran *et al*. (1978) designed, constructed and tested a cylinder-type peanut sheller, which rubs and rolls peanut pods between a rubber-level cylinder and a concave screen. The machine has a rated shelling capacity of 0.2 kg/minute at 200-420 rpm with 75% whole kernel recovery.

BPI developed a peanut shelling machine, which can shell at the rate of 300 kg/hr and has a shelling efficiency of 91.70 percent. It uses a 3-hp motor and has three oscillating assemblies. Peanut is fed through a hopper and passed between two rollers with clearance just enough to crack the pods. After cracking, the peanuts are expelled out of the shelling apron and perfectly shelled except those that are too small in diameter (Sarmiento, 1985).

UPLB has a peanut sheller that can be operated either with a 1/4 hp electric motor or manually using a foot-actuated pedal, and a shelling rate of 50 kg/hr (**Figure 12**). Stationary shelling bars with reciprocating slotted screen provide the shelling action. The machine weighs 70 kg and can be operated by one person. All sizes of two-bean-pod varieties can be shelled. The percentage of broken nuts at various specified adjustments seldom exceeds 5%. This machine has no cleaning and separating mechanism (Sarmiento, 1985).

DMMSU also developed a multi-purpose sheller-cleaner, which can be used for peanuts (**Figure 13**). The machine consists of two shelling rollers rotating at different speeds, an oscillating sieve and a blower. Its shelling capacity for peanut is 24 kg/hr while the cleaning efficiency is 83.5%. The damage to peanut seeds is 5.9%. The machine weighs about 50 kg and needs two men to operate it, one to pedal and the other to load (Sarmiento, 1985).

Orias (1980) designed a wooden peanut sheller (**Figure 14**) which can be operated by one person by simultaneously feeding the hopper with the pods and turning the crank clockwise. The pods pass through the gate into the shelling box where the shelling process occurs. The rubber plates attached to the rotary cylinder do shelling. These rubber plates press the pods against the wall of the shelling box once the crank is rotated. With this machine, winnowing is still necessary since no mechanism for separating the kernels from the shells is introduced. The machine has a shelling rate of 3.65 kg/hr and an efficiency of 97.0%.

A peanut sheller made of metal sheets and Orge (1982) developed belt (**Figure 15**). It is attached to the side of the table during operation through the adjusting screws at the base of the machine. Crushing occurs between two rollers, one held in place and the other one rotated by turning the crank. The distance between the two rollers can be adjusted to the size of seeds. The crushed peanuts fall into a belt conveyor, which revolves with the two pulleys and throws the broken pods on the rear side. The kernels fall to the front side since the belt is slanting. The machine has a 217.7% shelling efficiency compared with hand shelling.

Cortes (1983) improved the peanut sheller developed by Orias by adding a blower to separate the shells from the kernels (**Figure 16**). The shelling and blowing operations are coupled so that when the sheller is turned to crush the pods, the blower also turns to blow out the broken shells. Thus, shelling and broken shell separation becomes a simultaneous process and the labor needed to separate the kernels from the shells is eliminated. The machine has a shelling rate of 27.9 kg/hr, shelling efficiency of 96.9% and a cleaning/blowing efficiency of 92.4%.

Caballero and Tangonan (1985) published another design of a wooden peanut sheller (**Figure 17**). It is made of mostly wooden materials on the outside and metal sheet and pipes on the inside. It could be operated by hand cranking or by the use of 1/2 hp electric motor. The machine has a shelling rate of 25 to 30 kg/hr and whole kernel recovery of 65%.

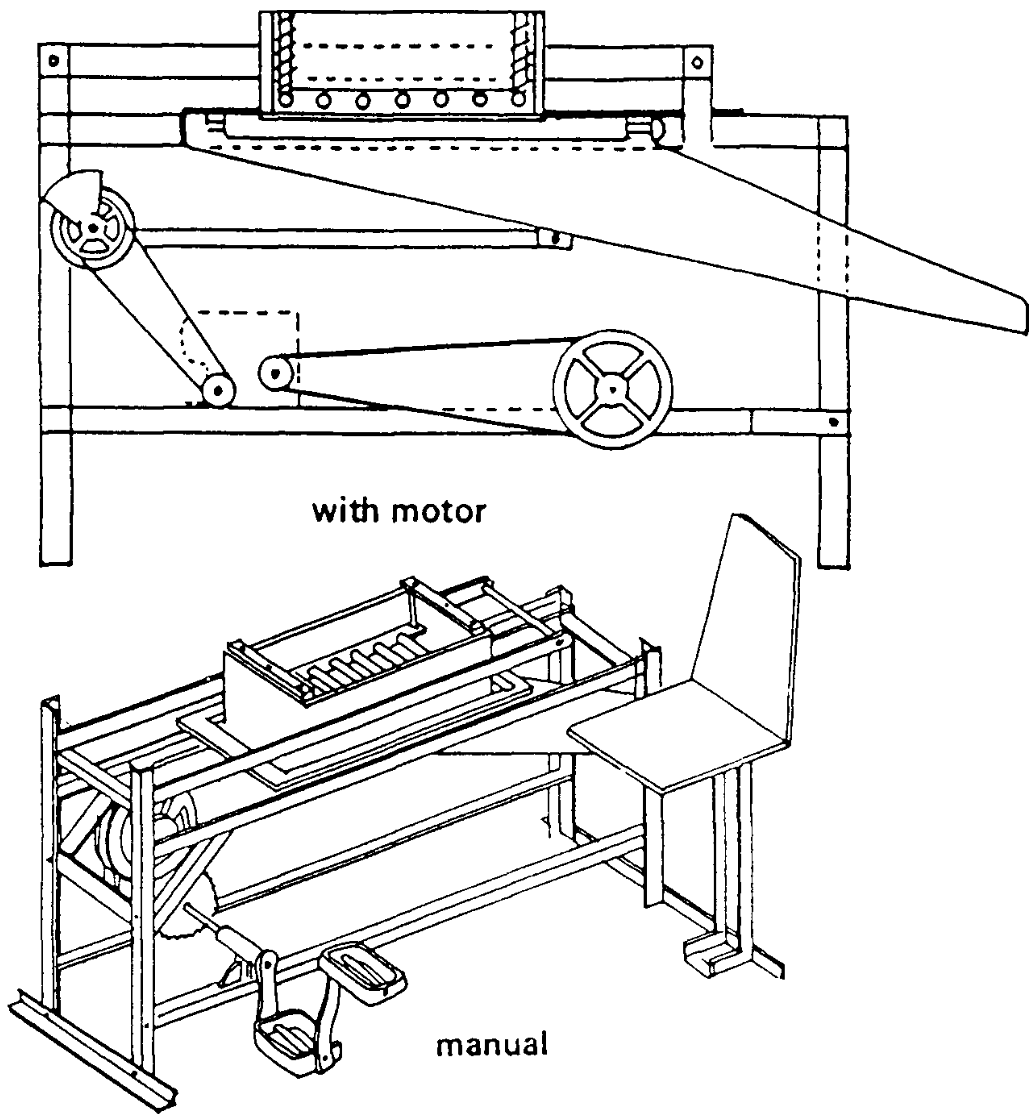

Figure 12. UPLB peanut sheller (manual or motorized) After Sarmiento, 1985).

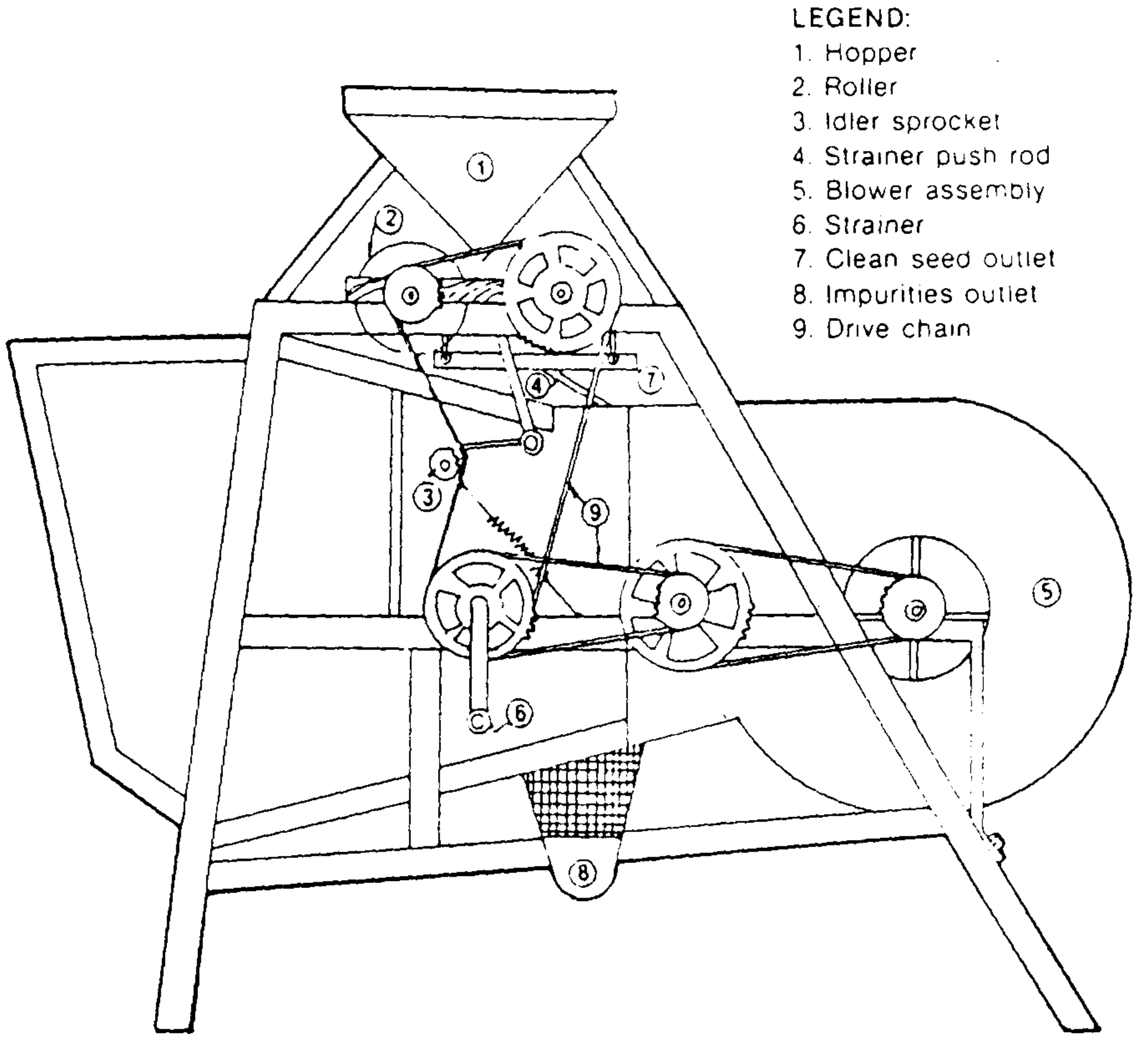

Figure 13. DMMSU multipurpose sheller-cleaner (After Sarmiento, 1985).

