AGRICULTURAL ENGINEERING DESIGN DATA HANDBOOK

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2006

About the Author

Alexis T. Belonio is a Professional Agricultural Engineer. Presently, he is an Associate Professor and Chairman of the Department of Agricultural Engineering and Environmental Management, College of Agriculture, Central Philippine University, Iloilo City. He finished his Bachelor of Science in Agricultural Engineering and Master of Science degrees from Central Luzon State University, Muñoz, Nueva Ecija. He has been deeply involved in teaching, research, project development, and entrepreneurial activity on various agricultural engineering projects since 1983.

He was awarded by the Philippine Society of Agricultural Engineers (PSAE) as Most Outstanding Agricultural Engineer in the Field of Farm Power and Machinery and by the Professional Regulation Commission (PRC) as Outstanding Professional in the Field of Agricultural Engineering in 1993. In 1997, he was awarded by the TOYM Foundation and the Jerry Roxas Foundation as the Outstanding Young Filipinos (TOYF) in the Field of Agricultural Engineering. He is presently a PSAE Fellow Member.

As a dedicated professional, he serves as technical consultant to various agricultural machinery manufacturers in Region VI. He also serves as a Reviewer of the TGIM Foundation Review Center on the field of Agricultural Machinery and Allied Subjects, and Agricultural Processing and Allied Subjects since 1998. He has written and published several research and technical papers.

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Acknowledgement:

The author is very much thankful to the Lord God Almighty who inspired him to prepare this material for the benefit of those who are called to serve in the agricultural engineering profession.

He is also thankful to Jane in typing this manuscript and to Cyrus in his invaluable suggestions during printing of this booklet.

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Trial Edition

PREFACE

This book is a compilation of the various data and charts commonly used in agricultural engineering courses. Students who are taking the course as well as those who are preparing for the Professional Agricultural Engineer Board Examination may find this book useful. Practicing Agricultural Engineers and those other Engineers working in the field of agriculture will find this book a handy reference for the data needed in the design of agricultural machines, power and energy sources, processing and handling of agricultural and food products, farm structures and electrification, irrigation and soil conservation, and other relevant information in the field of agricultural engineering.

Data were obtained from several sources which includes textbook, journals, technical magazines, codes and standards. Data and figures are presented in topical form for ease finding the information needed.

This book is in draft form yet additional data relevant to the need will be included in the future to make this material more comprehensive. Comments and suggestions are welcome for future improvement of this book.

God bless and may this book become useful to you!

ALEXIS T. BELONIO

TABLE OF CONTENT

AGRICULTURAL CROPS
Coefficient of Friction

Coefficient of Friction				
Crop	Steel	Smooth Concrete	Smooth Wood	Rough Wood
Barley	0.38	0.45	0.32	
Corn				
Ear	-	-	0.62	-
Shelled	0.37	0.42	0.31	0.32
Flaxseed	0.34	0.41	0.31	-
Oats	0.41	0.47	0.37	
Peas	0.26	0.30	0.27	
Rice, rough	0.41	0.52	0.44	0.52
Rye	0.41	0.35	0.33	
Sorghum	0.37	0.33	0.30	-
Soybean	0.36	0.44	0.32	0.30
Sugar beat	-	0.52	0.82	0.70
Tares	0.36	0.36	0.39	-
Vetch	0.33	0.24	0.26	-
Wheat	0.40	0.42	0.46	0.35

AGRICULTURAL CROPS
Composition of Copra at Various Level of Moisture

	% Composition		
	Oil	Meal	Water
Wet Copra	55.3	24.7	20.0
Undried Copra	60.9	27.1	12.0
Dry Copra	65.0	29.0	6.0
Copra (Moisture Free	69.1	30.9	0.0

AGRICULTURAL CROPS
Period of Maturity of Some Rice Varieties

Variety	Flowering (days)	Maturity (days)
IR 5	103	132
IR 8	96	127
IR 20	88	118
IR 24	93	122
IR 26	96	127
IR 28	75	102
IR 32	100	132
IR 36	80	114
IR 40	85	114
IR 42	102	132
IR 50	78	109
IR 54	90	122
IR 58	73	102
IR 60	80	107
IR 64	84	117

AGRICULTURAL CROPS
Production Yield of Various Crops

Crop	Yield (tons per hectare)
Banana	39
Cassava	71
Maize	20
Sweet Potato	65
Rice	26
Sorghum	16 – 18
Wheat	12

AGRICULTURAL CROPS
Main Product and By-Product Compositions

Crops	Main Product	By-Product	Ratio of Main Product to By-Product
Cereal			
Wheat	Grain	Straw	1:1.3
Barley	Grain	Straw	1: 1.2
Maize	Grain	Straw	1:1
Oats	Grain	Straw	1:1.3
Rye	Grain	Straw	1:1.6
Rice	Grain	Straw	1:1.4
Millet	Grain	Straw	1:1.4
Sorghum	Grain	Straw	1:1.4
Pulse			
Pea	Grain		1:1.5
Bean	Grain		1:2.1
Soya	Grain		1:2.1
Tuber and root crops		Stalk	
Potatoes	Tuber	Stalk	1:0.4
Feedbeet	Root	Stalk	1:0.3
Sugarbeet	Root		
Cocoa	Nut	Shell and outer fiber	1:0.2
Sugar Cane	Sugar	Bagasse	1:1.16

AGRICULTURAL CROPS
Processing Residue Compositions

Composition	Sugar Cane Bagasse (Dry)	Straws, Rice (Dry)	Straws, Wheat, Im-perial (Dry)	Straws/Husks Rice Hulls (Dry)	Al-mond Hulls (Dry)	Olive Pits (Dry)
Ash (%)	2.44	18.67	9.55	20.226	6.13	1.72
HHV (MJ/kg)	18.85	18.85	16.78	15.81	18.84	21.54
Chlorine (%)	0.03	0.58	2.06	0.12	0.02	0.04
Water-soluble Alkalis (%)						
Na_2O				0.022		
K_2O				0.665		
CaO				0.008		
Elemental Composition						
SiO_2	46.61	74..67	37.06	91.442	9.28	30.82
Al_2O_3	17.69	1.04	2.23	0.78	2.09	8.84
TiO_2	2.63	0.09	0.17	0.02	0.05	0.34
Fe_2O_3	14.14	0.85	0.84	0.14	0.76	6.58
CaO	4.47	3.01	4.91	3.21	8.07	14.66
MgO	3.33	1.75	2.55	<0.01	3.31	4.24
Na_2O	0.79	0.96	9.74	0.21	0.87	27.8
K_2O	4.15	12.3	21.7	0.72	52.9	4.4
SO_3	2.08	1.24	4.44	0.43	0.34	0.56
P_2O_5	2.72	1.41	2.04		5.1	2.46
CO_2/other					20.12	
Undetermined	1.39	2.68	14.32		-2.89	-0.7
Total	100	100	100	100.64	100	100
Alkali ((kg/GJ)	0.35	7.08	9.63	2.72	9.42	1.39

AGRICULTUAL CROPS
Oil Content, Melting Point, and Oil composition of Selected Oilseeds

Oilseed	Oil Content (%)	Melting Point (C)	Specific Sample Composition (%)		
			Saturated	Mono-unsaturated	Poly-unsaturated
Copra	65-68	23 to 26	91	7	2
Palm kernel	44-53	24 to 26	85	13	2
Sunflower seed	25-48	-16 to -18	17	29	52
Ground nut	45-55	-2	17	61	22
Rapeseed	36-50	-9	6	86	8
Cotton seed	15-24	-20	34	26	40
Sesame seed	44-54	-2 to 2	15	40	45
Soya bean		-23 to -20	15	25	60
Oil palm		33 to 40	53	38	9

AGRICULTURAL CROPS
Typical Composition of Selected Oil Cakes

	Dry Matter (%)	Crude Protein (%)	Crude Fiber (%)	Ash (%)	Ether Extract (%)	Nitrogen (%)
Copra	90.1	21	10	5	15	49
Palm kernel	89.0	19	13	4	15	49
Sunflower seed w/ hull	91.3	24	34	5	15	22
Groundnuts seed w/ hull	92.4	32	24	6	15	23
Groundnuts seeds w/o hull	92.6	46	5	5	15	30
Rapeseed	87.6	35	10	9	15	31
Cotton seed w/ hull	89.6	23	22	6	15	34
Sesame seed	89.5	40	7	13	15	25
Soya with hull	87.9	42	6	6	15	31

AGRICULTURAL AND FOOD PRODUCTS
Storage Data

Product	Storage Tempera-ture (°C)	Relative Humidity (%)	Storage life
Beer	+5 to +15	80 to 90	2 to 6 months
Blood, whole	+2 to +4		4 to 8 days
Bread, frozen	-15 to –25	90 to 95	4 to 6 months
Cider	+5 to +15	80 to 90	2 to 4 months
Furs	+2 to +4	60 to 70	6 months
Honey	+1 to +10		1 year
Hops	-1.5 to 0	50 to 60	1 to 4 months
Ice	+1 to +2	70 to 80	9 to 12 months
Nuts	+2 to +5	80 to 85	1 to 5 months
Rice	+3 to +6	60 to 70	4 to 6 months
Seeds, frozen	-18 to -20	60 to 70	1 to 4 years
Seeds	+2 to +4	60 to 70	4 to 10 weeks
Skins	+2 to +4	65 to 75	4 to 6 months
Tobacco	+2 to +4	70 to 80	4 to 6 months
Water			
Yeast	0 to +2	70 to 80	1 to 3 weeks

AGRICUTURAL AND FOOD PRODUCTS
Thermal Properties

Product	Freezing Tempe-rature (°C)	Specific Heat Above Freezing (kJ/kg -°C)	Specific Heat Below Freezing (kJ/kg- °C)	Latent Heat (kJ/kg)
Beer		3.6	1.8	287
Blood, whole				
Bread, frozen		2.93	1.42	115
Cider	-1	3.65	1.85	290
Furs				
Honey		2.1	1.7	60
Hops				
Ice		1.34	1.05	51
Nuts	-5	1.8	0.9	15
Rice	-2	0.9	0.5	15
Seeds, frozen				
Seeds				
Skins				
Tobacco				
Water	0	4.19	2.1	334
Yeast	-4	3.45	1.7	240

AGRICULTURAL EQUIPMENT OPERATION
Man-Hour Requirement Per Hectare

Rates of Work	Person-h/ha
Manual Tillage	
Slash and burn	240 - 360
Tillage with hoe	100 - 300
Hoeing, flooded soil	100 - 200
Spade, 25 cm depth	500
Animal Tillage	
2 oxen with redging plow	10
2 oxen with ard	30
4 horses with 2-bottom 14” moldboard	5.0
6 horses with 2-bottom 14” moldboard	4.8
12 horses with 3-bottom 16” moldboard	2.7
6 horses with 8-ft tandem disk harrow	1.8
4 horses with 12-ft spike-tooth harrow	0.8
8 horses with 12-ft spring-tooth harrow	1.2
Water buffalo plowing flooded soil	30 - 60
Water buffalo comb harrowing	40 - 60
5 water buffalo trampling (puddling) wet soil	32 - 40
2 bullocks with plank leveller	15

AGRICULTURAL EQUIPMENT OPERATION
Man-Hour Requirement Per Hectare

Rates of Work	Person-h/ha
Tractor Tillage	
4.5-hp pedestrian tiller	4.2
4.5-hp tractor and 4-bottom disk plow	1.3
80-hp tracklayer and 7-bottom disk plow	0.7
5-hp power tiller plowing wet soil	20 - 40
10-hp double-axle pedestrian tractor tilling wet soil	6 - 8
10-hp hydrotiller	4.4
12.5-hp compact tractor plowing wheat stubble	11 - 14
40-hp tractor rotovating wet soil	2.1
5-hp single-axle pedestrian tractor with puddling wheels and comb harrow	20
Clearing virgin forest with tracklayer	69.2
Clearing secondary forest with tracklayer	44.5
Clearing bush with tracklayer	12.3
Manual Planting	
Broadcasting	3.3
Using dibble stick	160

AGRICULTURAL EQUIPMENT OPERATION
Man-Hour Requirement Per Hectare

Rates of Work	Person-h/ha
Seeding in premarked rows and covering by foot	80
Push- or pull-type planter in dry soil	20
IRRI row seeder with pregerminated rice seed sown in wet soil	5 - 7
Animal Planting	
Bullock-drawn seed drill	5.3
2 bullocks and broadcasting and covering seed	21
4 horses and 8-ft disk drill	1.4
6 horses and 12-ft disk drill	0.9
2 horses and 2-row maize planter	1.8
2 horses and 1-row potato planter	4.3
Tractor Planting	
Airplane broadcasting of rice	0.3 - 0.6
5-hp pedestrian seeder (rice)	8
60-hp tractor and 4-row maize planter	0.7
Manual Weed and Pest Control	
Hand weeding transplanted rice	120 - 320
Hand weeding rice in broadcast field	1150
Hand weeding rice in dibbled field	380
Hand weeding rice in drilled field	321
Rotary push-type weeder in rice	30 - 150
Hand-carried IRRI power weeder	17
Knapsack sprayer	13 - 50
Dusting	7 - 16

AGRICULTURAL EQUIPMENT OPERATION
Man-Hour Requirement Per Hectare

Rates of Work	Person-h/ha
Animal Weed and Pest Control	
2 horses and 2-row (maize) shovel Cultivator	2.4
Tractor Weed and Pest Control	
35-hp tractor with cultivator	2.4 - 3
Airplane applying herbicide	0.2
Knapsack power duster (in rice)	2
Tractor-mounted sprayer (in rice)	0.5
Manual Harvesting, Threshing, and Processing	
Harvesting rice with sickle or knife	60 - 80
Reaping with a scythe	34
Bunding rice into sheaves	24
Hauling sheaves to thresher	39
Threshing rice with hand sticks	182
Threshing rice with flail	20 - 30
Threshing rice on a bamboo ladder	30 - 60
Winnowing grain by tossing in wind	40 kg/h
Hand-driven winnower	200 - 1200 kg/h
Harvesting, Threshing, and Processing with Animals	
2 horses and 6-ft reaper	1.7
4 horses and 8-ft binder	1.4
2 horses and 1-row maize binder	2.8
6 horses and 1-row maize picker	3.2
16 horses and 14-ft combine	1.0
2 horses and 6-ft mower mowing hay	2.0 - 2.4
2 oxen threshing by treading	60 - 89

AGRICULTURAL EQUIPMENT OPERATION
Man-Hour Requirement Per Hectare

Rates of Work	Person-h/ha
Engine-Powered Harvesting, Threshing, and Processing	
5-hp pedestrian windrower	5.4 - 10
Threshing rice by treading with 5 water buffalo	120 kg/h
Threshing rice by treading with tractor	600 - 2000 kg/h
5-hp IRRI axial-flow thresher, 4 men feeding	350 - 700 kg/h
Small (1/2-m) combine	0.18 t grain/h

AGRICULTURAL STRUCTURES
Air Changes per 24 Hours for Storage Rooms Due to Door Openings and Infiltration (Above 0 C)

Volume of room, ft^2	Air changes per 24 hr
200	44.0
300	34.5
400	29.5
500	26.0
600	23.0
800	20.0
1,000	17.5
1,500	14.0
2,000	12.0
3,000	9.5
4,000	8.2
5,000	7.2
6,000	6.5
8,000	5.5
10,000	4.9
15,000	3.9
20,000	3.5
25,000	3.0
30,000	2.7
40,000	2.3
50,000	2.0
75,000	1.6
100,000	1.4

AGRICULTURAL STRUCTURES
Air Infiltration Through Cracks and Around Windows

Type of window double-hung wood sash (unlocked)	Cubic feet per hour per foot of crack
Around frame in masonry wall, not caulked	8
Around frame in masonry wall, caulked	2
Around frame in wood-frame construction	6
Total for Average window, non-weather-stripped, 1/16-inch crack and 3/64-inch clearance. Includes wood-frame leakage	21
Weather-stripped	13
Total for poorly fitted window, non-weather-stripped, 3/32-inch crack and 3/32-inch clearance. Includes woo-frame leakage	69
Weather-stripped	19

AGRICULTURAL STRUCTURES
Daily Manure Production

Animals	Manure Available (kg/day/animal)
Pigs	
Porker, 3-8 months old, mixed ages	2.20
18-36 kg	2.55
36-55 kg	5.22
55-73 kg	6.67
73-91 kg	8.00
Cow	
Feedlot animal	14.0
Breeding animal	13.0
Work animal	7.50
Buffalo	
Breeding animal	14.0
Work animal	8.00
Horse	
Breeding animal	13.50
Work animal	7.75
Chicken	
Layer, 6 months or older	0.075
Broiler, day-old to 8 weeks	0.025

AGRICULTURAL STRUCTURE
Fresh Manure Production and Characteristics per 1000 kg Live Animal Mass per Day

Animal type	Total manure (kg)	Urine (kg)	Density (kg/ m^3)	Total solids (kg)	Volatile solids (kg)	Animal weight (kg)
Dairy	86	26	990	12	10	640
Beef	58	18	1000	8.5	7.2	360
Veal	62	-	1000	5.2	2.3	91
Swine	84	39	990	11	8.5	61
Sheep	40	15	1000	11	9.2	27
Goat	41	-	1000	13	-	64
Horse	51	10	1000	15	10	450
Layer	64	-	970	16	12	1.8
Broiler	85	-	1000	22	17	0.9
Turkey	47	-	1000	12	9.1	6.8
Duck	110	-	-	31	19	1.4

ANIMAL STRUCTURE
Manure Retention Time

Substrate	Retention time (days)
Liquid pig manure	15 - 25
Liquid cow/carabao manure	20 - 30
Liquid chicken manure	20 - 40
Animal manure mixed with plant material	50 - 80

Mesophilic temperature range

AGRICULTURAL STRUCTURE
Feeding Space Requirement for Dairy Cattle

Class, Age, Size of Animal	Length/animal (mm)
Calves (3-6 months)	46
Calves (7 months - one year)	51
Yearling. Heifer, milking and dry cows Cows in maternity stall	76

AGRICULTURAL STRUCTURE
Feeding Space Requirement for Goat

Animal	Weight (kg)	Feeding space (linear mm/animal)
Doe/Ewe	35	350
Doe/Ewe	50	400
Doe/Ewe	70	450
Kid/Lamb		250
Buck/Ram		500

AGRICULTURAL STRUCTURE
Feeding Space Requirement for Poultry

Stages	Feeder	
	Linear[a] m/100 birds	Round[b] pieces/100 birds
4 weeks and below	4	4
Above 4 weeks old	7.5	5

[a] If both sides of a linear feeder is available to the birds, count each side when figuring available space.
[b] 305 mm diameter pan.

AGRICULTURAL STRUCTURE
Daily Water Requirement

Uses	Water Requirement	
	Gpd	m3/day
Each household (min)	50 – 250	0.189 - 0.945
Each horse	12	0.045
Each cow producing milk	40	0.151
Each dry cow or steer	12	0.045
Each hog	4	0.015
Each sheep	2	0.008
Each 100 chickens	6	0.023
Each 100 turkeys	18	0.068

AGRICULTURAL STRUCTURE
Minimum Floor Space Requirement for Cattle

Area	Floor space m^2/ animal
Shed area	4
Loafing area	5

AGRICULTURAL STRUCTURE
Minimum Space Requirement for Cattle in Crowding Pen

Weight of the cattle kg	Space requirement m^2/animal
Up to 270	0.5
270 - 540	0.9
Over 540	1.1

AGRICULTURAL STRUCTURE
Minimum Space Requirement for Cattle in Holding Pen

Weight of the cattle Kg	Space requirement m^2/animal
Up to 270	1.3
270 - 540	1.6
Over 540	1.9

AGRICULTURAL STRUCTURE
Minimum Space Requirement for Goat and Sheep

Animal	Weight (kg)	Floor space (m^2/animal)		
		Solid floor	Slatted floor	Open yard
Doe/Ewe	35	0.8	0.7	2
Doe/Ewe	50	1.1	0.9	2.5
Doe/Ewe	70	1.4	1.1	3
Kid/Lamb		0.4-0.5	0.3-0.4	-
Buck/Ram		3.0	2.5	-

AGRICULTURAL STRUCTURE
Minimum Space Requirement for Pregnant and Lactating Doe/Ewe

Doe/Ewe	Floor space (m^2/animal)	
	Pregnant	Lactating
Small (50 kg - 70kg)	1.3	2.0
Large (over 70 kg)	1.6	2.3

AGRICULTURAL STRUCTURE
Minimum Space Requirement for Dairy Cattle

Class, Age, Size of Animal	Shed or Barn Floor Area (m^2/animal)
Calves (up to 3 months)	1
Calves (3 - 6 months)	2
Calves (7 months - one year)	3
Yearlings (1 - 2 years)	4
Heifer/Steer (2 - 3 years)	5
Milking and dry cows	6
Cows in maternity stall	10

AGRICULTURAL STRUCTURE
Minimum Space Requirement for Layers in Pen -Type Housing

Stage	Space requirements m^2/100 birds
Growing (7 - 22 weeks)	
Litter floor	14
Slotted floor	6
Slot-litter floor	7
Laying (beyond 22 weeks)	
Litter floor	17
Slotted floor	9
Slot-litter floor	14

AGRICULTURAL STRUCTURE
Minimum Space Requirement for Swine

Age and size of animal	Space requirements per animal m^2/ animal
Groups	
Up to 10 kg	0.11
11 - 20 kg	0.20
21 - 40 kg	0.35
41 - 60 kg	0.50
61 - 80 kg	0.70
81 - 100 kg	0.85
Gilts up to mating	1.00
Adult pigs in groups	2.50
Gestating sows	1.20
Lactating sows and litters	
Individual pens	7.40
Multi-suckling groups	5.60
Dry sows	1.80

AGRICULTURAL STRUCTURE
Minimum Swine Farrowing Crate Dimension

Measurement	Dimension (m)
Length	1.80
Width of stall	0.60
Width of creep	0.50
Height of stall	1.00
Height of creep	0.40

AGRICULTURAL STRUCTURE
Minimum Swine Height of Pen Partitions

Swine	Height of pen partition m
Under 25 kg	0.70
25 kg - 100 kg	0.90
Sow	1.00
Boar	1.20

AGRICULTURAL STRUCTURE
Minimum Temperature for Housed Swine in Still Air

Class	Temperature °C
Sows and boars	30
Piglets Newborn 3 weeks	 35 30
Weaners	30
Growers and Finishers	30

AGRICULTURAL STRUCTURE
Minimum Ventilation Rates of Swine Under Normal Condition

Stage	Ventilation rate m^3/min
Farrowing unit (sow and litter)	0.28
Nursery pens	0.08
Growing-finishing pens	0.12
Breeding and gestating pens (gilts, sows and boars)	0.28

AGRICULTURAL STRUCTURE
Recommended Lighting Intensity for Swine Housing

Area	Lighting intensity lux (Lumen/m^2)
Breeding, gestation and furrowing	150
Nurseries	100
Growing and finishing	50
Inspection areas	200

AGRICULTURAL STRUCTURE
Chick Brooding Temperature

Age of Chicks (Weeks)	Brooding Temperature (ºC)
0 - 1	32.2 - 35.0 (90 - 94ºF)
1 - 2	29.4 - 32.2 (90 - 94ºF)
2 - 4	26.7 - 29.4 (90 - 94ºF)

AGRICULTURAL STRUCTURES
Recommended Dimension for Slaughterhouse

Animals	Throughput	Dimension (in meters)
Large animals or (small animals)	2 (10)	8.6 x 5.8
	30 (150)	12.5 x 6.4
	60 (150-350)	23.3 x 15
Swine	200	53 x 21.5
	30	8 x 5
	120	12 x 5
	400	19.4 x 8.4

AGRICULTURAL STRUCTURE
Amount of Installed Watts Required for Farm Heating Applicants

Application	Outside temperature above 30°F	Outside temperature below 30°F	Estimated kwhr used
Brooding chicks, infrared	2 1/2-3 watts per chick	3-4 watts per chick	2-22.5 per chick per 8 wk
Brooding chicks, underheat	1 1/2 watts per chick	2-2 1/2 watts per chick	1 per chick per 8 wk
Lamb brooders	250 watts per 2 lambs	250 watts per lamb	25 per lamb per wk
Pig brooders	250 watts per litter	250 watts per litter	40 per litter per wk
Hotbeds	9-10 watts per sq ft	9-10 watts per sq ft	15-20 per 1,000 slips
Curving sweet potatoes	300 bu up to 300 bu	10 watts per bu up to 300 bu	1-4 kwhr per bu per curing period
	5 watts per bu, 300-1000 bu	5 watts per bu, 300-1000 bu	1-4 kwhr per bu per curing period
	4 watts per bu over 1000 bu	4 watts per bu over 1,000 bu	1-4 kwhr per bu per curing period
Stock watering	0	1 watt per gal	15 per mo

ANIMAL POWER
Average Pull, Approximate Speed, and Power Developed by Various Draft Animals

Animal	Ave. Weight (kg)	Approx Pull (kg)	Ave Speed (m/s)	Power Developed (hp)
Light Horse	400-700	60-80	1.0	1.0
Bullock	500-900	60-80	0.60-0.85	0.75
Buffaloes	400-900	50-80	0.80-0.90	0.75
Cows	400-600	50-60	0.70	0.45
Mules	350-500	50-60	0.90-1.00	0.70
Donkeys	200-300	30-40	0.70	0.35

ANIMAL POWER
Harnessing Factor

No. of Animals	Factor
1	1.0
2	1.9
3	2.5
4	3.1
5	3.5
6	3.8

BEARING
Values of Load Factor

Operating Condition	Applications	fw
Smooth operation free from shock	Electric motors, machine tools, air conditioners	1.0 to 1.2
Normal operation	Air blowers, compressors, elevators,	1.2 to 1.5
Operation accompanied by shock and vibration	Contruction machines, crushers, vibration screens, rolling mills	1.5 to 3.0

BEARING
Belt and Chain Factor

.

Type of Transmission	Fb
V belts	2 to 2.5
Flat belts with tension pulley	2.5 to 3
Flat belts	4 to 5
Chain Transmission	1.25 to 1.5

BEARING
Gear Factor

Gear Accuracy	Fg
Precision Gears	1 to 1.1
Ordinary machined gears	1.1 to 1.3

BEARING
Rules in the Use of Lubricants

Grease is use when	Oil is use when
1. The temperature is not over 93 C	1. The temperature is over 93 C
2. Speed are low	2. Speeds are high
3. Unusual protection is required from the entrance of debris	3. Oiltight seals are readily employed
4. Simple bearing seals are desired	4. Bearing type is not suitable for grease
5. Operation for long periods without attention is desired	5. The bearing is lubricated from a central supply that is also used for other machine parts..

BIOGAS
Gas Production Potential of Various Types of Manure (m^3/kg)

Manure	Retention Period (days)			
	25	30	35	50
Pig	0.058	0.063	0.068	0.077
Cow	0.030	0.034	0.037	0.043
Buffalo	0.030	0.034	0.37	0.043
Horse	0.045	0.051	0.056	0.065
Chicken	0.060	0.065	0.069	0.078

BIOGAS
Gas Requirement of Some Appliances

Appliances	Type	Gas Requirements (m^3/hr)
Gas burner	Non-continuous	
5 cm		0.22
10 cm		0.28
14 cm		0.42
Mantle lamp		
Ordinary	Non-continuous	0.071
25-watt equivalent		0.100
60-watt equivalent		0.195
Gas refrigerator	Continuous	
0.01 m^3		0.053
0.017 m^3		0.067
0.225 m^3		0.078
Incubator (per m^3 capacity)	Continuous	0.600
Gasoline engine	Non-continuous	
Per kW output		0.569
Per rated Kw		0.398
Diesel engine	Non-continuous	
Per kW output		0.700
Per rated kW		0.563

BIOGAS
Optimum Height/Length Ratios of Digesters and Tanks (freeboard excluded) for Volume Up to 70 m^3 and Wall Thickness of Up to 25 cm

Horizontal Cross-section	Height/Length Ratio, r (Height/Diameter or Height/side)	
	Floating Type (Integrated) Plants and Open Tanks	Floating (Separate Gasholder) and Fixed Type Plants
Circular	0.500	1.00
Square	0.500	1.00
Rectangular[a]		
L = 1.2 W	0.455	0.91
L = 1.4 W	0.420	0.84
L = 1.6 W	0.385	0.77
[a] Coefficient of W is the desired length/width proportion, P		

BIOGAS
Retention Time for Animal Manure for Mesophilic Temperature Range

Substrate	Retention time (days)
Liquid pig manure	15 - 25
Liquid cow/carabao manure	20 - 30
Liquid chicken manure	20 - 40
Animal manure mixed with plant material	50 - 80

BIOGAS
C/N Ratio and Nitrogen Content of Some Organic Materials

Biodegradable material	N %	C/N
A. Animal dung		
Hog	2.8	13.7
Carabao	1.6	23.1
Cow	1.8	19.9
Chicken	3.7	9.65
Duck	0.8	27.4
Pugo	5.0	6.74
B. Household waste		
Nightsoil	7.1	6.72
Kitchen waste	1.9	28.60
C. Crop residues (air dry)		
Corn stalks	1.2	56.6
Rice straw	07	51.0
Corn cobs	1.0	49.9
Peanut hulls	1.7	31.0
Cogon	1.07	-
Bagasse	0.40	-
D. Others		
Kangkong	4.3	7.8
Water lily	2.9	11.4
Grass trimmings	2.5	15.7

BIOGAS
Maximum Excavation Slope on Various Grounds

Kind of soil	Ratio of height to width
Sandy soil	1:1
Clayey sandy soil	1:0.67
Clayey soil	1:0.50
Clay	1:0.33
Soil with gravel	1:0.67
Dry loess	1:0.25

BIOGAS
Nutrient Content of Common Animal Excrements

Animal	P_2O_5		K_2O	
	kg/a	%	kg/a	%
Cow	34	0.2	84	0.5
Pig	56	0.4	35	0.3
Chicken (fresh dropping)	194	1.0	108	0.6
Chicken (dry droppings)	193	4.6	106	2.5

BIOMASS ENERGY
Biomass Ashes Softening and Melting Temperatures

Biomass Ash	Softening (°C)	Melting (°C)
Almond Shell	790	1140
Alhar Stalks	1275	1480
Bagasse	1325	1435
Bamboo Dust	1325	1425
Bean Straw	900	1150
Barley Straw	925	1100
Coconut Choir	1125	1175
Corn Cobs	900	1020
Corn Fodder	1010	1180
Corn Stalks	820	1091
Cotton Gin Trash	1010	1380
Cotton Stalks	1350	1425
Groundnut Shell	1190	1235
Jute Sticks	1325	1425
Mustard Shell	1375	1425
Olive Pits	850	1480
Pine Needle	1275	1375
Rice Hull	1437	1650
Rice Straw	823	1190
Safflower	770	1430
Sal Seed Leaves	1225	1375
Sal Seed Husk	1475	1525
Tree Prunings	770	1550
Walnut Shell	820	1250
Wood Chip	1050	1190

BIOMASS ENERGY
Biomass Heating Value and Composition

Type	Higher Heating Value (MJ/kg)	Elemental Analysis (% by weight, db)					
		C	H	O	N	S	Ash
Fir bark char	19.2	49.9	4.0	24.5	0.1	0.1	21.4
Rice hull char	14.2	36.0	2.6	11.7	0.4	0.1	49.2
Grass straw char	19.3	51.0	3.7	19.7	0.5	0.8	24.3
Municipal solid waste char	18.7	54.9	0.8	1.8	1.1	0.2	41.2
Redwood charcoal (694-822 K)	28.8	75.6	3.3	18.4	0.2	0.2	2.3
Oak charcoal (711 -914 K)	24.8	67.7	2.4	14.4	0.4	0.2	14.9

BIOMASS ENERGY
Crop-Residue Ratio of Biomass Materials

Material	Ratio
Paddy to Husk Ratio	1 : 0.16 to 0.350
Paddy to Paddy Straw Ratio	1 : 0.199 to 2.10
Sugar Cane to Bagasse Ratio	1 : 0.14 to 0.33
Sawdust to Timber Ratio	1: 0.1
Cotton Seed Wool to Stalk Ratio	1 : 1.0 to 5.61
Corn Grain to Cob Ratio	1 : 0.188 to 0.600
Ground Nut Pod to Shell Ratio	1: 0.20 to 0.44
Cassava Root to Cassava Stalk Ratio	1 : 0.161 to 0.500
Coconut Nut to Husk Ratio	1 : 0.28 to 0.45

BIOMASS ENERGY
Bulk Density of Biomass Materials

Biomass	Grading	Bulk Density (kg/m^3)
Alfalfa seed straw	cube 30 x 30 x 50 mm 7% moisture	298
Ash, fly		40 - 45
Ash, gas producer, wet		78
Bagasse		7 - 10
Barkwood, refuse		10 - 20
Barley straw	cube 30 x 30 x 50 mm 7% moisture	300
Bean straw	cube 30 x 30 x 50 mm 7% moisture	440
Charcoal		18 - 25
Chip, hogged fuel		10 - 30
Coal, anthracite		60
Coal, bituminous 50 mesh		50 - 54
Coal, lignite		40 - 45
Corn cobs	11% moisture	304
Corn stalk	cube 30 x 30 x 50 mm	391
Cotton gin trash	23% moisture	343
Garbage, household		50
Olive pits	10% moisture	567
Peach pits	11% moisture	474
Peat	dust	400
	briquettes 45 x 65 x 60 mm	600
Prune pits	8% moisture	514

BIOMASS ENERGY
Ash Content of Biomass Materials

Biomass	% Weight Ash, dry basis
Alfalfa Seed Straw, Cubed	6.0
Almond Shell	4.8
Barley Straw Mix	10.3
Bean Straw	10.2
Charcoal	2 - 5
Coffee Hull	1.3
Corn Cobs	1.5
Corn Stalk	6.4
Cotton Gin Trash	17.6
Cubed Cotton Stalks	17.2
Douglar Fir Wood Blocks	0.2
Furfural Residue	12.0
Hogged Wood Manufacturing Residue	0.3
Municipal Tree Pruning	3.0
Olive Pits	3.2
Peach Pits	0.9
Peanut Husk	1.5
Peat (average)	1.6
Prune Pits	0.5
Rice Hull	16 - 23
Safflower Straw	6.0
Wallnut Shell Mix, 1/4 in. Pelleted	5.8
Walnut Shell, Cracked	1.1
Wheat Straw and Corn Stalk	7.4
Wood Chips, Whole Log	0.1

BIOMASS ENERGY
Biomass Fuel Bulk Density

Biomass	Grading	Bulk Density (kg/m^3)
Rice hull	cube 30 x 30 x 50 mm	679
	unground, loose	100
Safflower straw	cube 30 x 30 x 50 mm	203
Sawdust	loose	177
	briquettes 100-mm long x 75-mm dia.	555
Slag, blast furnace		80 - 90
Straw	loose	16 - 20
	chopped or ground	50 - 192
	small rectangular bales	112 - 240
	big bales/round bales	48 - 200
	modules	90 - 110
	stack	40 - 48
	cubed	256 - 320
	pellets	300 - 609
Walnut shell	cracked	336
	8 mm pellets	599
Wood, blocks	17% moisture	256
chips	10% moisture	167
Wood	hard	330
	soft	250

BIOMASS ENERGY
Bulk Density of Wood and Wood Residues

Residue	Bulk density kg/m^3	Moisture content %
Acacia wood, chopped	170	
Bark, crushed	160-321	
Beech wood chips	180-235	10-40
Pine wood chips	152	
Planer shavings	96	
Rubber wood chips	140	
Sawdust	100-160	
Softwood chips	176-192	Dry
Spruce logs	310-410	
Spruce wood chips	160-240	10-40
Wood, pelleted	560-608	
Hardwood chips	224	
Wood chips	160-481	

BIOMASS ENERGY
Bulk Density of Biomass Residue

Residue	Moisture Content (%)	Bulk Density (kg/m^3)
Bagasse	10.20	84.90
Cassava Stalks	4.40	143.48
Coconut Husk	10.56	65.74
Coconut Shell	10.13	642.26
Corn Cob	11.13	135.41
Cotton Stalk	9.39	106.00
Paddy Straw	6.85	60.16
Peanut Shell	10.37	252.69
Paddy Husk	8.07	127.58
Sawdust	7.24	171.49

Residue size is 1-2 mm

BIOMASS ENERGY
Bulk Density of Agricultural Residues

Residue	Bulk density kg/m^3	Moisture content %
Bagasse	112-160	
Coconut coir	45	
Coconut shells, chopped	330	
Corn stalks, bales	100	10
Flax stive, bales	140	10
Palm oil shells	442	
Rice husks	100	
Rice husks, briquettes	680	
Rice straw, LP Size 10 mm	63-121	13
Rice straw, LP Size 17 mm	46-111	13
Rice straw, LP Size 70 mm	33-64	13
Rice straw, LP Size 170 mm	11-17	13
Rice straw, big roll bale	96-112	Dry
Straw bales stored, inside buildings	160-214	
Straw bales stored in the field	107-128	
Straw, bales	60-160	
Straw, chopped	40-60	
Straw, baled	68-80	Dry
Straw, baled	110-200	
Straw, briquettes	300-600	
Straw, briquettes	320-640	Dry
Straw, chopped	40-128	Dry
Straw, hammer-milled	40-100	Dry
Straw, loose	20-80	
Straw, LP	32-64	Dry
Straw, pelleted	560-720	
Wheat stalk, big bale	66-111	Dry
Wheat stalk, small bale	44-67	Dry