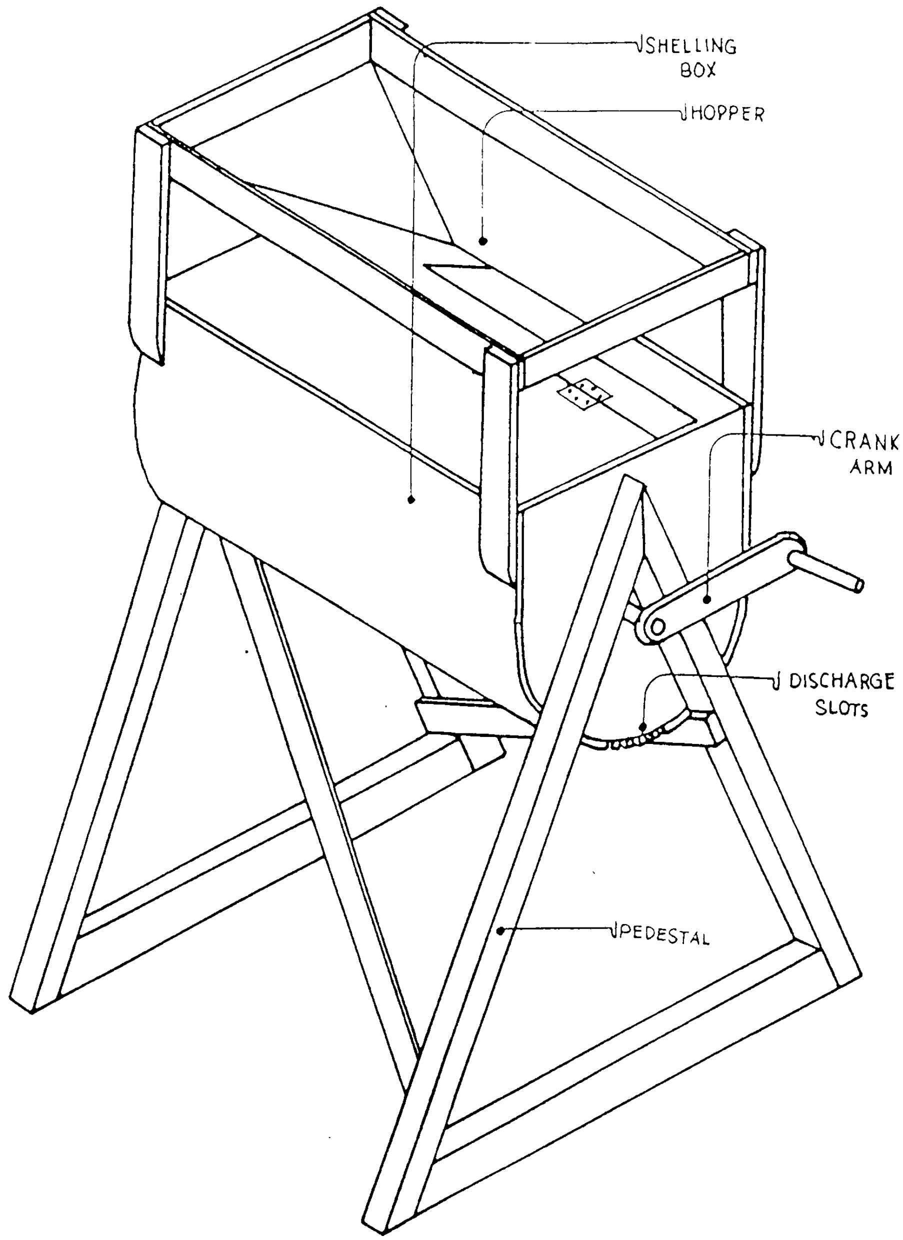

Figure 14. Orias hand-operated peanut sheller (After Orias, 1980).

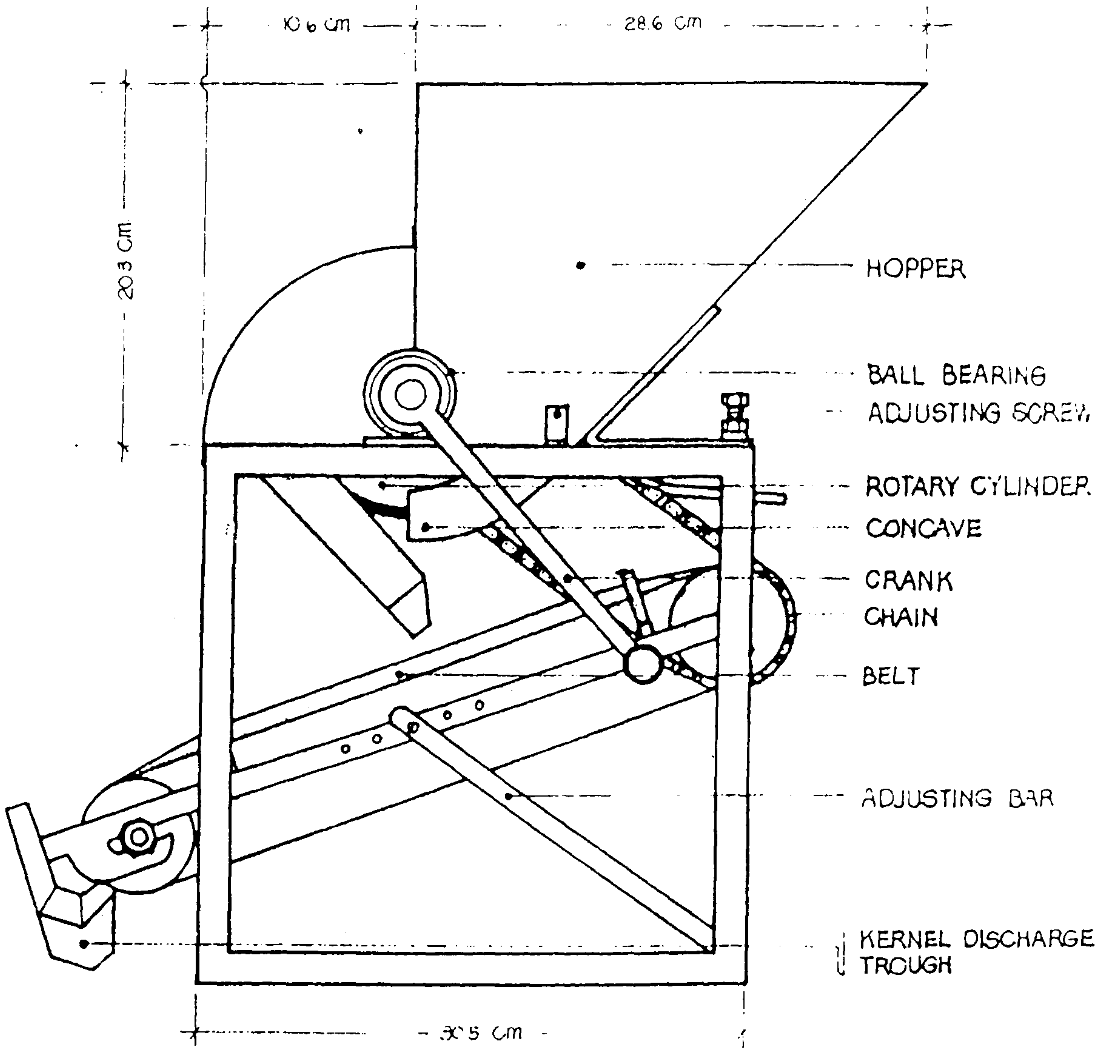

Figure 15. Orge hand-operated metal peanut sheller (After Orge, 1982).

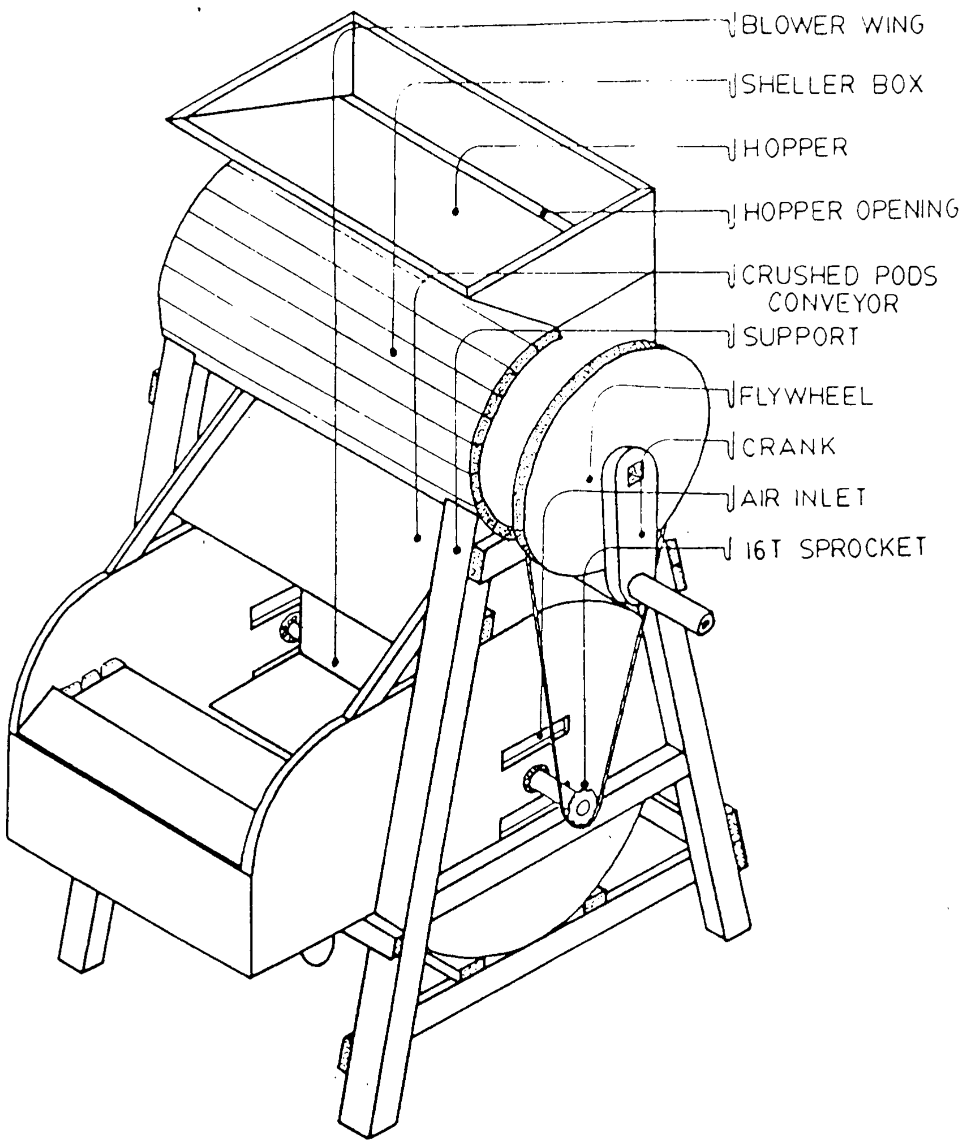

Figure 16. Cortes hand-operated wooden peanut sheller with blower (After Cortes, 1983).