BIOMASS ENERGY
Proximate Analysis of Biomass Residue

Residue	Proximate Analysis			Gross Calorific Value (kCal/kg)
	Volatile Matter (%)	Ash Content (%)	Fixed Carbon (%)	
Bagasse	74.06	6.68	19.26	4,322.5
Cassava Stalks	76.64	3.99	19.37	4,188
Coconut Husk	72.99	3.97	23.04	4,444
Coconut Shell	73.88	6.50	19.62	4,318
Corn Cob	75.64	8.86	15.49	4,232
Cotton Stalk	75.85	5.26	18.88	4,448
Paddy Straw	54.16	21.05	24.79	3,824
Peanut Shell	72.76	7.09	20.15	4,100
Paddy Husk	63.31	22.68	14.01	3,719
Sawdust	82.79	0.70	16.51	4,619

BIOMASS ENERGY
Heating Value, % Volatile, and % Ash of Various Fuel

Type of Biomass	Heating Values (MJ/kg, Dry /basis)		Approx. Analysis (% by Weight, Dry basis)	
	Higher	Lower	Volatile	Ash
Crop Residues	18.45	17.33	72.6	7.25
Barley straw	17.31	16.22	68.8	10.3
Bean Straw	17.46	16.3	75.3	5.93
Corn cobs	18.77	17.55	80.1	1.36
Corn stover	17.65	16.5	75.17	5.58
Cotton stalks	18.26	17.15	73.29	5.51
Rice straw (fresh)	16.28	15.32	69.33	13.42
Rice straw (weathered)	14.56	13.74	62.31	24.36
Sorghum stalks	15.4	14.32		
Wheat straw	19.23	16.47	71.3	8.9

BIOMASS ENERGY
Energy Consumption of the Different Presses for Biomass Materials

Press	Energy Consumption (kW-hr per ton)
Conical Screw	45 - 55
Cylindrical Screw	12 – 60
Pellet	10 – 175
Piston	10 – 150

BIOMASS ENERGY
Angle of Repose and Angel of Friction of Biomass Materials

Biomass	Angle of Repose (deg)	Angle of Friction (deg)
Ash, fly	42	
Bagasse	50	
Barkwood, refuse	45	
Charcoal	35	
Chip, hogged fuel	-	
Coal, anthracite	27	
Coal, bituminous 50 mesh	45	
Coal, lignite	38	
Garbage, household	-	
Rice hull	45 - 52	arctan 0.63
Sawdust	36	
Slag, blast furnace	25	
Wood chip	-	

BIOMASS ENERGY
Ultimate Analysis of Biomass Materials

Type of Biomass	Ultimate Elemental Analysis (% by Weight, Dry basis)							
	F. Carbon	Carbon	Hydrogen	Oxygen	Nitrogen	Sulfur	Chlorine	Residue
Crop Residues	20.15	46.76	5.4	40.72	1	0.02	0.03	6.07
Alfalfa seed straw	21..54	51.3	5.29	40.9	0.66	0.01	0.04	1.8
Barley straw	20.9	39.92	5.27	43.81	1.25			9.75
Bean Straw	18.77	42.97	5.59	44..93	0.83	0.01	0.13	5.54
Corn cobs	18.54	46.58	5.87	45.46	0.47	0.01	0.221	1.4
Corn stover	19.25	43.65	5.56	43.31	0.61	0.01	0.6	6.26
Cotton stalks	21.2	47.05	5.35	40.77	0.65	0.210	0.08	5.89
Rice straw (fresh)	17.25	41.78	4.63	36.57	0.7	0.08		15.9
Rice straw (weathered)	13.33	34.6	3.93	35.38	0.93	0.16		25
Sorghum stalks		40	5.2	40.7	1.4	0.22		12.5
Wheat straw	19.8	43.2	55	39.4	0.61	0.11	0.28	11.4
Energy Crops								
Sudan grass	18.6	44.58	5.35	39.18	1.21	0.08	0.13	9.47

BIOMASS ENERGY
Physical and Chemical Properties Biomass Residue

Residue	Moisture %	Proximate Analysis			Heating Value BTU/LB
		Volatile Matter %	Ash %	Fixed Carbon	
Coconut husk	13.67	66.46-78.42	2.73-9.91	17.31-34.71	7,785-9,686
Coconut shell	10.77	74.72-82.86	0.88-1.68	15.91-23.90	8,143-9,929
Rice Hull	10.46	57.37-71.34	12.90-28.08	8.75-16.44	5,745-7,186
Rice Stalk	11.26	62.63-70.86	14.72-21.76	11.52-25.61	5,653-6,861
Peanut Hull	11.56	74.25-75.37	2.56-4.04	20.59-22.19	7,000-7,756

BIOMASS ENERGY
Moisture Content Biomass Materials (Wood)

	Moisture content %	Condition
Acacia mearnsii	39	Green
Apple	43	Green
Aspen	44	Green
Birch chips	36	Green
Bole wood	35-60	
Douglas fir	30-60	
Douglas fir, bark	25-75	
Eucalyptus grandis	47	Green
Eucalyptus paniculata	28	Green
Eucalyptus saligna	45	Green
European larch chips	45	Green
Hornbeam	37	Green
Horse-chestnut	48	Green
Maple	39	Green
Mixed softwood	25-37	Air-dried
Mixed softwood chips	31-46	Air-dried
Mixed softwood chips	53-54	
Oak	35	Green
Oak chips	56	Green
Planer shavings	34	Green
Plum	45	Green
Red fir	29	Green
Robinia	42	Green
Sawdust	25-55	
Top wood	35-60	
Tree prunings	35-55	Green
Wood	45-65	Green
Wood bark	30-60	
Wood chips	40-50	
Wood shavings	16-40	

BIOMASS ENERGY
Moisture Content Biomass Materials
(Agricultural Residues)

	Moisture content %	Condition
Bagasse	40-60	
Barley straw	12-22	
Coconut shells	10-20	
Coffee hulls	65-75	Green
Corn cobs	25-45	
Corn stalks	40-60	
Cotton gin trash	7-12	
Cotton stalks	35-45	Green
Maize straw	50-70	
Peach pits	30-40	
Rice husks	7-10	
Rice straw	12-80	
Straw	16-20	
Straw	30-40	Green
Wheat straw	8-22	

CHARCOAL
Proximate Analysis Philippine Hardwood and Coconut Shell charcoal

Charcoal Species	Specific Gravity	Volatile Matter %	Fixed carbon %	Ash %	Heating kcal/kg	Value BTU/lb
Tangle	0.45	18.60	80.50	0.97	8,580	15,444
Red lauan	0.44	14.54	85.25	0.21	8,610	15,498
Mayapia		19.33	80.45	0.25	9,320	16,776
Apitong	51.64	19.10	79.70	1.20		13,713
Toog	0.61	17.70	79.10	3.40		10,270
Lanipau	0.44	25.70	72.80	1.50		14,000
Bagtikan	0.48	24.05	72.50	3.50		8,933
Mix of lauan & tangile		20.80	78.90	0.33		16,791
Mix with red lauan, w/ lauan bagtikan & tangile		20.52	78.28	1.20		15,010
Mix of different species		19.40	76.60	3.90		11,700
U.S. Black Hickory		20.00	77.00	3.00		7,500
Mixed hardwoods		19.40	76.60	4.0		11,700
Ipil-ipil		26.6	72.1	1.3	7,470	11,800

CHARCOAL
Proximate Analysis Philippine Hardwood and Coconut Shell Charcoal

Charcoal Species	Specific Gravity	Volatile Matter %	Fixed carbon %	Ash %	Heating kcal/kg	Value BTU/lb
Coconut shell		18.8	77.4	3.8	7,394	11,900
Bakauan babae		4.2	90.9	4.9		
Bakauan lalaki		4.1	90.9	5.0		
Mill residue		5.2	80.55	4.3		
Coconut trunks		15.80	77.80	6.4	6,422	
Coconut Husk					5,926	
Lump charcoal (coconut trunk)					9,600	

CHEMICAL FORMULA
Names and Formula for Chemicals

Popular Name	Chemical Name	Formula
Alcohol, grain	Ethyl alcohol	C_2H_5OH
Alcohol, wood	Methyl alcohol	CH_3OH
Alum, common	Aluminum potassium sulfate	$AlK(SO_4)_2.12H_{2+}O$
Alumina	Aluminum oxide	Al_2O_3
Aqua ammonia	Ammonium hydroxide solution	$NH_4OH + H_2O$
Asbestos	Magnesium silicate	$Mg_2Si_2O_7.2H_2O$
Aspirin	Acetylsalicylic acid	$C_2H_3O_2C_6H_4CO_2H$
Baking soda	Sodium bicarbonate	$NaHCO_3$
Banana oil	Amyl acetate	$CH_3CO_2C_5H_{11}$
Black lead	Graphite	C
Bleaching powder	Calcium hypochlorite	$CaOCl_2$
Boracic acid	Boric acid	H_3BO_3
Borax	Sodium borate	H_3BO_3
Brimstone	Sulfur	S
Brine	Strong sodium chloride solution	$NaCl\ H_2O$
Caustic potash	Potassium hydroxide	KOH
Caustic soda	Dosium hydroxide	NaOH
Chalk	Calcium carbonate	$CaCO_3$
Chloroform	Trichloromethane	$CHCl_3$
Cream of tartar	Potassium bitartrate	$KHC_4H_4O_6$
DDT	Dichlorodiphenyltrichloroethane	$(C_6H).Cl_2.CH.CCl_3$
Dry ice	Solid carbon dioxide	CO_2
Emery powder	Impure aluminum oxide	Al_2O_3
Ethanol	Ethyl alcohol	C_2H_5OH
Ether	Ethyl ether	$(C_2H_5)_2O$

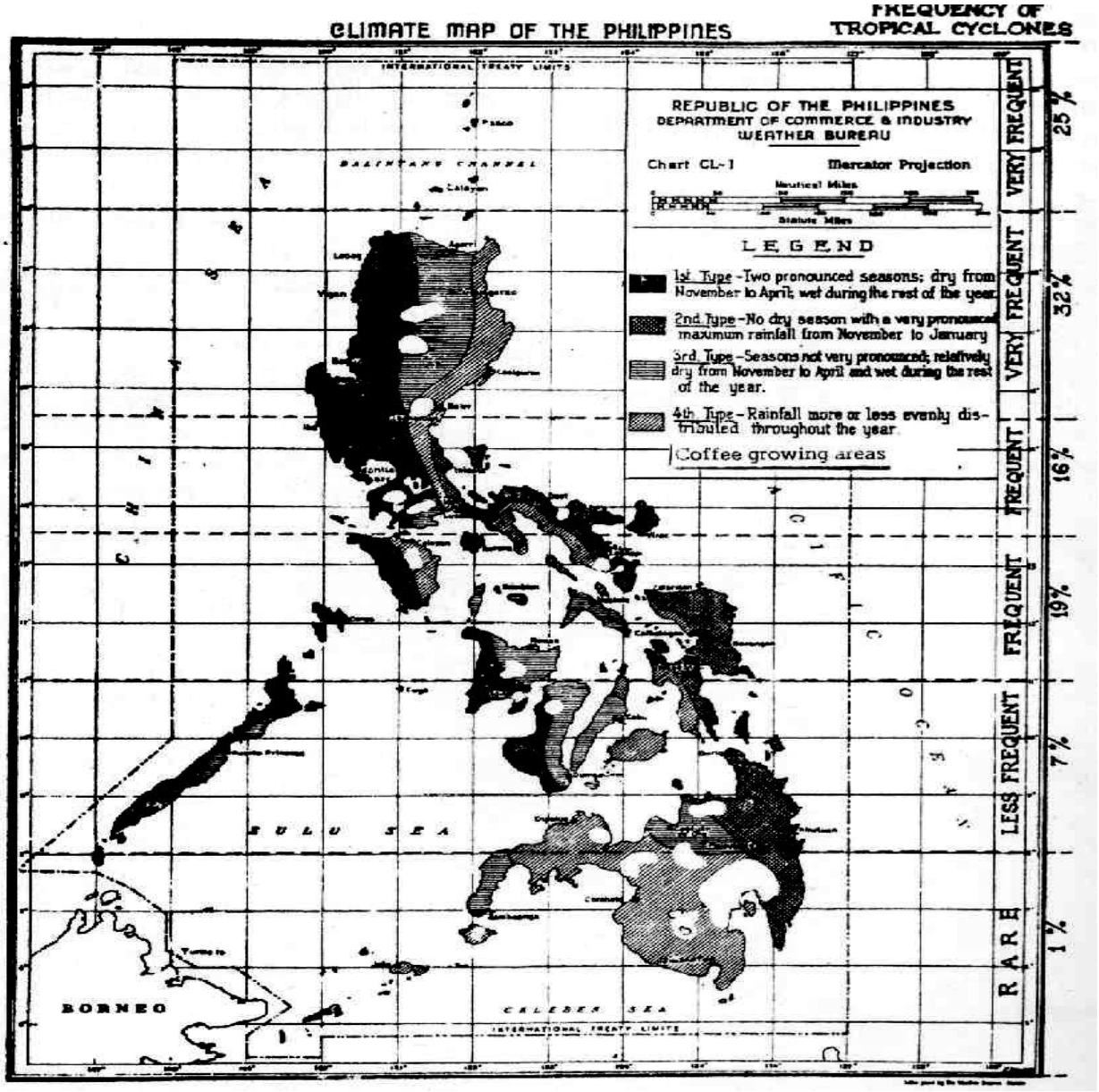
CHEMICAL FORMULA
Names and Formula for Chemicals

Popular Name	Chemical Name	Formula
Formalin	Formaldehyde	HCOH
	Natural magnesium silicate	$H_2Mg_3(SiO_3)_4$
Gypsum	Natural calcium sulfate	$CaSO_4.2H_2O$
Javelle water	Originally potassium hypochlorite solution, now usually sodium hypochlorite solution	$KOCl + H_2O$ $NaOCl + H_2O$
Limewater	Calcium hydroxide solution	$Ca(OH_2) + H_2O$
Magnesia	Magnesium oxide	MgO
Marble	Calcium carbonate	$MgCO_3$
Methanol	Methyl alcohol	CH_3OH
Milk of magnesia	Magnesium hydroxide in water	$Mg(OH)_2$
Natural gas	Mostly methane	CH_4
Oil of vitriol	Sulfuric acid	H_2SO_4
Oil of wintergreen (artificial)	Methyl salicylate	$C_6H_4OHCOOCH_3$
Paris green	Cooper aceto-arsenite	$3Cu(AsO_2)_2.Cu(C_2H_3O_2)_2$
Pearl ash	Potassium carbonate	K_2CO_3
Plaster of Paris	Calcium sulfate	$(CaSO_4)_2.H_2O$
Potash	Potassium carbonate	K_2CO_3
Quicklime	Calcium oxide	CaO
Red lead	Lead tetroxide	Pb_3O_4
Rochelle salt	Potassium sodium	$KnaC_4H_4O_6.4H_2O$
Salt	Sodium chloride	NaCl
Salt cake	Impure sodium sulfate	Na_2SO_4

CHEMICAL FORMULA
Names and Formula for Chemicals

Popular Name	Chemical Name	Formula
Salts of tartar	Potassium carbonate	K_2CO_3
Silica	Silicon dioxide	SiO_2
Slaked lime	Calcium hydroxide	$Ca(OH)_2$
Soda ash	Dry sodium carbonate	Na_2CO_3
Talc	Magnesium silicate	$H_2Mg_3(SiO_3)_4$
TNT	Trinitrotoluene	$C_6H_2CH_3(NO_3)_3$
Vinegar	Dilute and impure acetic acid	CH_3COOH
Washing soda	Crystalline sodium carbonate	$NaHCO_3$
Water glass	Sodium silicate	Na_2SiO_3
Wood alcohol	Methyl alcohol	CH_3OH

CLIMATE
Climate Map of the Philippines



CONCRETE
Mixing Proprotion

Class of mixture	Cement bags 40 kg	Sand		Gravel	
		Cubic ft.	Cubic m.	Cubic ft	Cubic m.
AA	1	1 ½	0.043	3	0.085
A	1	2.0	0.057	4	0.113
B	1	2 ½	0.071	5	0.142
C	1	3	0.085	6	0.170

CONCRETE
Mortar Mixing Proportion

Propor-tion	1.1	1.2	1.3	1.4	1.5	1.6
Cement	24.08	16.24	12.04	9.44	7.88	7.60
Sand	0.65	0.87	0.97	1.02	1.06	1.10

CONCRETE
Plaster Mixture

Class	Mixture	Cement bags	Lime bags	Sand cu. m.
A	1:2	9.0	9.0	1.0
B	1:3	6.0	6.0	1.0
C	1:4	4.5	4.5	1.0

CONCRETE
Cell Volume per Hollow Block

Stock	Cell Volume Per Block			
Width	1 Cell	2 Cells	3 Cells	4 Cells
4"	0.0007	0.0014	0.0021	0.0028
5"	0.001	0.002	0.003	0.004
8"	0.002	0.004	0.006	0.008
3"	None	None	None	None

CONCRETE
Plaster Volume per Hallow Blocks

Stock	Plaster Volume per Hallow Block.	
Width	1 Face	2 faces
4"	0.0010	0.0020
5"	0.0010	0.0020
8"	0.0010	0.0020
3"	0.0010	0.0020

CONCRETE
CHB Laid per Bag of Cement

CHB Size	Number of Pieces
4" x 8" x 16"	55 to 60
6" x 8" x 16"	30 to 36
8" x 8" x 16"	25 to 30

Note: 1 Bag of Cement is equal to one cubic ft.

CONCRETE
CHB Finish per Square Meter

Type of Finishing	Cement (Bag)	Sand (m^3)
Tolled Finish	1/8	0.0107
Plaster Finish	1/4	0.0213

CONCRETE
Volume of Cement per CHB

Size	Volume (m^3)
4" x 8" x 16"	0.001
6" x 8" x 16"	0.003
8" x 8" x 16"	0.004

CONCRETE
Recommended Mixing proportion

Type of Construction	Proportion
Side Walk 4 in thick	1:2:4
Floor Slab 4 in thick	1:2:4
Wall	1:2.5:5
Footing	1:2.5:5
Post	1:2.5:5
Machinery Foundation	1:3:6
Reinforced Concrete	1:2:4
Foundations	1:2.5:5
Water Roofing	1:2

CONVEYOR
Revolutions per Minute (rpm) of Pulley Shaft for Various Belt Speeds and Pulley Diameters

Belt speed (m/min)	Pulley Shaft rpm when Pulley Diameter is				
	50 cm	60 cm	76 cm	90 cm	110 cm
30	20	16	14	11	9
46	28	24	20	16	14
61	38	32	25	22	18
76	48	41	32	27	24
91	55	48	38	32	27
107	65	55	45	38	32
122	75	65	51	43	36

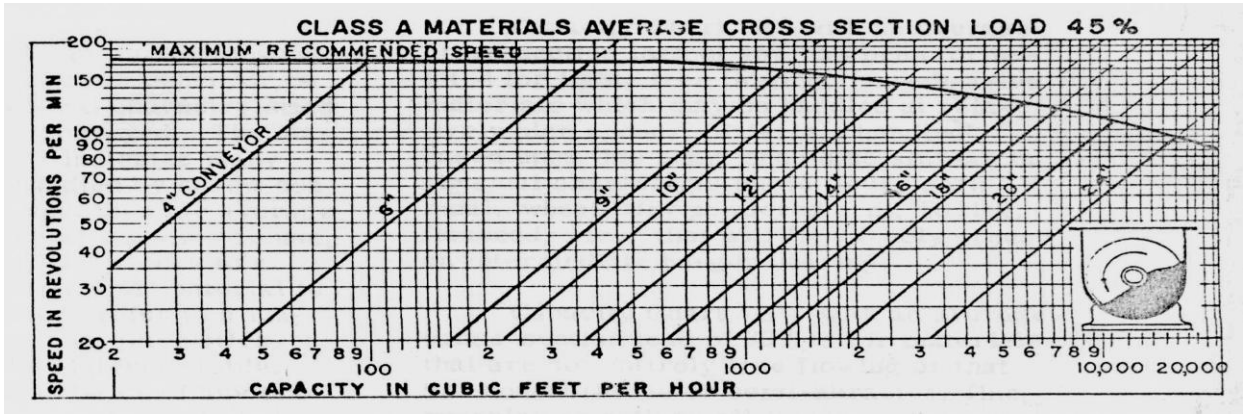
CONVEYOR
Characteristics of Various Conveyors

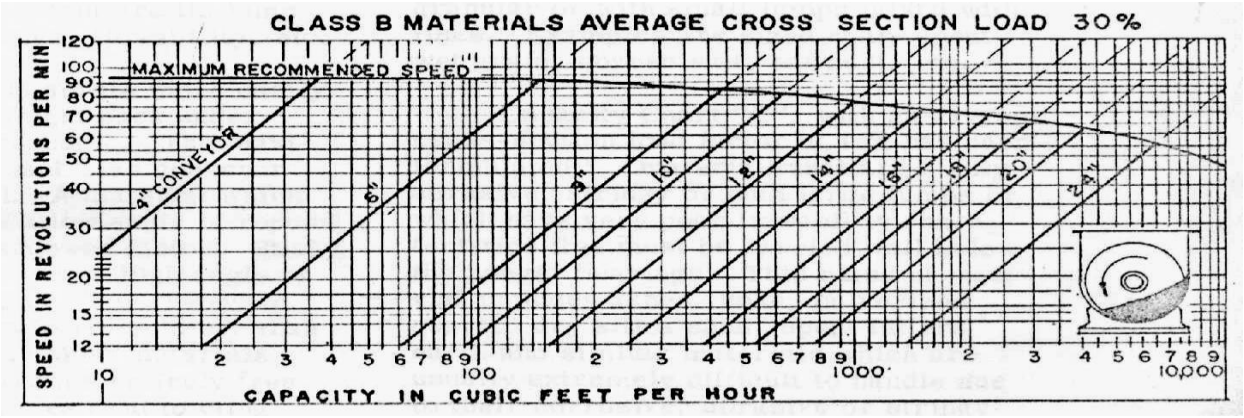
Type of Con-veyor	Type of Material	Capacity	HP Requirement	Cost	Advantages	Dis-advantages
Screw (Auger)	Ground granular or chopped	medium	Low to medium	medium	Can be used as mixer or for uniform flow feeder Good for unloading bulk storage Wide range available	Size of material limited Single sections limited in length Medium to heavy wear factor
Chain	Most feed grains and farm products	medium	medium	Low to medium	Inexpensive Multiple use Wide range available	Noisy Heavy wear factor
Bucket	Ground granular or lumpy	Medium to high	low	Medium to high	Efficient Minimum High capacity for vertical lift	Limited speed range Difficult to erect Expensive
Belt	Grain packaged units	High	Low	High	Can be used for distances Low power requirement	Limited in angle of elevation Expensive

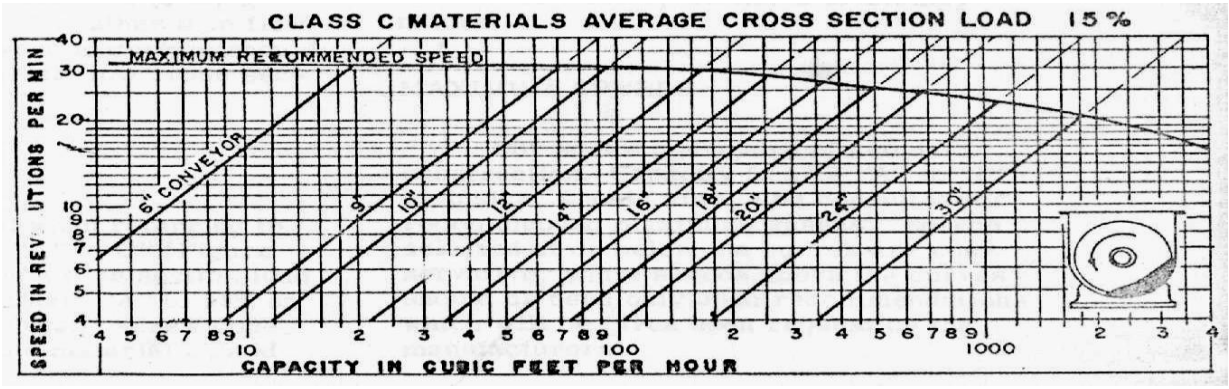
CONVEYOR
Characteristics

Type of Conveyor	Type of Material	Capa-city	HP Requirement	Cost	Advantages	Dis-advantages
Pneumatic	Grain ground feed chopped forage	Variable	High	Low to medium	Low first cost Low maintenance Flexibility of installation Easily cleaned	High power requirement Creates dust, usually requires separation equipment Conditions of operation vary with type of material
Vibrator	Grain ground feed	Low	Low	High	Can be used as meter Reliable Easily control	Limited capacity Cost
Oscillator	Grain, feed roughage	High	Low	Medium to High	Efficient Can handle large volumes Can handle several materials	Cost Must be solidly mounted Limited to lengths of about 100 ft
Pump and Pipe	Liquids, slurries	High	Low	Low to medium	Efficient Easy control Low maintenance	Materials limited Subject to freezing

CONVEYOR
Screw Capacity Chart







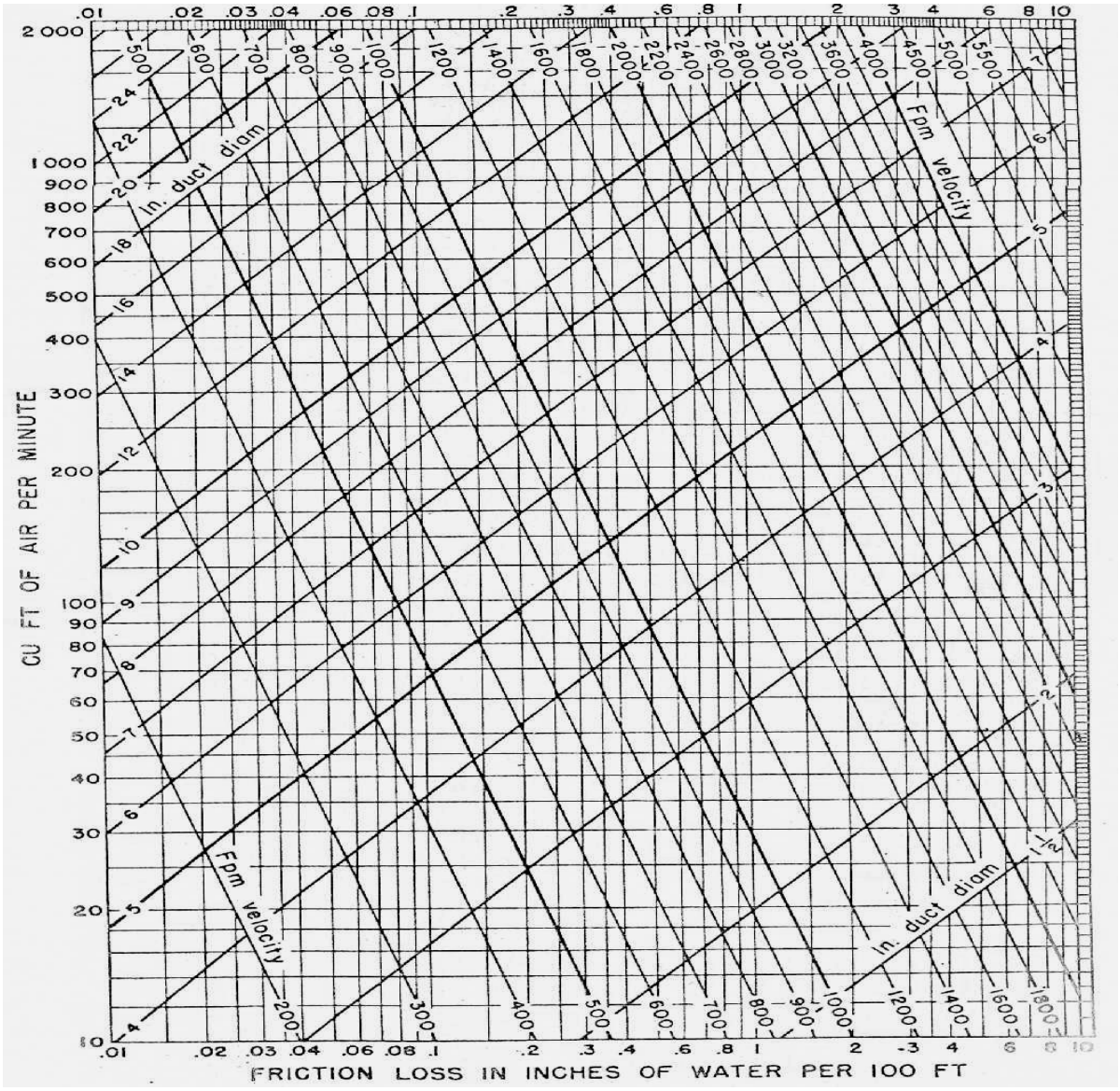
CONVEYOR
Dimensions and Capacities of Elevator Buckets

Bucket size (mm)			Capacity (cm^3)	Normal spacing on belt (mm)
Length	Projection	Depth		
76	64	64	142	102
102	70	76	283	102
127	89	95	566	127
152	102	114	850	152
178	114	127	1416	165
203	127	140	1982	178
229	152	159	3115	203
254	152	159	3398	203
279	152	159	3681	203
305	152	159	3964	203
305	178	184	5380	229

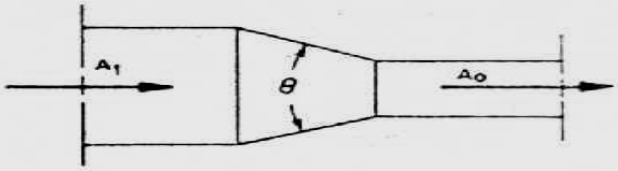
CONVEYOR
Capacity Constant for Inclined Conveyor

Angle (deg)	Constant
0	1.0
20	0.8
40	0.6
60	0.5
80	0.4

CONVEYOR
Friction of Air on Straight Duct

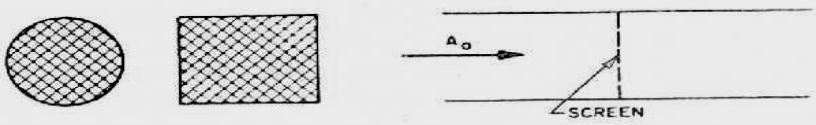


CONVEYOR
Friction Loss Coefficient
(Converging, Gradual, Round and Rectangle)



A_o/A_1	C_o θ, degrees					
		1200	30	40	50	60
0.1	0	0.01	0.02	0.03	0.05	0.07
0.2	0	0.01	0.02	0.03	0.05	0.07
0.3	0	0.01	0.02	0.03	0.05	0.06
0.4	0	0.01	0.02	0.03	0.04	0.06
0.5	0	0.01	0.01	0.02	0.04	0.05
0.6	0	0.01	0.01	0.02	0.03	0.04
0.7	0	0	0.01	0.02	0.03	0.04
0.8	0	0	0.01	0.01	0.02	0.03
0.9	0	1	0	0.01	0.01	0.01

CONVEYOR
Friction Loss
(Obstruction, Rectangular, Round)



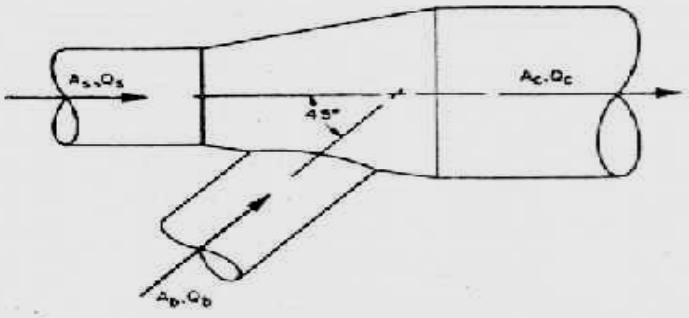
$$n = A_{or}/A_o$$

where

n = free area ratio of screen
A_{or} = total flow area of screen
A_o = area of duct

n	0.30	0.40	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.90	1.0
C_o	6.2	3.0	1.7	1.3	0.97	0.75	0.58	0.44	0.32	0.14	0

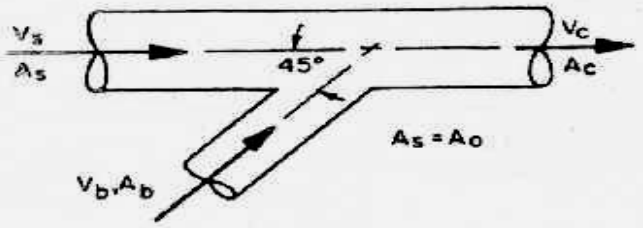
CONVEYOR
Friction Loss Coefficient
(Converging, Wye, Round, Square and Rectangle)



Branch, $C_{c,b}$

$\frac{A_s}{A_c}$	$\frac{A_b}{A_c}$	Q_b/Q_s									
		0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
0.3	0.2	−2.4	−.01	2.0	3.8	5.3	6.6	7.8	8.9	9.8	11
	0.3	−2.8	−1.2	0.12	1.1	1.9	2.6	3.2	3.7	4.2	4.6
0.4	0.2	−1.2	0.93	2.8	4.5	5.9	7.2	8.4	9.5	10	11
	0.3	−1.6	−.27	0.81	1.7	2.4	3.0	3.6	4.1	4.5	4.9
	0.4	−1.8	−.72	0.07	0.66	1.1	1.5	1.8	2.1	2.3	2.5
0.5	0.2	−.46	1.5	3.3	4.9	6.4	7.7	8.8	9.9	11	12
	0.3	−.94	0.25	1.2	2.0	2.7	3.3	3.8	4.2	4.7	5.0
	0.4	−1.1	−.24	0.42	0.92	1.3	1.6	1.9	2.1	2.3	2.5
	0.5	−1.2	−.38	0.18	0.58	0.88	1.1	1.3	1.5	1.6	1.7
0.6	0.2	−.55	1.3	3.1	4.7	6.1	7.4	8.6	9.6	11	12
	0.3	−1.1	0	0.88	1.6	2.3	2.8	3.3	3.7	4.1	4.5
	0.4	−1.2	−.48	0.10	0.54	0.89	1.2	1.4	1.6	1.8	2.0
	0.5	−1.3	−.62	−.14	0.21	0.47	0.68	0.85	0.99	1.1	1.2
	0.6	−1.3	−.69	−.16	0.04	0.26	0.42	0.57	0.66	0.75	0.82
0.8	0.2	0.06	1.8	3.5	5.1	6.5	7.8	8.9	10	11	12
	0.3	−.52	0.35	1.1	1.7	2.3	2.8	3.2	3.6	3.9	4.2
	0.4	−.67	−.05	0.43	0.80	1.1	1.4	1.6	1.8	1.9	2.1
	0.6	−.75	−.27	0.05	0.28	0.45	0.58	0.68	0.76	0.83	0.88
	0.7	−.77	−.31	−.02	0.18	0.32	0.43	0.50	0.56	0.61	0.65
	0.8	−.78	−.34	−.07	0.12	0.24	0.33	0.39	0.44	0.47	0.50
1.0	0.2	0.40	2.1	3.7	5.2	6.6	7.8	9.0	11	11	12
	0.3	−.21	.54	1.2	1.8	2.3	2.7	3.1	3.7	3.7	4.0
	0.4	−.33	.21	0.62	0.96	1.2	1.5	1.7	2.0	2.0	2.1
	0.5	−.38	.05	0.37	0.60	0.79	0.93	1.1	1.2	1.2	1.3
	0.6	−.41	−.02	0.23	0.42	0.55	0.66	0.73	0.80	0.85	0.89
	0.8	−.44	−.10	0.11	0.24	0.33	0.39	0.43	0.46	0.47	0.48
	1.0	−.46	−.14	0.05	0.16	0.23	0.27	0.29	0.30	0.30	0.29

CONVEYOR
Friction Loss Coefficient
(Converging, Wye, Round and Rectangle)



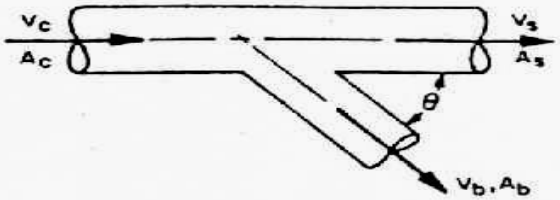
Branch, $C_{c,b}$

V_b / V_c	A_b/A_c 0.1	0.2	0.3	0.4	0.6	0.8	1.0
0.4	−.56	−.44	−.35	−.28	−.15	−.04	0.05
0.5	−.48	−.37	−.28	−.21	−.09	0.02	0.11
0.6	−.38	−.27	−.19	−.12	0	0.10	0.18
0.7	−.26	−.16	−.08	−.01	0.10	0.20	0.28
0.8	−.21	−.02	0.05	0.12	0.23	0.32	0.40
0.9	0.04	0.13	0.21	0.27	0.37	0.46	0.53
1.0	0.22	0.31	0.38	0.44	0.53	0.62	0.69
1.5	1.4	1.5	1.5	1.6	1.7	1.7	1.8
2.0	31.	3.2	3.2	3.2	3.3	3.3	3.3
2.5	5.3	5.3	5.3	5.4	5.4	5.4	5.4
3.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0

Main, $C_{c,s}$

V_s / V_c	A_b/A_c 0.1	0.2	0.3	0.4	0.6	0.8	1.0
0.1	−8.6	−4.1	−2.5	−1.7	−.97	−.58	−.34
0.2	−6.7	−3.1	−1.9	−1.3	−.67	−.36	−.18
0.3	−5.0	−2.2	−1.3	−.88	−.42	−.19	−.05
0.4	−3.5	−1.5	−.88	−.55	−.21	−.05	0.05
0.5	−2.3	−.95	−.51	−.28	−.06	0.06	0.13
0.6	−1.3	−.50	−.22	−.09	0.05	0.12	0.17
0.7	−.63	−.18	−.03	0.04	0.12	0.16	0.18
0.8	−.18	0 . 1	0.07	0.10	0.13	0.15	0.17
0.9	0.03	0.07	0.08	0.09	0.10	0.11	0.13
1.0	−0.01	0	0	0.10	0.02	0.04	0.05