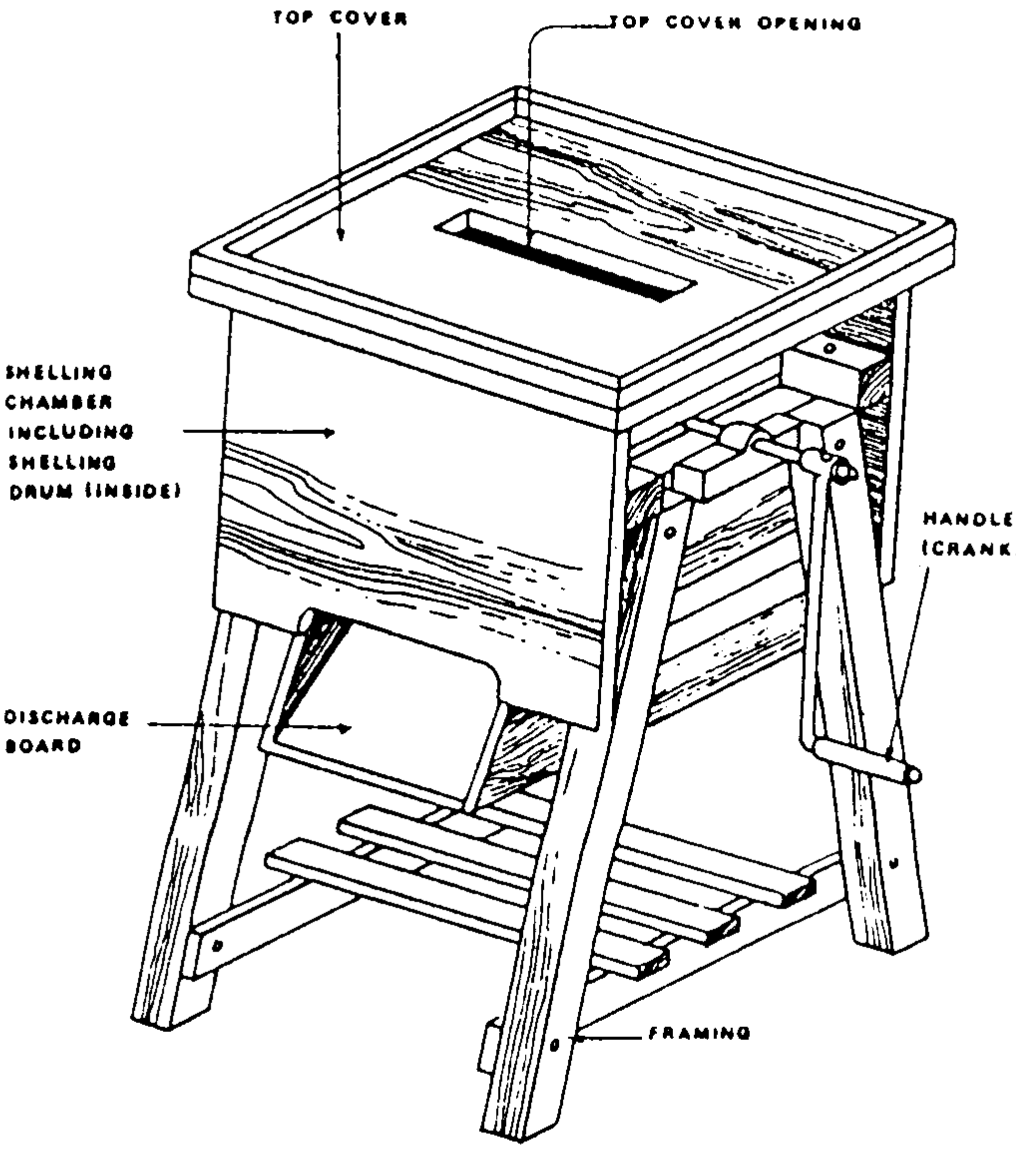

Figure 17. Caballero and Tangonan wooden peanut sheller (Caballero & Tangonan, 1985).

Ancheta (1990) also reported another two peanut shellers from AMDP. One is manually operated while the other one is motorized. The manual sheller (**Figure 18**) has a shelling rate of 18-20 kg/hr and efficiency of 97-99%. The sheller produces a mixture of shelled kernels and broken shells which still need manual winnowing. The sheller consists of a hopper and a manually cranked shelling drum. The shelling drum is composed of rectangular shelling bars attached to a single shaft. The motorized peanut sheller (**Figure 19**) is powered by a 1.5-hp electric motor. Aside from a hopper and shelling drum, it has a cleaning mechanism that consists of an oscillating screen and a blower. The machine has a shelling rate of 130-160 kg/hr, shelling efficiency of 97-99% and purity or cleaning efficiency of 97-99%.

Traders and processors take charge of shelling peanut in the Cagayan Valley region. A shelling plant in the same place locally designs and makes its own peanut shellers. The shellers are driven by 2-20 hp diesel engines provided with oscillating screen trays that remove some small and shriveled nuts before shelling. After shelling, another oscillating screen tray with air aspirator removes the shell. Shelling recovery reaches 60-65%. Processors operate their peanut shellers for 100 days/yr. only. Local shellers operate at 100 bags/hr at 25 kg/bag (Picar and de Padua, 1983).

Storing

Farmers traditionally store peanuts in the unshelled form. The shell acts as a natural protective covering for the relatively soft seeds against mechanical damage and insect infestation. They use sacks but some store peanut in open concrete pits under their farmhouses, and they periodically turn the peanut pile with a saddle. Others use bamboo baskets to store peanut. For shelled peanut, traders use bags piled to a maximum of 7-8 layers only. Otherwise, the oil content of the peanut stacked at the bottom of the pile is pressed out. Farmers and traders store peanut for a short time. Usually, they store shelled peanut for 2 months and unshelled peanut for six months only (Sarmiento, 1985).

Madriaga and Tamayo (1992) studied the influence of storage containers on the viability of unshelled peanut seeds. The different storage containers used were tin can, cement bag, plastic sack, polyethylene plastic bag and open container. They found that percent germination and seed vigor index decreased with the duration of storage regardless of packing materials used. Seeds stored in tin cans had significantly higher germination and seed vigor index than those in other containers. In addition, it controlled moisture absorption from the environment up to a period of 6 months.

Quitco (1989) observed that black discoloration developed on peanut seeds in the field and warehouses. She identified the main fungus causing this black discoloration as *Macrophima phaseolina* (Tassi.) Gold. Having less than 75% relative humidity in the storage areas can reduce the development of the black symptom.

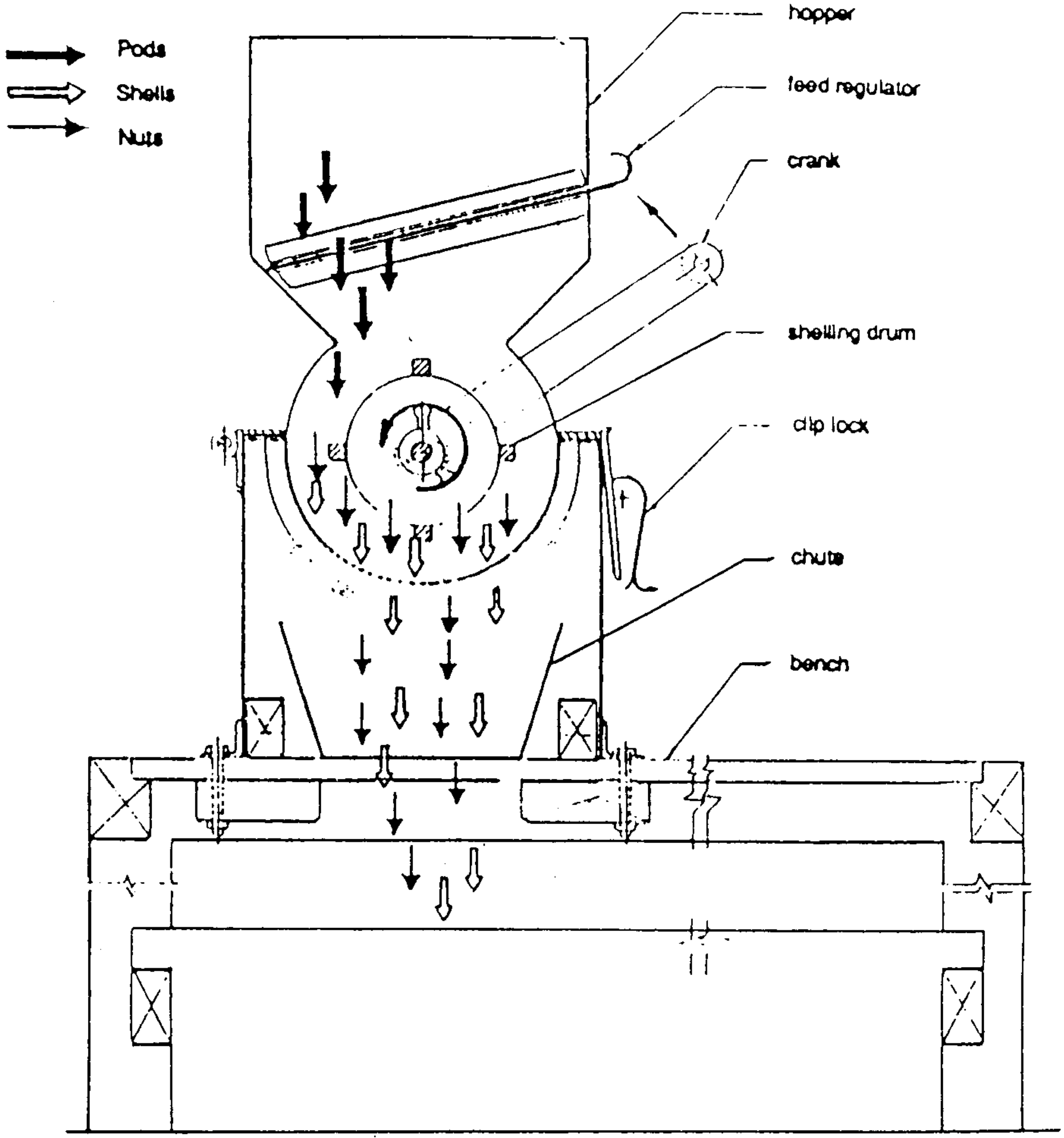

Figure 18. AMDP hand-operated peanut sheller (After Ancheta, 1990).

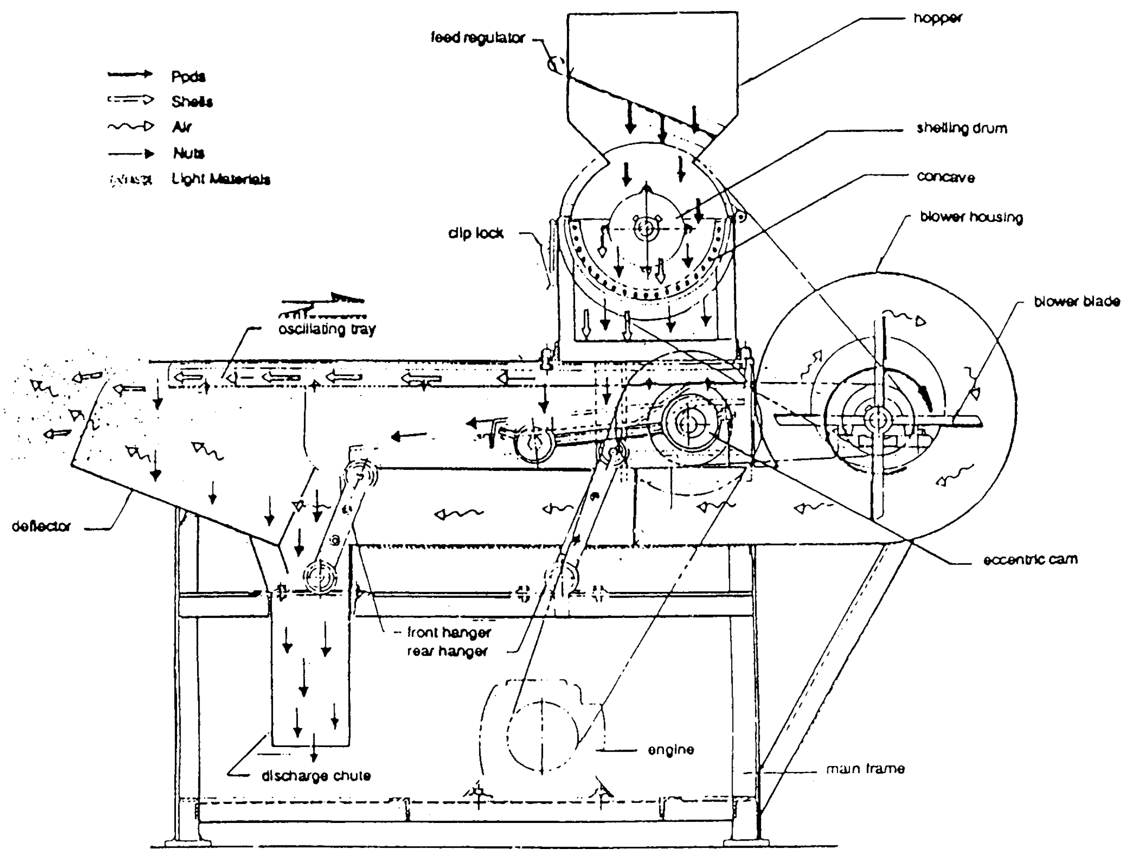

Figure 19. AMDP motor-operated peanut sheller (After Ancheta, 1990).

At the trader's level, peanuts generally contain about 35 ppm aflatoxin, which increases to about 188 ppm when it is delivered to the wholesaler's warehouse. Peanuts in the wholesaler's warehouse for more than 3 months had aflatoxin level ranging from 9 to 989 ppm with an average of 275 ppm (Quitco *et al*., 1987).

Under Philippine conditions of high relative humidity and temperature, storing peanut with low moisture content at room temperature does not preserve the quality and viability of the seeds. Under such conditions, the seeds imbibe atmospheric moisture due to its high oil content until it comes in equilibrium with the ambient environment. High seed moisture content increases seed respiration and the activities of its associated microflora, generally resulting in the total loss of seed viability in about 5 months. To minimize the effects of adverse conditions and maintain seed viability, it is recommended that shelled peanut be dried to about 6-8% MC and sealed in moisture vapor proof packaging materials (PCARR, 1978).

Mendoza *et al*. (1981) mentioned that the equilibrium moisture content (EMC) of peanuts at ambient conditions is a more satisfactory criterion for stability of peanuts since optimum stability occurs when the moisture of peanuts is stable with respect to the ambient conditions. They found that the EMC of peanut pods at ambient conditions of 30^{o}C and 75% relative humidity is in the order of 12 to 14% (dry basis). Beyond these conditions, significant increments in the absorbed moisture would eventually lead to deterioration due to mold growth and losses in viability. On the other hand, the structure of the cell membrane at the very low moisture content may be destroyed, probably by damage from lipid autoxidation.

Tumambing (1997) determined the EMC of two varieties of peanuts (BPI-9 and UPLPN-2) at different relative humidities and temperature (27 to 38^{o}C). He found that the EMC of peanut pods at ambient conditions of 30^{o}C and 75% relative humidity is about 11% (dry basis) which is a little lower than that reported by Mendoza *et al*. (1981) probably due to different peanut varieties used.

In storing peanut at commercial scale, an ordinary air-conditioned room with dehumidifiers to maintain a relative humidity of 40% and a temperature of 15.5^{o}C will maintain seed viability for at least 6 months if original seed moisture is at safe storage level (PCARR, 1978).

Ramos (1993) reported a new storage method for peanut pods developed at NAPHIRE using modified atmosphere storage. This method uses ordinary steel drums in storing 7-10% moisture content peanut pods (sundried) with 15% carbon dioxide gas. With this method, 80% of the seeds remain viable for 6 months in storage. The peanut pods must be shelled manually for use as seeds.

Sorting

After shelling, processors manually clean and sort peanut into reject, broken whole nut, and unshelled nut. They winnow peanut on a circular bamboo tray called "bilao" and hand pick the nuts (**Figure 20**). Substandard kernels and other impurities are manually sorted from good kernels (**Figure 21**) done by separating the split, damaged, moldy and other defective kernels (PCARRD, 1991). Children and women work on a contractual basis. They squat on the floor and perform this activity. They usually start at 6:00 a.m. and stop at 5:00 p.m. (average of 10 working hours) (Picar and de Padua, 1983).

Damaged and moldy kernels are sold at a lower price and are intended for processing mostly in the manufacture of candles and waxes (PCARRD, 1991). Lustre *et al*. (1998) reported that quality of peanuts especially in size and volume are the problems confronting the peanut industry in the Philippines.

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Consumption, Processing and Utilization of Peanuts

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Introduction

Peanut is one of the most nutritive crops available as a complement to cereal grains. The protein content of peanut is approximately 25 to 30%, on dry weight basis (PCARR, 1983). Raw peanut contains about 3% ash and about 4% peanut meal (obtained after oil extraction). The cotyledon has about 15% carbohydrates and the seed coat, 1%. Of the 26 inorganic constituents present in the kernel, calcium, phosphorus, potassium, magnesium and sulfur are found in high amounts.

At 25% protein and 45% oil, peanut provides an inexpensive, high-protein, high-energy food for humans and livestock so it can supply a high quality, healthy vegetable oil for cooking. A concentrated food peanut pound for pound, has more protein, minerals, and vitamins than beef liver; more fat than heavy cream; and more food energy than sugar. One cup of roasted peanut has the energy value of approximately 4 cups of milk, 5 cups of meat and 7 chicken eggs. It contains 25% to 30% high quality protein, 46 to 50% oil, and is a good source of vitamins A and B (PCARR, 1978).

Peanut flavor is closely associated with the oil and on separation, the flavor goes with the oil rather than with the meal (PCARRD, 1983). The average fatty acid distribution of peanut oil is as follows: 20% saturated fatty acids, 50% mono-unsaturated fatty acids, oleic acid and 30% linoleic acid. The presence of unsaturated fatty acids in dietary fats has been shown to induce lowering of blood cholesterol which in turn is helpful in the prevention of heart diseases.

The nutrients in peanuts are unaffected by heating. Moderate heat treatment, either by boiling or roasting, does not significantly alter the nutritive value of peanut protein. Oven roasting, however, has deleterious effects and peanuts roasted to a dark brown color are found to be worthless for growth and development. Unheated kernels are excellent sources of thiamin and niacin. The seed coat of peanuts contains 25% of the total thiamin, which is lost during roasting and blanching. Thiamin is drastically reduced when nuts are roasted at 150 to 160 ^{o}C for 20 to 40 minutes.

The high protein content of peanuts and its being flavorful make peanut an excellent enriching ingredient. Escueta (1985) recommended the development and use of peanut product such as flour and isolates to supplement, fortify and improve taste and quality of foods. Peanut flour has been found to be an excellent supplement to wheat flour and other low carbohydrate diets. It contains four times more protein, eight times more fat, and nine times more minerals than wheat flour. Peanut protein isolate can be used to fortify bakery products and as a substitute for milk in infant foods and other nutritious foods. Palomar *et al*. (1996) observed that peanut is the most preferred enriching ingredient in some bakery products. Doughnuts containing a mixture of meal from both toasted and untoasted peanut receive finer texture rating. Doughnuts containing 30% meal from untoasted peanut receive very strong aroma rating. Those containing 10% peanut meal are the most desirable doughnuts with meal from toasted peanut having a slight advantage.

Peanut-supplemented lady buttons contain significantly the highest crude fat ($p<0.05$) which is about twice the amount in a product containing soybean at the same level of enrichment. Protein content of the product is significantly increased by the addition of crushed peanuts (Palomar *et al*., 1996). This is also observed in "kabkab", a cassava-based grate product (Palomar *et al*., 1996).

Peanut Consumption

Peanut is already a naturally compounded food, ready to be eaten with minimum preparation (Lusas, 1979), by simple roasting and grinding processes (Rhee, 1985). The per capita consumption of peanut is shown in Table 11. Peanut is popularly consumed either as fried (62.5%), boiled (60.1%) or as peanut butter (61.6%). Peanut oil is relatively unknown to Filipino consumers while peanut butter is a favorite product (35.4%), followed by fried (17.2%), roasted (16.6%), and boiled peanuts (11.1%). NAPHIRE (1989) also observed that peanut is usually consumed as boiled, salted, roasted in or out of shell, and as peanut butter. It is also used in the manufacture of candy bars, cakes, brittle and other confectionery preparations.