CONVEYOR
Friction Loss Coefficient
(Diverging, Wye, Round and Rectangle)



$\theta = 15° - 90°$

$A_c = A_s$

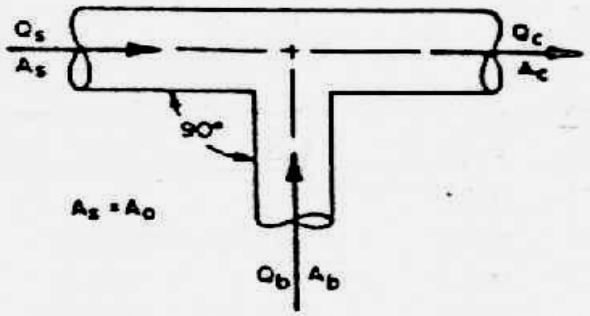
Branch, $C_{c,b}$

V_b/V_c	θ, degrees				
	15	30	45	60	90
0	0.92	0.94	0.97	1.0	1.0
0.1	0.92	0.94	0.97	1.0	1.0
0.2	0.65	0.70	0.75	0.84	1.0
0.4	0.38	0.46	0.60	0.75	1.1
0.6	0.20	0.31	0.50	0.65	1.2
0.8	0.09	0.25	0.41	0.80	1.3
1.0	0.10	0.25	0.52	0.90	1.3
1.2	0.11	0.32	0.67	1.1	1.4
1.4	0.22	0.63	0.88	1.4	1.6
1.6	0.41	0.72	1.2	1.8	1.8
2.0	0.99	1.4	1.9	2.7	2.2
2.6	2.5	2.9	2.7	4.6	—
3.0	6.5	6.7	7.0	7.3	—

Main

V_s/V_c	0	0.1	0.2	0.3	0.4	0.5	0.6	0.8	1.0
$C_{c,s}$	0.40	0.32	0.26	0.20	0.15	0.10	0.06	0.02	0

CONVEYOR
Friction Loss Coefficient
(Converging, Wye, Round and Rectangle)



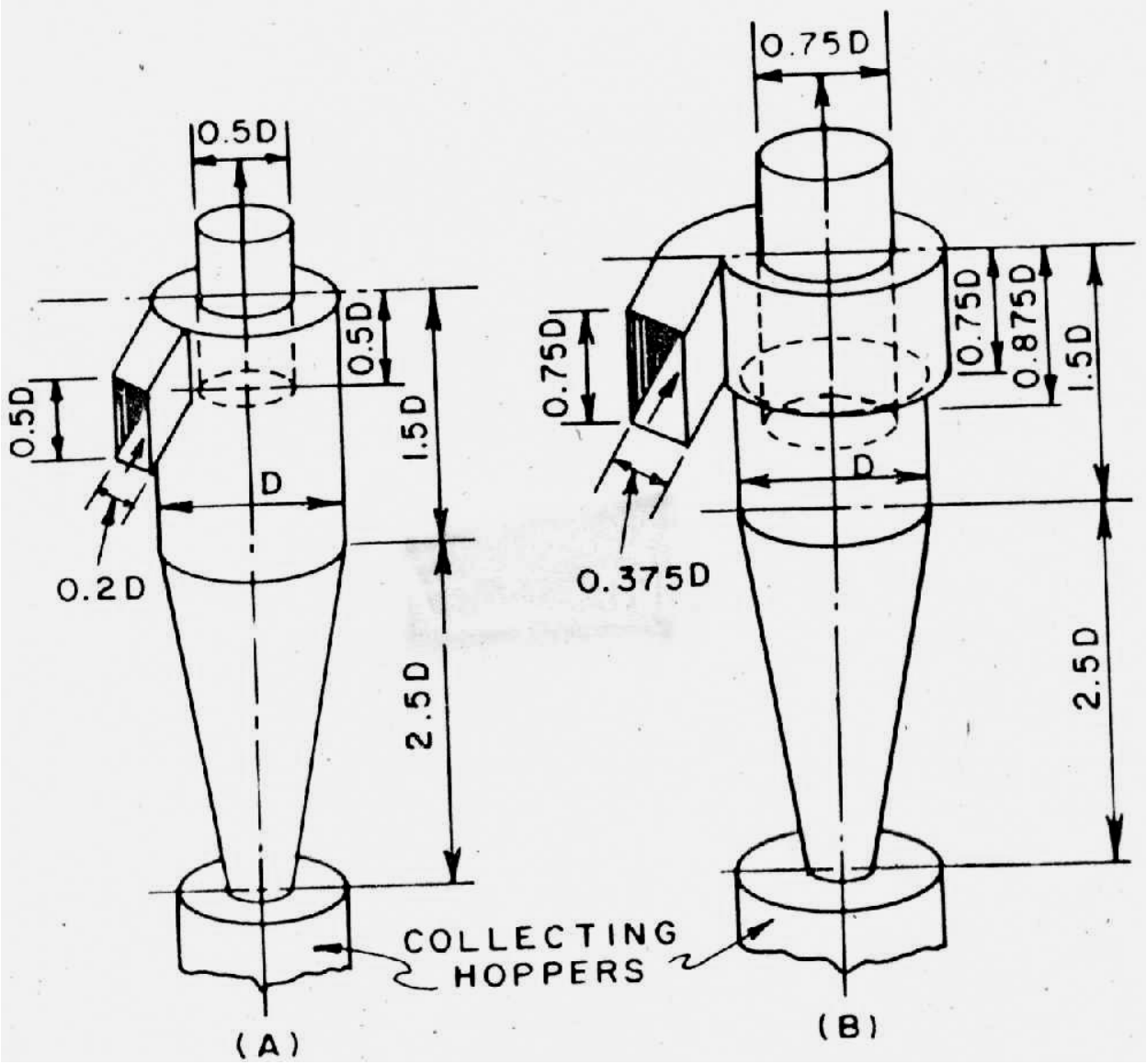
Branch, $C_{c,b}$

$\frac{Q_b}{Q_c}$	A_b/A_c 0.1	0.2	0.3	0.4	0.6	0.8	1.0
0	−1.0	−1.0	−.75	−.75	−.70	−.65	−.60
0.1	0.40	−.37	−.38	−.41	−.41	−.39	−.37
0.3	9.2	2.3	0.75	0.44	0.19	0.10	−.07
0.4	16	4.3	1.6	0.98	0.53	0.36	0.26
0.5	26	6.8	2.4	1.6	0.84	0.58	0.46
0.6	37	9.7	3.5	2.2	1.2	0.81	0.62
0.7	43	13	4.7	2.9	1.5	1.0	0.78
0.8	65	17	5.9	3.7	1.9	1.2	0.94
0.9	82	21	7.3	4.6	2.2	1.5	1.1
1.0	101	26	8.9	5.4	2.7	1.7	1.2

Main

Q_b/Q_c	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
$C_{c,s}$	0	0.16	0.27	0.38	0.46	0.53	0.57	0.59	0.60	0.59	0.55

CONVEYOR
Cyclone Separator Design



High Efficiency **Medium Efficiency**

CONVEYOR
Velocities for Controlling Various Types of Dust

Type of dust or Fine	Process or Operation	Required Air Velocities (ft/min)	
		At Dust Source	At Face of Hood
Fine powders	Bagging	200-400	
	Belt conveyor (at transfer point)	250	
Grain	Elevator boot and head		1500
Granite	Hand pneumatic tool	200	
	Surfacing machines	1500	
	All tools		500
Grinder	Swing grinder		200
Lead	Metal spraying	200	
Sand	Bagging	400	
Welding	Electric welding	200	
Zinc	Metal Spraying	125	

CONVEYOR
Air Velocities Needed to Convey Solids of Various Bulk Densities

Bulk Density (lb/ft^3)	Air velocity
10	2900
20	4120
30	5050
40	5840
50	6500
60	7150
70	7100
80	8250
90	8700
100	9200
110	9700
120	10,500

CONVEYOR
Recommended Conveying Velocities for Various Materials

Material	Conveying Velocities (ft/min)
Barley	5000 – 6500
Beans	6000
Coffee Beans	3000 – 3500
Corn, shelled	5000 – 7000
Cotton	4000 – 6000
Cotton seed	4000 – 6000
Chopped hay	4000
Ensilage	6000
Oats	4500 – 6000
Rags	4500 – 6500
Salt	5500 – 7500
Sand	6000 – 9000
Sawdust	4000 – 6000
Wheat	5000 – 7000
Wool	4500 - 6000

CONVEYOR
Approximate Relative Capacity of Chain Conveyor

Inclination	Factor
20	0.77
30	0.55
40	0.33

CONVEYOR
Constants for Determining Horsepower for Belt Conveyors

Conveyor belt width (cm)	Constants		Additional hp for tripper
	A	B	
36	0.20	0.00140	0.70
41	0.25	0.00140	0.85
46	0.30	0.00162	1.00
50	0.30	0.00187	1.40
60	0.36	0.00224	1.70
76	0.48	0.00298	2.50

CONVEYOR
Cross-Section Area of Loaded Belt and Maximum Belt Speeds

Belt width (cm)	Clear margin (cm)	Total cross section area (m^2) for 20° surcharge angle	Operation speed[a] (m/min)	
			Normal	Maximum
30.5	4.1	0.0072	61	122
35.6	4.3	0.0089	61	122
40.6	4.6	0.0122	61	137
45.7	4.8	0.0161	76	137
50.8	5.1	0.0204	76	152
61.0	5.6	0.0308	91	183
76.2	6.4	0.0504	107	213

[a] Belt speed should be 91 m/min where a tripper is to be used, and 46-76 m/min where a plow is to be used.

COOKSTOVE
Thermal Efficiency of Various Cookstoves

Stove	Efficiency (%)
Wood Stove	
Open Fire	3 – 11
Improved	11- 30
Charcoal Stove	
Traditional	2 – 9
Improved	4 - 12

COOKSTOVE
Heat Utilization

Stove	Heat Utilization Efficiency (%)
Traditional Open Fire	8.0
Thai Charcoal Stove	3.1
Two-Pot Uninsulated Metal Wood Stove w/ Chimney	27.9
Two-Pot Massive Wood Stove w/ Chimney	15.4
Three-Pot Massive Wood Stove w/ Chimney	6.0

COOKSTOVE
Efficiencies Charcoal Fuel Cookstove

Cookstoves	Efficiency (%)
Cambodian traditional	14.5
Thai-bucket cookstove	16.2
Chinese traditional	12.5
QB Phil. charcoal/firewood	27.0
Phil. charcoal/wood	21.5
Lao improved	16.5
Vietnamese improved	25.0
Malaysian improved	18.0
Bang Sue stove	18.2

COOKSTOVE
Efficiencies Wood-Fired Cookstove

Cookstoves	Efficiency (%)
Cambodian traditional	11.0
Lao traditional	14.3
Vietnamese traditional	15
Nepalese one-pot ceramic	10.5
Thai-bucket cookstove	15
Roi-et cement	11.4
RTFD improved wood/char	15.0
Rungsit stove	12.0
Chinese traditional	12.2
Malaysian traditional	9.5
Phil. charcoal/wood	12.0
Nepal one-pot metal	13
Nepalese two-pot ceramic	13.0
Indian "Harsha" cookstove	25.2
Saengpen, nam char wood cement	17.5
Bang Sue stove	18.2
Malaysian improved	19.7

CORN MILL
Performance Criteria

Criteria	Performance Data
Main Product Recovery, percent minimum of the product input	
a) Grit # 10	28
b) Grit # 12	21
c) Grit # 14	7
d) Grit # 16	6
e) Grit # 18	2
Main Product, percent, minimum	64
By-Product, percent, maximum	31
Losses, percent, maximum	5
Grits of other sizes, percent, minimum	7
Degerminator Efficiency, percent, minimum	80
Noise Level, [db (A)], maximum	92*

* Allowance noise for six (6) hours of continuous exposure based on Occupational Safety and Health Standards, Ministry of Labor, Philippines. 1983.

CROPS
Water Requirement

Crops	Depth per Year or Per Season (cm)	Average Growing Period (days)	Critical Period	Remarks
Banana	15-30	Annual	Early growth stage	Requires excellent drainage for the entire root zone. Since the roots are deep, the soil must be drained to a far greater depth
Bean	30-50	60-90	Flowering and pod development	Vegetative period is not sensitive when followed by ample water supply.
Cabbage	30	70-90	Head formation and enlargement	_
Cacao	45-200	Perennial	_	Waterlogged areas and areas with prolonged drought are not good. Cacao is ruined by flooding for several weeks, but it is adversely affected by stagnant water, thus drainage is necessary for heavy soils.
Cassava	100-150	Annual		It can withstand periods of prolonged drought except at planting.
Cauliflower	_	_	No critical moisture sensitive stage; frequent irrigation required from planting to harvest	_
Citrus	90-120	Perennial	During flushes of new growth fruits setting, and rapid increase of fruit size	Sticky and poorly drained soils should be avoided. No stagnant water should stand in the grove as this will enhance disease development particularly in the trunk and root system.

CROPS
Water Requirement

Crops	Depth per Year or Per Season (cm)	Average Growing Period (days)	Critical Period	Remarks
Corn	60	90-120	Silking and ear development	Last irrigation of corn has to be done in the middle of the reproductive stage (kernel formation) since yield tends to become low when not irrigated up to the productive stage growth. Corn as to be irrigated, at least, once every 2 weeks (DS) up to the reproductive stage of growth. It should not be allowed under the waterlogged condition at any time for more than 2 days.
Cotton	70-130	150-180	Flowering period	Over supply of water retards fruiting and branch development, and delays maturity. It should not be allowed under waterlogged conditions at any stage of growth for more than 4 days.
Cowpea	35-50	110-120	_	A weekly irrigation of 35 mm throughout the growing season of the crop will ensure crops of good quality.
Cucumber	30	60-70	_	It is relatively tolerant to high moisture especially when the soil is easily drained. During dry-season planting, a weekly irrigation of 35-40 mm would be best for the crop.
Eggplant	50	90-120	_	During dry season planting, a weekly irrigation of 35-40 mm would be best for the crop.

CROPS
Water Requirement

Crops	Depth per Year or Per Season (cm)	Average Growing Period (days)	Critical Period	Remarks
Garlic	36-40	90-120	_	This requires moderately wet soil.
Grapes	50-120	180-270	Shoot elongation and flowering, fruit filling	
Lettuce	30	40-50	Just before harvest when the ground cover is complete	
Mungo	40	90-100	Germination and at flowering stage and pod-filling stage	_
Onion	35-55	90-100	During the period of root and bulb formation	_
Papaya	120	_	_	Constant availability of soil moisture is associated with continuous growth which results in the regular production of flowers and fruits. Root system is sensitive to standing water; 2 days immersion is fatal.
Peanut	58	140-160	Peak of flowering to early fruiting	_
Peas	35-50	65-100 fresh 85-120 dry	Start of flowering and when pods are swelling	_
Pechay	30	40-60	–	–

CROPS
Water Requirement

Crops	Depth per Year or Per Season (cm)	Average Growing Period (days)	Critical Period	Remarks
Pili	–		–	Sufficient water should be available during the dry months to irrigate the plants. During the succeeding years, either a small amount or no irrigation is necessary.
Potato	50-70	100-150	Period of stolonozation and tuber initiation	Drought even for short period can have serious effect on yield and quality of crop, especially when it is accompanied with high temperature or it occurs during the last 9 weeks of growth. Inadequate or irregular water supply not only results in poor yield.
Radish	30	40-60	Period of rooting and bulb formation	An evenly distributed rainfall is required.
Soybean	45-70	100-120	Germination and pod development	It can withstand short drought without injury; can tolerate waterlogged conditions at any stage of growth of not more than 8 days.
Squash	45-70	100-130	–	–
Sugarcane	150-250	270-365	Vegetative period, particularly during period of tillering and stem elongation	Dry condition at maturation stage is extremely helpful in the accumulation of sugar in the plant; therefore, no irrigation is needed when the crop reaches the flowering stage.

CROPS
Water Requirement

Crops	Depth per Year or Per Season (cm)	Average Growing Period (days)	Critical Period	Remarks
Sweet Potato	46	60-120	After formation of tubers	An annual rainfall of 30-50 cm is considered to be best with low humidity, as the crop reaches maturity. It can tolerate considerable periods of drought but yields are very much reduced if a water shortage occurs 50-60 days after planting when shortage root initiation has begun.
Sweet Pepper	58	90-120	Throughout the growth period but particularly just prior and at start of flowering	–
Taro	250	–	–	It is primarily adapted to moist environments, but can be grown under a wide range of conditions, from paddy culture to dry upland conditions under irrigation. It is necessary to provide sufficient water for vegetative growth or leaf development when grown in dry upland areas where rainfall is less than 175 cm. The use of furrow and sprinkler irrigation has proved satisfactorily.

CROPS
Water Requirement

Crops	Depth per Year or Per Season (cm)	Average Growing Period (days)	Critical Period	Remarks
Tobacco	40-60	40-60	Period of rapid growth; knee high to blossoming	It is relatively drought-tolerant but sensitive to flooding.
Yam	115 or	_	Requires adequate moisture throughout growing period	It is greatly considered drought-resistant. For optimum yield, adequate moisture between the 14th and 20th weeks of growth is of great importance. The major areas of production are centered where there is a sharply demarcated dry season of 2-5 months and a rainfall of 115 cm or more during the growing season.

CROPS
Water Requirement of Selected Non-Rice Crops

Crop	Water Requirement (cm^3/season)	Ave. Growing Period (days)	Expected Yield (t/ha)	Critical Period
Corn	60	80 - 115	4 - 7	Silking and ear formation
Cucumber	30	45 - 60	-	
Eggplant	30	90 - 120	9.5	Flowering and fruiting vegetative stage
Garlic	40	90 - 120	-	Vegetative stage
Mungbean	30 - 50	60 - 90	1.2	Flowering and pod formation
Onion	35 - 55	90 - 120	22.0	Root and bulb formation
Peanut	58	140 - 160	1.5	Peak flowering and early fruiting
Peas	30 - 50	100 - 102	2.3	Flowering and pod formation
Pechay	30	40 - 60	-	
Pole sitao	50	50 - 60	10 - 13	Flowering
Soybean	45 - 70	100 - 120	1.5	Germination and pod filling
Squash	45 - 60	100 - 130	15 - 26	Flowering
Sunflower	45 - 50	80 - 95	1.0	Planting and heading stage
Sweetpotato	20	90 - 120	10.0	At planting and 40-60 days after planting
Tomato	40 - 60	90 - 140	40.0	Vegetative stage
Watermelon	56	90 - 120	15 - 26	

DAIRY PRODUCT
Storage Life

Product	Storage temperature℃	Relative humidity %	Storage life
Butter	0 to -4.5	80 to 85	1 to 3 months
Butter, frozen	-15 to -20	70 to 85	8 to 12 months
Cheese, blue	+2 to +4	80 to 90	2 to 4 moths
Cheese, cottage	-1 to +2		2 to 3 weeks
Cheese, cream	0 to +2		2 to 3 weeks
Cheese, Camembert	-1 to +2	65 to 75	1 to 9 months
Cheese, Cheddar	-1 to +2	65 to 70	3 to 12 months
Cheese, Swiss	+2 to +4	80 to 85	4 to 10 months
Cream, double	+1 to +3		2 to 5 days
Cream, whipped	+1 to +3		2 to 5 days
Cream, frozen	-20 to -30		2 to 3 months
Cream, single	+1 to +3		2 to 5 days
Eggs, yolk dried	+5 to +10	Low	1 to 4 months
Eggs, shell	0 to +2	85 to 90	5 to 6 months
Eggs, white	0 to +2	85 to 90	6 to 12 months
Eggs, white dried	+5 to +10	Low	1 to 5 months
Eggs, whole dried	+5 to +10	Low	1 to 4 months
Eggs, whole	0 to +2	85 to 90	9 to 12 months
Eggs, yolk	0 to +2	85 to 90	6 to 12 months
Ice cream	-20 to -30		1 to 2 months
Milk, dried	+7 to +13	Low	1 to 4 months
Milk, skimmed	+0.5 to +10		5 to7 days
Milk, condensed	+4 to +7		2 to 4 months
Milk, evaporated	+5 to +20		6 to 12 months
Milk, pasteurized	+0.5 to +2		5 to7 days

DAIRY PRODUCT
Thermal Properties

Product	Freezing temperature ℃	Specific heat above freezing kJ/kg ℃	Specific heat below freezing kJ/kg ℃	Latent heat kJ/kg
Butter	-5	1.38		53
Butter, frozen	-5		1.05	
Cheese, blue	-16	2.68	1.35	135
Cheese, cottage		3.65	1.86	2.65
Cheese, cream		2.95	1.45	170
Cheese, Camembert		2.05	1.04	55
Cheese, Cheddar	-12	2.10	1.30	126
Cheese, Swiss	-10	2.6	1.35	130
Cream, double	-2	3.69	1.85	270
Cream, whipped	-2	3.1	1.55	190
Cream, frozen		1.7		
Cream, single	-2	3.27		242
Eggs, yolk dried		1.55	0.77	9
Eggs, shell	-2	3.55	1.74	243
Eggs, white	-0.5	3.9	1.94	290
Eggs, white dried		1.9	0.95	31
Eggs, whole dried		1.8	0.89	13
Eggs, whole	-2	3.55	1.76	246
Eggs, yolk	-0.5	2.95	1.5	170
Ice cream		3.2	1.63	207
Milk, dried		1.75	0.88	
Milk, skimmed	-0.5	3.9	1.95	304
Milk, condensed	-15	2.4	1.19	93
Milk, evaporated	-2	3.5	1.7	246
Milk, pasteurized	-0.5	3.8	1.9	290

DRYER
Tray Loading Density

Classification	Product	Loading Capacity
Fruits	Sliced Mango	0.54 kg/sq ft
	Jack fruit	0.54 kg/sq ft
	Sweet Potato Chips	0.35 kg/sq ft
Vegetables	Chili	0.39 kg/sq ft
	Cassava	1.25 kg/sq ft
	Carrots	1.25 kg/sq ft
	Bell Paper	0.77 kg/sq ft
Fish	Tabagak (whole)	0.56 kg/sq ft
	Abo (whole)	0.78 kg/sq ft
	Bangus (split)	0.76 kg/sq ft
	Bilong Bilong (whole)	0.46 kg/sq ft
	Tamudios (split)	0.46 kg/sq ft
	Sap sap (whole)	0.57 kg/sq ft
	Dalino an (split)	0.37 kg/sq ft
	Panit (split)	0.65 kg/sq ft

DRYER
Recommended Drying Temperature

Crops	Drying Temperature (C)
Grains and Cereals	
For seeds	40 – 45
For milling or processing	40 – 55
Sliced Fruits or Vegetables	50 – 70
Fish	40 – 70
Green leaves	35 – 40

DRYER
Recommended Drying-Air Temperature

Purpose	Grain			
	Rice	Corn	Sorghum	Soybean
Seed	43	43	43	43
Commercial	43	55	60	50
Animal Feed	-	83	83	83

DRYER
Recommended Airflow Rates for Various Grain Drying Systems.

Dryer Type	Capacity (ton)	Approx. Airflow Rate (m^3/min-ton)
Batch-in-bin		
Small	2	50
Large	100	23
Recirculating Batch		
Small	5	56 - 85
Large	10	70 - 100
Continuous Flow		
Small	5 - 10	85 - 115
Large	10 - 25	115 - 140

DRYER
Specifications for Various Dryers

Item	Batch-in-Bin		Recirculating Bin		Continuous-Flow	
	Small	Large	Small	Large	Small	Large
Capacity (t)	2	100	5	10	5-10	10-25
Approx. hp	3	10	15	25	15-20	25-50
Approx. airflow (m^3/min per t)	50	23	56-85	70-100	85-155	155-140
Approx. drying air Temperature (°C)	43	43	60-80	60-80	60-80	60-80
Approx. burner capacity (Btu/hr)	1×10^5	4×10^6	2×10^6	4×10^6	4×10^6	8×10^6

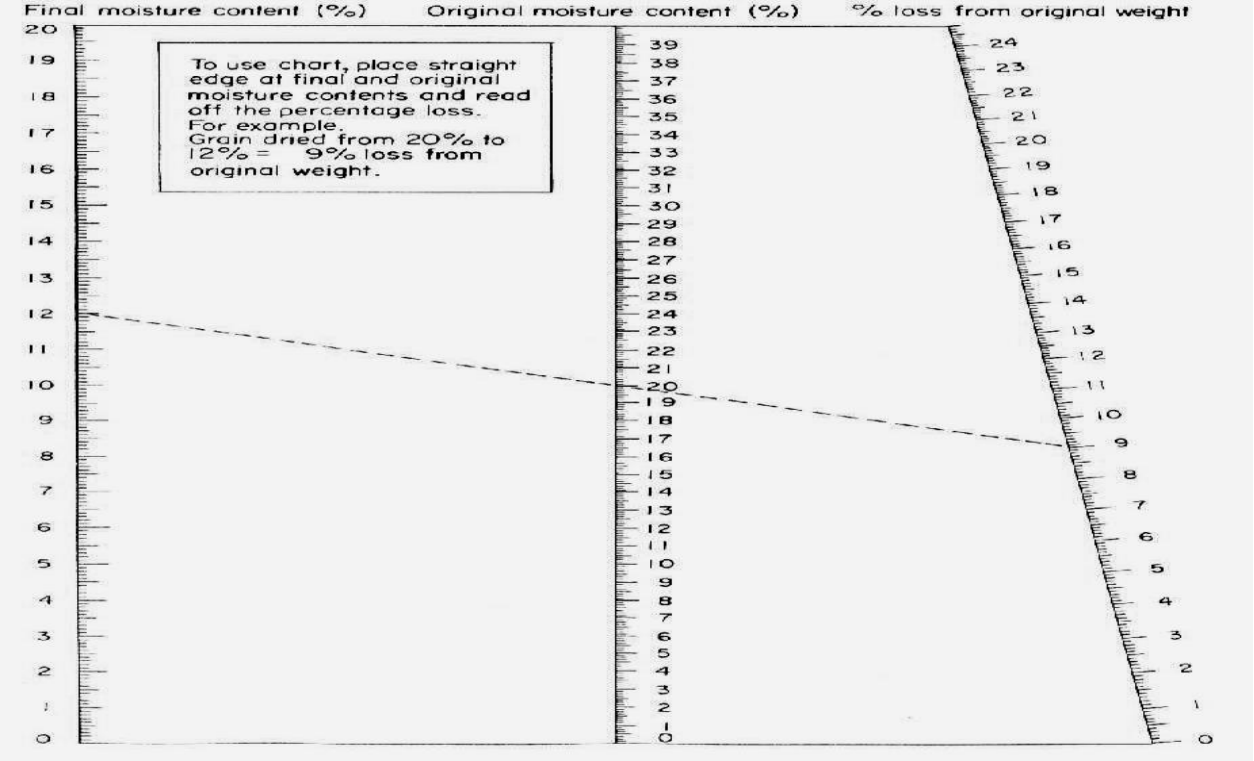
DRYER
Recommended Maximum Grain Depth and Minimum Airflow for Natural Drying of Paddy

	Moisture Content (%)		
	18	20	22
Recommended Depth (m)	2.44	2.44	1.83
Recommended Minimum Airflow (m^3/sec/m^3)	0.0269	0.0403	0.0538

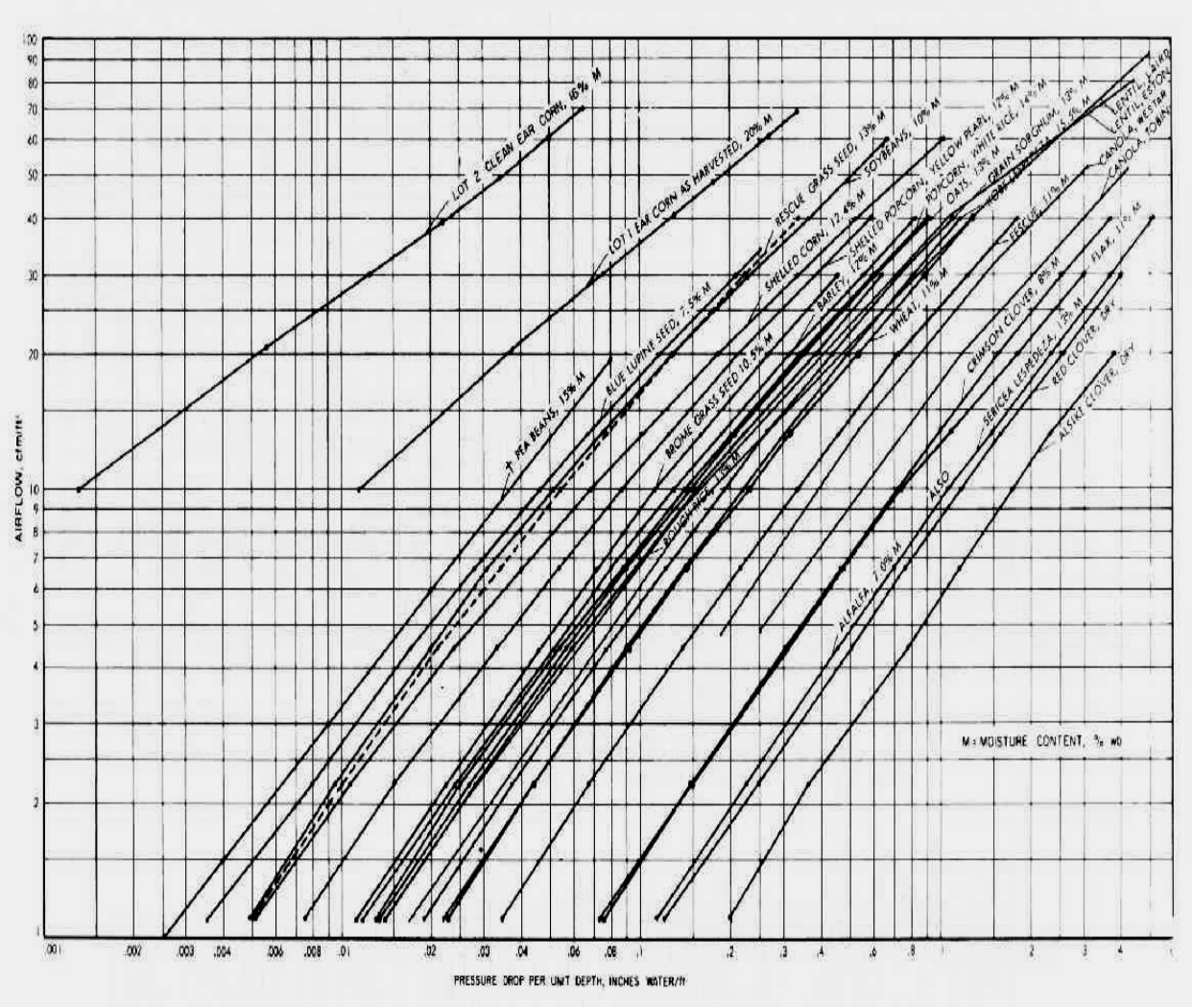
DRYER
Performance Requirements for Mechanical Dryers

Criteria	Batch	Continuous Flow
Moisture Gradient, max	2.0	2.0
Product Quality		
Cracked Grain % Increase, max	5.0	2.0
Head Yield % Reduction, max	5.0	5.0
Hulled/Damaged Grain Increase, max	3.0	3.0
Spillage %, max	0.5	0.5
Heat Utilization %, min	7.5	70

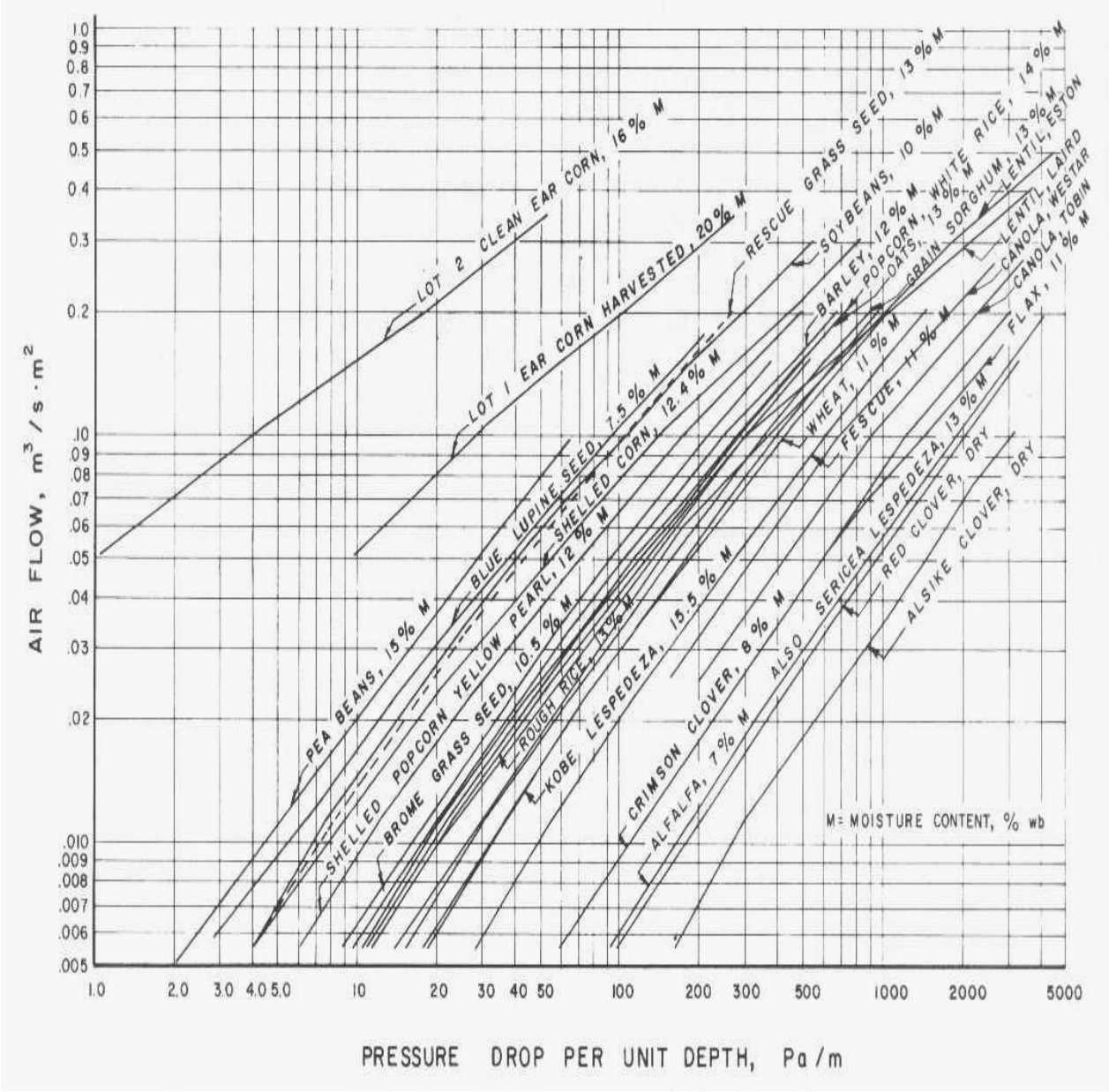
DRYER
Percentage Moisture Loss



DRYER
Resistance of Grain Seed to Airflow
(Shedd's Curve – English System)



DRYER
Resistance of Grain Seeds to Airflow
(Shedd's Curve - SI System)



DRYER
Suitability for Drying Vegetables

Vegetable	Suitability for Drying
Asparagus	Poor to fair
Beans, green	Fair to good
Beans, lima	Fair
Broccoli	Not recommended
Cabbage	Fair
Carrots	Good
Cauliflower	Poor
Celery	Poor
Okra	Fair to good
Onions	Good to excellent
Peas	Fair to good
Peppers, green or red	Good
Peppers, chili	Excellent
Popcorn	Good
Potatoes	Good
Pumpkins	Fair to good
Radishes	Not recommended
Corn, sweet	Good
Cucumbers	Poor
Eggplant	Poor to fair
Garlic	Good
Horseradish	Good
Lettuce	Not recommended
Mushrooms	Good
Mustard greens	Poor
Squash	Poor to fair
Sweet potatoes	Fair
Tomatoes	Fair to good
Turnips	Fair to good
Yams	Fair

DRYER
Drying Time and Preparation Requirement of Vegetables

Vegetable	Preparation	Blanching Time		Drying Time (Hours)
		Steam (min)	Water (min)	
Asparagus	Wash thoroughly. Cut large tips in half.	4 - 5	3à - 4à	4 - 6
Beans, green	Wash thoroughly. Cut in short pieces or lengthwise. (May freeze for 30 to 40 minutes after blanching for better texture)	2 - 2à	2	8 - 14
Broccoli	Trim, cut as for serving. Wash thoroughly. Quarter stalks lengthwise.	3 - 3à	2	12 - 15
Cabbage	Remove outer leaves; quarter and core. Cut into strips 1/8 inch thick.	2 1/2 - 3**	1à - 2	10 -12
Carrots	Use only crisp, tender carrots. Wash thoroughly. Cut off roots and tops; preferably peel, cut in slices or strips 1/8-inch thick	3 - 3à	3à	10-12
Cauliflower	Prepare as for serving.	4 - 5	3 - 4	12 - 15

DRYER
Drying Time and Preparation Requirement of Vegetables

Vegetable	Preparation	Blanching Time		Drying Time (Hours)
		Steam (min)	Water (min)	
Celery	Trim stalks. Wash stalks and leaves thoroughly. Slice stalks	2	2	10 - 16
Corn, cut	Select tender, mature sweet corn. Husk and trim. Cut the kernels from the cob after blanching.	5 - 6	4 - 5	6 - 10
Eggplant	Use the directions for summer squash	3à	3	12 - 14
Garlic	Peel and finely chop garlic bulbs. No other pretreatment is needed. Odor is pungent	No blanching needed.		6 - 8
Horseradish	Wash; remove small rootlets and stubs. Peel or scrape roots. Grate.	None		4 - 10

DRYER
Drying Time and Preparation Requirement of Vegetables

Vegetable	Preparation	Blanching Time		Drying Time (Hours)
		Steam (min)	Water (min)	
Mushrooms	Scrub thoroughly. Discard any tough, woody stalks. Cut tender stalks into short sections. Do not peel small mushrooms. Peel large mushrooms, slice.	None		8 - 10
Okra	Wash, trim, slice crosswise in 1/8 to an inch disks.	None		8 - 10
Onions	Wash remove outer "paper shell". Remove tops and root ends, slice 1/8-to an inch thick.	None		3 - 9
Peas, green	Shell.	3	2	8 - 10
Peppers and Pimientos	Wash, stem, core. Remove "partitions." Cut into disks about 3/8-by 3/8-inch	None		8 - 12
Potatoes	Wash, peel. Cut into shoestring strips an inch thick, or cut in slices 1/8-inch thick.	6 - 8	5 - 6	8 - 12

DRYER
Drying Time and Preparation Requirement of Vegetables

Vegetable	Preparation	Blanching Time		Drying Time (Hours)
		Steam (min)	Water (min)	
Pumpkin and hubbard squash	Cut or break into pieces. Remove seeds and cavity pulp. Cut into 1-inch strips. Peel rind. Cut strips crosswise into pieces about 1/8-inch thick	2 - 3à	1	10 - 16
Squash, summer	Wash, trim, cut into an inch slices	2à - 3	1à	10 - 12
Tomatoes, for stewing	Steam or dip in boiling water to loosen skins. Chill in cold water. Peel. Cut into sections about an inch wide, or slice. Cut small pear or plum tomatoes in half.	3	1	10 -18

DRYER
Drying Time and Preparation Requirement for Fruits

Fruit	Prepa-ration	Pretreatment (Choose One)			Other	Drying Timer (hours)
		Sulfur	Blanch			
			Steam (min)	Syrup (min)		
Apples	Peel and core cut into slices or rings about 1/8-inch thick	3/4	3-5 (depending on texture)	10	-ascorbic acid solution-ascorbic acid mixture-fruit juice dip-sulfate dip	6-12
Apricots	Pit and halve. May slice if desired.	2	3-4	10	-ascorbic acid solution-ascorbic acid mixture-fruit juice dip-sulfate dip	24-36
Bananas	Use solid yellow or slightly brown-flecked bananas. Avoid bruised or overripe bananas. Peel and slice 1/4-inch to 1/8-inch thick, crosswise or lengthwise.				-honey dip- ascorbic acid solution- ascorbic acid mixture-fruit juice dip-sulfite dip	8-10

DRYER
Drying Time and Preparation Requirement for Fruits

Fruit	Prepa-ration	Pretreatment (Choose One)			Other	Drying Timer (hours)
		Sulfur	Blanch			
			Steam (min)	Syrup (min)		
Berries Firm: Soft:	Wash and drain berries. With waxy coating blueberries, cranberries, currants, gooseberries, huckleberries Boysenberries and strawberries				-plunge into boiling water 15-30 seconds to "check" skins. Stop cooking action by placing fruit in ice water. Drain on paper towels -no treatment necessary	24-36 24-36
Cherries	Stem, wash, drain, and pit fully ripe cherries. Cut in half, chop or leave whole.			10 (for sour cherries)	-whole: dip in boiling water 30 seconds or more to check skins. -cut and pitted: no treatment necessary	24-36

DRYER
Drying Time and Preparation Requirement for Fruits

Fruit	Prepa-ration	Pretreatment (Choose One)			Other	Drying Timer (hours)
		Sulfur	Blanch			
			Steam (min)	Syrup (min)		
Citrus peel	Peels of citron, grapefruit, kumquat, lime, lemon, tangelo and tangerine can be dried. Thick-skinned navel orange peel dries better than thin-skinned Valencia peel. Wash thoroughly. Remove outer 1/6-to 1/8-inch of peel. Avoid white bitter pith.				-No treatment	8-12

DRYER
Drying Time and Preparation Requirement for Fruits

Fruit	Prepa-ration	Pretreatment (Choose One)			Other	Drying Timer (hours)
		Sulfur	Blanch			
			Steam (min)	Syrup (min)		
Figs	Select fully ripe fruit. Immature fruit may sour before drying. Wash or clean whole fruit with damp cloth. Leave small fruit whole, otherwise cut in half.	1 (whole)			-Whole: dip in boiling water 30 seconds or more to check skins. Plunge in ice water to stop further cooking. Drain on paper towels.	6-12**
Grapes Seedless:	Leave whole				-Whole: dip in boiling water 30 seconds or more to check skins. Plunge in ice water to stop further cooking. Drain on paper towels.	12-20
With Seeds:	-Cut in half and remove seeds.				-Halves: No treatment necessary.	