The average per capita consumption per month of raw peanut is 182.95 g, as of 1989. Among the peanut products considered, boiled (153.36 g), roasted (111.91 g) fried (111.08 g) and peanut butter (73.20 g) are the top four items consumed. Peanut is highly acceptable among the Filipino consumers since the positive attitudes towards peanut outweigh the negative ones. The ranking of peanut is as follows: nutritious (74.7%); delicious (57.2%); a health food (29.2%); and expensive (25.3%). Nutritionists also recommend peanut butter for children and invalids because it is nutritious, easily digested, and low in carbohydrates. However, price and perception of peanuts as an unhealthy and fattening food are the usual reasons for non-consumption. Reasons such as "too oily", "causes pimples and constipation", "activates tonsilitis", "enhances skin growth", "causes diarrhea and high blood pressure" are the usual comments among eaters.

The survey also observed that peanut is usually consumed less frequently (weekly or monthly) compared to other food items (cereals, meat/fish, vegetables), which are consumed daily or almost regularly. The calculated energy and protein consumption per day is less than the required daily allowance (RDA) again due to the high cost of peanut and other traditional sources of protein such as meat, poultry, fish and dairy products.

Ilocos Region, Northern Mindanao, and Eastern Visayas are the three leading household consumers of peanut butter, with an above average quantity consumption from 575 g to 641 g/month. The national average household consumption is only 432 g/month. At the per capita level, the top three consumers are Ilocos Region, Central Mindanao, and

Southern Mindanao, whose respective demand range from 95 to 105 g/month. Western Visayas has the lowest household and per capita consumption.

Table 11. Per capita consumption of peanut, 1971-1980.

Year	**Average Per Capita Consumption (kg/mo)**
1971	0.31
1972	0.29
1973	0.27
1974	0.32
1975	0.54
1976	0.57
1977	0.64
1978	0.50
1979	0.50
1980	0.50

The average monthly household consumption rate for peanut butter in the Philippines is about 432.04 g valued at P27.10, or an equivalent of 73.20 g at the per capita level valued at P4.70, with Western Visayas having the lowest household and per capita consumption of 289 g and 42 g/month, respectively (Table 12). The national average frequency of consumption is approximately twice a month (Garcia *et al.*, 1990).

The average household and per capita consumption of peanut candies in the Philippines is 186.60 g and 27.90 g, respectively. Cagayan Valley, Southern Tagalog, Northern Mindanao and Ilocos Region all have a household consumption of more than the national average consumption, while the rest of the regions consume less. In general, Filipinos eat peanut candies weekly.

Peanut Preparations

The use of peanuts in the food industry has concentrated on its direct consumption as snack food. However, its highly acceptable sensory properties and value make it a popular raw material for food product development (Del Rosario *et al.*, 1992). Some peanut products are area-specific, but peanut butter is usually produced in all the 13 regions of the Philippines (Table 13), followed by fried, roasted, greaseless and candied (i.e. brittle) peanuts and the different brands are shown in Table 14 (PCARRD, 1983; Garcia *et al*., 1989).

Table 12. Monthly household and per capita quantity and expenditures consumption of peanut butter in the Philippines (Garcia, 1990).

Region	Household Quantity (g)	Household Value (P)	Per Capita Quantity (g)	Per Capita Value (P)	Average Frequency of Consumption*
NCR Metro Manila	404.97	27.93	62.11	4.43	2.59
1 Ilocos Region	641.50	20.02	109.11	5.06	2.67
2 Cagayan Valley	300.00	20.45	50.00	3.42	3.00
3 Central Luzon	351.94	26.61	68.82	4.47	2.94
4 Southern Tagalog	365.47	23.46	73.87	4.72	2.59
5 Bicol Region	313.26	23.44	58.60	4.69	2.44
6 Western Visayas	288.89	32.54	41.89	4.43	2.63
7 Central Visayas	462.40	22.18	67.56	3.67	2.54
8 Eastern Visayas	575.56	35.94	76.76	4.96	2.78
9 Western Mindanao	440.89	24.47	61.20	3.98	2.50
10 Northern Mindanao	600.00	32.69	76.54	4.70	2.59
11 Southern Mindanao	456.87	29.56	94.56	6.65	2.72
12 Central Mindanao	544.24	28.07	108.83	4.90	2.62
Philippines	432.04	27.10	73.20	4.70	**2.61**

*1.0 – Daily; 2.0 – Weekly; 3.0 - Monthly

Table 13. Peanut products manufactured by region in the Philippines (Garcia, 1990).

Peanut Product	NCR	1	2	3	4	5	6	7	8	9	10	11	12
Peanut brittle	/	/		/									
Peanut butter	/	/	/	/	/	/	/	/	/	/	/	/	/
Peanut cake	/						/		/	/			
Coated peanut	/	/		/	/		/				/	/	/
Greaseless peanut	/	/	/	/	/		/	/		/	/	/	
Peanut kisses								/					
Panutsa		/			/	/							
Pastillas												/	/
Pinato								/	/		/	/	/
Roasted peanuts	/	/		/	/	/	/	/	/	/		/	/
Peanut turon													/
Turrones de mani				/							/		
Peanut cookies								/	/				
Peanut broas									/				
Peanut polvoron										/			
Fried peanut	/	/		/	/	/	/	/	/	/	/	/	/
Boiled peanut				/	/	/	/		/		/	/	/
Baked peanut								/					
Bandi													/
Candied peanut	/	/		/	/	/		/	/	/	/	/	/

Table 14. Brand names of peanut product produced/sold in each region (Garcia *et al*., 1990).

Region	**Brands**
NCR Metro Manila	Lily's, Tobi, Yummy, Nagaraya, Ludy's, Lady's Choice, Expo, Goldilocks, Growers and Baliuag Products
1 Ilocos Region	Esmabe, Dega's, Expo, BSU Food Processing Center, Good Shepherd, G & E, Growers, Nagaraya, Lady's Choice, Keaton's and Taiwan
2 Cagayan Valley	
3 Central Luzon	Lily's, Lady's Choice, Growers, Expo, Danny's, Dodong's, Chiqui's, Cita's and Allen's Sweets
4 Southern Tagalog	Crompton, Ludy's, Lily's Lady's Choice, Planters, Nagaraya, Nene's, Growers, Expo, Holiday, Yummy, Lipton, and Tobi
5 Bicol Region	Lesly, dela Rosa, and Gila
6 Western Visayas	Lady's Choice, Expo, Growers and Metro Biscuits
7 Central Visayas	Coralandia, Lady's Choice, Joy's Foods, Planters, Tobi, Lola Pureza's, Bread and Butter, Candyman and Growers
8 Eastern Visayas	Lady's Choice
9 Western Mindanao	Lady's Choice, Lily's, Joy's Foods, Growers, Roy's and Jef-Jef
10 Northern Mindanao	Lady's Choice, Noralyn's Iligan's, Goya, Lily's, Nagaraya, Royal, Growers and Planters
11 Southern Mindanao	Lola Pureza's, Growers, Tobi, Lady's Choice, and Planters
12 Central Mindanao	Lady's Choice, Chedeng's, KJ's, Ding's, and Sonia's

"Peanut kisses" is another product produced in the region with ground peanuts, eggwhite/sugar, vanilla and shortening and the basic ingredients. It is only manufactured in Central Visayas (Table 13). Its production involved several steps (Alkuino *et al*., 1998). The products are sold in 100 and 200 g packs placed first in a pouch then in a box. It is one of the Visayan peanut delicacies (**Figure 22**) sold in Cebu City and other cities in the Visayas and Mindanao. Quality control forms an important aspect of its production to achieve and maintain the desired level of quality and raw peanut selection is an important step in the manufacture of peanut kisses (Alkuino *et al*. 1998). Baking is one of its critical control points to check the time and temperature (Palomar *et al*., 1998).

Boiled Peanut. Fresh newly dug, unshelled peanuts are boiled in a weak brine (2 to 3% brine) and eaten as a delicacy in some areas (Woodroof, 1973). The kernels are moist and quite brittle, with a mild nutty flavor, and a firm, slightly gelatinous texture (Rhee, 1985). Boiled peanuts are sold by street vendors (Garcia, 1987) sometimes using wilted banana leaves (**Figure 23**) but can also be dried and packed as ready to eat unshelled peanuts with higher shelf life.

Fried Peanut. Deep fat frying is the most common method of cooking peanut; it is usually salted and sometimes spiced with pepper or garlic. However, most consumers found them greasy. Bigger peanut companies produce greaseless peanuts. Greaseless peanuts are produced either by the use of a vacuum fryer or processing is done by roasting rather than by frying.

Roasted Peanuts. Roasting is a rapid cooking procedure using dry heat, producing a variety of salted and unsalted forms, unshelled, shelled whole kernel, split kernel, and chopped nut products. Household establishments roast the unshelled peanuts in large open pan in sand with constant mixing during heating while others (small, medium and large manufacturers) use electrically-heated, gas fired roasters (Garcia, 1987) or wood-fueled roasters (Alkuino *et al*., 1998) for both shelled and unshelled products. **Figure 24** shows a wood-fueled peanut roaster used by a small scale peanut processor in the Visayas.

Peanut Butter. An unidentified St. Louis physician is believed to have invented peanut butter in the 1870s; the first patent for its preparation was awarded to J.H. Kellogg Battle Creek, Michigan. Since that time, the product has been enjoyed for its desirable flavor as sandwich spread and for its versatility as a snack and cooking ingredient (Lusas, 1979) and is a very profitable business venture (Anonymous, 1996). A number of peanut butter brands are available in the Philippine market (**Figure 25**).

The basic steps in peanut butter manufacturing are cleaning of shelled peanuts, roasting, blanching, blending of ingredients, grinding, cooling and packaging (Rhee, 1985). The typical formula includes 98% peanuts and 2% salt. Some producers still use corn meal-grinder or a modified equipment for higher capacity in the manufacture of peanut butter. However, grinding is done twice or thrice to get the desired particle size. There are at least two types of peanut butter, the dry and soft type, the latter being added with cooking oil which formula results in separation of oil during storage, one of the major problems confronting especially the small peanut butter manufacturers in the Philippines (Lustre *et al*., 1998). Initial results show that application of carrageenan at very low level minimize the problem (Palomar *et al*., 1998).

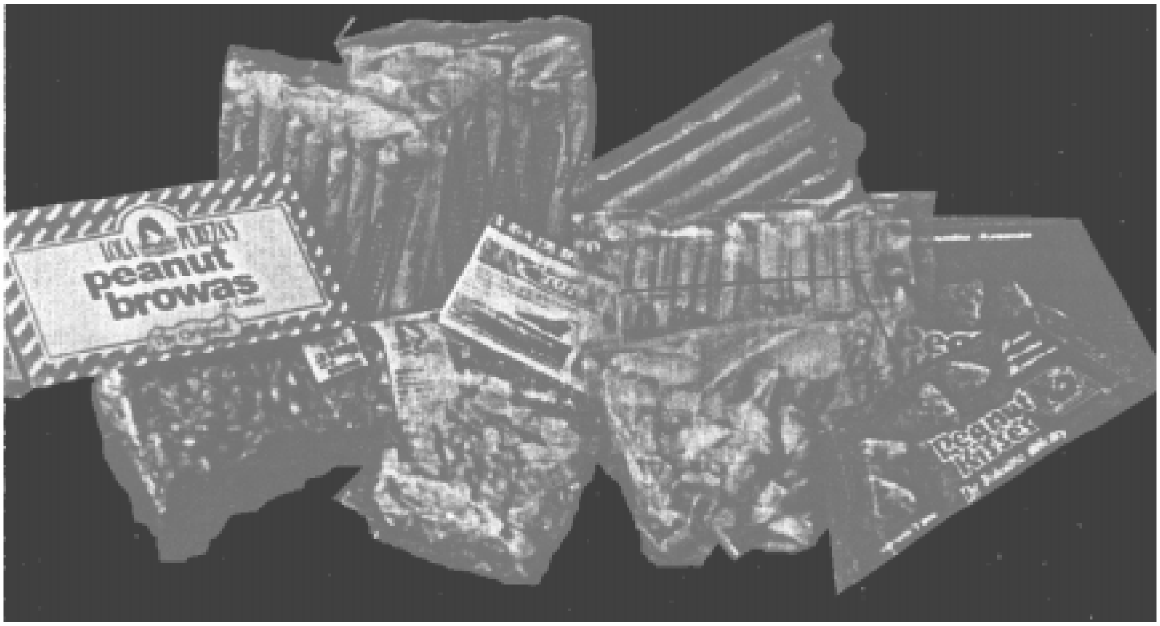

Figure 22. Different Visayan peanut delicacies.

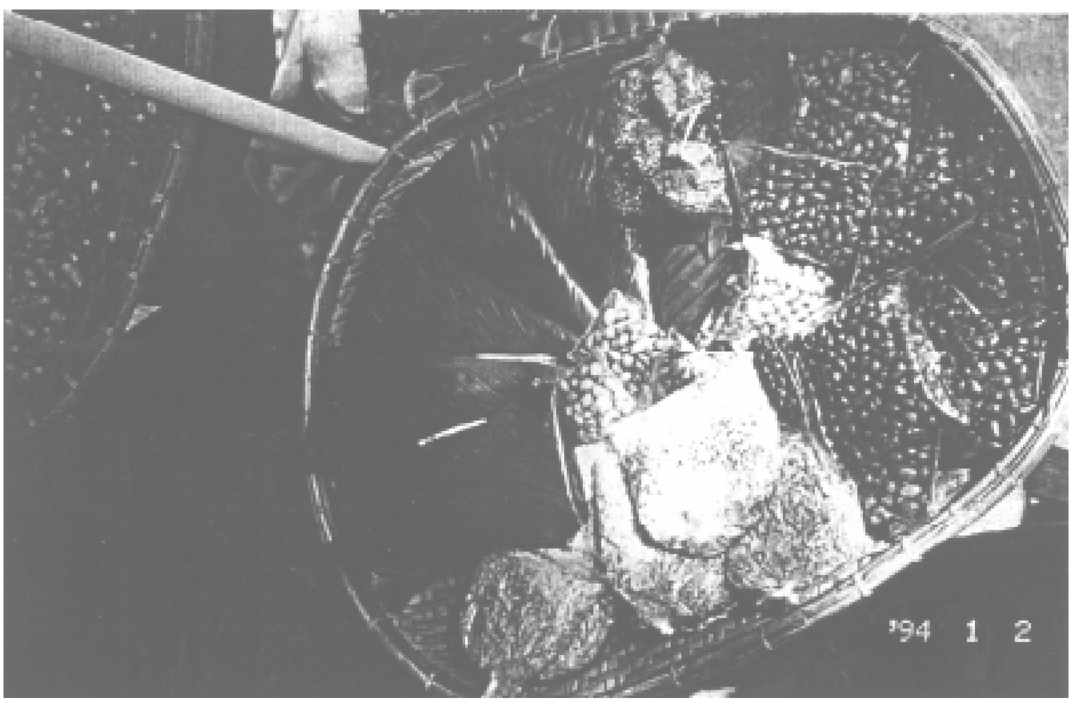

Figure 23. Various peanut products sold at the sidewalk with banana leaf as one of the packaging materials.

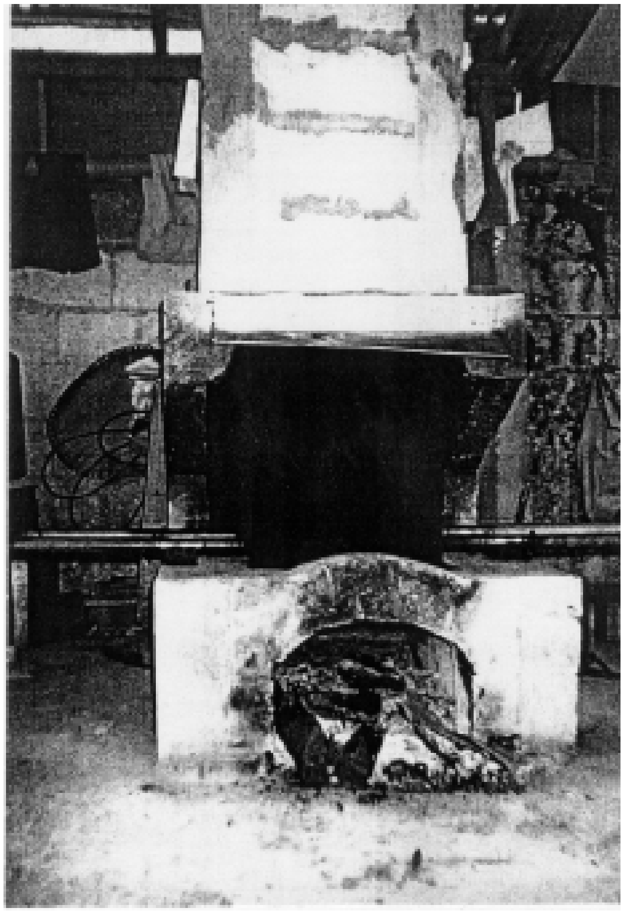

Figure 24. Peanut roaster used by small scale peanut processors.

Figure 25. Brands of peanut butter in the Philippine market.

Other Products. In the Philippines, peanut butter, besides being used as a bread spread, is also used as ingredient in cooking various dishes such as steak from goat's meat (Mediavillo, 1985) or in cookies, and other bakery products. Ground peanut is the tasty thickening agent in a popular Filipino dish called *kare-kar*e (Anonymous, 1977). Peanut is also used in making candies and pastries, and as a substitute for chick peas (garbanzos) or beans in preparing boiled meat (Anonymous, 1977).

New Products Developed. Peanut has already been processed into new non-traditional products. A high protein non-dairy food spread (similar to cheese spread) has been developed for the Philippine market. It has a shelf life of at least 6 months without refrigeration (P-CRSP, 1993). Soft curd developed from peanut milk is prepared from steam blanching which is acceptable among students. The suitability of peanut milk as a substrate for bacterial fermentation of yogurt and yogurt milk has been observed. Soft white cheese can be processed from peanut using an acetic acid coagulant with 35% peanut milk as a substitute. Three peanut sauce formulations have been developed and sensory evaluation indicate high acceptability, with bottled sauces at pH adjusted to 3.5 to have moderate acceptability.

Peanut milk is slurry produced by grinding one volume of raw peanuts with six volumes of water for 30 min. When unprocessed, acceptability as food beverage is low due to a beanie flavor and very high fat content (Rubico *et al*., 1987). Films from full-fat peanut milk are more susceptible to oxidative rancidity than those from partially defatted peanut milk (Del Rosario *et al*., 1992). Peanut *majareal* is a product produced only in Cebu City that is processed by deskinning the nuts, boiling until soft, grinding, mixing with sugar and cooking under low fire. Studies done at UPLB showed that *majareal* processed following the DOST Dulce recipe is more acceptable than the product processed from IFST peanut bar recipe (P-CRSP, 1994).

Additional peanut products include rice-peanut chippy, peanut *taho*, peanut jam, peanut curd or *tokwa*, choco-coated peanut brittle and peanut *pastillas*. These products have passed the acceptability test, nutritional value and economic viability tests (CVARRD, 1998).

Peanut Oil

Peanut oil, obtained from kernels, is pale yellow and has the characteristic color and flavor of peanuts (Rhee, 1985). Normally, commercially refined peanut oil contains only traces of linolenic acid (Garcia, 1990). Considering the trace levels of linolenic acid, peanut oil has excellent stability against oxidation and is considered a premium cooking and frying oil. Peanut oil is used mainly for edible purposes as salad oil and in the preparation of margarine, shortenings and mayonnaise, as well as for cooking and frying.

However, given the above favorable characteristics, the Philippine consumption rate for peanut oil is insignificant since it is seldom used in the Filipino diet. Of the 1,126 respondents all over the Philippines, only six reported using peanut oil. This indicates that peanut oil is relatively unknown to Filipino consumers probably due to the greater popularity of coconut oil, which is used more throughout the country because of its availability and price (Garcia, 1990).

By-Product Utilization

The part of peanut that remains after oil is processed is called peanut meal. Mixed with wheat flour, the good quality meal is used in making bread, biscuits, and cake. Inferior meal is used as livestock feed and fertilizer (Anonymous, 1977). Studies on peanut product development involve the development of peanut cakes and candies. Peanut kisses a sweet confectionery, is prepared from defatted and roasted peanut meal. The oil (21.4%) is extracted from peanut to produce the meal (76%). The peanut kisses turn brown on baking. A lower temperature may be employed to get a white product similar to the commercial sample. The product is suitable and highly acceptable.

Doughnuts containing mixtures of meal from both toasted and untoasted peanuts receive a fine texture rating. Those containing 10% peanut meal are the most desirable doughnuts with meal from toasted peanut having a slight advantage. The meal from toasted peanut results in a more acceptable mixture than from the untreated peanut.

An Isabela farmer has shown that goats raised on a feed ration of concentrate and peanut by-products (leaves, stems, tops, pods and shells) yield more profit than those given pure concentrate (Bernardo, 1988). The creeping peanut variety, with its fine and leafy stems, makes good forage for livestock. When cured into first class hay, it compares favorably with clover and alfalfa (Anonymous, 1977).