DRYER
Drying Time and Preparation Requirement for Fruits

Fruit	Prepa-ration	Pretreatment (Choose One)			Other	Drying Timer (hours)
		Sulfur	Blanch			
			Steam (min)	Syrup (min)		
Nectarines and Peaches	When sulfuring pit and halve; if desired, remove skins. For steam and syrup blanching, leave whole, then pit and halve. May also be sliced on quartered.	2-3 (halves) 1 (slices)	8	10	-ascorbic acid solution-ascorbic acid mixture-fruit juice dip-sulfuring	36-48**
Pears	Cut in half and core. Peeling preferred. May also slice or quarter.	5 (halves) 2 (slices)	6 (halves)	10	-ascorbic acid solution-ascorbic acid mixture-fruit dip.	-sulfiting 24-36**

DRYER
Drying Time and Preparation Requirement for Fruits

Fruit	Prepa-ration	Pretreatment (Choose One)			Other	Drying Timer (hours)
		Sulfur	Blanch			
			Steam (min)	Syrup (min)		
Persim-mons	Use firm fruit of long, soft varieties or fully ripe fruit of round drier varieties. Peel and slice using stainless steel knife.				-may syrup blanch	12-15**
Pineapple	Use fully ripe, fresh pineapples. Wash, peel and remove thorny eyes. Slice lengthwise and remove core. Cut in 1/2-inch slices, crosswise.				-No treatment necessary	24-36
Plums (Prunes)	Leave whole or if sulfuring, halve the fruit.	1			-Sun drying: (whole dip in boiling water 30 seconds or more to check skins. -Oven or dehydrator drying: rinse in hot tap water.	24-36**

DYNAMOMETERS
Recommended Kind for Given Engine Speed and Output

Kind of Dynamometers	Standard Measuring Range	
	RPM	Output (PS)
Prony Brake	less than 1,000	less than 10
Hydraulic Dynamo	less than 2,500	less than 2,000
Fan dynamo	less than 2,000	less than 200
Electric Dynamo	750 – 4,000	less than 30,000
Torsional dynamo	1,000 – 2,000	less than 50,000

ELECTRIC MOTOR
Full Load Efficiency Range

Horsepower	NEMA Design B Standard, 3-phase Induction Motor	3-phase 4-pole Energy Efficient Motor
1	68-78	80-84
1.5	68-80	81-84
2	72-81	81-84
3	74-83	83.-88.5
5	78-85	85-88.5
7.5	80-87	86-90.5
10	81-88	87.5-90.5
15	83-89	89.5-91.5
20	84-89	90-93
25	85-90	91-93
30	86-90.5	91-93
40	87-91.5	91.5-93
50	88-92	91.5-94
60	88.5-92	91-94
75	89.5-92.5	92-95
100	90-93	93-95
125	90.5-93	93-95
150	91 - 93.5	93-96
200	91.5 - 94	94-95
250	91.5 - 94.5	

ELECTRIC MOTOR
Wire and Fuse Sizes
(Single-Phase Induction Motors Full-Load Currents) 220 Volt

Motor, hp	Approx. Full-Load Current	Extension-Cable Wire Size	Branch-Circuit Fuse Size	Approx. Rating Overload Protection
1/6	1.6	16	15	1.8
1/4	2.3	16	15	2.6
1/2	3.7	14	15	4.3
3/4	5.1	12	15	5.9
1	6.5	12	20	7.5
1 1/2	9.2	10	30	10.6
2	12.0	10	40	13.8
3	17.0	8	50	19.6
5	28.0	6	60	33.4

ELECTRIFICATION
Load Requirement for Farm Building

Building	Electric items	Min. value watts	Design value*
Farm shop	General lighting, bench grinder, drill air compressor, trouble lamp, portable saw; optional: welder, soldering iron, battery charger	4, 600	3 watts/sq. ft floor area plus 3,300 watts if no welder but plus 7,000 watts if welder will be selected
Poultry brooding	Electric brooder, general lighting, service lighting; optional: ventilation fan, automatic feeder, water warmer	1, 150	4 watts per chick if small flock, 3 watts per chick if large (1000 or more) flock, 4 watts for chick for any size flock with infrared brooders
Poultry laying	Artificial lighting, feed-room lights, egg-room lights, egg cooler; optional: egg candler, vent fan, exhaust fan for egg- room, debiller, automatic feeder, water warmer, washer, grader	2, 300	5 watts per bird plus 1,320 watts/hp of automatic feeder
Dairy barn	Vacuum pump, lighting, vent fan, convenience outlets; optional: pail heater, dehorner, gutter cleaner, clippers	3, 450	200 watts per cow for first 20 cows and 60 watts per cow for those in excess of 20, plus 1,320 watts/hp of gutter cleaner
Milking room (parlor)	Vacuum pump, (pipeline), lighting, vent fan, convenience outlets	2, 300	900 watts per stall
Milk house	Lighting , milk cooler, water heater lamps, vent fan; optional: electric hoists	4, 600	250 watts per cow for first 20 cows and 100 watts per cow for those in excess of 20
General-purpose barn	Lighting, convenience outlets, hammer mill, mixer, elevator conveyor equipment; optional: hay drier fan, vent fan, heat lamps, clippers, deicers	3, 450	30 watts/sq. ft outside dimensions plus 1,320 watts/hp each motor
Pig farrowing Residence	Heat lamps, service lighting Lights and appliances	2, 300 4, 000 without range, 12, 000 with range	500 watts per pen 14 watts/sq. ft outside dimensions

* Add 1,320 watts/hp for each motor not listed in the "Electrical items" column.

ELECTRIFICATION
Copper Wire Properties

Wire size, AWG	Current-carrying, amp (2 or 3 wires in cable or raceway)	Area cir. mils	Weight of bare wire, lb/1, 000 ft	Resistance ohms/1, 000 ft, 20 °C	Current-carrying capacity, amp (single wire in open air)
14	15	4 , 107	12.43	2.58	20.0
12	30	6 ,530	17.77	1.62	25.0
10	30	10, 380	31.43	1.02	40.0
8	40	16, 510	49.98	0.641	55.0
6	55	26, 250	79.46	0.410	80.0
4	70	41, 740	126.4	0.259	105.0
3	80	52, 640	159.3	0.205	120.0
2	95	66, 370	200.9	0.162	140.0
1	110	83, 690	253.3	0.129	165.0
0	125	105, 500	319.5	0.102	195.0
00	145	133, 100	402.8	0.081	225.0
000	165	167, 800	507.9	0.064	260.0
0000	195	211, 600	640.5	0.051	300.0
Wire	215	250, 000	772.0	0.043	340.0
Size =	240	300, 000	926.0	0.036	375.0
Area,	260	350, 000	-	0.031	420.0
Cir	280	400, 000	-	0.027	455.0
Mils	320	500,000	-	0.022	515.0

*For types T, R, TW, and RW insulations.

ELECTRIFICATION
Suggested Illumination for Farmstead Areas

Area	Illumination (foot-candles)
Machine shop	
General	10 - 15
Close work	30 - 40
Hay and grain storage	2
General storage	3 - 5
Stairways	5
General work areas	9 - 11
Vegetable grading and packing	30
Tobacco grading	100
Service-drive alleys	4 - 5
Service-walk alleys	9 - 11
Milk house	30 - 40
Milking area	20 - 25
Pump house	5
Laundry area	40
Yard lighting	1 - 5
Animal-bedding area	2
Poultry-laying lights	3 - 4
Animal-feeding areas	3 - 5
Feeding grinding	10
General illumination in residence	5 - 7
Laundry	10
Reading area	30
Seed cleaning and separating	20
Egg handling	10
Clod-storage room	5
Attic, storage	4 - 5
Cellar, storage	4 - 5
Kitchen (general)	10
Work, range, sink	40
Loading platform	3 - 5

ELECTRIFICATION
Fluorescent Lamps* - Preheat Starting: Lumen Ratings for Lamps

Watts	Tube length, in.	Rated lumens			
		3500° white	Daylight	Soft white	2500° white
6	9	210	186	-	198
8	12	330	295	-	310
13	21	585	520	-	545
14	15	490	435	380	460
15	18	615	585	480	600
20	24	920	800	700	860
30	36	1,470	1,350	1,170	1,380
40	48	2,300	1,920	1,720	2,100
100	60	4,200	3,900	3,300	4,000

*****Average values.

ELECTRIFICATION
Incandescent Lamps:* Lumen Ratings for Lamps

Watts	Initial lumens	Lumens at 70% rated life	Rated average laboratory life, hr
6	40	-	1,500
10	79	72	1,500
15	140	121	1,200
25	260	217	1,000
40	468	428	1,000
50	660	625	1,000
60	828	786	1,000
75	1,110	987	750
100	1,620	1,530	750
150	2,580	2,340	750
200	3,640	3,240	750
300	5,820	5,160	750

*Inside-frosted bulb.

ELECTRIFICATION
Types of Conductor Insulation

Trade Name	Type Letter	Where used
Code rubber	R	General use
Heat-resistant rubber	RH	General use
Moisture-resistant rubber	RW	General use and wet locations
Thermoplastic	T	General use
Moisture-resistant thermoplastic	TW	General use and wet locations
Weatherproof	WP	Wet locations; inside open wiring by special permission
Underground cable	UF	Suitable for direct burial in the earth and general use
Range cable	SR, SRT	Rubber or neoprene or thermoplastic cover; suitable for damp places
Service-entrance cable	ASE, SE, USE	Used as service-entrance conductors, range, clothes drier, and some water heaters
Mineral insulation	MI	General use and wet locations

ELECTRIFICATION
Resistance Properties of Certain Metals and Alloys

Material	Resistivity at 68°F, ohms/cir mil-ft
Silver	9.8
Annealed copper	10.4
Hard-drawn copper	10.8
Annealed aluminum	17.0
Hard-drawn aluminum	17.5
Tungsten (annealed)	26.3
Zinc	33.2
High brass	50.0
Pure iron	60.0
Steel wire	64 - 106
Manganin	290.0
Constantan	300.0
Cast iron	450 - 600
Nichrome	675.0

ENERGY
Conversion Factors

Source	Amount	Equivalent
Electricity	600 kwh	1.000 BOE
Gasoline	1000 li	6.182 BOE
Kerosene	1000 li	6.449 BOE
Diesel Oil	1000 li	6.717 BOE
Fuel Oil	1000 li	7.027 BOE
Av Turbo	1000 li	6.742 BOE
L P G	1000 kg	8.439 BOE
Coal	1000 kg	3.047 BOE
Wood*	1 MT	1.626 BOE
Charcoal**	1 MT	4.283 BOE
Bagasse*	1 MT	1.701 BOE
Biogas	1000 cu.m.	1.213 BOE

* Assumed 50% moisture

** Assumed 10% moisture

ENGINE
Brand and Made

Engine	Made
ACME Engines	ACME Motori S.PA 31049 Valdobbiadene, Travisoo, Italy
Honda Engines	Honda Motor, Co. Ltd. Tokyo, Japan
Kohler Engines	Kohler Co. Koohler, Wisconsin, 53044 USA
Kubota Engines	Kubota, Ltd 2-47 Shikitsuhigashi 1- chome, Nanuaku, Osaka, Japan
MAG Kerosene Engine	Motosacoche SA, Geneva, Switzerland
Mitsubishi Katsura Diesel Engine	Mitsubishi Heavy Ind., Ltd Taiwan, Republic of China
Robin Engines	Fuji Heavy Industries LTd. Engine and Machinery Division, Subam Building 1-7-2 Nistru-Shinjuku-ku Tokyo 160 Japan
Yanmar-Yeh Hsing Diesel Engine	Yanmar Group Yeh Shing Industrial Machinery Co., Ltd. No. 106 1-sec, Chung Hsiao, W. Road, Taipei
Ducati Air Cooled Diesel Engine	Ducati Meccanica S.P.A. VIA A.C. Ducati, 3 Borgo Panigele – 40100, Italy

ENGINE
Specifications

Brand	ACME	Ducati	Honda	Robin
Model	AON 48W	IS 7	GX 160	EY 15 D
Type	4-stroke vertical air cooled diesel	4-cycle vertical air cooled	4-cycle air cooled, gasoline horizontal shaft	Air cooled, 4 cycle gasoline, horizontal, PTO shaft
Bore x Stroke	85 mm x 85 mm	75 mm x 78 mm	68 mm x 45 mm	63 mm x 46 mm
Displacement	482 cc	345 cc	163 cc	143 cc
Output Power	11.3 hp/3000 rpm	7.5 hp / 3200 rpm	5.3 hp/3600 rpm	3.5 hp/4000 rpm
Maximum torque	2.52 kg-m/2058 rpm		1.1 kg-m/2500 rpm	0.68 kg-m/2800 rpm
Ignition system	Direct injection		Transistor	
Maximum fuel consumption	2.66 li/hr	193gts/hp-hr	240 g/hp-hr	
Dry Weight	55 kg	48 kg	14 kg	13.2 kg

ENGINE
Classification by Crankshaft Speed

Classification Ignition system	Low Speed	Middle Speed	High Speed
Electric spark plug	Less than 800 r.p.m.	800 – 2,500 r.p.m.	more than 2,500 r.p.m.
Injection	Less than 700 r.p.m.	700 – 1,000 r.p.m.	more than 1,000 r.p.m.

ENGINE
Relationship Between Color of Exhaust Gas and Suitability of Mixing Ratio of Fuel and Air

Color of Exhaust Gas	Mixing Ratio of Fuel and Air
Colorless	optimum
Black	fuel ….. excessive
Light Yellow	air …… excessive
Gray	fuel and lubricating oil … excessive
Light Sky Blue	lubricating oil …… excessive

ENGINE
Fuel Specific Gravity

Fuel	Specific Gravity
gasoline	0.67 – 0.76
kerosene	0.78 – 0.85
light oil	0.81 – 0.83
heavy oil	0.85 – 0.91

ENGINE
Lubrication Oil and Viscosities

SAE No.	Range of viscosity; Saybolt universal (seconds)			
	0^0F		210^0F	
	min.	max.	min.	max.
5W	-	4000	-	-
10W	6000(a)	12000	-	-
20W	12000(b)	48000	-	-
20	-	-	45	58
30	-	-	58	70
40	-	-	70	85
50	-	-	85	110

ENGINE
Firing Orders (4 Stroke Cycle)

No. of Cylinder	Order of Firing
2	O Δ No. 1 – No. 2
3	O O Δ No. 1 – No. 2 – No. 3
4	O O Δ Δ No. 1 – No. 2 – No. 4 – No. 3
6	O O O Δ Δ Δ No. 1 – No. 5 – No. 3 – No. 6 – No. 2 – No. 4

ENGINE
Ignition Systems

Contact or Non Contact Power Source	Contact System	Non- Contact System
Magnet Battery	contact type magnet contact-type distributor	Transistor magnet Capacitor discharge ignition magnet Transistor ignition

ENGINE
Governor

Engine		JIS No.	Instantaneous Performance	Stabilizing Performance
Kind	**Size & Use**			
Kerosene, Diesel	small size for land use	JIS B 8010	less than 20% 15%	less then 10% 8%
Diesel	small size for boat	JIS F 4303	less than 12%	-

ENGINE
Calorific Value of Fuel

Kind of fuel	Calorific Value (Kcal/kg)
Gasoline	10,500 – 11,000
Kerosene	10,500
Light oil	10,500
Heavy oil	10,500
Benzol	9,600
Methyl alcohol	4,830
Ethyl alcohol	6,720
Natural gas	8,000 – 13,000

ENGINE
Thermal Efficiency & Losses

Kind of Engine	Kerosene		Gasoline E (small size)	Diesel E (4 cycle)	Gas E	Hot bulb E (2 cycle)
	Low speed	Middle speed				
r.p.m.	400-900	1000-1500	1300-1800	500-1000	100-500	300-350
Indicated therm. eff.	25-27	19-24	26-29	39-41	34-40	28-37
Effectiv therm. eff.	17-22	16-20	21-23	29-33	25-36	18-27
Cooling loss	40-39	41-40	37-34	25-24	35-23	18-23
Deliveryy loss	33-32	30-31	33-31	39-34	35-37	56-40
Mechanical loss	10-7	13-9	9-12	7-9	5-7	8-10

ENGINE
Fuel Consumption Ratio

Kind of Engine	Fuel	Fuel Consumption Ratio (g/ps/hr)
Kerosene (middle speed)	light oil	300 – 390
Gasoline	gasoline	200 – 350
Diesel (4 cycle)	heavy oil	180 –220
Hot bulb (2 cycle))	heavy oil	260 – 310
Gas E	gas	2,300 – 2,800

ENGINE
Specifications of Locally Available Engines

Brand	Make	Type	Rated Engine Speed (rpm)	Horse power (hp)	Bore x stroke (mm)	CR	Max. power output indicated rpm (kw/rpm)	Max. torque at indicated rpm (kg-m/rpm)	Specific fuel consumption (g/kw-hr)
ACME Diesel Engine	Italy	4-stroke vertical, 1 cylinder, diesel engine	3000	11.3	85 x 85	19:1	7.35/3009	2.52/2058	282.2
ACME Gasoline Engine	Italy	4-stroke, vertical, overhead, 1-cylinder, gasoline engine	3600	11.0	80 x 65	7:1	6.39/3315	2.09/2247	354.1
CIXI Diesel Engine	China	4-stroke, horizontal, 1-cylinder, diesel engine	2600	5.0	75 x 75	-	3.34/2324	1.5/2001	360.0
HONDA Diesel Engine	Japan	4-stroke, overhead, 1-cylinder, diesel engine	3600	6.0	76 x 70	19:1	5.01/3461	1.643/2591	292.1
HONDA Gasoline Engine	Japan	4-stroke, diagonal, 1-cylinder, gasoline engine	3600	8.0	-	-	5.11/3303	1.59/2979	383.5

ENGINE
Specifications of Locally Available Engines

Brand	Make	Type	Rated Engine Speed (rpm)	Horse power (hp)	Bore x stroke (mm)	CR	Max. power output indicated rpm (kw/rpm)	Max. torque at indicated rpm (kg-m/rpm)	Specific fuel consumption (g/kw-hr)
Katsura Mitsubishi Diesel Engine	Tai-wan, China	4-stroke, horizontal, 1-cylinder diesel engine	2200	5.5	68 x 80	-	5.03/2373	1.96/1276	367.3
MAG Kerosene Engine	Swit-zer-land	4-stroke, horizontal, 1-cylinder kerosene engine	3800	7.0	74 x 60	-	3.0/3562	1.01/2524	753.4
Mitsubishi Diesel Engine	Thai-land	4-stroke, horizontal, 1-cylinder, diesel engine	2400	7.0	76 x 78	18:1	4.69/2230	2.14/1297	241.9
Mitsubishi Shakti Engine	India	4-stroke, horizontal, 1-cylinder, diesel engine	2200	9.0	90 x 95	21:1	6.46/2173	3.031/2053	231.2
RUGGER INI Motor	Italy	4-stroke, horizontal, 1-cylinder, diesel engine	3000	11.0	-	-	7.27/2873	2.50/2460	284.9

ENGINE
Specifications of Locally Available Engines

Brand	Make	Type	Rated Engine Speed (rpm)	Horse power (hp)	Bore x stroke (mm)	CR	Max. power output indicated rpm (kw/rpm)	Max. torque at indicated rpm (kg-m/rpm)	Specific fuel consumption (g/kw-hr)
Shakti Diesel Engine	India	4-stroke, horizontal, 1-cylinder, diesel engine	3000	10.0	80 x 90	20:1	5.09/1559	4.20/1172	369.3
Shuangniao Diesel Engine	China	4-stroke, horizontal, 1-cylinder, diesel engine	2000	4.0	70 x 75	-	3.39/2204	1.5/2204	297.4
TARO Diesel Engine	China	4-stroke, horizontal, 1-cylinder, diesel engine	2400	8.0	80 x 75	-	5.33/2179	2.529/1937	387.6
Tsinkiang Diesel Engine	China	4-stroke, horizontal, 1-cylinder, diesel engine	2600	6.0	75 x 75	-	4.09/2498	3.91	313.1
Wisconsin Gasoline Engine	United Stated of America	4-stroke, horizontal, 1-cylinder gasoline engine	3600	14.1	95 x 76	-	9.16/3310	2.95/2306	410.4

ENGINE OIL
API Service Classification for Diesel Engine

Classification	Definition
CA	Light-duty diesel engine service Service typical of diesel engines operated in mid to moderate duty quality fuels.
CB	Moderate-duty diesel engine service Service typical of diesel engines operated in mild to moderate duty with lower quality fuel which necessitate more protection from wear and deposits.
CC	Moderate-duty diesel and gasoline engine service Service typical lightly supercharged diesel engines operated in moderate to severe duty.
CD	Severe-duty diesel engine service Service typical of supercharged diesel engines in high-speed, high-output duty requiring highly effective control of wear and deposit.

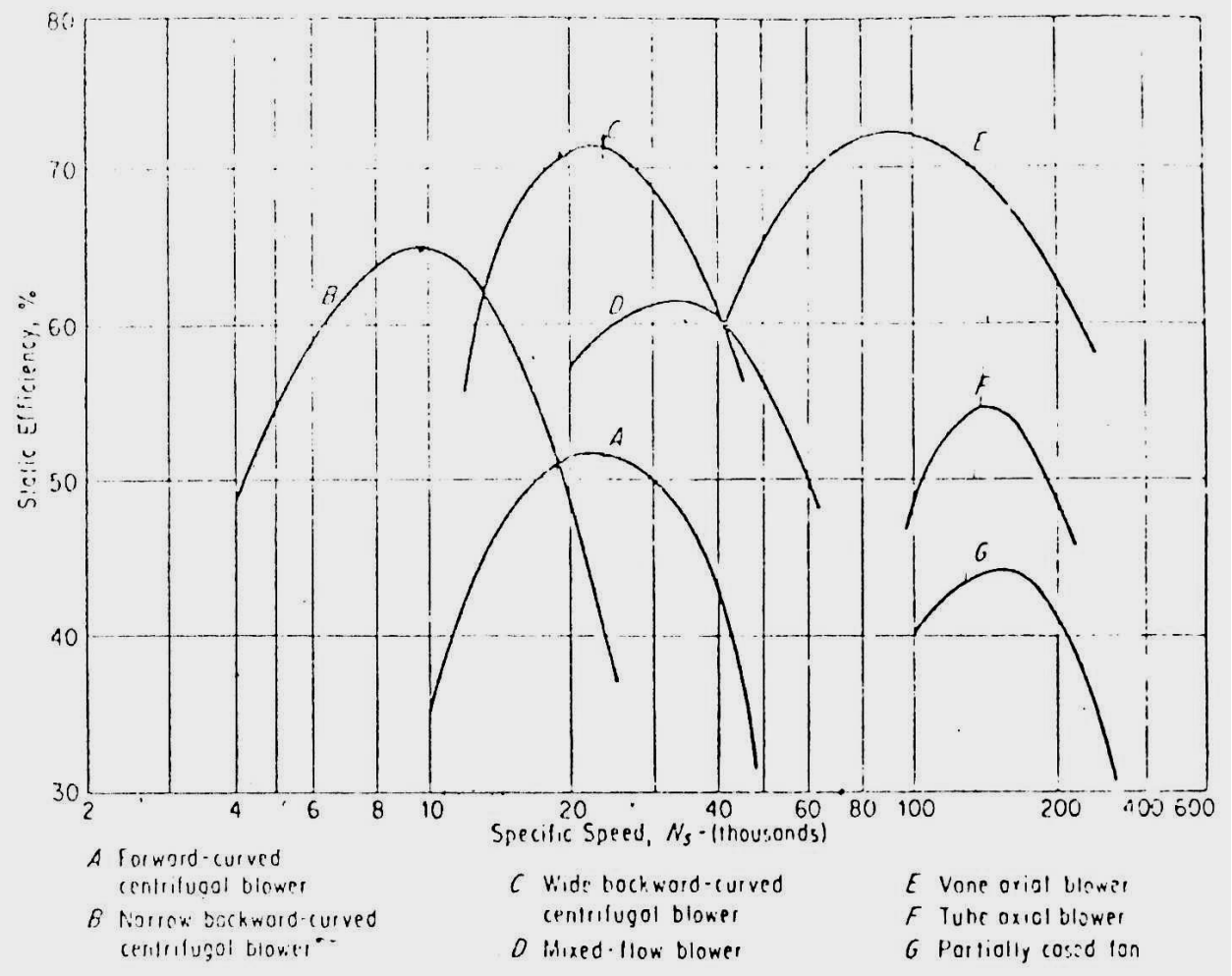
FAN
Comparisons of Backward and Forward Curved Fans

Backward Curve	Forward Curve
More expensive	Have lower noise level
Have no overloading characteristics	Have overloading characteristics
Operates against high pressure (0-30 cm water)	Normally operate in low pressure range (0-15 cm water)
Have no unstable region of operation	Have one unstable operating region
Sturdy construction and easy to install	Usually of light construction

FAN
Typical Pressure and Flow Coefficient

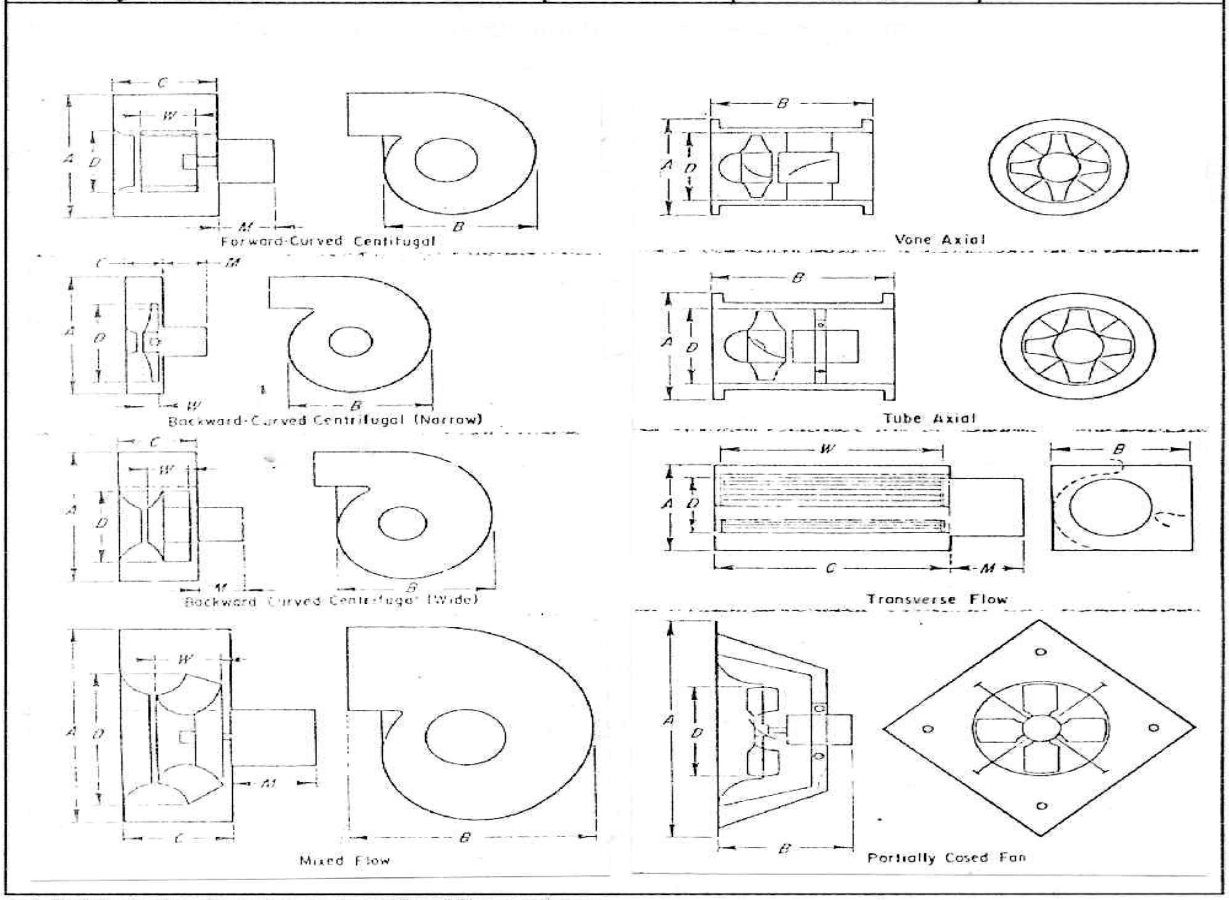
Air Moving Unit	Specific Speed	Typical Pressure Coefficient (Ψ)	Typical flow Coefficient (ϕ)
Forward Curve Centrifugal	13000	1.00	0.150
	20000	2.00	0.500
	40000	1.00	0.750
Backward-Curved Centrifugal (narrow)	4000	1.40	0.002
	8000	1.00	0.010
	20000	0.80	0.100
Backward-Curved Centrifugal (wide)	15000	1.00	0.080
	30000	0.75	0.300
	45000	0.50	0.500
Mixed Flow	20000	1.00	0.200
	30000	0.75	0.300
	60000	0.50	0.800
Vane Axial	50000	0.70	0.400
	80000	0.40	0.250
	200000	0.20	0.200
Tube Axial	100000	0.30	0.400
	150000	0.20	0.300
	200000	0.10	0.100
Partially Case Fan	100000	0.30	0.400
	150000	0.20	0.300
	300000	0.05	0.100

FAN
Static Efficiency of Various Fan Types



FAN
Casing Dimension

Fan or Blower	Dimension		
	A	B	C
Forward-Curved Centrifugal	1.7 D	1.5 D	1.25 W + 0.1 D
Backward-Curved Centrifugal (Narrow)	1.4 D	1.35 D	W + 0.1 D
Backward-Curved Centrifugal (Wide)	2.0 D	1.6 D	W + 0.16 D
Mixed-Flow		2.0 D	
Vane Axial	2.0 D	1.2 D	0.46 D
Tube Axial		1.0 D	
Traverse Flow	2.2 D	2.2 D	W + D / 4
Partially Cased Fan		0.5 D	



*D & W are the diameter and width of fan or blower.

FARM EQUIPMENT
Capacity, Power Requirement, and Fuel Consumption Rate

Machine	Capacity	Power Requirement	Fuel Consumption Rate
Power Tiller IRRI PT-3	1 to 1.5 ha/day	4-6 hp diesel 5-8 hp gasoline	0.61 liter/hr diesel 0.86 liter/hr gasoline
Power Tiller IRRI PT-5	0.6 ha/day plowing 0.9 ha/day harrowing 2.5 ha/day reaping	5 hp gasoline	1.1 liters/hr
. Hydro Tiller IRRI HT-1	1.8 ha/day first pass 2 hac/day second pss	10 hp gasoline 6.5-9 hp diesel	1.5 li/hr gasoline 1.0 li/hr diesel
Cono Puddler Mounted on power tiller	1.5 ha/day		1.6 li/hr
Cono Puddler Animal drawn	1 ha/day	1 draft animal	
IITA-IRRI Rolling Injection Planter	16,000 hills/hr	1 person	
IRRI TR 6-Row Rice Transplanter	0.3-0.4 ha/day	1 person	
IRRI Drum Seeder	1 ha/day	14 man hrs/ha	

FARM EQUIPMENT
Capacity, Power Requirement, and Fuel Consumption Rate

Machine	Capacity	Power Requirement	Fuel Consumption Rate
IRRI Watt-Miser Electric Pump	1-3 ha	0.5-1.5 hp electric motor	
MA-IRRI "Tapak-Tapak" Pump	3 li/sec for a 2-m lift 2 li/sec for a 4-m lift	1 person	
IRRI "Sipa" Pump			
100 mm	1200-1500 li/min	4-5 hp gasoline 3-4 hp diesel	
150 mm	2000-3000 li/min	5-7 hp gasoline 4-6 hp diesel	
190 mm	3500-5000 li/min	7-10 hp gasoline 6-8 hp diesel	
250 mm	5500-7000 li/min	10-14 hp gasoline 9-12 hp diesel	

FARM EQUIPMENT
Capacity, Power Requirement, and Fuel Consumption Rate

Machine	Capacity	Power Requirement	Fuel Consumption Rate
IRRI Axial Flow Pump	3000 li/min	5 hp gasoline or diesel 3 hp electric motor	1.2 li/hr gasoline
IRRI Diaphragm Pump	190 li/min @ 1-m head 120 li/min @ 2-m head	1 man	
Push-Type Single Row Cono Weeder	0.18 ha/day	40-50 man-hr/ha	
Push-Type Two Row Cono Weeder	0.26 ha/day	25-35 man-hr/ha	
Push-Type Hand Weeder		35-75 man-hr/ha	
IRRI Plunger-Auger Fertilizer Injector	0.5 ha/day	16 man-hr/ha	
IRRI RE2-1.0 m Reaper	2.4 ha/day	5 hp gasoline	1 li/hr
CAAMS-IRRI 1.0m Reaper	2.4 ha/day	3 hp gasoline	1 li/hr
IRRI TH-6 Portable Thresher	600 kg/hr	5 hp engine	1 li/hr
IRRI TH-7 Axial Flow Thresher	400-500 kg/hr	7 hp engine	

FARM EQUIPMENT
Capacity, Power Requirement, and Fuel Consumption Rate

Machine	Capacity	Power Requirement	Fuel Consumption Rate
IRRI TH12 Axial Flow Thresher/Sheller	1000-1500 kg/hr	12 hp gasoline 10 hp diesel	
AMDP Two Drum Corn Sheller model CS2-1000 w/ Aspirating Cleaner	1.0-1.2 tons/hr	5 hp gasoline or diesel	
Hand-Operated Corn Sheller	300-400 kg/day	1 person	
IRRI GC-7 Portable Grain Cleaner	1000 kg/hr	0.50 hp electric motor 1.0 hp gasoline	0.5 li/hr
IRRI DR-1 Batch Dryer		2 hp electric motor 3 hp gasoline	0.75 li/hr gasoline
UPLB Flatbed Dryer		3 hp electric motor 5 hp gasoline	

FARM EQUIPMENT
Capacity, Power Requirement, and Fuel Consumption Rate

Machine	Capacity	Power Requirement	Fuel Consumption Rate
IRRI Micromill	50 kg of paddy per hr	1 hp electric motor 3 hp gasoline	1 kw-hr/hr 0.5 li/hr gaoline
UPLB Improved Village Rice Mill	300 kg of paddy per hr		
IRRI 4-Row Ultralite Transplanter	0.20-0.25 ha/day	1 person	
AMDP-FMRC Rice Transplanter	0.45-0.55 ha/day	2 persons	
BPI Cassava Chipping Machine	300 kg/hr 1300 kg	1 person 1-3 hp motor or engine	

FARM EQUIPMENT
Dimension of Philippine, Thai and IRRI Plow

Types of Plow	Length of Moldboard L (cm)	Height of Mold-board H (cm)	Radius of Curvature of Moldboard (cm)	Cutting Angle of Plow	Share Angle	Inverting Angle
Philippine	22.50	18.50	25.03	10.00	7.65	50.00
Thai improved	14.50	18.00	26.00	25.00	18.00	42.00
IRRI	17.50	21.50	19.93	20.00	17.74	35.00

FARM EQUIPMENT
Power Tiller and Engine Performance

	Spiral Plow	Two Bottom disc Plow	Moldboard Plow	Spiral and Comb Harrow	Rotary Tilling
Rated Power, KW	6.7-9.0	3.0-9.0	5.2-7.5	9	7.5
Rated Speed, rpm	3200-3600	1800-3600	3000-3600	3600	3600
Axial Load, kg	55.8-92.2	25.2--1111.2	74.6--83.3		18.2-21.6
Axial Torque, kg-m	41.4-68.1	118.5--98	53.4-59.6		13.2-15.7
Axial Power, KW	2.5-5.19	1.15-6.10	3.92--3.78		1.88-4.65
Fuel Consumption li/hr	1.4-4.67	.97-5.8	2.22-2.48		1.45-2.65
Spec. fuel consumption, gm/kW-hr	269-941	269-844	470-580		417-770
Transmission Efficiency, %		77.5-87.6			80-81.7

FARM EQUIPMENT
Power Tiller Field Performance

	Spiral Plow	Two Bottom Disc Plow	Mold-board Plow	Spiral and Comb Harrow	Rotary Tilling
Travelling Speed, kph	1.02-2.70	2.45-4.9	3.44-4.10	1.49	1.69-2.94
Average depth of Tillage, mm	86-110	79-935	96-130	111	51-76
Average width of tillage, mm	1020-1250	305-579	234-287	1033	701-1005
Actual field capacity, ha/hr	.108-.205	.094-.198	.049-.085	.127	.106-.268
Theoretical field capacity, ha/hr	.204-.220	.101-.220	.055-.105	.178	.148-.310
Plowing efficiency, %5	53.6-93.2	53.7-97	80.3-90.3	70.2	71.6-88.4
Fuel Consumption , li/hr	.66-31.6	.64-4.27	.62-2.10	3.97	2.22-2.5
Noise level, db (A)	86-96	82-103	81-92	101	88-95

FARM EQUIPMENT
Fertilizer Applicator Metering Device Performance
Positive Metering Device for Granulated Crystalline Fertilizer

Metering Device	Suitability for Low and High Application Rates	Fertilizer rate Control	Ease of Cleaning	Relative Cost	Ease of Manufacture	Remarks
Vertical rotor with cells on the periphery	Very good	Difficult	Difficult as individual cells have to be cleaned	Moderate	Precision manufacturing difficult	Low inter-row variation Sensitive to topography of field
Revolving-bottom type	Good	Difficult	Difficult	High	Difficult	Particularly suited to row crop planters and high application rates
Star wheel	Very good	Difficult	Difficult	High	Difficult	Suitable for seed cum-fertilizer drills
Fluted roller	Very good	Easy	Flushing with water required after use	Moderate	Easy	Efficient operation when material is dry

FEED MILL
Specifications of Hammer Mill

Rotor Diameter, mm	1080	1080	560	560
Width of Crashing Chamber, mm	400	300	400	300
Main shaft Speed, rpm	1480	1480	2950	2940
Peripheral Velocity, m/s	84	84	86	286
Power, kw	90-110	55-15	30-37	22
Capacity, tph	15-18	9-12	5-6	3.5

FEED MILL
Energy Requirement for Feed Grinding (kW-hr/ton)

Crop	Hammer Mill	Burr Mill
Shelled Corn	7.4	3 – 5.8
Oats	11.5	5 – 14
Barley	9	4 – 10
Ear Corn	6	-
Hay	8	-

FEED MILL
By-Product and Percentage Composition of Various Agricultural Crops

Crop	By-Product	By-product feed as % original by weight
Castor	Castor Meal	50
Cocoa Bean	Cocoa shell meal	11
Coconut	Coconut meal	34 – 42
Cotton	Cottonseed meal	47
Maize	Corn bran	10
	Corn germ meal	19
Oil palm	Sludge (dried)	3
	Palm kernel meal	22
Peanut (unshelled)	Croundnut meal	43
Rice	Rice bran	10
	Broken rice	4
Rubber seeds	Rubber seed meal	50
Sago (trunks)	Coarse sawdust	60
	Crude wet sago	40
	Unrefined sago flour	21
	Sago refuse	19
Sesame	Sesame meal	80
Soya bean	Soya bean	78
Sugar Cane	Green tops	7
	Molasses	3
Sorghum	straw	-
Sweet potato	haulm	-
	Unsaleable tubers	-

FEED MILL
Specific Energy and Relative Energy Efficiency for Various Hammer Mill Hammer Thickness

Hammer Thickness (mm)	Specific Energy (kW-hr/ton)	Relative Energy Efficiency (%)
8.00	9.5	117
6.35	8.1	100
3.18	6.5	80
1.59	5.5	69

FEED MILL
Specific Energy Consumption (kW-hr/ton) for Grinding Corn with Different Hammer Thickness

Hammer Thickness (mm)	Hammer Tip Speed (m/s)		
	54	71	86
6.35	4.6	6.5	12.9
3.18	3.7	5.6	11.0
1.59	3.9	4.8	7.6

FEED MILL
Mixing Time of Various Feed Mixers

Feed Mixer	Mixing Time (min)
Horizontal – Type with Helical Screw	5 – 10
Vertical-Type with Screw	10 - 15

FEED MILL
Nutrient Standards for Swine Feeds

Kinds of Feeds	Crude Protein % NLT	Crude Fiber % NMT	Crude Fat % NMT	Moisture % NMT	Ash % NMT	Mineral % NMT
Hog Pre-Starter mash/Crumble/ Pellet	22	5	4	13	To be supplied by the feed manufacturer	If more than 5% the maximum percentage of calcium (Ca) or phosphorous (P) shall be indicated
Hog Starter Mash/Crumble/ Pellet	18	8	4	13		
Hog Grower Mash/Crumble/ Pellet	16	10	4	13		
Hog Breeder Mash/Crumble/ Pellet	14	12	4	13		
Hog Lactating Mash/Crumble/ Pellet	15	10	4	13		
Hog Fattener Finisher Mash/Crumble/ Pellet	13	10	4	13		

Legend: NLT - Not less than
NMT - Not more than

FEED MILL
Nutrients Standards for Poultry Feeds

Kinds of Feeds	Crude Protein % NLT	Crude Fiber % NMT	Crude Fat % NLT	Moisture % NMT	Ash % NMT	Mineral % NMT
For Broilers (meat-type chickens)					To be supplied by the feed manufacturer	If more than 5% maximum percentage of calcium (Ca) or phosphorous (P) shall be indicated
Broiler Starter mash/Crumble/Pellet	21	8	4	13		
Broiler Finisher Mash/Crumble/ Pellet	18	9	4	13		
For Egg-type Chickens						
Chicks Starter Mash/Crumble/ Pellet*	19	8	4	13		
Chicken Grower Mash/Crumble/ Pellet	16	10	4	13		
Chicken Layer mash/Crumble/Pellet No. 1	18	10	4	13		
Chicken Layer Mash/Crumble/ Pellet No. 2	16	10	4	13		

Legend: NLT - Not less than: NMT - Not more than

FEED MILL
Nutrients Standards for Poultry Feeds

Kinds of Feeds	Crude Protein % NLT	Crude Fiber % NMT	Crude Fat % NLT	Moisture % NMT	Ash % NMT	Mineral % NMT
For Pigeons					To be supplied by the feed manufacturer	If more than 5% maximum percentage of calcium (Ca) or phosphorous (P) shall be indicated
Pigeon Feeds Pellet	18	10	4	13		
For Turkeys						
Turkey Starter Mash/Crumble/ Pellet	28	8	4	13		
Turkey Grower Mash/Crumble/ Pellet No. 1	20	10	4	13		
Turkey Grower Mash/Crumble/ Pellet No. 2	16	10	4	13		
For Ducks						
Duck Starter Mash/Crumble/ Pellet	19	10	4	13		
Duck Grower Mash/Crumble/ Pellet	16	10	4	13		
Duck Layer Breeder Mash/Crumble/ Pellet	16	10	4	13		
Duck Finisher Mash/Crumble/ Pellet	16	10	4	13		

Legend: NLT - Not less than
NMT - Not more than

FISH
Storage Data

Product	Storage temperature ℃	Relative humidity %	Storage life
Cod, fresh	+0.5 to +2	85 to 95	6 to 12 days
Cod, frozen	-20 to –28		6 to 10 months
Haddock, fresh	+0.5 to +2	85 to 95	6 to 12 days
Haddock, frozen	-20 to –28		9 to 12 months
Halibut, fresh	+0.5 to +2	85 to 90	6 to 10 days
Halibut, frozen	-20 to -28	-	6 to 10 months
Herring, fresh	+0.5 to +2	85 to 90	6 to 10 days
Herring, smoked	+4.5 to 10	50 to 60	3 to 4 months
Herring, frozen	-20 to -28		6 to 10 months
Mackerel, fresh	+0.5 to +2	85 to 90	6 to 9 days
Mackerel, frozen	-220 to -28		3 to 6 months
Shellfish, fresh	-1 to 0.5	85 to 95	3 to 7 days
Shellfish, frozen	-20 to -30	90 to 95	3 to 6 months
Tuna, fresh	+0.5 to +2	85 to 95	6 to 12 days
Tuna, frozen	-20 to -28		9 to 12 months

FISH
Thermal Properties

Product	Freezing temperature ℃	Specific heat above freezing kJ/kg ℃	Specific heat below freezing kJ/kg ℃	Latent heat kJ/kg
Cod, fresh	-2	3.63		260
Cod, frozen			1.82	
Haddock, fresh	-2	3.64		260
Haddock, frozen			1.82	
Halibut, fresh	-2	3.56		260
Halibut, frozen			1.8	
Herring, fresh	2.3			215
Herring, smoked	-2	2.93		213
Herring, frozen			1.65	
Mackerel, fresh	-2	3.1		190
Mackerel, frozen		1.56		
Shellfish, fresh	-2	3.62		277
Shellfish, frozen			1.88	
Tuna, fresh	-2	3.44		235
Tuna, frozen			1.7	

FLUID
Properties

Fluid	Density kg/m^3†		Melting point ˚C‡	Boiling point ˚C‡	Specific heat capacity kJ/kg K§	Thermal conductivity W/m K§	Dynamic viscosity MPa s¶
	Liquid	*Gas*					
Air	-	1.2	-	-	1.02	0.25	0.018
Ammonia	-	0.77	-78	-33	2.12	0.023	0.010
Benzene	880	-	5.5	80	1.45	0.16	0.65
Butane	600	2.70	-138	-0.5	1.68	0.015	0.007
Carbon dioxide	-	1.98	-56	-78	0.85	0.016	0.015
Carbon monoxide	-	1.25	-199	-191	1.05	0.029	0.017
Carbon tetrachloride	1600	-	-23	76	0.86	0.11	0.97
Chlorine	-	3.21	-101	-34	0.48	0.085	0.013
Ethanol	790	-	-117	78	2.45	0.17	1.2
Glycerol	1260	-	20	290	2.42	0.29	1500
Hydrogen	-	0.09	-259	-253	14.3	-	0.009
Hydrogen sulfide	-	1.54	-54	-61	1.0	0.014	0.012
Methane	470	0.72	-182	-164	2.22	0.033	0.011
Methanol	790	-	-94	65	2.52	0.21	0.60
Nitrogen	-	1.25	-210	-196	1.0	0.025	0.017
Oxygen	-	1.43	-218	-183	0.92	0.026	0.020
Propane	500	2.02	-190	-42	1.57	0.017	0.008
R11	1500	5.8	-111	24	0.88	0.090	0.40
R12	1300	6.3	-158	-30	0.69	0.009	0.26
R22	1200	4.7	-160	-41	0.78	0.011	0.23
R113	1550	7.4	-35	48	0.95	0.077	0.68
R114	1450	7.8	-94	4	0.71	0.010	0.38
Water	1000	-	0	100	4.19	0.59	1.00

FLUID

Physical Properties of Fluid

Properties	Gas	Supercritical Fluid	Liquid
Density, g/cm^3	0.006-0.002	0.2-0.9	0.6-1.6
Viscosity, μPa-s	10-30	10-90	200-3000
Diffusion Coefficient, cm^2/s	0.1-0.4	$(0.3\text{-}0.7) \times 10^{-3}$	$(0.2\text{-}2.0) \times 10^{-5}$

FRUITS AND VEGETABLES

Chilling Injury

Fruits and Vegetables	Approximate Temperatures at which Chilling Starts (°F)
Avocado	40-50
Banana	55
Cucumber	40-43
Lemon	50-53
Mango	40
Lanzones	50-55
Papaya	43
Pineapple	43
Potato	32
Sweet potato	32
Tomato	45

FRUITS AND VEGETABLES
Drying Requirements

Material	MCi (%)	MCf (%)	Tmax (°C)	Pretreatment
		Fruits		
Apples	-	24	70	Slicing and sulfuring
Grapes	80	15-20	70	Sulfuring
Bananas	-	15	70	Longitudinal halves
Guavas	-	7	65	Halves, deseed
		Vegetables		
Green peas	80	5	65	Blanching
Cauliflower	80	6	65	Slicing
Carrots	70	5	75	Slicing and blanching
Green beans	70	5	75	Blanching
Onion, Garlic	80	4	55	Slicing
Cabbage	80	4	55	Shredding and blanching
Sweet potatoes	75	7	75	Cubes
Potatoes	75	13	-	Cubes
Leafy vegetables	80	10	-	-
Chilies	-	10	-	-
Cassava	62	17	-	Cubes

FRUITS AND VEGETABLES
Ethylene Production Rate and Ethylene Sensitivity

Common Name	Ethylene Production Rate	Ethylene Sensitivity
Acerola, Barbados cherry	L	M
African horned melon, kiwano	M	H
Amaranth, pigweed	VL	M
Apple	VH	H
Apricot	M	H
Artichoke	VL	L
Asian pear, nashi	H	H
Asparagus, green, and white	VL	M
Avocado	H	H
Babaco, Mt. Papaya	M	H
Banana	M	H
Beans	L	M

FRUITS AND VEGETABLES
Harvesting Indicator

Fruit/Vegetable	
A. Roots, bulbs and tubers	
Radish and carrot	large enough and crispy
White potato, onion & garlic	tops begin to dry out and topple down
Ginger	Large enough
Green Onion	Longest
B. Fruit Vegetable	
Cowpea, sitao, snap beans, batao, and sigarillas	Well-filled pods that snap readily
Lima beans	Well-filled pods that are beginning to lose their greenness
Okra	Full size fruits, the tips can be snap readily
Upo and patola	Immature (overmature if thumbnail can not penetrate flesh readily)
Eggplant, ampalaya	Immature (overmature if color dulls or changes and seeds are tough
Sweet corn	Exude milky sap when thumbnail penetrate kernel
Tomato	Seed slip when fruit is cut, or green color turns pink
Sweet pepper	Deep green color turning dull or red
Watermelon	Color of lower parts turns creamy yellow, dull hollow sound when thumped
C. Flower Vegetables	
Cauliflower	Crud compact (overmature if flower cluster elongates and become loose)
Broccoli	Bud cluster compact (overmature if loose)
D. Leafy Vegetables	
Lettuce, pechay	Big enough but before flowering unless flower are desired
Cabbage	Head compact (overmature if head cracks)

FRUIT AND VEGETABLE
Storage Data

Product	Storage temperature °C	Relative humidity %	Storage life
Apples	-1 to +3	90 to 98	1 to 6 months
Apricots	-0.5 to 0	90 to 95	1 to 2 weeks
Artichokes, globe	-0.5 to 0	90 to 95	1 to 2 weeks
Avocado	+7 to +13	85 to 90	2 to 4 weeks
Asparagus	0 to +2	95 to 97	2 to 3 weeks
Bananas	+13 to +15	90 to 95	5 to 10 days
Beans, green	+4 to +7	90 to 95	7 to 10 days
Beetroot	0 to +2	95 to 97	3 to 5 weeks
Blackberries	-0.5 to 0	95 to 97	1 to 3 days
Broccoli	0 to +2	90 to 95	7 to 14 days
Brussels sprouts	0 to +2	90 to 95	3 to 5 weeks
Cabbage	0 to +2	90 to 95	3 to 4 months
Carrots	0 to +21	90 to 95	1 to 2 weeks
Cauliflower	0 to +2	90 to 95	2 to 4 weeks
Celery	0 to +2	90 to 95	2 to 3 months
Cherries	-0.5 to0	90 to 95	2 to 3 weeks
Coconuts	0 to +2	80 to 85	1 to 2 months
Cranberries	+2 to +4	90 to 95	2 to 4 months
Cucumber	+7 to +10	90 to 95	9 to 14 days
Dates, dried	+18 to +20	60 to 75	6 to 12 months
Eggplant	0 to +2	90 to 95	2 to 4 weeks
Endive	0 to +2	90 too 95	2 to 3 weeks
Figs, dried	0 to +4	50 to 60	9 to 12 months
Garlic, dry	0 to +2	65 to 70	6 to7 months
Gooseberries	-0.5 to +1	90 to 95	2 to 4 weeks
Grapefruit	+10 to +16	85 to 90	4 to 6 weeks
Grapes	-1 to +1	85 to 90	1 to 6 months
Horseradish	0 to +2	90 to 95	1 to 3 weeks
Kale	0 to +2	90 to 95	1 to 3 months
Leeks	0 to +2	90 to 95	1 to 3 months
Lemons	+4 to +15	86 to 88	1 to 6 months

FRUIT AND VEGETABLE
Storage Data

Product	Storage temperature °C	Relative Humidity %	Storage life
Lettuce	0 to +1	95 to 98	2 to 3 weeks
Limes	+3 to +10	85 to 90	1 to 6 months
Mangoes	0 to +2	90 to 95	1 to 3 months
Marrow	+10 to +13	90 to 95	5 to 14 days
Melons, honeydew	+7 to +10	85 to 90	3 to 4 weeks
Melons, water	+2 to +4	85 to 90	5 to 15 days
Mushrooms	0 to +4	90 to 95	3 to 4 days
Mushrooms, spawn	+1 to +2	75 to 80	8 months
Olives, fresh	+2 to +5	85 to 90	4 to 6 weeks
Onions	-	65 to 70	1 to 8 months
Oranges	0 to +10	85 to 90	1 to 3 months
Parsley	0 to +2	90 to 95	1 to 3 months
Parsnips	0 to +2	90 to 95	2 to 6 months
Peaches	-1 to +1	88 to 92	2 to 4 weeks
Pears	-1 to 0	90 to 95	2 to 7 weeks
Peppers, sweet	+7 to +10	90 to 95	2 to 3 weeks
Plums	-1 to +1	90 to 95	2 to 4 weeks
Pomegranates	0 to +1	88 to 90	2 to 4 weeks
Potatoes	+10 to +13	90 to 95	22 to 3 months
Potatoes, late	+3 to +10	90 to 95	3 to 6 months
Quinces	+5 to +10	90 to 95	2 to 3 weeks
Raspberries	-0.5 to 0	90 to 95	2 to 3 days
Rhubarb	0 to +2	95 to 99	2 to 4 weeks
Spinach	0 to +2	90 to 95	9 to 14 days
Strawberries	-0.5 to 0	90 to 95	5 to 7 days
Sweet corn	0 to +2	90 to 95	4 to 8 days
Tangerines	0 to +3	85 to 90	2 to 4 weeks
Tomatoes, green	+13 to 21	85 to 90	1 to 3 weeks
Tomatoes, ripe	+7 to +10	85 to 90	4 to 7 days
Turnips	0 to +10	90 to 95	4 to 5 months
Yams	+2 to +9	90 to 95	3 to 6 months

FRUITS AND VEGETABLES
Optimum Condition for Handling and Care of Fresh Product

Fruits/ Vegetables			Sell Quickly (1-2 D)	Refrigerated (40°C)	Sprinkle with Water	Remarks
	Temp(° F)	RH (%)				
Apples	30-32	85-90		Helpful	No	Avoid brushing
Avocados	40-45	85-90	Yes	No	No	Display no padded surface
Banana						
Ripe	56-58	85-90	Yes	No	No	-do-
Ripening	58-68	90-95		No	No	Avoid brushing
Cabbage	32	90-95		Helpful	Yes	
Carrots	32	90-95		Profitable	Yes	Moisten roots only on bunches
Cauliflower	32	90-95	Yes	Profitable	Yes	Sprinkle only if refrigerated
Corn, sweet	31-32	90-95	Yes	Profitable	Yes	Keep cold
Eggplant	45-50	85-90	Yes	No	No	Do not bruise keep off ice
Grapes	30-32	85-90	Yes	Helpful	No	Keep well ventilated
Lemons	38-40	85-90		Helpful	Yes	Sprinkling
Lettuce	32	90-95		Helpful	Yes	Avoid soaking with water
Mushroom	32-35	80-90	Yes	Helpful	No	Handle carefully Keep dry
Onion, dry	32	65-70		No	No	Remove loose wrapper Keep dry
green	32	90-95	Yes	Profitable	Yes	Keep well ventilated
Oranges	34-38	85-90		Helpful	No	Remove decayed fruit
Peppers	45-50	90-95	Yes	Profitable	Yes	
Pineapple	45-55	85-90	Yes	No	No	-do-
Potatoes	40-50	85-90		No	No	Keep out of sun
Squash	40-50	85-90	Yes	Helpful	Yes	
Sweet Potatoes	55-60	85-90		No	No	Keep ventilated
Tomatoes						
Ripe	45-50	85-90	Yes	Helpful	No	Sell quickly Refrigerate
Green	55-70	85-90		No	No	Ripen in back Sort frequently
Watermelon	40-50	80-85		Helpful		Cover with transparent film

FRUITS AND VEGETABLES
Thermal Properties

Product	Freezing temperature °C	Specific heat above freezing kJ/kg °C	Specific heat below freezing kJ/kg °C	Latent heat kJ/kg
Apples	-1.5	3.64	1.88	281
Apricots	-1	3.68	1.92	284
Avocado	-0.5	3.01	1.67	219
Asparagus	-0.5	3.94	2.00	312
Bananas	-1	3.35	1.76	251
Beans, green	-0.5	3.81	1.97	298
Beetroot	-1	3.77	1.92	293
Blackberries	-1	3.68	1.92	284
Broccoli	-0.5	3.85	1.97	302
Brussels sprouts	-1	3.68	1.93	284
Cabbage	-1	3.94	1.97	307
Carrots	-1	3.68	1.88	280
Cauliflower	-1	3.89	1.97	30
Celery	-1	3.98	2.01	314
Cherries	-2	3.64	1.88	280
Coconuts	-0.8	2.43	1.43	
Cranberries	-0.5	3.77	1.93	288
Cucumber	-0.5	4.06	2.05	319
Dates, dried	-16	1.51	1.08	67
Eggplant	-1	4.0	2.01	312
Endive	-0.5	3.94	2.0	307
Figs, dried	-12	1.63	1.13	80
Garlic, dry	-1	2.89	1.67	207
Gooseberries	-1	3.77	1.93	293
Grapefruit	-1	3.81	1.93	293
Grapes	-2	3.60	1.84	270
Horseradish	-2	3.55	1.79	251
Kale	-0.5	3.85	1.9	291
Leeks	-1.5	3.68	1.93	293
Lemons	-1.5	3.81	1.93	295

FRUITS AND VEGETABLES
Thermal Properties

Product	Freezing temperature °C	Specific heat above freezing kJ/kg °C	Specific heat below freezing kJ/kg °C	Latent heat kJ/kg
Lettuce	0	4.02	2.0	316
Limes	-1.5	3.83	1.42	288
Mangoes	-1	3.7	1.86	271
Melons, honeydew	-1	3.94	2.0	
Melons, water	-1	3.89	2.0	307
Mushrooms	0	3.89	1.97	302
Mushrooms, spawn	0			
Olives, fresh	-1.5	3.35	1.76	251
Onions	-1	3.37	1.93	286
Oranges	-1	3.77	1.92	288
Parsley	-1	3.8	1.9	285
Parsnips	-1	3.52	1.84	260
Peaches	-1	3.77	1.42	288
Pears	-1.5	3.6	1.88	275
Peppers, sweet	-1	3.94	1.97	307
Plums	-1	3.68	1.88	274
Potatoes	-1	3.56	1.86	270
Potatoes, late	-0.5	3.43	1.8	258
Quinces	-2	3.8	1.91	94
Raspberries	-0.5	3.56	1.86	284
Spinach	-0.5	3.94	2.0	307
Strawberries	-0.5	3.85	1.76	300
Sweet corn	-0.5	3.31	1.76	246
Tangerines	-1	3.77	1.93	290
Tomatoes, green	-0.5	3.98	2.0	312
Tomatoes, ripe	-0.5	3.94	2.0	312
Turnips	-1	3.89	1.97	302
Yams	-1	3.53	1.77	248

FRUITS AND VEGETABLE
Heat of Respiration

Product	Heat of respiration kJ/kg 24 hours		
	0°C	5°C	10°C
Apples	0.9	1	
Apricots	1.3	1.9	4.8
Artichokes, globe	6.1	8.2	14
Avocado	n/a	15	25
Asparagus	7.3	14	27
Bananas			9
Beans, green		12	17
Beetroot	1.3	2.4	3.1
Blackberries	4.3	9.7	19
Broccoli	4.7	13	17
Brussels sprouts	5.1	10	19
Cabbage	2.3	2.6	3.8
Carrots	2	3	4
Cauliflower	4.5	6.3	12
Celery	1.9	2.7	5.1
Cherries	1.3	3.5	7.7
Coconuts			
Cranberries		1.2	1.7
Cucumber			5.9
Dates, dried			
Eggplant (aubergine)			
Endive	2.4	2.9	4.7
Figs, dried			
Garlic, dry	1.5	6.1	15
Gooseberries	1.7	3.5	6.5
Grapefruit			3
Grapes	0.4	1.1	1.7
Horseradish	2.1	2.9	7.0
Kale	2.5	2.9	4.1
Leeks	2.8	6.1	15
Lemons	-	-	41

FRUITS AND VEGETABLE
Heat of Respiration

Product	Heat of respiration kJ/kg 24 hours		
	0°C	5 °C	10°C
Lettuce	2.7	3.4	5.6
Limes	0.5	0.7	1.1
Mangoes	3.2	4.1	12
Marrow			6.1
Melons, honeydew		1.7	2.1
Melons, water		2.1	3.9
Mushrooms	8.6	18	31
Mushrooms, spawn			
Olives, fresh	1.0	3.0	7.5
Onions	1.0	1.3	1.9
Oranges	1.08	1.8	3.3
Parsley	11	19	38
Parsnips	1.35	2.7	7.2
Peaches	1.34	1.95	4.3
Pears	1.0	2.2	3.1
Peppers, sweet		2.7	3.1
Plums	0.64	1.7	2.6
Pomegranates	0.9	1.3	2.6
Potatoes			3.0
Potatoes, late		3.1	4.3
Quinces		2.2	3.0
Raspberries	5.1	8.6	10
Rhubarb	2.8	3.9	4.9
Spinach	5.1	11	21
Strawberries	3.7	5.8	19
Sweet corn	10	19	28
Tangerines	1.1	1.9	3.9
Tomatoes, green			5
Tomatoes, ripe			7
Turnips	2.2	2.4	3
Yams		4.2	6

FUEL
Density and Gross heating Value

Fuel	API	Kg/l	BTU/lb	Kcal/kg	KJ/kg
Avgas	64.6	0.7216	20,950	11,639	48,729
Avturbo	47.1	0.7923	19,800	11,000	46,055
Coconut Oil	21.5	0.9248	155,748	8,749	36,630
Diesel	36.0	0.8448	19,650	10,917	45,706
Ethanol	46.7	0.7940	12,800	7,111	29,773
Fuel Oil	155.0	0.9659	18,600	10,333	43,263
Gasoline Premium	61.0	0.7351	220,500	11,389	47,683
Gasoline Regular	59.0	0.7428	20,750	11,528	48,264
Kerosene	47.1	0.7923	19,800	11,000	46,055
LPG	-	0.5500	21,180	11,767	49,264
Methanol	46.3	0.7960	9,600	5,333	22,329
Naphtha	60.0	0.7389	20,620	11,456	47,962
Coal			9,000		20,900
Bagasse (50% moisture)			4,000		9,300
Wood Waste (30% moisture)			4,000		9,300
Rice Hull			6,000		14,000
Coco-shell			8,630		20,100
Coco Husk			7400		17, 200
Natural Gas			1,020 (Btu/ft^3)		37,975 (KJ/m^3)

FUEL
Density and Gross Heating Value

Fuel	API	Kg/l	BTU/lb	Kcal/kg	KJ/kg
Biogas			650 (Btu/cu.ft)		24,200 (KJ/cu.m)
Premium	61.0	0.7351	0.500	11,389	47,683
Regular	59.0	0.7428	20,750	11,528	48,264
At 33% Thermal Efficiency			10,340	2,606	10.909
At 100% Thermal Efficiency			3,412	860	3,600

FUEL
Properties

Property	Propane	Butane
Chemical composition	C_3H_8	C_4H_{10}
Boiling Point, °F	-43.8	+31.1
Specific gravity, liquid, at 60/60 F	0.508	0.584
Specific gravity, vapor, at 60 F, 14 psia (air = 1)	1.522	2.006
Specific heat, vapor, at 14 psia, Btu/lb, cy	0.390	0.396
Specific heat vapor, at 14 psia, Btu/lb CX	0.346	0.363
Heat of vaporization, at 14 psia, Btu/lb	183	166
Weight, lb/gal	4.23	4.86
Vapor produced, cu. ft/gal	36.5	31.8
Heat content, gross Btu/lb	21,690	21,340
Explosion limits, % in air (lower)	2.0 - 2.4	1.5 - 1.9
Explosion limits, % in air (upper)	7.0 - 9.5	5.7 - 8.5
Air required for combustion, lb/lb of fuel	15.6	15.4

FUEL
Proximate Analysis and Heat Content

Fuel	Proximate Analysis				Heat Content (BTU/lb)
	Moisture (%)	Volatile Matter (%)	Fixed Carbon (%)	Ash (%)	
Anthracite Coal Fines		13.3	74.7	12.0	12750
Apitong Bagasse		19.2	79.7	1.2	13713
Arhar Stalk		83.5	14.8	1.8	6522
Bagasse		82.4	15.5	2.1	7930
Bagtikan		24.1	72.5	3.5	8933
Bakauan Babae		4.2	90.9	4.9	
Bakauan Lalaki		4.1	90.0	5.0	
Bamboo Dust		75.8	15.6	9.1	6956
Barley Straw		73.8	18.8	7.3	7422
Charcoal Briquette					11603
Coconut Choir		70.3	26.8	2.9	7913
Coconut Husk	13.7	72.4	26.0	6.3	8736
Coconut Shell	10.8	78.9	20.3	0.8	8630
Coconut Shell Charcoal	4.7	5.5	91.1	3.4	14223
Coconut Trunk		79.7	19.3	1.0	8182
Coffee Ground		82.6	16.2	1.2	7990
Coffee Hull					7727
Coffee Hull dust					8519
Coir Dust		61.9	28.2	9.9	7437
Corn Cobs		78.9	19.0	2.1	7716
Corn Dust		61.9	28.2	9.9	7437
Corn Fiber		68.2	28.2	3.0	8095
Cotton Stalk		70.9	22.4	6.7	7956

FUEL
Proximate Analysis and Heat Content

Fuel	Proximate Analysis				Heat Content (BTU/lb)
	Moisture (%)	Volatile Matter (%)	Fixed Carbon (%)	Ash (%)	
Ethanol (190 Proof)					11697
Green Charcoal		32.6	33.48	33.9	8935
Groundnut Shell		68.1	25.0	6.9	7478
High Grade Coal (Semirara)	12.4	40.1	34.9	12.6	9134
Ipil-ipil Wood		82.6	16.6	0.8	8144
Jute Stick		75.3	19.0	5.7	8434
Kerosene (low grade)					18500
Lanipau		25.7	72.8	1.5	14000
Low Grade Coal (Semirara)	12.1	24.5	2.2	61.2	2760
Mayapia		19.3	80.4	0.2	16776
Mill Residue		5.2	80.5	4.3	
Mix of Diff. Species		19.4	76.6	3.9	11700
Mix of Lauan & Tangile		20.8	78.9	0.3	16791
Mix of Red Lauan w/ Lauan, Bagtikan & Tangile		20.5	78.3	1.2	15010
Mustard Shell		70.1	14.5	15.4	7652

FUEL
Proximate Analysis and Heat Content

Fuel	Proximate Analysis				Heat Content (BTU/lb)
	Moisture (%)	Volatile Matter (%)	Fixed Carbon (%)	Ash (%)	
Oat Straw		78.9	17.1	4.1	7696
Peanut Hull	11.6	74.8	21.4	3.3	7378
Petroleum Cokes		23.0	85.9	0.5	13220
Premium Gasoline					20250
Pine Needle		72.4	26.1	1.5	8739
Red Lauan		14.5	85.2	0.2	15498
Regular Gasoline					20120
Rice Hull		64.4	12.6	20.5	6466
Rice Hull Briquette		61.5	15.3	23.2	6230
Rice Hull Briquetted					
@ 550°C	2.8	59.1	14.5	23.6	6206
@ 450°C	3.9	59.8	20.0	16.4	6010
@ 350°C	4.4	58.6	18.9	18.2	5814
Rice Stalk		66.7	18.6	18.2	6257
Rye Straw		83.0	15.0	2.0	7869
Sal Seed Leaves		60.0	20.2	19.8	8087
Sal Seed Husk		62.5	28.1	9.4	8956
Tangile		18.6	80.5	1.0	15444
Toog		17.7	79.1	3.4	10270
Wheat Straw		79.6	16.8	3.6	7956
Wood		77.5	17.5	2.0	6710
Wood Charcoal					11786
Wood Waste					7454

FUEL
Stoichiometric Air Requirement

Fuel	Density (lb/ft^3)	Stoichiometric Air Requirement
A. Gas		
Acetylene	6.76	13.35 lb air/lb of fuel
Biogas		5.7 $m^{3\ air}/m^3$ of fuel
Butane		31.1 ft^3 air/ft^3 of fuel
Carbon Monoxide	7.27	2.48 lb air/lb of fuel
Ethane	7.82	16.16 lb air/lb of fuel
Ethylene	7.30	14.85 lb air/lb of fuel
Hydrogen	0.52	34.80 lb air/lb of fuel
Methane	4.16	17.32 lb air/lb of fuel
Natural Gas		9.6 ft^3 air/ft^3 of fuel
Propane		24.0 ft^3 air/ft^3 of fuel
Town Gas		3.7 $m^{3\ air}/m^3$ of fuel
B. Solid		
Anthracite		13.35 lb air/lb of fuel
Bituminous		10.70 lb air/lb of fuel
Coke		11.20 lb air/lb of fuel
Corn Cobs		5.7 kg air/kg fuel
Corn Strover		4.0 kg air/kg fuel
Crude Oil		14.45 lb air/lb of fuel
Lignite		8.75 lb air/lb of fuel
Peat		7.30 lb air/lb of fuel
Pure Carbon		11.58 lb air/lb of fuel
Rice Hull		4.7 lb air/lb of fuel
Semi-Anthracite		11.59 lb air/lb of fuel
Semi-Bituminous		11.41 lb air/lb of fuel
Sub-Bituminous		10.24 lb air/lb of fuel
Wood, dry		6.2 kg air/kg fuel

* at maximum percentage of CO_2

FUEL
Properties of LPG Fuel

Substance	Density (g/cm^3)	Boiling Temp. (°C)	Octane Member (Research)
Methane	-	-125	110
Ethane	0.374	-53	104
Propane	0.508	-8	100
Butane	0.584	0	92
Pentane	0.631	36	61