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SOCIOECONOMIC PROFILES OF PHILIPPINE POPULATION AND PEANUT PRODUCERS

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Introduction

Peanut, locally known in the Philippines as "mani", is also called and reported as groundnut in the export market. In the Philippines, it is commonly consumed as nuts in roasted or boiled form or out of the shell. It is widely used in the manufacture of peanut butter and vegetable oil. It is also used as a confectionery and to fortify other food preparation. Because of its low profile vegetative growth, peanuts remain as one of the most dependable cash crops in a country frequently visited by typhoons such as the Philippines.

Despite the high demand for peanuts in the country, the industry continuously experience low domestic yield resulting in continued importation to satisfy the country's total consumption requirements. In 1996, the major sources of the Philippine imports of groundnuts are Indonesian (45%), the USA (17%), Peoples' Republic of China (14%), Taiwan (10%) and other countries like Thailand, Germany, Singapore, Australia and Hongkong (NCSO, 1997). **Figure 26** shows the production of peanut in the world. The supply and utilization requirement for peanuts in the Philippines is reflected in Table 15. In 1996, the country's utilization requirement amounted to 92,400 MT. To fill up this amount, the Philippines imported 59,000 MT to supplement the domestic production of 33,400 MT.

Profile of the Philippine Population

The Philippines is composed of three major island groups comprising Luzon, Visayas and Mindanao. Recent available data from the National Census and Statistics Office (NCSO), show that the total population of the Philippines as of 1995 was 68,616,536 persons. The population grew at the rate of 2.32 % annually during the 1990-1995 period. More than half (56 %) of the Philippine population reside in Luzon. The remainder is almost equally distributed between Mindanao (24 %) and Visayas (21%).

Among the 16 administrative regions, Southern Tagalog registered the largest population accounting for 14.5 %, followed by the National Capital Region, 13.8 % of the entire Philippine population. Central Luzon registered the largest population accounting for 10.1 % of the total population. These three regions combined accounted for 38.4 % of the country's total population.

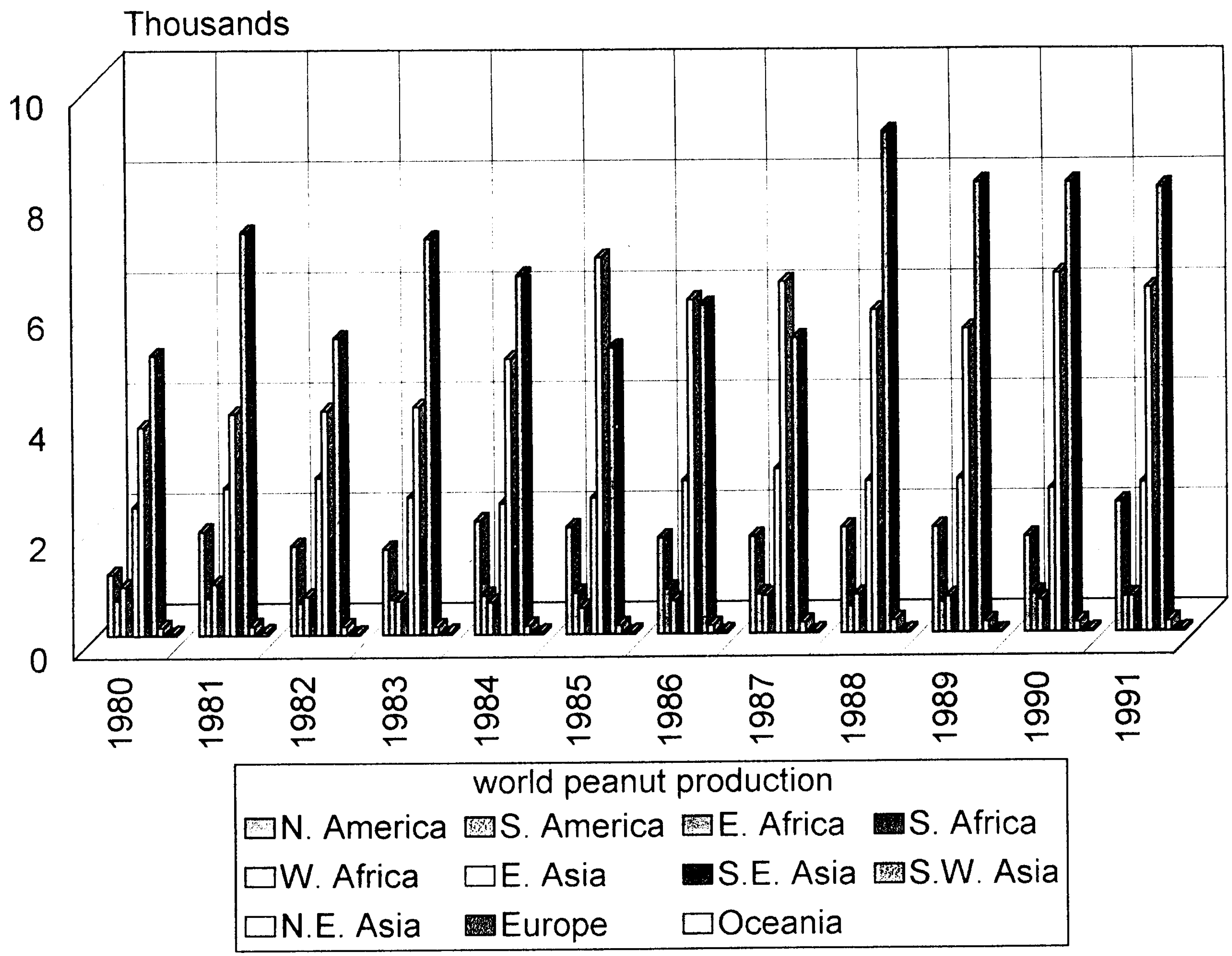

Figure 26. World peanut production, 1980-1991.

Table 15. Peanut supply and utilization in the Philippines, 1995-1996.

Item	Year 1995	1996
	(000 MT)	
Supply		
Production	36.200	33.446
Imports	40.829	58.967
Total Supply	77.029	92.413
Utilization		
Seeds	.190	.180
Feeds and Waste	.385	.462
Processing	5.392	6.468
Net Food Disposable	71.061	85.302
Total Utilization	77.029	92.413

Source: Supply and utilization accounts of selected agricultural commodities.
Part I. BAS, DA Q. City 1997.

The Philippines has a relatively young population with a median age of 20.4 years. More than half (58 %) of the 1995 total population are in the productive age group (15-64 years of age). The number of households in 1995 was 13,508,775 with an average size of 5.1 person per household.

Agriculture, hunting and forestry still remain as the major source of livelihood among the people. According to the 1995 NCSO report, seven out of ten persons 15 years old and over whom at anytime in the past year, were in agriculture, hunting and forestry. Rice and corn are the major commodities grown in the Philippines, with peanut bringing in less than 1 % of the share in both area and value of production (Table 16).

Profile of the Peanut Farmers

Previous studies were conducted related to peanut production and its economics (Huelgas *et al.*, 1990; Recide, 1997). These studies covered the two top peanut producing regions, Ilocos and Cagayan Valley, and some provinces in Central and Southern Luzon and the Visayas. The profile of peanut farmers is presented in Table 17. The average age of peanut farmers is about mid-forties. These farmers have been engaged in peanut production for about 14 to 16 years. More than 50 % of the peanut growers are owner-operators but a little more than 30% are tenants. The rest are part owners or amortizing owners and Certificate of Land Title (CLT) holders.

The farm size as shown in the study of Huelgas and co-workers (1990) averages 2.24 hectares. In the study of Recide (1997), the average farm size is 4.66 hectares but only 0.98 hectares are devoted to peanut production. Both studies reveal that the farmers still use the traditional or native varieties due to the lack of improved varieties of peanuts.

Table 16. Agricultural crops grown in the Philippines, 1994.

Item	**Area (1000 ha)**	**Percentage Share**	**Value (million pesos)**	**Percentage Share**
Agricultural Crops	13.087.3	100.00	P 205,407.9	100.00
A. Cereals	6,657.3	50.87	83,566.3	40.68
Palay	3,651.5	27.90	61,331.6	29.86
Corn	3,005.8	22.97	22,234.7	10.82
B. Major Crops	4,884.0	37.32	86,325.8	42.03
Coconut	3,066.7	23.43	22,621.1	11.02
Sugar Cane	395.7	3.02	17,239.4	8.39
Banana	330.0	2.52	12,328.2	6.00
Mango	58.0	*	6,164.5	3.00
Pineapple	68.9	*	5,934.5	2.89
Coffee	141.1	1.07	5,120.3	2.49
Cassava	211.3	1.61	3,023.1	1.47
Abaca	107.1	*	1,633.5	*
Rubber	85.6	*	1,478.7	*
Onion	7.7	*	1,116.8	*
Tomato	17.3	*	1,100.6	*
Eggplant	19.3	*	962.6	*
Tobacco	48.2	*	959.2	
Garlic	5.6	*	903.4	
Cabbage	7.8	*	493.1	*
Peanut	**47.9**	*****	**473.2**	*****
Mango	34.1	*	467.9	*
Cacao	17.0	*	300.0	*
Citrus a/	29.2	*	1,639.0	*
C. Other Crops b/	1,506.0	12.12	35,575.8	17.29

a/ Calamansi, mandarin
b/ fibercrop, rootcrop, spices, tubers and legumes
* less than 1 percent
Source: BAS, DA

Table 17. General characteristics of peanut farmers in the Philippines.

Item	Huelgas 1985-86	Recide 1997
Ave. Age	44.00	48.0
Ave. Years in Farming	14.00	16.0
Tenure Status		
Owner Operator (%)	50.98	55.0
Tenant	33.33	31.2
Amortizing Owner	9.31	10.0
Others a/	6.37	3.8

a/ CLT holder, part-owner, rent free

Profile of Peanut Manufacturers

A survey conducted (Lustre *et al.*, 1998) with 25 peanut companies (14 in Metro Manila, 4 in Northern Luzon and 11 in the Visayas and Mindanao) showed that 76 % are engaged in manufacturing alone, 17 % are in both manufacturing and trading while 7 % are peanut users. The companies in Metro Manila are either medium or large in size but those located in other regions are primarily small who sold their products only in the local market. Only 5 % of the 14 processors in Metro Manila exported their products. This does not mean, however, that only products of companies directly exporting are in the export market. It has been observed that several peanut products find their way to the export market without the knowledge of the manufacturers.

Majority (71 %) in Metro Manila processors are technologically active, developing new products and improving existing technologies sourced from locally known practices (59 %), family procedures, R & D institutions, foreign companies and other manufacturers.