FURNACE
Burning and Furnace Efficiency

Furnace	Burning Efficiency (%)	Furnace Efficiency (%)
Tilted Grate with Heat Exchanger	93	56
Inclined Grate w/o Heat exchanger	95	71
Flat Grate w/o Heat Exchanger	99	67
Cyclonic	99	62

GASIFICATION
Gas Composition of Gasifier

Carbon Monoxide, CO	15 – 30 %
Hydrogen, H^2	12 – 20 %
Methane, CH_4	0.5 – 7 %
Carbon dioxide, CO_2	3 – 15 %
Nitrogen N_2	50 – 58 %

GASIFICATION
Types, Advantages, and Disadvantages of Gas Producers

Type	Advantages	Disadvantages
Updraft	Suitable for many biomass fuel Can gasify wet fuel Does not require any specific fuel size	Generates large amount of tar Very large
Downdraft	Generates little amount of tar Can be built very compact Can be built for very small gas output	Requires special Cannot be built over 200 kW electric output Fuel needs to be well sized
Crossdraft	Very compact gasifier Highly suitable for small power output Good for changing loads	Suitable for charcoal only Only for special prepared fuel Cannot gasify wet fuel
Fluidized Bed	Highest gasification rate per m2 grate area Ideal for small fuel particle	Generates tar Only for small fuel particles (<20 mm) Not well developed technology

GEARS
Summary

Type	Applications	Advantages	Disadvantages
External spur	Parallel shafting Moderate Speed	Moderate cost No end thrust	Small contact ratio
Internal spur	Parallel shafting Moderate speeds Same shaft directions	Short centers Large contact ratio Partial safety guard No end thrust	Difficult mounting Expensive
Helical	Parallel Shafting High Speeds	Quiet operation High load-carrying capacity	End Thrust
Herring bone	Parallel shafting Heavy duty	No end thrust Large tooth contact High load-carrying capacity	Expensive
Bevel types Straight tooth	Angular drives Moderate speeds	Moderate cost	Difficult Mounting
Zerol	Angular drives	Long gear life Smooth and quiet Low stress concentration at tooth tip	Expensive Difficult mounting
Spiral	Right-angle drives High speeds	Good tooth meshing High load-carrying capacity	Expensive Difficult Mounting
Hypoid	Nonintersecting shafts Right-angle drives	Mounting rigidity possible High load-carrying capacity	Expensive
Worm gears	Nonintersecting shafts Right-angle drives	High ratios Quiet operation High load-carrying capacity Compact Self-locking possible	Difficult Mounting
Rack and pinion	Rotary to linear Or linear to rotary	Compact	Difficult mounting Slow Speeds Small contact ratio

GEAR OIL
Kinematic Viscosity

SAE Viscosity Number	Kinematic Viscosity (100°C) mm^2/s	
	Min	Max
70W	4.1	-
75W	4.1	-
80W	7.0	-
85W	11.0	-
90	13.5	2.0
140	24.0	41.0
250	41.0	-

GRAINS
Dry Matter Loss Constant

Grain size	A	C	D	E
Long	0.001889	0.7101	0.02740	31.63
Medium	0.000914	0.6540	0.03756	33.61

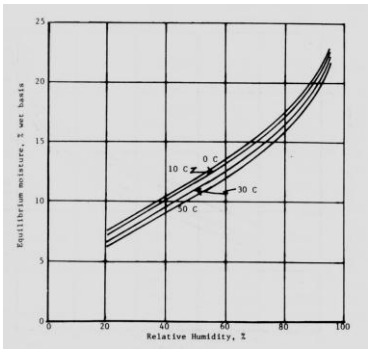
GRAINS
Rough Rice Heat of Vaporization

Moisture Content (% dry basis)	Temperature (°C)	Heat Vaporization (kJ/kg)
5	10	3563-4743
	20	3803-4470
	30	4047-4229
	40	4015-4285
15	10	2698-3078
	20	2862-2953
	30	2846-2987
	40	2753-3040
30	10	2474-2550
	20	2468-2508
	30	2451-2471
	40	2426-2438

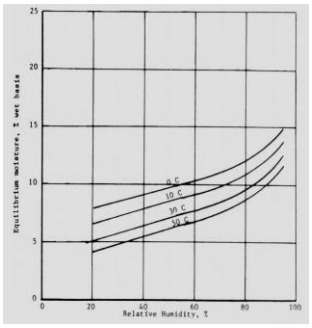
GRAINS AND SEEDS
Physical Properties

Grain/Seed	Moisture Content (%wb)	Void Space (%)	Kernel Specific Gravity	Bulk Density (g/cm^3)
Barley	10.4	39.5	1.33	0.615
	9.8	45.4	1.21	
	10.7	49.9	1.24	
Castor beans				0.589
Clover				0.769
Corn, Ear				0.448
Corn, Shelled	25.0	44.0	1.27	0.717
Cottonseed				0.410
Cowpeas				0.769
Grain Sorghum	9.5	37.0	1.22	0.641
	9.9	36.8	1.26	0.718
Kapok				0.448-0.512
Lentils				0.769
Millet	9.4	36.8	1.11	0.615-0.641
Mustard				0.743-0.769
Oats	9.8	47.6	1.05	0.410
	10.3	55.5	0.99	
Peanuts, unshelled				0.218
Rice, rough	11.9	50.4	1.11	0.577
	12.4	46.5	1.12	
Soybeans	6.9	36.1	1.18	0.769
	7.0	33.8	1.13	
Wheat	9.8	42.6	1.30	0.769
	9.8	40.1	1.29	

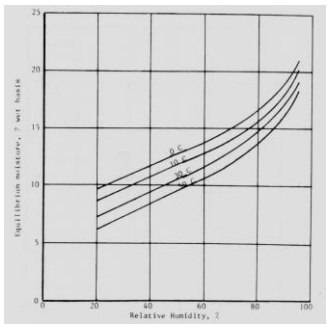
GRAINS AND CEREALS
Equilibrium Moisture Content Curves



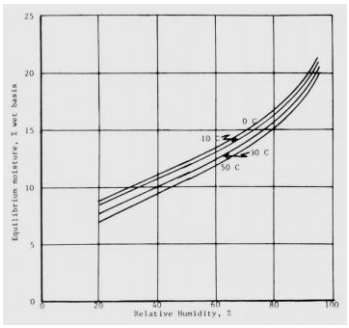
Edible Beans



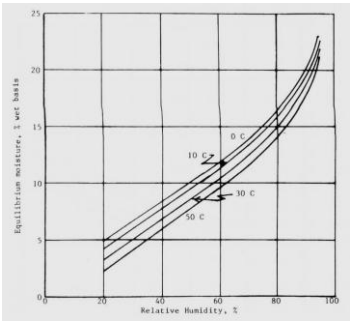
Peanuts in Pod



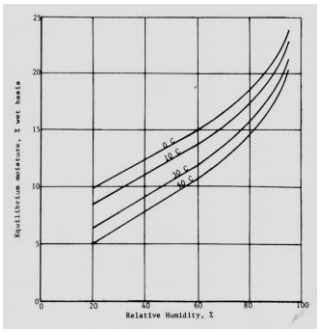
Rough Rice



Sorghum



Soybean



Yellow Dent Corn

HEAT TRANSFER
Film Coefficient for Air at Various Surfaces

Surface	Film Coefficient f, Btu/(hr)(ft^2)(°F)
Very Smooth	$1.4 + 0.28\nu t$
Smooth wood or plaster	$1.6 + 0.3\nu$
Cast concrete	$2.0 + 0.4\nu$
Rough stucco	$2.1 + 0.5\nu$

HEAT TRANSFER
Thermal Conductivities of Some Building Insulation

Material	Density lb/ft^3	Temperature, °F	Conductivity, Btu/(hr)(ft)(°F)
Building brick		68	0.4
Concrete:			
Cinder			0.20
Stone	144		0.54
Hair felt	17	86	0.021
Wood, pine across grain	34	59	0.087
Cork:			
Granulated	8		0.025
Board	7		0.0225
Board	10.6		0.025
Glass wool, curled	4-10		0.024
Cellular glass	9.0		0.40

HEAT TRANSFER
Fluid Properties

Medium	Density kg/m3	Specific heat capacity kg/kJ K at temperature °C	Thermal conductivity W/m K at temperature °C	Boiling point °C at 101.3 kPa	Freezing point °C
Aroclor*†	1140	1.16 at 25	0.11 at 25	340	-7
		1.36 at 200	0.11 at 200		
Dowthern A*†	1070	1.55 at 12	0.14 at 12	258	-12
	880	2.51 at 230	0.13 at 150		
Essotherm*	850	1.90 at 25	0.13 at 25	-	-
	710	2.75 at 250			
Ethanediol	1100	2.29 at 15	0.26 at 15	198	-13
Fenso 68*	890	1.12 at 50	0.13 at 50	-	-
Glycerol	1260	2.42 at 15	0.29 at 15	290	20
IL 2023*	880	1.90 at 25	0.13 at 25	-	-
	760	2.53 at 200	0.12 at 200		
Steam (saturated) ‡	600	2.03 at 100	0.025 at 100	-	-
	46	6.15 at 300	0.067 at 300		
Water ‡	1000	4.19 at 15	0.59 at 15	100	0
	917	4.31 at 150	0.68 at 150		

*Trade name.

† No longer commercially available.

‡ Under pressure for temperatures above 100°C.

HEAT TRANSFER
Thermal Conductivities of Different Materials

Material	Conductivity W/m K	Resistivity m K/W
Air	0.026	38.6
Aluminum	150	
Asbestolux	0.12	8.67
Asbestos: flues and pipes	0.27	3.68
insulating board	0.14	6.93
lightweight slab	0.053	18.7
Asphalt: light	0.58	1.73
heavy	1.23	0.83
Brass	150	
Bricks: common	1.43	0.69
engineering	0.79	1.25
Brine	0.48	2.10
Building board	0.079	12.62
Building paper	0.065	15.39
Caposite	0.052	19.28
Cardboard	0.144 to 0.288	6.9 to 3.5
Celotex	0.048	21.0
Concrete: 1:2:4	1.4	0.69
lightweight	0.40	2.5
Copper	300	
Cork	0.043	23.1
Cotton waste	0.059	16.9
Densotape	0.25	4.0
Diatomaceous earth	0.087	11.5
Econite	0.098	10.19
Felt	0.039	25.7
Fiberglass	0.036	27.7
Firebrick	1.30	0.76
Fosalsil	0.14	0.69

HEAT TRANSFER
Thermal Conductivities of Different Materials

Material	Conductivity W/m K	Resistivity m K/W
Glass	1.05	0.97
Glasswool	0.04	24.8
Gold	310	
Granwood floor blocks	0.32	3.1
Gyproc plasterboard	0.16	6.3
Gypsum plasterboard	0.16	6.3
Hardboard	0.094	10.68
Holoplast: 25 mm panel	0.14	7.3
Ice	2.31	0.43
Insulating board	0.059	16.99
Iron: cast	65	0.154
wrought	58	0.0172
Material	*Conductivity W/m K*	*Resistivity m K/W*
Jute	0.036	27.7
Kapok	0.036	27.7
Lead	35	0.029
Linoleum: cork	0.072	13.9
PVC	0.22	4.65
rubber	0.30	3.33
Marinite	0.11	9.36
Mercury	7	0.143
Mica sheet	0.65	1.53
Mineral wool	0.056	23.1
Nickel	58	0.0172
Onozote	0.029	34.7
Paper	0.13	7.69
Perspex	0.21	4.8
Plaster	0.48	2.1

HEAT TRANSFER
Thermal Conductivities of Different Materials

Material	Conductivity W/m K	Resistivity m K/W
Platinum	69	0.0145
Polystyrene: cellular	0.033	29.8
Polyurethane: cellular	0.042	23.9
Polyzote	0.032	31.5
Porcelain	1.04	0.96
Refractory brick:		
Alumina	0.32	3.1
Diatomaceous	0.13	7.70
Vermiculite insulating	0.19	5.13
Refractory concrete:		
Diatomaceous	0.26	3.9
Aluminous cement	0.46	2.15
Rubber: natural	0.16	6.3
Silicone	0.23	4.4
Sand	0.42	2.4
Scale, broiler	2.3	0.43
Silver	420	
Sisalkraft building paper	0.066	15.0
Slate	2.0	0.5
Snow	0.22	4.65
Steel, soft	46	
Steel wool	0.108	9.22
Stillite	0.036	27.7
Stone: granite	2.9	0.35
Limestone	1.5	0.62
Marble	2.5	0.42
Sandstone	1.9	0.55

HEAT TRANSFER
Thermal Conductivities of Different Materials

Material	Conductivity W/m K	Resistivity m K/W
Sundeala: insulating		
Material	Conductivity W/m K	Resistivity m K/W
board	0.052	19.3
medium		
hardboard	0.074	13.9
Tentest	0.05	19.8
Thermalite	0.20	4.9
Tiles:		
Asphalt and asbestos	0.55	1.8
Burnt clay	0.84	1.2
Concrete	1.2	0.90
Cork	0.084	11.9
Plaster	0.37	2.63
Treetex	0.056	17.8
Water	0.60	1.7
Weyboard	0.091	11.1
Weyroc	0.14	6.9
Woodwool	0.040	24.8
Wool	0.043	23.1
Zinc	64	

HEAT TRANSFER
Heat-Loss Coefficients

	Watts/sq. ft/°F TD
Watt loss through solid back walls (wall thickness, 8 in.):	
Plain brick, no inside finish	0.146
Inside plaster direct on walls, no furring	0.135
Inside furred with 1/2-in. plaster	0.087
Inside 1/2-in. rigid insulation furred on brick	0.064
Inside furred with 1 5/8. mineral-wool insulation	0.035
Inside furred with 3 5/8-in. mineral-wool insulation	0.022
Watt loss through brick-veneer walls, wood framing, and sheathing:	
Inside plaster, no insulation	0.082
Inside 1/2-in. insulating board	0.061
Inside plaster with single-ply aluminum foil	0.053
Inside plaster with 2-in. mineral-wool blanket	0.025
Inside plaster with 3 5/8-in. mineral-wool fill	0.017
Watt loss through concrete-block walls, 8-in. concrete block with air cells:	
No interior finish, no insulation	0.164
Inside plaster on blocks, no insulation	0.152
Inside furred and plastered, no insulation	0.091
Inside furred, plastered, and 1 5/8-in. insulation	0.035
Inside furred, plastered, and 3 5/8-in. insulation	0.022
Watt loss through wall with wood siding or shingles, 1-in. wood sheathing and moisture barrier:	
Inside plaster	0.073
Inside 1/2-in. insulating board	0.056
Inside 1/2-in. insulating board and plaster	0.055
Inside 1-in. insulating board and plaster	0.044
Inside plaster with 2-in. insulating blanket	0.025
Inside plaster with 3 5/8 in. insulation	0.018

HEAT TRANSFER
Heat-Loss Coefficients

	Watts/sq. ft/°F TD
Watt loss through floors:	
6-in. concrete bare	0.173
4-in. concrete bare	0.202
4-in. concrete with asphalt tile	0.173
4-in. concrete with double floor on sleepers	0.073
Double wood floor:	
Over ground, solid, and unventilated foundation	0.100
With lath and plaster beneath	0.073
With 1/2-in. rigid insulation beneath joists	0.056
With lath and plaster beneath and 3 5/8-in. rock-wool fill	0.019
Over ground with asphalt tile surface	0.085
Over ground with 1-in. insulation blanket	0.044
Over ground with 2-in. insulating blanket	0.030
Over ground with 3 5/8-in. mineral-wool insulation	0.023
Watt loss through interior walls:	
Studding with lath and plaster, one side	0.097
Studding with lath and plaster, both sides	0.095
4-in. brick plastered both sides	0.126
Studding with 1/2-in. rigid insulation, one side	0.075
Studding with 1/2-in. rigid insulation, both sides	0.056
Studding with 3 5/8-in. mineral-wool fill	0.019
Watt loss through ceilings:	
Single wood on joists, no flooring above	0.132
Lath and plaster, no flooring above	0.181
Lath and plaster with double flooring above	0.070
Lath and plaster with 3 5/8-in. mineral wool above	0.019
1/2-in. gypsum board with 3 5/8-in. mineral wool above	0.020
Lath and plaster with 2-in. insulating blanket	0.035
Lath and plaster with 1-in. insulating blanket	0.056

HEAT TRANSFER
Heat-Loss Coefficients

	Watts/sq. ft/°F TD
Watt loss through roofs:	
Flat metal roof, no insulation beneath	0.275
Slate or tile on sheathing, no insulation	0.161
Asphalt shingles or roll roofing, no insulation	0.155
Wood shingles, no insulation	0.141
Flat with tar and gravel, tar and gravel board	0.088
Asphalt shingles with 1/2-in. insulating board	0.067
Slate or tile with 1/2-in. insulating board	0.070
Wood shingles with 1/2-in. insulating board	0.064
Asphalt shingles with 3 5/8-in. insulation	0.025
Slate or tile with 3 5/8-in. insulation	0.025
Wood shingles with 3 5/8-in. insulation	0.024
(For reflective insulation use recommendations of manufacturer)	
Watt loss through windows and doors and glass:	
Glass, single thickness	0.331
Glass, double thickness (3/4-in. air space)	0.132
Double glass (1/4-in. air space)	0.167
Single glass with storm window	0.200
Skylight, single glass	0.340
Skylight, double glass (3/4-in. air space)	0.141
Hollow-glass block wall	0.135
Solid-wood door exposed to outside	0.150
Solid-wood door with glass storm door	0.103

HUMAN BODY
Heat Loss

Activity	Total Loss, Btu/hr	Sensible-heat loss, Btu/hr	Latent-heat loss Btu/hr
Seated at rest	330	180	150
Seated, very light work	400	195	205
Moderately active, standing, light work	450	200	250
Light factory work	750	220	530
Moderately heavy factory work	1,000	300	700
Heavy work	1,450	465	985

HUMAN BODY
Heat Loss in Low Temperature Spaces

Temperature of space, °F	Total heat loss, Btu/hr
50	720
40	840
30	950
20	1,050
10	1,200
0	1,300
-10	1,400

HYDRO POWER
Turbine Efficiency

Turbine	Efficiency (%)
Undershoot Waterwheel	25 – 40
Overshoot Waterwheel	50 – 70
Breast Wheel	50 – 60
Poncelet Waterwheel	40 – 60
Vertical Shaft Watermill	20 – 35
Impulse Turbine	70 – 87
Cross Flow Turbine	60 – 80
Reaction Turbine	65 - 90

HYDRO POWER
Specific Speed of Various Turbine Types

Turbine	Specific Speed
Impulse Turbine	
Single-Jet Pelton	10 - 35
2 – Jet Pelton	10 – 45
3 – Jet Pelton	10 – 55
Turgo	20 – 80
Crossflow	20 – 90
Reaction Turbine	
Francis	70 – 500
Kaplan	350 – 1100
Properteis	600 - 900

INCUBATOR
Operation Characteristics

Bird	Incub. Period (days)	Temp. (C, dry bulb)	Humidity (C, wet bulb)	Humidity Last 3 ($days^2$)	No Egg Turning After	Open Vents Addt'l 1/4	Open Vents (if needed)
Chicken	21	37.8	29.4 - 30.6	90	18^{th} day	10^{th} day	18^{th} day
Turkey	28	37.2	28.9 - 30	90	25^{th} day	14^{th} day	25^{th} day
Duck	28	37.8	29.4 - 30	90	25^{th} day	12^{th} day	25^{th} day
Muscovy Duck	35-37	37.8	29.4 - 30	90	31^{st} day	15^{th} day	30^{th} day
Goose	28-34	37.2	30 - 31.1	90	25^{th} day	1^{st} day	25^{th} day
Guinea	28	37.8	29.4 - 30.6	90	25^{th} day	14^{th} day	24^{th} day
Peafowl	28-30	37.2	28.9 - 30	90	25^{th} day	14^{th} day	25^{th} day
Coturnix Quail	17	37.8	29.4 - 30	90	15^{th} day	8^{th} day	14^{th} day
Pigeon	17	37.8	29.4 - 30	90	15^{th} day	8^{th} day	14^{th} day

IMPLEMENT
Criteria for the Selection

Criterion	Cultivator	Chisel Plough	Subsoiler
intended use	shallow, stubble tillage	loosening at plowing depth	loosening and breaking up of plough sole
chisel type	wide to normal	normal to narrow	narrow to normal
tine type	spring, spring loaded or rigid	spring loaded or rigid	rigid
angle of attack	up to 60 deg.	30 deg.	30 deg.
distance between tines	at least 55-60 cm	at least 70 cm	at least 75 cm
furrow distance	about 20 cm	25-30 cm	30-50 cm
required frame height	70 cm	70-80 cm	70-90 cm
rear mounted tools	necessary	desirable	desirable
working depth	5-15 cm	15-30 cm	30-50 cm

IMPLEMENT
Draft of Moldboard Plow (N/cm2)

Soil	Equation
Silty clay	$7 + 0.049\ S^2$
Clay loam	$6 + 0.053\ S^2$
Loam	$3 + 0.021\ S^2$
Sandy silt	$3 + 0.056\ S^2$
Silty loam	$2.8 + 0.023\ S^2$
Sand	$2 + 0.0.13\ S^2$

S is speed in km per hour

IMPLEMENT
Differences Between Moldboard and Disc Plow

Criteria	Disc	Moldboard
inverting	medium	good
mixing	medium	hardly
crumbling	medium/good	medium
burying of long stubble	not completely	completely
plough sole compaction	Little	by landside (heel) less by share
susceptibility for damage by roots and stones	little	more
possible fields of use	Heavy, dry, stony soils forest soils	clean fields
durability	High	medium
weight	High	
drought requirement	High	high

IMPLEMENT
Specific Draft

Machine	Normal Range
Plow	5-12 lb/in^2 of furrow section
Lister	400-750 lb per row
One-way disk	150-350 lb per ft width
Single-disk harrow	40-130 lb per ft width
Tandem-disk harrow	80-160 lb per ft width
Tandem disk harrow, 22 in-diameter, 9 in spacing	170-225 lb per ft width or 90% of weight
Spike tooth harrow	30-60 lb per ft width
Spring-tooth harrow	75-150 lb per ft width
Duck foot field cultivator	90-160 lb per ft width
Roller	30-60 lb per ft width
Subsoiler	80-160 lb per in. of depth

IMPLEMENT
Draft Requirement of Tillage, Seeding, and Planting Equipment

Machine	Typical Range of Requirements
Tillage	
Mouldboard or disk plough	(Specific draft or force per furrow cross-sectional area)
Light soil	2.1-4.1 N/cm^2 [3-6 lbf/in^2]
Medium soil	3.4-6.2 N/cm^2 [5-9 lbf/in^2]
Heavy soil	5.5-9.7 N/cm^2 [8-14 lbf/in^2]
Lister (in firm soil)	1.8-3.6 kN/bottom [400-800 lbf/bottom]
Vertical-disk plough (one-way Disk)	2.6-5.8 kN/m [180-400 lbf/ft]
Disk harrow	
Single-acting	0.7-1.5 kN/m [50-100 lbf/ft]
Tandem (light-duty)	1.5-2.9 kN/m [100-200 lbf/ft]
Offset or heavy tandem	3.6-5.8 kN/m [250-400 lbf/ft]
Subsoiler	120-190, 190-280 N/cm depth [70-110, 110-160 lbf/inch depth]
Chisel plough or chisel-type field Cultivator	0.23-0.69 kN/m per cm depth
Field cultivator with sweeps, 8 to 13 cm (3 to 5 in) depth	1.5-4.4 kN/m [100-300 lbf/ft]
Powered rotary tiller, Conventional, 8 to 10 cm (3	10-17, 17-24, 21-28 equiv. N/cm^3 [15-25, 25-35, 30-40 equiv. lbf/in^2]
Spring-tooth harrow	1.1-2.9 kN/m [75-200 lbf/ft]
Spike-tooth harrow	0.3-0.9 kN/m [20-60 lbf/ft]
Rod weeder	0.9-1.8 kN/m [60-120 lbf/ft]

IMPLEMENT
Draft Requirement of Tillage, Seeding, and Planting Equipment

Machine	Typical Range of Requirements
Roller or packer	.3-2.2 kN/m [20-150 lbf/ft]
Rotary hoe	0.4-1.5 kN/m [30-100 lbf/ft]
Row-crop cultivator	
Shallow	0.6-1.2 kN/m [400-80 lbf/ft]
Deep	0.11-0.23 kN/m per cm depth [20-40 lbf/ft per inch depth]
Planting	
Row-crop planter,drilling seed only	0.45-0.8 kN [100-180 lbf] per row
Grain drill	0.4 - 1.5 kN/m [30-100 lbf/ft]
Broadcaster	
Row-crop planter, most other crops including vegetables	
Fertilizer application	
Fertilizer spreader (broadcast)	

IMPLEMENT
Typical Disk Harrow Blade Spacing and Weight per Unit Length of Gang

Disc Blade Dimension (cm)	Blade Spacing (cm)	Weight per Unit Length (Kg/m)
40	16 - 23	60 – 165
50	20 - 25	120 – 240
60	28 - 30	150 - 270

IMPLEMENT
Field Efficiency of Various Equipment

Equipment	Field Efficiency (%)
Plow	
Indigenous	30-60
Moldboard	30-80
Disk	30-80
Disk Harrow	
Single action	65-85
Double action	60-80
Rotary Tiller	60-80
Harrow	
Spike/Peg	70-90
Spring tine	70-90
Rolling or Leveling	60-80
Cultivating	60-85
Row Planter	50-65
Transplanter	30-60
Grain Drill	60-75
Reaping or Binding	60-80
Combining	50-75
Mowing	50-80
Raking	60-85
Baling	50-75
Field Chopping	40-70

IMPLEMENT
Operating Speed of Various Agricultural Field Equipment

Equipment	Speed (km/hr)
Plow	
Indigenous	1.6-3.5
Moldboard	2.4-5.0
Disk	2.5-5.0
Disk Harrow	
Single action	1.6-4.2
Double action	1.5-4.0
Rotary Tiller	0.8-2.8
Harrow	
Spike/Peg	1.6-6.0
Spring tine	1.6-5.0
Rolling or Leveling	0.8-5.0
Cultivating	1.6-4.0
Row Planter	1.6-5.0
Transplanter	0.8-2.5
Grain Drill	1.6-5.0
Reaping or Binding	1.6-3.5
Combining	1.6-4.8
Mowing	1.6-4.8
Raking	2.4-5.0
Baling	2.4-5.0
Field Chopping	3.0-5.0

IMPLEMENT
Specific Power Requirement

Equipment	Specific Power Requirement
Plow	
Indigenous	0.14-07 kg/cm^2
Moldboard	0.21-1.12 kg/cm^2
Disk	0.21-1.00 kg/cm^2
Disk Harrow	
Single action	0.45-1.5 kg/cm
Double action	1.20-2.70 kg/cm
Rotary Tiller	0.70-3.50 kg/cm
Harrow	
Spike/Peg	1.80-2.70 kg/peg
Spring tine	10.0-25.0 kg/tine
Rolling or Leveling	0.15-0.90 kg/cm
Cultivating	6-20 kg/shank
Row Planter	30-70 kg/row
Transplanter	10-20 kg/row
Grain Drill	6-22 kg/row
Reaping or Binding	1-2 kg/row
Combining	2-4 kg/row
Mowing	0.5-0.8 hp/ft
Raking	0.2-0.6 hp/ft
Baling	1-3 hp/ton
Field Chopping	1-3 hp/ton

IRRIGATION
Manning Roughness Coefficients for Various Boundaries

Boundary	Manning roughness n, $ft^{1/6}$
Very smooth surface such as glass, plastic, or brass	0.010
Very smooth concrete and plane timber	0.011
Smooth concrete	0.012
Ordinary concrete lining	0.013
Good wood	0.014
Vitrified clay	0.015
Shot, concrete, untroweled, and earth channels in best condition	0.017
Straight unlined earth canals in good condition	0.020
Rivers and earth canals in fair condition - some growth	0.025
Winding natural streams and canals in poor condition - considerable moss growth	0.035
Mountain streams with rocky beds and rivers with variable sections and some vegetation along banks	0.040-0.050
Alluvial channels, sand bed, no vegetation	
1. Lower regime	
Ripples	0.017-0.028
Dunes	0.018-0.035
2. Washed-out dunes or transition	0.014-0.024
3. Upper regime	
Plane bed	0.011-0.015
Standing waves	0.012-0.016
Antidunes	0.012-0.020

IRRIGATION
Lengths of Run Furrows and Corrugations

Slope (%)	Lengths of Furrows or Corrugations (ft)			
	Loamy Sand and Course Sandy Loams	Sandy Loams	Silt Loams	Clay Loams
0 - 2	250 - 400	300 - 660	660 - 1320	880 - 1320
2 - 5	200 - 300	200 - 300	300 - 660	400 - 880
5 - 8	150 - 200	150 - 250	200 - 300	250 - 400
8 - 15	100 - 150	100 - 200	100 - 200	200 - 300

IRRIGATION
Permissible Velocities for Vegetated Channels

Vegetative Cover	Slope range (%)	Permissible Velocities in fps	
		Easily Eroded Soils	Erosion Resistant Soils
Bermuda grass	0-5	6	8
	5-10	5	7
	over 10	4	6
Blue grama	0-5	5	7
Buffalo grass	5-10	4	6
Grass mixture	0-5	4	5
	5-10	3	4
Annual crops for temporary protection	0-5	2.5	3.5

Note: Use velocities over 5 fps only where good cover and proper maintenance can be obtained.

IRRIGATION
Basic Reservoir Shapes of SFR

Type	General Description	Slope (%)	Storage Ratio
Straight embankment	Suited to an area with an undulating topography. A dam is built across a valley and water is impounded on the upstream side of the dam.	2 - 15	2 - 7
Rectangular balanced excavation	On slightly sloping land, the excavated earth can be used to impound some water above ground level. On higher slopes, it can be designed so that all water is stored above ground level	< 2 2 - 12	1.5 - 2.5 1.5 - 2.5
Semicircular embankment	Water is impounded against the slope behind a semicircular embankment	4 - 7	2.5 - 4.0
Dugout pond	The only design suited to flat areas. A reservoir is constructed by excavating the earth leaving a storage space that can be filled with water. Water is stored below ground level and pumping is required to draw out water.	Flat	1.0

IRRIGATION
Improved Surface System Characteristics

Site and Situation Factors	Redesigned Surface Systems	Level Basins
Infiltration rate Topography Crops	Moderate to low Moderate slopes All	Moderate Small slopes All
Water supply	Large streams	Very large streams
Water quality	All but very high salts	All
Efficiency Labor Requirement	Average 60-70% High, training required	Average 80% Low, some training
Capital requirement Energy requirement Management skill Machinery operations	Low to moderate Low Moderate Medium to long fields	Moderate Low Moderate Short fields
Duration of use	Short to long	Long
Weather	All	All
Chemical application	Fair	Good

IRRIGATION
Microirrigation System Characteristics

Site and Situation Factors	Emitters and Porous Tubers
Infiltration rate	All
Topography	All
Crops	High value required
Water supply	Small streams, continuous and clean
Water quality	All - can potentially use high salt waters
Efficiency	Average 80-90%
Labor Requirement	Low, to high some training
Capital requirement	High
Energy requirement	Low to moderate
Management skill	High
Machinery operations	May have considerable interference
Duration of use	Long term, but durability unknown
Weather	All
Chemical application	Very good

IRRIGATION
Sprinkler System Characteristics

Site and Situation Factors	Intermittent Mechanical-Move	Continuous Mechanical-Move	Solid-Set and Permanent
Infiltration rate Topography Crops	All Level to rolling Generally shorter crops	Medium to high Level to rolling All but trees and vineyards	All Level to rolling
Water supply	Small streams nearly continuous	Small streams nearly continuous	Small streams
Water quality	Salty water may harm plants	Salty water may harm plants	Salty water may harm plants
Efficiency Labor Requirement	Average 70-80% Moderate, some training	Average 80% Low, some training	Average 70-80% Low to seasonal high, little training
Capital requirement Energy requirement Management skill Machinery operations	Moderate Moderate to high Moderate Medium field length, small interference	Moderate Moderate to high Moderate to high Some interference circular fields	High Moderate Moderate Some interference
Duration of use	Short to medium	Short to medium	Long term
Weather	Poor in windy conditions	Better in windy conditions than other sprinklers	Windy conditions reduce performance, good for cooling
Chemical application	Good	Good	Good

IRRIGATION
Seasonal Evapotranspiration Crop Coefficient K for Irrigated Crops

Crop	Length of Normal Growing Season or Period[d]	Evapotranspiration Coefficient K[b]
Bananas	Full year	0.80 to 1.00
Beans	3 months	0.60 to 0.70
Cocoa	Full year	0.70 to 0.80
Coffee	Full year	0.70 to 0.80
Corn (maize)	4 months	0.75 to 0.85
Cotton	7 months	0.60 to 0.70
Dates	Full year	0.65 to 0.80
Flax	7 to 8 months	0.70 to 0.80
Grains, small	3 months	0.75 to 0.85
Grain, sorghums	4 to 5 months	0.70 to 0.80
Oilseeds	3 to 5 months	0.65 to 0.75
Orchard crops		
Avocado	Full year	0.50 to 0.55
Grapefruit	Full year	0.55 to 0.65
Orange and lemon	Full year	0.45 to 0.55
Pasture crops:		
Grass	Between frosts	0.75 to 0.85
Potatoes	3 to 5 months	0.65 to 0.75
Rice	140 days	1.00 to 1.10
Soybeans	140 days	0.65 to 0.70
Sugarcane	Full year	0.80 to 0.90
Tobacco	4 months	0.70 to 0.80
Tomatoes	4 months	0.65 to 0.70
Truck crops, small	2 to 4 months	0.60 to 0.70
Vineyard	5 to 7 months	0.50 to 0.60

MEAT
Storage Data

Product	Storage temperature °C	Relative humidity %	Storage life
Bacon, fresh	+ 1 to -4.5	85 to 90	2 to 6 weeks
Beef, fresh	0 to +1	88 to 92	3 to 10 days
Beef, frozen	-15 to -25	90 to 95	9 to 12 months
Ham, fresh	0 to +1	85 to 90	7 to 12 days
Ham, frozen	-15 to -25	90 to 95	6 to 8 months
Lamb, fresh	0 to +1	85 to 90	5 to 12 days
Lamb, frozen	-15 to -25	90 to 85	9 to 10 months
Lard	+7 to +9	90 to 95	4 to 8 months
Lard, frozen	-15 to -25	90 to 95	9 to 14 months
Offal, fresh	0 to +1	85 to 90	3 to 7 days
Offal, frozen	-15 to -25	90 to 95	3 to 4 months
Pork, fresh	0 to +1	85 to 90	3 to 7 days
Pork, frozen	-15 to -15	90 to 95	4 to 6 months
Poultry, fresh	0 to +10	85 to 90	4 to 6 days
Poultry, frozen	-15 to 20	90 to 95	8 to 12 months
Rabbit, fresh	0 to +1	90 to 95	1 to 5 days
Rabbit, frozen	-15 to -25	90 to 95	0 to 6 months
Sausages, fresh	0 to +1	85 to 90	3 to 12 days
Sausages, frozen	-15 to -25	90 to 95	2 to 6 moths
Veal, fresh	0 to +1	90 to 95	5 to 10 days
Veal, frozen	-15 to -25	90 to 95	8 to 10 months
Venison, fresh	0 to +1	85 to 90	3 to 7 days
Venison, frozen	-15 to -25	90 to 95	3 to 4 months

MEAT
Thermal Properties

Product	Freezing temperature ℃	Specific heat above freezing kJ/kg ℃	Specific heat below freezing kJ/kg ℃	Latent heat kJ/kg
Bacon, fresh	-2	1.53	1.1	68
Beef, fresh	-2	3.2		231
Beef, frozen			1.67	
Ham, fresh	-2	2.53		167
Ham, frozen			1.46	
Lamb, fresh	-2	3.0		216
Lamb, frozen			1.86	
Lard		2.09		210
Lard, frozen			1.42	
Offal, fresh	-2	2.9		220
Offal, frozen				
Pork, fresh		2.13		128
Pork, frozen				
Poultry, fresh	-3	3.3	1.3	246
Poultry, frozen			1.76	
Rabbit, fresh		3.1		228
Rabbit, frozen			1.67	
Sausages, fresh	-2	3.72		216
Sausages, frozen			2.34	
Veal, fresh	-2	3.08		223
Veal, frozen			1.67	
Venison, fresh	-2	3.05		220
Venison, frozen			1.6	

PADDY
Physical and Thermal Properties

Angle of Repose	
Emptying or Funneling	36 deg.
Filling or Piling	20 deg.
Density	
Bulk	567 - 623 k/m^3
True	1324 - 1372 kg/m^3
Coefficient of Friction	
Steel	0.41
Smooth Wood	0.44
Rough Wood	0.52
Smooth Shiny Tin	0.48
Smooth Side Press Wood	0.55
Across Grain of Plywood	0.53
Rough Side Asbestos Cement Wall Board	0.37
Heat of Vaporization	2400 - 3100 kJ/kg
Length	6.30 - 10.75 mm
Porosity	46 - 64%
Specific Gravity	1.17 - 1.26
Specific Heat	0.288 - 0.470 Kcal/kg -°C
Surface Area	54 - 65 mm^2
Terminal Velocity	5.7 - 7.1 m/sec
Thermal Conductivity	0.1982 - 0.2655 Kcal/hr-m-°C
Thermal Diffusivity	0.0012130 - 0.0009055 m^2/hr
Thickness	1.40 - 1.90 mm
Width	2.20 - 3.92 mm

PADDY
Recommended Drying Temperatures

Purpose	Drying Temperature (°C)
For seeds	43 and below
For milling	54 and below
For flash drying	90 and below

PLOWING
Specific Resistance

Soil Type	Specific resistance of Plow (N/cm^2)	Specific Resistance of Soil (N/cm^2)
Sandy soil	2.1-2.5	2.0-3.2
Sandy loam	2.5-4.2	2.3-3.5
Loam	3.5-4.9	2.5-4.0
Clay loam	4.9-7.0	3.0-5.0
Clay	7.0-7.7	3.5-6.0

PLOWING
Plowing Pattern Efficiency for Square Field

Pattern	Efficiency (%)
Headland	93.0
Continuous	95.7
Circuitous, diagonal turn strip	94.0
Circuitous, rounded corners	91.9
Circuitous, 270 turn	84.0

POWER
Consumption of Various Appliances (220 Volt)

Appliance	Watts
Air Conditioner (evaporative - mobile)	1200-2500
Cassette Deck	30
Circular Saw (small)	1350
Coffee Grinder	75
Coffee Percolator	540
Computer (Desktop)	200
Printer (Ink Jet)	15 - 40
Drill	250-500
Dishwasher	1000-3000
Domestic Water Pump	500
Exhaust fan	40 - 75
Fan	20 - 100
Fax (standby)	10
Floor Polisher	350
Freezer	500
Heater	500 - 3000
Iron	1250
Juicer/Blender	350
Kettle or Jug	1600 - 3000
Microwave Oven	600 - 1000
Radio	15 - 60
Record Player	75
Refrigerator	300
Sewing machine	60
Stove	5000 - 10000
Television	60 - 200
Toaster	500 - 1500
Vacuum cleaner	700 - 1200
Washing Machine	600
Welder - 140A	4000
Video Recorder	17 - 50

POWER TILLER
Travel Speeds

	Travel Speed	
	(cm/s)	**(km/h)**
Rotary tillage	25 - 50	0.9 - 1.8
Miscellaneous field work*	50 -70	1.8 - 2.5
Plowing	70 -120	2.5 - 4.3
Transportation**		15 or 25 or 30

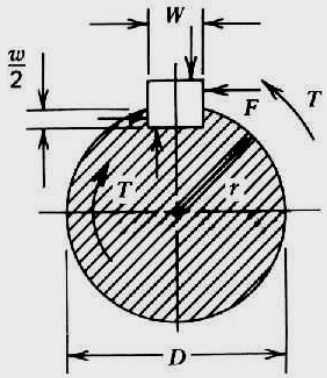
* Puddling, inter-row cultivation, seeding, moving, etc.

** Nominally traffic law may determine legal speeds. Actual max. speeds may be set by local customs.

POWER TILLER
Classifications

	Light	Medium	Heavy
Power	6 hp and below	7-10 hp	10-16 hp
Capacity	0.1 to 0.9 ha/day	1.0-1.5 ha/day	1.2-1.6 ha/day
Fuel Consumption	5-8 lpd	8-10 lpd	10-12 lpd

POWER TRANSMISSION
Square Key Selection Guide
(American National Standard)



Shaft Diameter—nominal		*Square Stock, W*	*Shaft Diameter—nominal*		*Square Stock, W*
Over	*To (inclusive)*		Over	To (inclusive)	
5/16	7/16	3/32	1 3/4	2 1/4	1/2
7/16	9/16	1/8	2 1/4	2 3/4	5/8
9/16	7/8	3/16	2 3/4	3 1/4	3/4
7/8	1 1/4	1/4	3 1/4	3 3/4	7/8
1 1/4	1 3/8	5/16	3 3/4	4 1/2	1
1 3/8	1 3/4	3/8	4 1/2	5 1/2	1 1/4

Notes: All dimensions in inches.
See appendix for other keys.

POWER TRANSMISSION
Pulley Arc of Contact Factor for *C*

Arc of contact*, deg.	Factor, C	Arc of contact*, C	Factor, C
180	1.00	132	0.87
174	0.99	126	0.85
168	0.97	120	0.83
162	0.96	114	0.80
156	0.94	108	0.78
150	0.92	102	0.75
144	0.90	96	0.72
138	0.88	90	0.69

* For small pulley

POWER TRANSMISSION
Correction Factors for Degrees of Contact on Small Pulley

Arc of contact, degrees	Correction factor	Arc of contact, degrees	Correction factor
180	1.00	133	0.87
174	0.99	127	0.85
169	0.97	120	0.82
163	0.96	113	0.80
157	0.94	106	0.77
151	0.93	90	0.73
145	0.91	91	0.70
139	0.89	83	0.65

POWER TRANSMISSION
Plate Size Based on Width for Flat Belt

Size of plate	Belt width, mm	Diameter of bolt, mm
0	38-51	6
1 small	64-102	6
1 large	127-152	7
2 small	178	8
3 small	254-406	10
3 large	432-508	10
4	533-610	11
5	Above 610	13

POWER TRANSMISSION
Service Factors for Components of Farm Implements

Function of operating unit	Service factor
Cutting (sickle bars)	1.5
Cutting (sickle bars with counter weight)	1.3
Cutting (reels)	1.0
Pickup attachments for combines	1.0
Feeding (front cylinder beaters, feeder rolls, draper canvas, etc.)	1.3
Threshing, chopping, etc. (combine cylinders, corn-sheller cylinders, hammer-mill motors, etc.)	1.5
Separation (rear cylinder beaters, straw walkers, etc.)	1.0
Cleaning (fans, cleaning shoes, sieves, etc.)	1.0
Expelling (straw spreaders, husk blowers, etc.)	1.3
Delivery (augers, elevators, etc.)	1.3
Traction for self-propelled machines	1.3
Hydraulic system, oil pumps	1.3

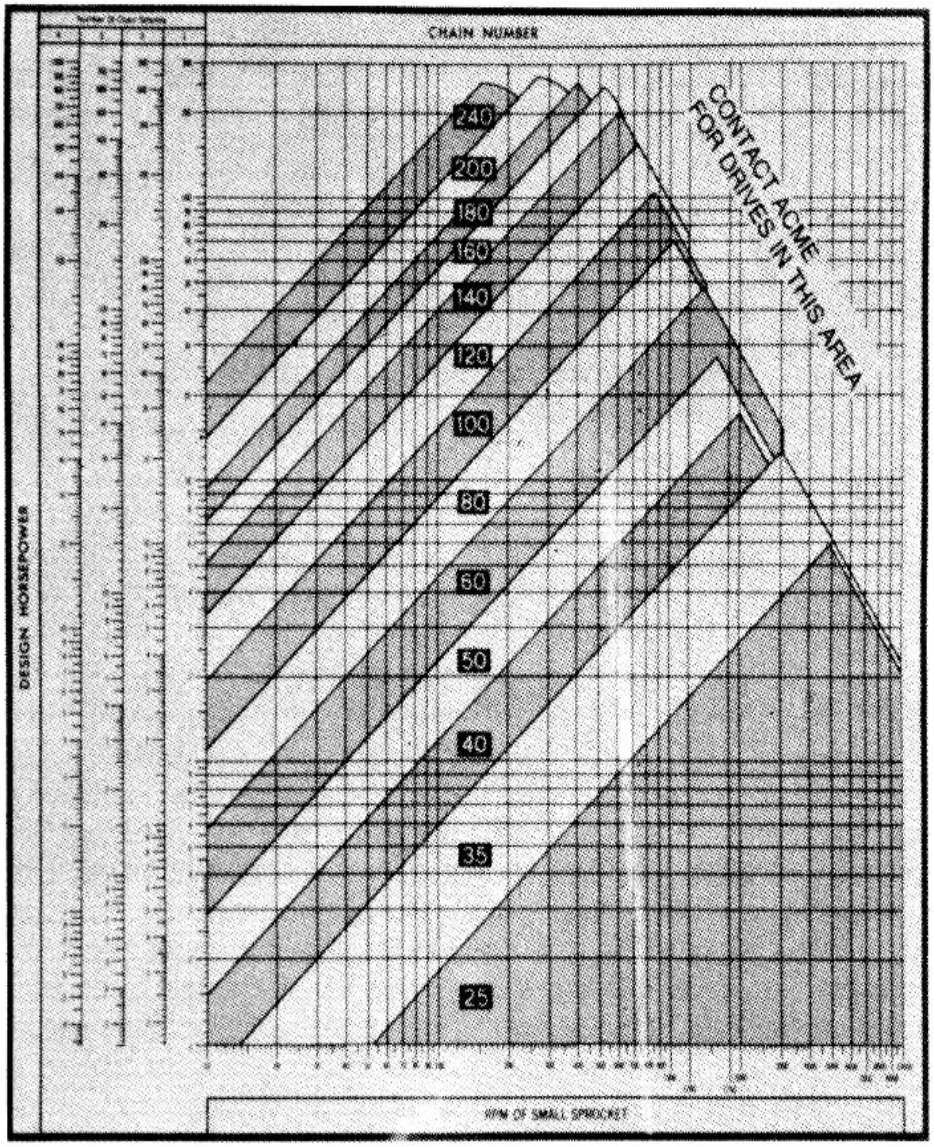
POWER TRANSMISSION
Service factors, *S*

Applicators	Squirrel-cage ac motor		Wound rotor a-c motor (slip ring)	Single-phase capacity motor	Diesel engine, 4 or more cyl, above 700 rpm
Agitators	1.0-1.2	1.2-1.4	1.2	-	-
Compressors	1.2-1.4	-	1.4	1.2	1.2
Belt conveyors	-	1.4	-	-	-
Screw conveyors	-	1.8	-	-	-
Crushing machinery	-	1.6	1.4	-	1.4-1.6
Fans, centrifugal	1.2		1.4	-	1.4
Fans, Propeller	1.4	2.0	1.6	-	1.4
Generators and exciters	1.2	-	-	-	2.0
Line shafts	1.4	-	1.4	1.4	1.6
Machine tools	1.0-1.2	-	1.2-1.4	1.0	-
Pumps, centrifugal	1.2	1.4	1.4	1.2	-
Pumps, reciprocating	1.2-1.4	-	1.4-1.6	-	1.8-2.0

POWER TRANSMISSION
Standard Roller Chain Dimensions, mm

Standard chain number	Pitch, P	Max. roller diameter, D_r	Width, W	Pin diameter, D_p
25	6.35	3.30	3.18	2.30
35	9.53	5.08	4.76	3.58
41	12.70	7.77	6.35	3.58
40	12.70	7.92	7.94	3.96
50	15.88	10.16	9.53	5.08
60	19.05	11.91	12.70	5.94
80	25.40	15.88	15.88	7.92
100	31.75	19.05	19.05	9.53
120	38.10	22.23	25.40	11.10
140	44.45	25.40	25.40	12.70
160	50.80	28.58	31.75	14.27
180	57.15	35.71	35.71	17.45
200	63.50	39.67	38.10	19.84
240	76.20	47.63	47.63	23.80

POWER TRANSMISSION
Roller Chain Pitch Selection Chart



POWER TRANSMISSION
Standard Roller Chain Sprocket Diameters for Chain Number 40

Number of teeth	Pitch diameter	Outside diameter
11	45.08	50.88
12	49.07	55.02
14	57.07	63.26
15	61.08	67.36
16	65.10	71.46
17	69.12	75.55
18	73.14	79.64
19	77.16	83.73
20	81.18	87.81
21	85.21	91.88
22	89.70	95.95
24	97.30	104.09
25	101.33	108.15
26	105.36	112.22
27	109.40	116.28
28	113.43	120.33
29	117.46	124.40
30	121.50	128.45
31	125.53	132.51
32	129.57	136.56
34	137.64	144.68
35	145.75	152.78
38	153.79	160.88
39	157.83	164.93
40	161.87	168.99
41	165.91	173.04
42	169.95	177.09
43	173.98	181.14
44	178.02	185.19
45	182.06	189.24

POWER TRANSMISSION
Standard Roller Chain Sprocket Diameters for Chain Number 60

Number of teeth	Pitch diameter	Outside diameter
11	67.62	76.31
12	73.60	82.52
13	79.60	88.72
14	85.61	94.89
15	91.62	101.04
16	97.65	107.19
17	103.67	113.33
18	109.71	119.46
19	115.74	125.60
20	121.78	131.71
21	127.82	137.83
22	134.54	143.92
24	145.95	156.13
25	151.99	162.23
26	158.04	168.33
27	164.09	174.42
28	170.14	180.50
29	176.20	186.59
30	182.25	192.67
31	188.30	198.77
32	194.35	204.84
34	206.46	217.02
35	212.52	223.09
38	218.57	229.17
39	224.63	235.25
40	242.80	253.48
41	248.86	259.56
42	254.92	265.63
44	267.03	277.79
45	273.09	283.86

POWER TRANSMISSION
V-Belt Specifications

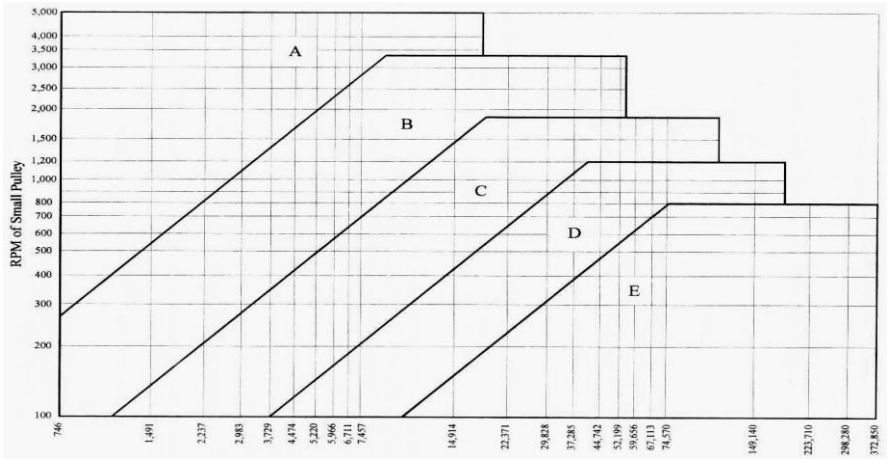
Type of Cross section	b_b, mm	h_b, mm	Power range (one or more belts), watts
A	13	8	186-1457
B	16	10	746-18642
C	22	13	11186-74570
D	32	19	37285-186425
E	38	25	74570 and up

POWER TRANSMISSION
V-Pulley Specifications

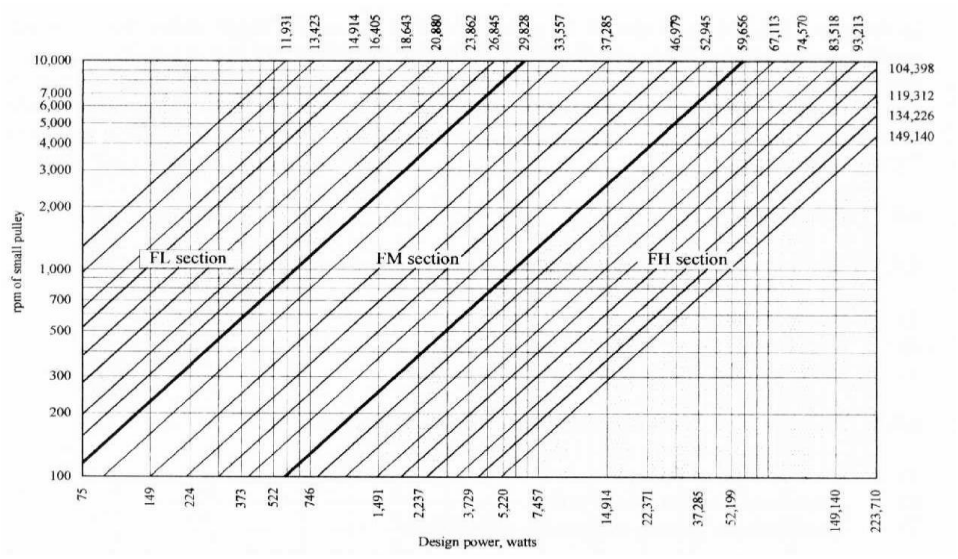
Pitch diameter		x, mm	h_g, mm	a, degrees	b_g, mm	E, mm	d,mm	l,mm
Min. recommended, mm	Range (mm)							
65	65-140 Over 140	3.2	12	34 38	12.5 12.8	+1.8 9.5 -0	12-21	25-40
115	115-180 Over-180	4.4	15	34 38	16.2 16.5	+3.8 12.7 -0	16-30	32-50
175	175-200 201-305 Over 305	5.1	20	34 36 38	22.3 22.5 22.7	+3.8 17.5 -0	30-50*	63-80*
300	300-330 331-430 Over 430	7.6	27	34 36 38	32 32.3 32.6	+6.4 22.2 -0		
450	450-610 Over 610	10.2	33	36 38	38.8 39.2	+6.4 28.6 -0		

grooved V-pulleys

POWER TRANSMISSION
Belt Selection Chart



POWER TRANSMISSION
Flat chord Belt Selection Chart



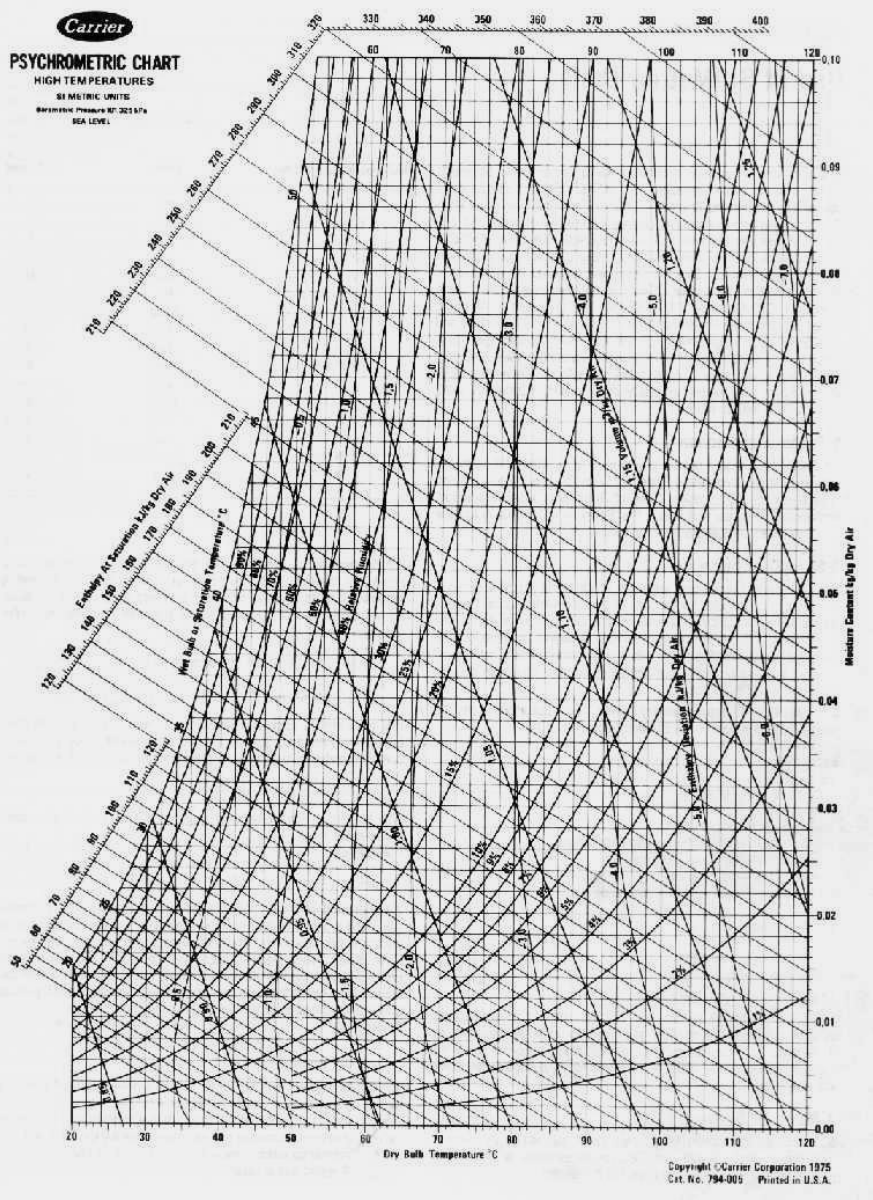
POWER TRANSMISSION
Power Ratings for Section A V-belt

Rpm of Small Pulley	Pitch diameter of small pulley, mm									
	70	80	90	100	110	120	130	140	150	160
200	172	216	268	313	358	410	455	500	544	589
400	298	388	477	567	656	738	828	910	992	1081
600	410	537	671	798	917	1096	1171	1290	1409	1536
800	507	679	843	1007	1171	1335	1491	1648	1805	1961
1000	604	805	1014	1215	1409	1603	1797	1991	2177	2364
1160	671	910	1141	1365	1588	1812	2036	2245	2461	2670
1200	694	932	1171	1402	1633	1864	2088	2312	2528	2744
1400	776	1051	1320	1588	1849	2110	2364	2617	2863	3102
1600	850	1156	1462	1760	2058	2314	2625	2901	3169	3438
1750	902	1238	1566	1887	2200	2513	2811	3102	3393	3669
1800	917	1260	1603	1931	2252	2565	2871	3169	3460	3743
2000	992	1365	1730	2088	2431	2770	3102	3423	3729	4027
2200	1051	1454	1849	2230	2602	2968	3311	3646	3975	4280
2400	1111	1544	1961	2371	2767	3147	3512	3855	4191	4504
2600	1163	1626	2073	2498	2916	3311	3684	4042	4385	4698
2800	1215	1700	2170	2617	3050	3460	3848	4206	4549	4862
3000	1260	1775	2259	2729	3169	3594	3982	4347	4683	4981

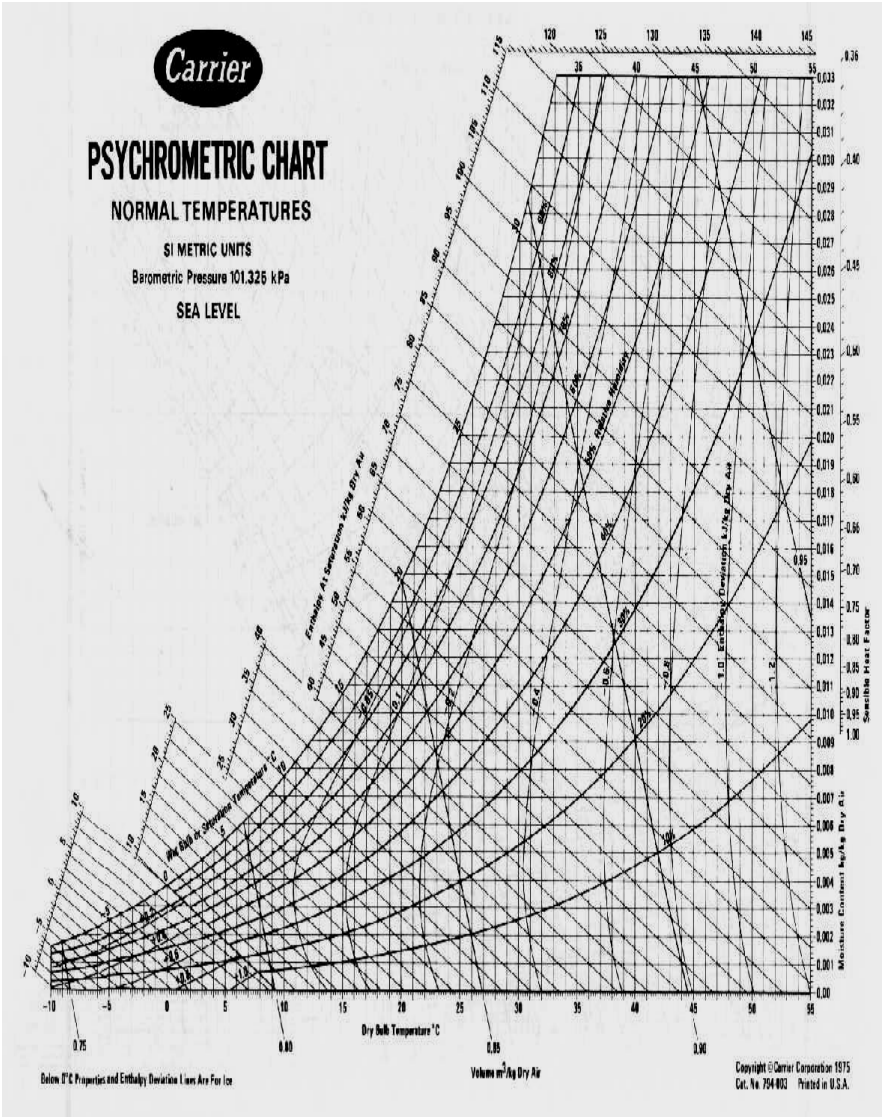
POWER TRANSMISSION
Power Ratings for Section B V-belt

Rpm of Small Pulley	Pitch diameter of small pulley (mm)										
	120	130	140	150	160	170	185	190	200	220	240
200	544	626	708	790	865	947	1066	1104	1178	1298	1447
870	1782	2081	2379	2677	2968	3259	3691	3833	4116	4534	5078
400	962	1111	1268	1417	1566	1708	1931	1998	2148	2364	2647
600	1335	1551	1767	1984	2192	2401	2714	2819	3028	3333	3743
800	1670	1946	2230	2506	2774	3050	3445	3579	3840	4236	4743
1000	1976	2319	2655	2990	3318	3646	4124	4280	4601	5063	5667
1160	2207	2595	2975	3365	3721	4086	4631	4802	5153	5667	6338
1200	2267	2662	3057	3438	3825	4198	4750	4929	5287	5816	6495
1400	2528	2983	3423	3855	4288	4705	5317	5518	5913	6488	7226
1750	2938	3475	3989	4497	4996	5473	6174	6398	6831	7457	8277
1600	2774	3274	3758	4236	4705	5160	5831	6048	6465	7077	7830
1800	2990	3535	4064	4586	5086	5570	6279	6503	6942	7606	8352
2000	3192	3773	4340	4884	5421	5928	6659	6890	7345	7979	8725
2200	3363	3982	4579	5153	5705	6227	6972	7203	7681	8277	8948
2400	3512	4161	4780	5369	5936	6465	7203	7435	7830	8426	9098
2600	3632	4303	4944	5548	6115	6637	7360	7606	7979	8501	9023
2800	3729	4415	5063	5667	6234	6749	7420	7606	7979	8426	
3000	3796	4497	5145	5742	6286	6778	7397	7606	7904		

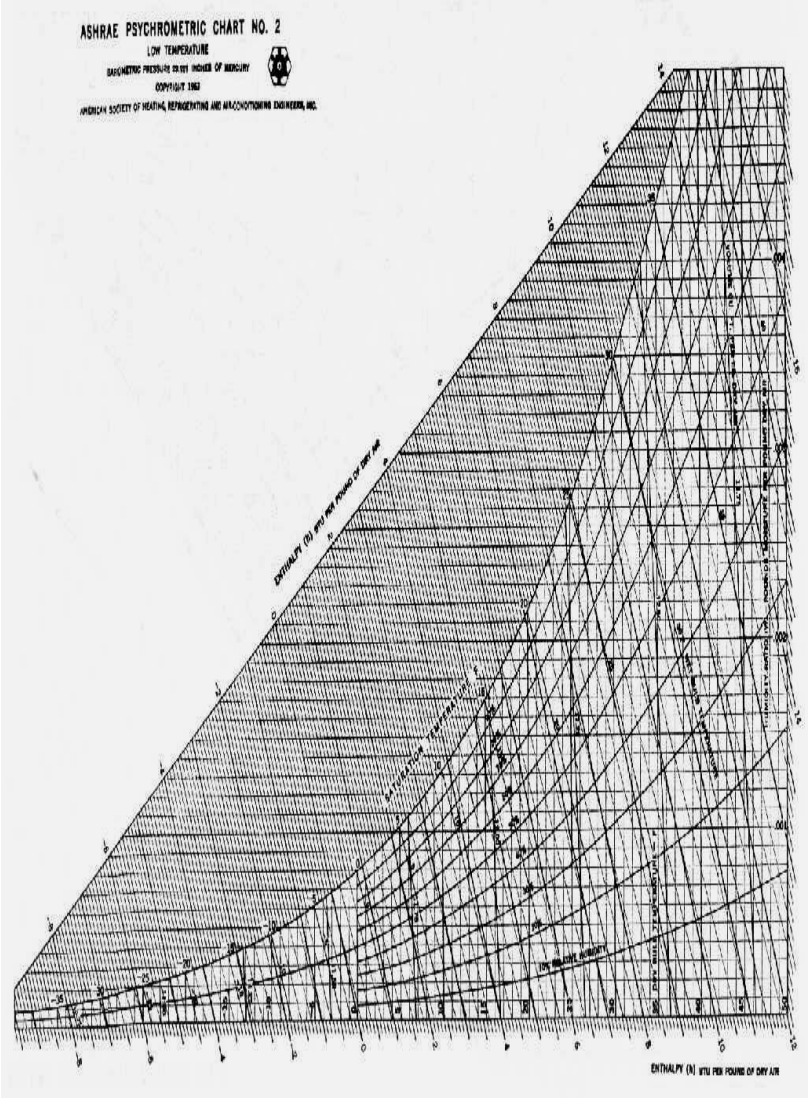
.PSYCHROMETRIC CHART
High Temperature



PSYCHROMETRIC CHART
Normal Temperature



PSYCHROMETRIC CHART
Low Temperature



PUMPS
Selection Table for Pump capacity and Head

Type of Pump	Low Capacity		Medium Capacity		High Capacity	
	LH	HH	LH	HH	LH	HH
Centrifugal Single-Stage	x	x	x	x	x	x
Mixed Flow					x	x
Axial Flow					x	
Portable Submersible	x	x	x			
Reciprocating Plunger		x				
Reciprocating Piston			x	x	x	x
Gear		x	x	x		
Vane	x	x	x			
Screw			x	x	x	x
Diaphragm	x		x			

PUMPS
Overall Pump Efficiency

Pump Type	Overall Efficiency
New electric motor and water pump	95
Reconditioned pump and motor units	60

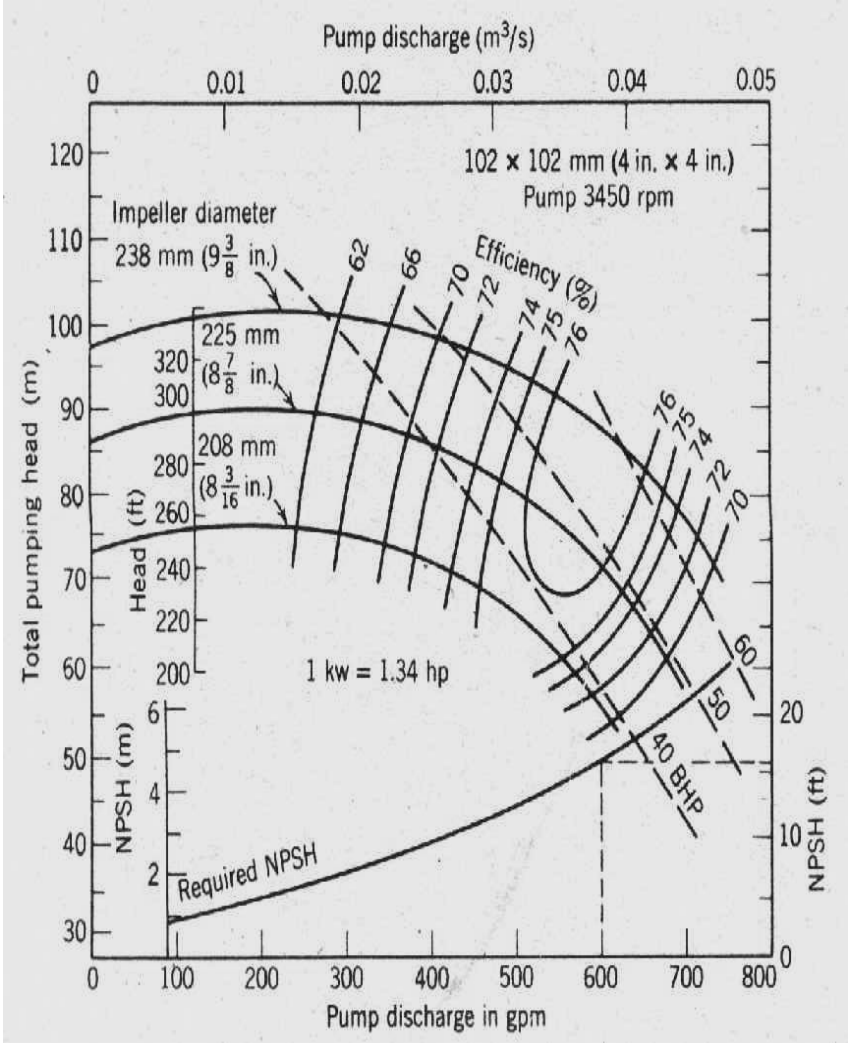
PUMPS
Performances of Water Pumps

Pump Type	Range of Head Suction (m)	Discharge (m)	Efficiency (%)	Starting Torque	Speed (rev/min)
Piston	7 10	100 30	80 80	High High	30 30
Double Acting Piston	7	100	85	High	30
Screw	0	5	60	Low	30-400
Diaphragm	7	30	90	High	30
Rope and Bucket	0	50		High	2
Spiral Wheel	0	1	60	Low	80
Propeller	0	7	60	Low	400-2000

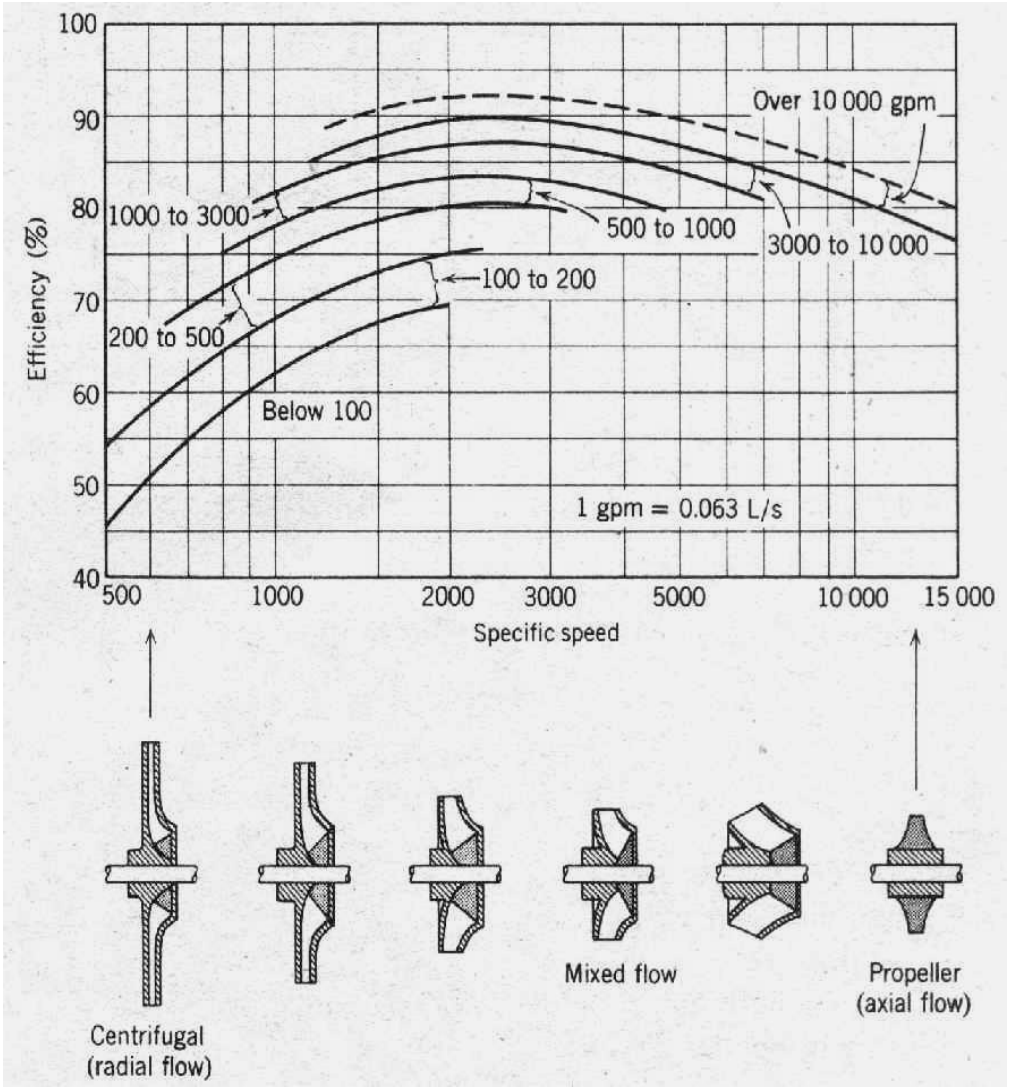
PUMPS
Recommended Suction Pipe Diameter for Various Flow Rates

Pump Pipe (in)	Flow Rate (m^3/min)	(lpm)
1	0.02 - 0.05	20 - 50
1-1/4	0.04 - 0.08	40 - 80
1-1/2	0.07 - 0.15	70 - 150
2	0.11 - 0.22	110 - 220
2-1/2	0.018 - 0.36	180 - 360
3	0.28 - 0.56	280 - 560

PUMPS
Characteristics Curve of Centrifugal Pump



PUMPS
Specific Speed



PUMPS

Loss of Head in Feet, Due to Friction per 100 Ft of 15 Year Old Ordinary Steel Pipe

Rated Flow		Nominal Diameter of Pipe, in.							
m3/ hr	lps	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3
0.25	0.069	2.5							
0.50	0.139	9.4	2.4						
0.75	0.208	20.0	5.0	1.6					
1.00	0.278	35.0	9.0	2.7					
1.50	0.417		18.0	5.5	1.5				
2.00	0.556		30.3	10.0	2.5	1.2			
3.00	0.834			20.0	5.2	2.4			
4.00	1.110			30.4	8.5	4.0	1.5		
5.00	1.390				13.5	6.0	2.3		
6.00	1.670				18.0	8.5	3.2	1.0	
8.00	1.950				32.0	15.0	5.5	1.7	
10.0	2.780				50.0	23.0	8.0	2.6	1.1
12.0	3.340					32.0	11.5	3.7	1.6
14.0	3.890					43.0	15.5	5.0	2.1
16.0	4.450						20.0	6.4	2.6
18.0	5.000						25.0	7.7	3.5
20.0	5.560						30.0	9.8	4.0
25.0	6.950						44.0	14.0	6.0
30.0	8.340							20.0	8.0
35.0	9.730							26.0	11.0

Pipe coefficients: The values of friction given in the table are for commercial wrought iron or cast iron pipe of 15 years' service when handling soft clear water. For other classes of pipe, the values taken from the table should be multiplied by a coefficients below:

New smooth brass and steel pipe = 0.6
New smooth iron pipe = 0.7
25-year old ordinary pipe = 1.2

PUMPS
Pipe Friction Table – Galvanized Pipe

Pipe Friction Tables - Galvanised Pipe

Feet per 100 feet of pipe or metres per 100 metres of pipe
Friction loss can be in any units per 100 units of pipe.
Allowance has been made for the normal number of pipe fittings.