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COMPARATIVE MARKET PRICE OF PEANUT

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Introduction

Peanut is traded in local and international markets. The commodity is sold raw either shelled or unshelled, and fresh or dry, and processed or preserved. The price of peanut is then set based on commodity form and kilogram weight measure.

The farm price for peanut for the first half of 1998 showed pricing for unshelled, fresh and dry, and for shelled peanut (Table 18). The prices differed based on product form. The farm price for unshelled fresh averaged P13.35 /K; for unshelled dry, P16.03 /K; and for shelled dry, P31.78 /K. The 1996 and 1998 average farm price for shelled peanut showed an increase of P1.23. The average farm price for shelled peanut was highest at P48.00 /K in Cagayan Valley, and lowest at P21.47 /K in Western Visayas. Peanut traders then, can purchase from regions with low farm prices.

Product development and new processing technology for desired food products on the other hand, is highly influenced by the prevailing market price of its essential raw material or main ingredient, such as peanut, specified in the production process. In other words, the price rate of a needed basic commodity may in the end account for the affordability of the processed end product in the market.

Table 18. Farm price (P/K) for average peanut, Philippines, January –June 1998.

	Unshelled		Shelled
	Fresh	Dry	Dry
Average	13.35	16.03	31.78
June	15.05	17.00	19.38
May	11.71	15.40	35.55
April	13.16	14.06	36.23
March	16.04	18.16	39.69
February	9.22	15.61	34.34
January	11.62	14.42	31.84
Highest			
Southern Tagalog	25.00		
Western Mindanao		25.57	
Cagayan Valley			48.00
Lowest			
ARMM	6.13		
Bicol		10.53	
Western Visayas			21.47

Farm, Wholesale, and Retail Prices

At monthly prices ranging from P26.48 /K to P35.85 /K in 1996 (Table 19), the average farm price of shelled peanut was P30.55 /K. Farm price was low at harvest (January-February) and highest at time of planting (October). The average farm price could cover the production cost of P21.31 /K and provide a profit margin of P9.24 but cannot compete with the price of imported peanut at P16.95 /K. Also, the 1996 calculated total cost of production (P16,193.31 /ha) based on recommended peanut farm practices may further have added costs on land and modern farm machinery and equipment rentals.

To lessen the unit cost of peanut production, an increased farm yield is necessary. A low peanut production with many buyers would actually increase peanut farm prices. Two top peanut producing regions, Cagayan Valley and Ilocos Region, could yield a field harvest of over 1 MT/ha/harvest yet, most regions yielded less than 1 MT/ha/harvest. The unstable peanut farm price shrunk the total peanut crop hectare. In Cagayan Valley, a large peanut crop area was shifted to corn crop.

Table 19. Monthly farm price of shelled peanut (P/K), Philippines, 1992-1996.

Year	**1992**	**1993**	**1994**	**1995**	**1996**
Average	22.01	22.13	29.12	29.89	30.55
January	23.55	21.16	23.46	25.92	27.93
February	21.80	19.23	24.12	25.96	28.57
March	23.81	22.67	29.94	26.42	29.74
April	19.04	23.39	28.04	28.85	30.51
May	19.89	21.94	27.31	28.29	32,22
June	20.03	23.35	28.55	29.10	33.06
July	21.00	21.05	32.32	32.38	33.31
August	22.14	22.49	29.94	29.86	26.48
September	23.73	22.47	29.95	38.34	29.72
October	20.82	23.71	37.20	30.70	35.85
November	26.73	21.73	30.69	30.93	32.39
December	22.60	22.32	27.87	31.95	28.52

Source: Bureau of Agricultural Statistics, Philippines.

The average wholesale price of shelled peanut was P25.82 /K (Table 20), from a lowest to highest range of P20.95 /K to P29.26 /K in 1996. Wholesale price was low when local supply was abundant after harvest (March-April) or imported peanut was available (December).

Table 20. Monthly wholesale price of shelled peanut (P/K), Philippines, 1992-1996.

Year	**1992**	**1993**	**1994**	**1995**	**1996**
Average	26.53	27.59	32.04	31.65	25.82
January	30.02	26.30	33.08	30.05	26.14
February	27.65	26.74	33.22	30.63	29.26
March	25.94	25,54	33.39	31.13	23.69
April	24.30	25.72	27.48	30.59	24.46
May	23.10	25.95	33.21	29.58	27.57
June	24.93	25.54	33.38	32.10	27.65
July	30.11	28.93	30.97	33.61	25.47
August	26.31	26.43	30.92	34.79	25.24
September	25.74	27.73	28.14	32.98	25.32
October	26.74	30.71	33.97	32.99	25.99
November	26.23	30.93	32.90	31.20	26.55
December	27.32	30.58	33.90	30.20	20.45

Source: Bureau of Agricultural Statistics, Philippines.

The average retail price of shelled peanut was P28.28 /K from a price range of P25.90 /K to P31.59 /K in 1996 (Table 21). The continuous supply of imported peanut stabilized the monthly retail prices of local shelled peanut.

Table 21. Monthly retail price of shelled peanut (P/K), Philippines, 1992-1996.

Year	**1992**	**1993**	**1994**	**1995**	**1996**
Average	31.17	32.60	34.75	23.37	28.28
January	32.44	30.85	33.06	24.95	31.59
February	31.78	29.75	34.42	20.98	28.68
March	31.61	29.13	35.59	21.48	26.45
April	31.66	30.57	35.15	21.70	25.90
May	29.39	31.88	35.15	23.32	28.74
June	29.52	32.33	35.32	21.97	28.74
July	30.58	32.82	34.39	25.35	26.23
August	31.48	33.49	34.63	25.59	28.62
September	31.85	33.82	34.53	22.95	28.89
October	30.82	35041	34.67	21.60	29.25
November	30.92	35.22	34.96	23.72	27.18
December	31.95	35.92	35.16	26.84	28.93

Source: Bureau of Agricultural Statistics, Philippines.

In 1997, shelled peanut in Metro Manila (MM) had an average wholesale price of P30.22 /K and an average retail price of P34.90 /K. The shelled peanut national average retail price was higher at P37.45. For the regional average retail price, CARAGA region had the highest at P49.36 /K and Cagayan Valley the lowest at P34.77 /K (Table 22). Traders and manufacturers however, buying in bulk preferred a wholesale price. Metro Manila could be a local gauge for the wholesale and retail pricing of peanut.

Table 22. Wholesale/retail price (P/K) of shelled peanut, Metro Manila/Philippines, 1997

	Wholesale	**Retail**	
		Metro Manila	**Philippines**
Average	P 30.22	P 34.90	P 37.45
December	26.67	36.18	39.85
November	30.21	35.82	38.59
October	30.82	35.64	37.96
September	29.31	35.60	37.39
August	28.15	35.58	37.32
July	28.80	34.95	37.44
June	31.20	34.96	37.18
May	32.06	34.10	37.66
April	32.59	34.07	36.21
March	31.42	34.05	36.60
February	28.35	33.82	36.32
January		33.81	36.57
Highest – CARAGA			49.36
Lowest – Cagayan Valley			34.77

The national 1986 to 1997 farm, wholesale, and retail comparative prices for peanuts with shell is presented in Tables 19, 20 and 21. The average farm, wholesale, and retail prices for peanuts with shell increased 42%, 54%, and 55%, respectively, from 1986 to 1997. Within the 12-year period, peanuts with shell command high prices during the last quarter months but with low prices at first quarter months. Of the three methods of pricing local peanut with shell, wholesale prices followed by retail were higher over farm prices.

Gross Domestic Supply and Demand

The peanut gross domestic supply from 1992 to 1996 included imports from other countries (Table 23). The total peanut volume increased from 62,008 MT to 93,967 MT within the five-year period. A 20% increase in peanut imports was matched only by a 2% increase in local production.

Table 23. Gross domestic supply of peanut (MT), Philippines, 1992-1996.

Year	Production (MT)	Imports (MT)	Gross Supply (MT)	%	Percent Share Production	Imports
1992	33,993	28,015	62,008		54.82	45.18
1993	34,030	32,550	66,580	7.37	51.11	48.89
1994	36,290	41,028	77,318	16.13	46.93	53.07
1995	36,856	40,829	77,685	0.48	47.44	52.56
1996	34,118	58,967	93,085	19.82	36.65	63.35

Source: Foreign Trade Statistics, National Census and Statistics Office

A projected peanut supply and demand for the years 1999 to 2003 is found in Table 24. A five-year projected demand for peanut showed an increase from 96,306 MT to 105,175 MT. A low annual average peanut production (34,983 MT) would result in more supply deficits.

Table 24. Projected peanut supply and demand (MT), Philippines, 1999-2003.

Year	Population (000) 1/	Domestic Prod (MT) 2/	Domestic Demand Seed 3/	Food 4/	Total Demand	Supply Deficit (000)
1999	75,207	34,323	4,548	91,753	96,306	61,983
2000	76,951	34,330	4,563	93,880	98,443	64,113
2001	78,737	34,337	4,578	96,059	100,637	66,300
2992	80,563	34,344	4,593	98,287	102,880	68,536
2003	82,432	34,350	4,608	100,567	105,175	70,825

1/ Based on NSO population projections.
2/ Based on annual growth rate of 0.2%.
3/ Based on average seed requirement of 80 K (shelled) /ha.
4/ Based on BAS average per capita consumption of 1.22 K/year.

Export and Import

In 1989, 208 MT of roasted peanut valued at $515T was exported (Table 11). From 1990, peanut exports of 300 MT valued at $1M were grouped into peanut butter and prepared or preserved products. Peanut butter was shipped to 17 countries and territories led by the USA, Trust Territories of Pacific Island, Italy, UK/North Ireland, and Kuwait. Peanut prepared or preserved was exported to more than 30 countries particularly to Saudi Arabia, Hongkong, USA, Canada, and Republic of Korea. As of 1997, the unit value of exported peanut butter was P105 /K and peanut prepared or preserved was P74 /K

The quantity and value of imports in 1997 were: peanut butter, 964 MT at $1.7M or P55 /K; peanut prepared or preserved, 289 MT at $165T or P17 /K; and crude material, 51,971 MT at $35M or P20 /K (Table 12). A bulk of the imported peanut butter came from the USA, Singapore, Taiwan, and Canada. Peanut prepared or preserved were mostly from Indonesia, USA, Singapore, and China. The landed cost of shelled peanut from China in 1996 was higher at P19.78 /K than the P16.77-P18.08 /K from Vietnam, India, and Hongkong.

In 1997, a unit price difference between peanut butter and peanut prepared or preserved exported and imported was P50 and P57, respectively. Imports exceeded exports by 944 MT of peanut butter and over 50,000 MT of crude material.

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