Galls/ Min	Litres/ Min	½"	¾"	1"	1¼"	1½"	2"	2½"	3"
2	9	12.0	3.8	1.0	-	-	-	-	-
4	18	40.0	10.0	3.0	1.0	-	-	-	-
6	27	79.0	20.0	6.0	2.0	0.9	-	-	-
8	36	-	35.5	10.7	3.1	1.4	-	-	-
10	45	-	53.0	16.2	4.5	2.0	0.6	-	-
12	55	-	75.0	23.5	6.1	2.7	0.8	0.4	-
15	68	-	-	34.8	9.2	4.0	1.2	0.5	-
18	82	-	-	48.0	12.5	5.5	1.9	0.7	-
20	90	-	-	59.2	15.5	7.0	2.4	0.8	
25	114	-	-	89.0	23.0	10.5	3.6	1.4	0.4
30	136	-	-	-	34.0	15.8	5.3	1.7	0.7
35	159	-	-	-	45.0	21.0	7.2	2.3	0.9
40	182	-	-	-	57.0	27.0	9.2	3.2	1.2
45	205	-	-	-	70.0	33.0	11.0	4.1	1.5
50	227	-	-	-	85.0	39.8	14.0	4.6	1.9
55	250	-	-	-	-	48.0	16.0	5.9	2.2
60	273	-	-	-	-	56.5	19.5	6.8	2.6
65	295	-	-	-	-	65.0	22.8	7.7	3.0
70	318	-	-	-	-	75.0	26.0	9.0	3.4
75	341	-	-	-	-	85.0	30.0	10.3	3.8
80	364	-	-	-	-	95.7	33.5	11.5	4.4
85	386	-	-	-	-	-	37.2	13.0	4.9
90	409	-	-	-	-	-	42.0	14.5	5.5
95	432	-	-	-	-	-	46.0	16.2	6.1
100	455	-	-	-	-	-	46.8	17.8	6.8
110	500	-	-	-	-	-	60.0	21.0	8.0
120	546	-	-	-	-	-	71.5	24.0	9.3
130	591	-	-	-	-	-	83.8	28.0	11.0
140	636	-	-	-	-	-	95.0	32.0	12.4
150	682	-	-	-	-	-	-	37.0	14.2

PUMPS
Pipe Friction Table – Polythene Pipe/PVP Pipe

Pipe Friction Tables - Polythene Pipe PVC Pipe

Feet per 100 feet of pipe or metres per 100 metres of pipe
Friction loss can be in any units per 100 units of pipe.
Allowance has been made for the normal number of pipe fittings.

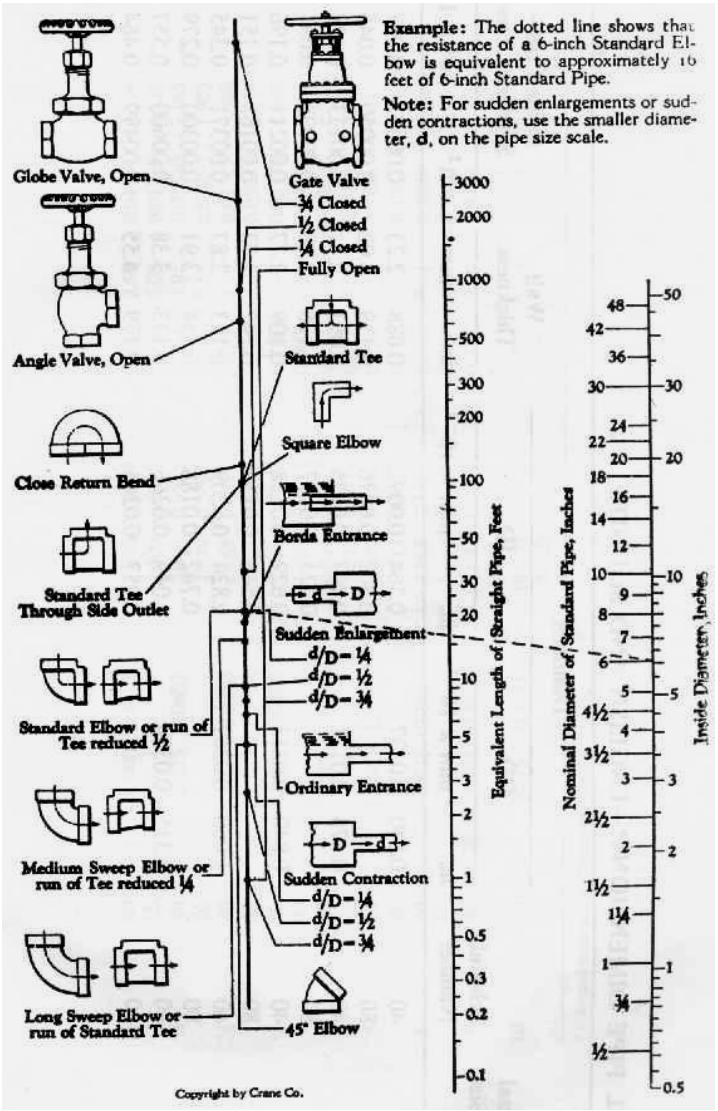
Polythene Pipe - Blue or White Stripe

		English Size Inside (Dia)									
		½"	¾"	1"	1¼"	1½"	2"	1½"	2"	2½"	3"
Galls/ Min	Litres Min	Metric Size Outside 16	25	32	40	50	63	PVC Pipe Class B			
2.5	11	25	3	1	-	-	-	-	-	-	-
5	23	90	12	3	1	0.5	-	0.4	-	-	-
10	45	-	40	10	4	1.5	0.3	1.2	0.5	-	-
15	68	-	80	20	8	3	0.7	2.1	0.6	0.2	-
20	90	-	-	30	13	5	1.3	3.2	1.0	0.4	0.2
25	114	-	-	50	20	8	2	4.2	1.6	0.6	0.3
30	135	-	-	60	25	10	3	6	2.1	0.8	0.4
35	159	-	-	-	30	14	4	8	2.8	1.0	0.5
40	182	-	-	-	40	18	5	10	3.8	1.2	0.7
50	227	-	-	-	60	27	7	20	5.2	1.7	1.0
60	273	-	-	-	-	38	9	22	7.4	2.5	1.3
70	318	-	-	-	-	50	12	25	9.5	3.3	1.7
80	364	-	-	-	-	-	16	31	13	4.2	2.0
90	409	-	-	-	-	-	20	40	20	5.1	2.2
100	455	-	-	-	-	-	24	48	22	6.4	3.0
120	546	-	-	-	-	-	34	62	26	8.4	3.9
140	636	-	-	-	-	-	46	81	33	12	5.1
160	727	-	-	-	-	-	-	-	40	15	7
180	818	-	-	-	-	-	-	-	50	25	9
200	910	-	-	-	-	-	-	-	60	27	10

PUMPS
Equivalent Resistance of Pipe Fittings and Valves
(length of straight pipe in feet)

Nominal Pipe Diameter (in.)	90 Elbow	Tee	Gate Valve	Swing Check Valve
1/2	1.55	3.10	0.36	4.32
3/4	2.06	4.12	0.48	5.72
1	2.62	5.24	0.61	7.27
1-1/4	3.45	6.90	0.81	9.58
1-1/2	4.02	8.04	0.94	11.2
2	5.17	10.3	1.21	14.4
2-1/2	6.16	12.3	1.44	17.1
3	7.67	15.3	1.79	21.3

PUMPS
Resistance of Valves and Fittings



REFRIGERATION
Properties of Some Refrigerants

Refrigerant	Refrigerating effect, Btu/lb standard cycle	Remarks
Ammonia	474.5	Highly toxic, flammable
Carbon dioxide	55.5	Nontoxic, nonflammable, high operating pressure
Methyl chloride	150.3	Somewhat toxic, flammable
Sulfur dioxide	141.4	Very toxic, nonflammable
Freon-12	51.1	Nontoxic, nonflammable
Freon-21	69.5	Nontoxic, nonflammable

REFRIGERATION
Air Velocity Requirement During Refrigeration of Some Products

Product	Air velocity m/s
Fruit	0.3 to 0.45
Vegetables	0.35 to 0.45
Meat, fresh	0.45 to 0.5
Dairy products	0.5 to 0.6
Nuts	0.35 to 0.45
Flowers	0.75 to 1.0
Chocolate products	0.2 to 0.3
Furs	0.6 to 0.75
Bottled goods	1.0 to 1.25
Canned goods	1.0 to 1.25
Wrapped and sealed products	0.75 to 0.75

REFRIGERATION
Average Product Storage Density

Category	Description	Density kg/m^3
1	Cauliflower	150 to 199
	Flan cases	
	Pommes dauphines	
	Ice cream	
2	Raspberries	200 to 249
	Pizzas	
	Lobsters	
	Snails	
3	Sheep, carcasses	250 to 299
	Spinach greens	
	Beef, fore quarters	
	Lobsters tails	
	Tartlets	
4	Beef, hind quarters	300 to 349
	Fruit, for retail and collectives	
	Green beans, for retail and collectives	
	Fish, for retail and collectives	
	Sweets in pots	
	Minced meat	

REFRIGERATION
Average Product Storage Density

Category	Description	Density kg/m^3
5	Vegetables, for retail and collectives	350 to 399
	Chickens, guinea-fowl	
	Pig, carcasses	
	Chips	
6	Briskets, loins of pork, in pallet cases	400 to 449
	Minced meat, steaks and grills	
	Geese, turkeys	
7	Back fat, in pallet cases	450 to 499
	Frozen fruit, for industry	
	Frozen vegetables, for industry	
	Frozen fish, for industry	
8	Paste for pastry	500 and over
	Meat, in case	
	Butter, in carton	
	Ham shoulder, in pallet cases	
	Chestnuts	
	Frozen fruit, in cans and pallet cases	
	Frozen eggs	
	Giblets, in cases	
	Italian style pastas, e.g. cannelloni, ravioli	

REFRIGERATION
Percentage Moisture Content in Fresh Meats, Fruits and Vegetables

Product	Moisture Content, % wb
Beef	
Chuck	65
Flank	45
Loin	57
Neck	62
Plate and brisket	53
Rib	59
Round	67
Shank, force	70
Shank, hind	69
Sides	60
Lamb	
Breast or chuck	56
Leg, hind (medium fat)	64
Loin	53
Neck	57
Shoulder	52
Fore quarter	55
Hind quarter	61
Mutton	
Chuck (lean)	65
Chuck (all analysis)	48
Flank (medium fat)	46
Leg, hind (lean)	67
Leg, hind (medium fat)	63
Loin (medium fat)	50

REFRIGERATION
Percentage Moisture Content in Fresh Meats, Fruits and Vegetables

Product	Moisture Content, % wb
Neck (medium fat)	58
Shoulder (lean)	67
Shoulder (medium fat)	62
Fore quarter	53
Hind quarter	55
Pork	
Ham, fresh (lean boned)	60
Ham, fresh (medium fat)	54
Loin chops (lean)	60
Loin, chops (medium fat)	52
Loin, tenderloin	67
Middle cuts	48
Shoulder	51
Veal	
Breast	70
Chuck	76
Leg	74
Loin	73
Shoulder	73
Vegetables	
Asparagus	94
Cabbage	91
Carrots	83
Lettuce	94
Peas	75
Potatoes, white	73
Potatoes, sweet	69
Tomatoes	94
Radishes	92

REFRIGERATION
Percentage Moisture Content in Fresh Meats, Fruits and Vegetables

Product	Moisture Content, % wb
Fruits	
Apples	83
Cherries	82
Strawberries	90
Grapefruit	88
Lemons	89
Oranges	87
Pears	83
Peaches	87

RICE
Safe Storage Period (days) of Rough Rice at 0.5% Dry Matter Loss as Function of Temperature and Moisture

Moisture (% wb)	Temperature (°C)				
	10	20	30	40	50
10	220.4	181.9	161.4	152.7	139.5
15	123.2	98.2	66.0	41.0	3.0
20	23.4	13.7	8.0	5.5	4.7
25	15.7	7.9	4.6	3.0	2.5
30	13.1	5.8	3.1	1.3	1.0

RICE DRYER
Recommended Temperature for Drying Paddy

Purpose	Drying Temperature (°C)
For Seeds	43 and below
For Milling	54 and below
For Flash Drying	100 and below

RICE HULL
Average Production Region

Region	Metric tons
Philippines	1, 932,846
CAR	39,064
I Ilocos	168,125
II Cagayan Valley	203,793
III Central Luzon	341,191
IV Southern Tagalog	203,504
V Bicol	149,098
VI Western Visayas	255,000
VII Central Visayas	38,004
VIII Eastern Visayas	85,225
IX Western Mindanao	74,812
X Northern Mindanao	78,019
XI Southern Mindanao	133,328
XII Central Mindanao	163,683

RICE HULL
Physical and Thermal Properties

Bulk density of rice hull = 0.10 g/cc
True density of rice hull = 1.61 g/cc
Apparent density of rice hull = 0.65 g/cc
Apparent surface area of rice hull = 3855 m^2/m^3
Weight of rice hull = 3.087 mg
Total void space fraction = 93%
Porosity of fuel = 54%
Void space fraction between rice hulls, Eb = 85%
Rice hull contains 15 – 21% ash (SiO2) by weight
Channel formation will occur in rice hull char at 8.5 – 9 cm/sec superficial gas velocity and on rice hull at 20 – 23 cm/sec superficial gas velocity
Pyrolysis takes place at rice hull bed of 250 – 500 C
Bulk density of rice hull is approx. 100 – 120 kg/m^3
Char is 32% of the husk bulk density
1 kg of rice hull requires 4.7 kg of air for complete combustion
Tar higher heating value is 20 – 34 mJ/kg
Condensable hydrocarbon and H_2O is 30% by weight of rice hull
At operating temperature of 1200 C carbonized rice hull will turn to ash.
Rice hull ash softening temperature is 1400 C
Slugging is formed by localized complete combustion of rice hull resulting from high localized air flow
Formation of caves or channels will allow air to reach the carbon surface at ER > 1.0
Rice husk has normally 12 – 16% moisture and about 20% at a very high humidity condition

RICE MILL
Recommended RPM for the Different Sizes of Under-Runner Disc Huller and Rubber-Roll Huller

Under-Runner Disc Huller		Rubber-Roll Huller			
Stone Diameter (mm)	RPM	Diameter (mm)	Width (mm)	RPM High	RPM Low
400	670	150	64	1320	900
700	380	220	76	1200	900
900	295	250	250	1000	740

RICE MILL
Design Requirements

Machine	Requirement
Under-Runner Disk Huller	
Abrassive coating	Not more than 1/6 to 1/7 of stone diameter
Peripheral Speed	14 m/s
Recommended Composition	50% by weight of emery grit 14, 15% by weight of emery grit 16, 33% silicium carbide grit 16, 20% magnesite, 20% chloride brine
Rubber Roll Huller	
Rollers	Adjustable roll runs about 25% slower than fixed roll; smaller roll runs faster than larger roll
Peripheral speed	14 m/s

RICE MILL
Design Requirements

Machine	Requirement
Paddy Cleaner with Vibrating Sieves and Aspirator	Use 0.2 m^2 of screen area per ton of paddy. For capacities up to 10 tph use 8m^3/minute of airflow per ton of paddy; for capacities more than 10 tph use 5 m^3/minute
Scalper Cleaner with one Rotating Screen and Aspirator	Use 0.2 m^2 of screen area per ton paddy with 14 m^3/minute of airflow per ton of paddy
Scalper Cleaner with 2 Rotating Screens and Aspirator	Use 0.25 m^2 of screen area per ton of paddy
Compartment Type Paddy Separator	
Capacity	40 kg brown rice per hour for long grains, 60 kg brown rice per hour for short grains.
	New models has 65 kg brown rice per hour for long grains, 100 kg brown rice per hour for short grains.
Abrassive Cone Whitener	
Peripheral speed	13 m/s
Abrassive Cone Polisher	Rpm is slower by 25% than abrasive whitening cone

RICE MILL
Capacities and Power Requirement of Rubber Roll Hullers

Size	**Dimensions of the rolls (mm)**		**Capacity (t/h)**		**Horsepower requirements**
	Length	**Diameter**	**Long grains**	**Short grains**	
4	100	220	0.9	1.25	2.5
6	150	220	1.2	1.9	4
10	254	254	2.2	3.8	6

RICE MILL
Capacities and Power Requirements of Disc Shellers

Disc diameter (mm)	Capacity (kg paddy/h)	Horsepower Requirements
750	450-600	3.0
1000	700-1000	3.5
1250	1000-1400	4.0
1400	1600-2100	5.5

RICE MILL
Vertical Cone Whitener Size, Power Requirements, and Practices

Cone diameter (mm)	hp[a]	Capacity (kg brown rice/h)					
		Single pass		Double pass		Triple pass	
		Long grain	Short grain	Long grain	Short grain	Long grain	Short grain
500	4	350	420	570	680	680	800
600	7.5	550	650	890	1100	1050	1250
800	10	750	900	1230	1450	1460	1725
1000	15	1000	1200	1700	2000	1900	2300
1250	20	1350	1600	2200	2600	2600	3000
1500	25	1700	2000	2700	3200	3200	3800

[a] Add 30% for whitening parboiled paddy.

RICE MILL
Operation

Operation	Equipment	By-Product
Precleaning and de-stoning	Pre-cleaner and Destoner	Foreign material such as straw, chaff, weed seeds, stones, metal sands
Paddy grading	Thickness or length grader	Paddy different length or thickness
Hulling or dehusking	Under-runner stone disc or rubber roll	Paddy of different length or thickness
Sifting	Plansifter	Coarse bran and germs
Husk aspiration	Husk Aspirator	Husk
Separation of paddy and brown rice	Paddy Separator	Return paddy
Brown rice grading	Thickness length or grader	Immature kernels or brown rice of different length or thickness
Conditioning of brown rice (exposing brown rice to steam and air to increase moisture content from 14 to 15%)	Conditioning tank	None
Tempering of brown rice (allow steamed brown rice to equalize to a uniform moisture content of 15%)	Tempering Bins	None
Abrasive whitening (from brown rice to undermilled rice)	Abrasive Whitener or Whitening Cone	Bran and germ
Friction whitening (from undermilled to milled rice)	Friction whitener	Fine bran
Rice polishing or refining (from milled rice to polished rice)	Polisher or Refiner	Very fine bran
Sifting	Plansifter or Gyrosifter	Brewer's rice
Rice grading 9from mixture of polished rice to whole and broken rice)	Indented Cylinder Grader	Broken grain
Sorting 9with mixed discolored grains to purely white milled rice0	Color Sorter	Discolored grain
Glazing or coating (addition of nutrients in the from of glucose talcum or lyzine)	Glazing Drum	None
Blending (whole enriched milled rice with brokens with known percentages)	Mixing or Proportioning Tanks	None
Weighing	Auto Weigher	None
Packaging	Packing Machine	None

RICE MILL
Number of Bags to Worn Out Pair of Rubber Roller

Rubber Roll Size (in.)	Number of Bags (50 kg paddy processed per pair of rubber roll)
2-1/2	200-250
3	300-350
4	400-600
6	850-900
8	950-1000
10	1500-2000

Hulling efficiency ranged from 60-88%

RICE MILL
Capacities and Power Requirements of Disc Shellers

Disc diameter (mm)	Capacity (kg paddy/h)	Horsepower Requirements
750	450-600	3.0
1000	700-1000	3.5
1250	1000-1400	4.0
1400	1600-2100	5.5

RICE MILL
Peripheral Speeds and Operating Pressures of Horizontal Whitening Machine

	Grinding Type	Friction Type
Peripheral Speed	Over 600 m/min	Below 300 m/min
Pressure	Below 50 g/cm^2	Over 200 g/cm^2

RICE MILL
Comparison Between Grinding-Type and Friction-Type Horizontal Whitening Machine

	Grinding-Type		Friction-Type	
	Initial Stage	Middle Stage	Initial Stage	Middle Stage
Efficiency	High	Low	Low	High
Breakage	Small	Small	Much	Much
Whitening Degree	High	High	Low	Low
Glossiness	Low	Low	High	High
Moisture Absorption	Fast	Fast	Slow	Slow
Deformation	Partially	Partially	Full	Full
Embryo Removed	Easy	Easy	Easy	Difficult

RICE THRESHER
Performance Criteria for Mechanical Rice Thresher

Criteria	Performance Data
Threshing Recovery, percent minimum	97.0
Threshing Efficiency, percent, minimum	99.8
Losses, percent, minimum a) Blower Loss b) Separation Loss c) Unthreshed Loss d) Scattering Loss	 1.2 1.3 0.2 0.3
Purity, percent, minimum a) With Sifter and Fan b) Without Sifter and With Fan c) Without Cleaning Devices	 97.0 95.0 80.0
Mechanically Damaged Grain, percent, maximum	2.0
Net Cracked Grain, percent, maximum	5.0
Noise, Level, [db (A)], maximum	95.0*

- Allowance noise level for six (6) hours of continuous exposure based on Occupational Safety and Health Standards, Ministry of Labor, Philippines. 1983.

RICE THRESHER
Recommended Operating Speed for Various Types of Threshing Machine

Cylinder Type	Hold-On Feeding	Throw-In Feeding
Wire loop w/o concave	2650	3650
Wire loop w/ concave	2150	2900
Peg Tooth	2150	2900
Rasp Bar	2650	3650

RICE THRESHER
Design and Performance Specifications

Threshing Cylinder	
Length	540 – 1200 mm
Diameter	150 – 560 mm
Threshing Cylinder Speed	644 – 889 rpm
Engine Speed	1427 – 3223 rpm
Blower Speed	631 – 2672 rpm
Rated Power	3 – 16 hp
Fuel Consumption Rate	0.51 – 3.4 liters per hour
Actual Capacity	879 – 2548 kg per hour
Diameter to Length Ratio	0.24 – 0.73
Threshing Cylinder Peripheral Speed	4.68 – 24.8 m/s
Specific Fuel Consumption Rate	0.13 – 0.32 liters/hr-rated hp
Specific Output	275 – 1875 kg/liter of fuel

SEEDER
Seeds Specific Gravities

Grain	Kernel Specific Gravity
Barley	1.13 - 1.33
Corn, shelled yellow dent	1.10
Corn, yellow and white	1.27 - 1.30
Flaxseed	1.19
Grain Sorghum	1.10
Millet	1.22 - 1.26
Oats	1.11
Rice	0.95 - 1.06
Rye	1.23
Soybean	1.13 - 1.18
Wheat, hard	1.29 - 1.30
Wheat, soft	1.32

SEEDER
Seed Density per Square Meter Area

Crop	Average Seed Density((Seeds per m^2)
Corn for grain	6 - 12
Corn for silage	9 - 15
Sugar beets	10 -15
Beans	30 - 60
Rape	50 - 90
Peas	60 - 100
Small grain	150 - 400
Ray-grass	700 - 2000

SEEDER
Crops Seed Metering Requirements

Crop	Seed Factors		Agronomic Factors		Seed Metering Requirements Average Throughout per Row[2]	
	Seed size (seeds/kg)	Critical Length (mm)	Typical Seeds per sq. m	Typical Row Spacing (mm)	(g/s)	(seeds/s)
Wheat	20,000-40,000	4.5-6.5	120-140	180	2-4	60-120
Sorghum	25,000-40,000	2.5-4.5	10-25	360-910	0.3-0.8	10-26
Cotton	8,000-15,000	6-8	9-22	1,000	2.1-5	25-65
Sunflower	12,000-25,000	6-10	4-6	540-750	0.3-0.5/13-20	10-15
Chickpea		6-9	40-60	180-750	0.2-4.8/13-20	20-30/80-120
(Dessil)	5,000-7,500					
(Kabuli)	2,000-2,800	9-11	30-40	180-750	6.2-8.5/25-34	15-20/60-80
Soybeans	3,500-6,000	5-8	20-40	590-910	6.4-13/11-22	30-60/50-100
Maize	2,000-4,500	6-12	3-5	750-910	1.7-2.8/2-3.5	6-10/7-12
Peanuts						
(Spanish)	2,000-2,200	8-12	10-20	750-910	10-20/12.5-25	20-40/25-50
					14-27/16-33	17-33/20-40
(Large)	1,000-1,500	12-18	8-16	750-910		
Broad beans	600-1,000	20-25	10-16	180-910	6.3-10/31-50	5-8/25-40

SEEDER
Gravity-Type Metering Device Performance for Granulated Crystalline Fertilizer

Metering Device	Suitability for Low and High Application Rates	Fertilizer rate Control	Ease of Cleaning	Relative Cost	Ease of Manufacture	Remarks
Adjustable opening with notched, agitating disk	Good	Easy Increase the size	Easy	Low	Precision manufacturing difficult	Inter-row variation high
Adjustable orifice with spur wheel	Good	Easy	Easy	Low	Easy to manufacture	High inter Variation

SEEDER AND PLANTER
Seed Plates Requirement for Pneumatic Planter

Crop	Recommended Seed spacing (cm)	No. of holes on Plate	Seed-hole Diameter (cm)	Air Suction Pressure (kPa)	Angle of Seed Hole Displacement for Picking-up Seed (°)
Soybeans	5	32	4	4-7	11-25
Sorghum	10	16	3	3-9	22-5
Pigeon pea	10	16	3	3-9	22-5
Mustard	10	16	1.5	3-9	22-5
Okra	20	8	3	3-9	45
Maize	30	6	6	3-9	60
Groundnut	15	12	6	3-9	24
Cotton	45	4	4	3-9	90
Radish	10	16	2	3-9	22.5

SEEDER AND PLANTER
Mechanism and Types of Energy Sources

Component	Energy Source				
	Mechanical	**Electrical**	**Pneumatic**	**Hydraulic**	**Combination**
Metering devices	Fluted roller agitators, discs, drums, cell plates, orifice plates	Spinners/disk-operated by electric motors	Blower for picking of seed in pneumatic planter	Pumping for gels containing seeds	Fluid drilling, Pneumatic planting, etc.
Seed conveyors	Tubes, belts or funnels	Air conveyance through tubes and nozzles	Pumping gel through tubes and nozzles		
Furrow openers	Shovels, hoes, runners, discs, T-slots, ridgers				
Covering devices	Seed firming, wheels, chains, leveling boards, soil gathering, flaps, disc covers				
Soil pressing wheels	Cast iron wheels, steels wheels, open center type, solid rubber, pneumatic and convex or concave shaped				
Transport and drive wheels	Rigid wheel, pneumatic type wheel				
Row markers	Disc and blade type				

SEEDS
Plant and Row Spacing of Various Crops

Crops	Plant Spacing (cm)	Row Spacing (cm)
Groundnut	5-10	22-60
Soybean	4-7	20-60
Maize	20-25	45-60
Cotton	20-40	50-80
Peas	5-15	45-60
Rice (transplanted)	15-20	20-30
Sorghum	10-15	30-45
Sunflower	20	45-80
Wheat	3-5	15-22

SEEDS
Indicative Cake and Meal Composition

Product	Dry Matter	Proteins		Fats (%)	Nitrogen-Free	Crude (%)	Ashes (%)
		Crude (%)	Digestible (%)				
Peanut							
Cake	93.0	52.3	47.6	1.6	26.3	6.9	5.9
Meal	91.8	42.7	38.0	1.9	25.4	17.0	4.8
Soybean							
Cake	91.0	44.0	39.0	4.9	30.0	5.9	6.2
Meal	90.3	45.7	42.0	1.3	31.4	5.8	6.1
Cotton							
Cake	91.5	38.0	31.9	7.0	30.3	10.2	6.0
Meal	89.3	42.0	35.3	0.7	30.2	9.6	6.8

SEEDS
Grain and forage Seeds Density

Seeds	Density (kg/m^3)
Barley	616
Bluegrass	180-385
Corn, popcorn	
Ear	900
Shelled	719
Cottonseed	410
Flaxseed	719
Grain sorghum	719-642
Oats	410
Orchard grass	180
Rice (Rough)	577
Rye	719
Timothy	577
Wheat	770
Legumes (Field Beans, Soybeans, Cowpeas, Alfalfa, Clovers, Vetch)	770
Long, loose hay	12.5
Baled hay	6.0
Chopped hay	11.0

SEEDS AND GRAINS
Angle of Repose

Seed/Grain	Angle of Repose, Deg	
	Filling or Piling	Emptying or Funneling
Barley	16	28
Corn (shelled)	16	27
Oats	18	32
Rice (rough)	20	36
Rye	17	26
Sorghum (grain)	20	33
Soybeans	16	29
Wheat	16	27

SEEDS AND OIL
Yield for Various Crops

Common Name	Scientific Name	Indicative Yield of Seeds (t/ha)	Oil Content in the Seeds (%)
Almond	*Prutus dulcis*	3.0	25 - 50
Bean, broad	*Vicia faba*	6.6	1 - 2
Cashew	*Anacardium occidentale*	1.0	38 - 46
Castorbean	*Ricinus communis*	5.0	35 - 55
Chickpea	*Cicer arietinum*	2.0	5 - 6
Cocoa	*Theobroma cacao*	3.3	50
Coconut	*Cocos nucifera*	6000[a]	0.63[b]
Cotton	*Gossypium spp.*	1.5	20
Mustard, white	*Sinapis alba*	8.0	50
Pea, cow	*Vigna unguiculata*	2.5	
Peanut	*Arachis pypogaea*	5.0	36 - 50
Sesame	*Sesamun indicum*	0.5	50
Soybean	*Glycine max*	3.1	17 - 26
Sunflower	*Helianthus annus*	3.7	35 - 40

[a] Nuts [b] Oil (t / ha)

SOIL
Physical Properties

Soil Texture	Saturated Hydraulic Conductivity, K_s[a] (mm/h)	Total Pore Space (% by vol)	Apparent Specific gravity (A_s)
Sandy	50 (25-250)	38 (32-42)	1.65 (1.55-1.80)
Sandy Loam	25 (12-75)	43 (40-47)	1.50 (1.40-1.60)
Loam	12 (8-20)	47 (43-49)	1.40 (1.35-1.50)
Clay loam	8 (3-5)	49 (47-51)	1.35 (1.30-1.40)
Silty clay	3 (0.25-5)	51 (49-53)	1.30 (1.25-1.35)
Clay	5 (1-10)	53 (51-55)	1.25 (1.20-1.30)

[a]Saturated hydraulic conductivities vary greatly with soil structure and structural stability, even beyond the normal ranges shown.

Note: Normal ranges are shown in parentheses.

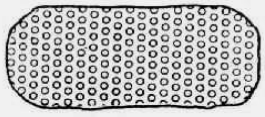
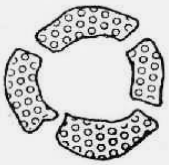
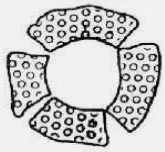
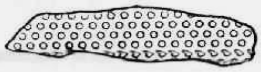
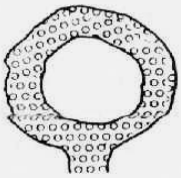
SOIL
Physical Properties

Soil Texture	Field Capacity, FC_v (% by vol)	Permanent Wilting, PWP_v (% by vol)	Available Water	
			(% by vol)	mm/m
Sandy	15 (10-20)	7 (3-10)	8 (6-10)	80 (70-100)
Sandy Loam	21 (15-27)	9 (6-21)	12 (9-15)	120 (90-150)
Loam	31 (25-36)	14 (11-17)	17 (14-20)	170 (140-190)
Clay loam	36 (31-42)	18 (15-20)	18 (16-22)	190 (170-220)
Silty clay	40 (35-46)	20 (17-22)	20 (18-23)	210 (180-230)
Clay	44 (39-49)	21 (19-24)	23 (20-25)	230 (200-250)

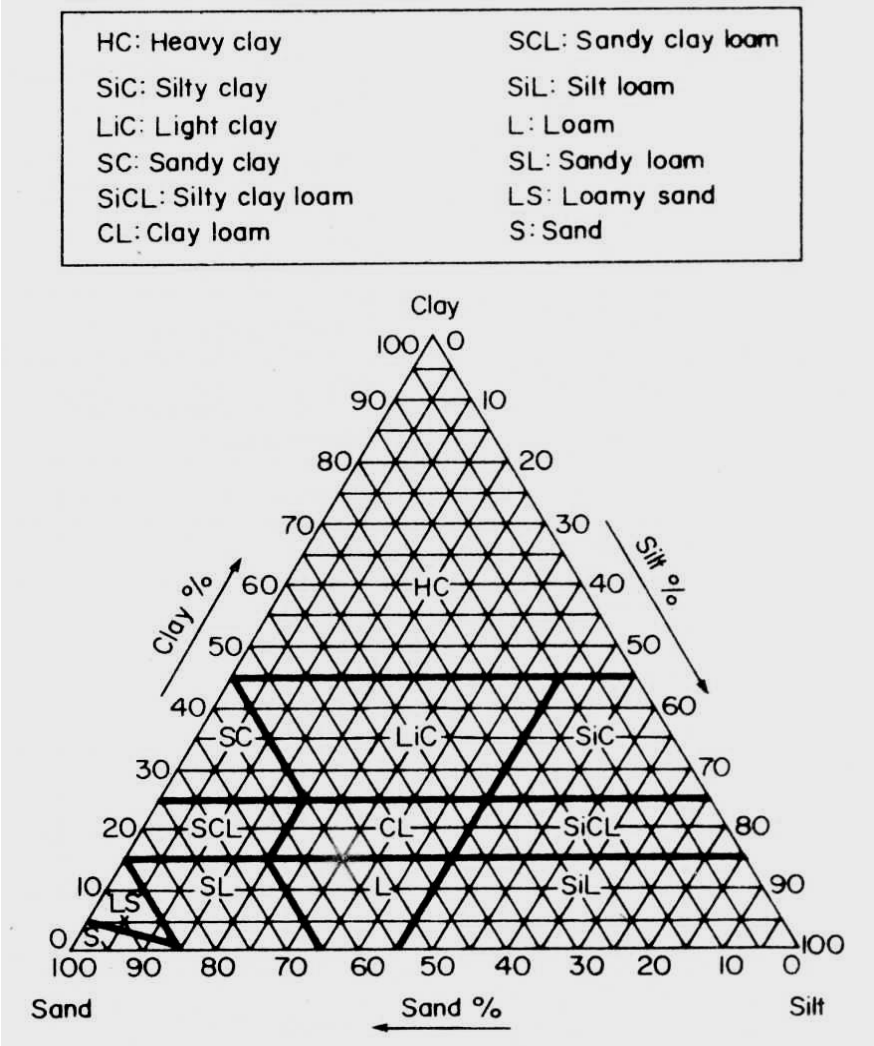
[a]Saturated hydraulic conductivities vary greatly with soil structure and structural stability, even beyond the normal ranges shown.

Note: Normal ranges are shown in parentheses.

SOIL
Texture Determination

View of Sample After Rolling	Ring Condition	Texture and Description
		*Sand, loamy sand - no roll forms* - Leaves much moisture on hand when squeezed, shows virtually no cohesion, will not ribbon.
		*Sandy loam - beginning of a roll* - Wet outline on hand when squeezed, forms only a very weak ribbon when forced, not more than 1-2 cm.
		*Loam and silt loam - the roll is continuous but breaks when a ring is formed* - Shows definite cohesion, will form definite ribbon up to 2.5 cm long when squeezed between the thumb and forefinger.
		*Clay loam, sandy clay loam, silty clay loam - the roll is continuous but the ring cracks* - Shows strong cohesion, will ribbon up to 5 cm long.
		*Silty clay, sandy clay and clay - the roll is continuous and the ring is whole* - Strongest cohesion and longest ribbons formed.

SOIL
Textural Triangle



SOLID MUNICIPAL WASTE
Ultimate Analysis

Material	C (%)	H (%)	O (%)	N (%)	CL (%)	S (%)	MC (%)	Ash (%)	HHV (Btu/lb)
Mixed waste	27.5	3.7	20.6	0.45	0.5	0.83	23.2	23.4	4,830
Corrugated	36.79	5.08	35.41	0.11	0.12	0.23	20.0	20.26	6,322
Newsprint	36.62	4.66	31.76	0.11	0.00	0.19	25.0	1.55	6,233
Magazines	32.93	4.64	32.85	0.11	0.13	0.21	0.16	13.13	5,466
Other paper	32.41	4.51	29.91	0.31	0.61	0.19	23.0	9.06	5,481
Plastics	56.43	7.79	8.05	0.85	3.00	0.29	15.0	8.59	11,586
Rubber/ Leather	43.09	5.37	11.57	1.34	4.97	1.17	10.0	22.49	8,433
Wood	41.20	5.03	34.55	0.24	0.09	0.07	16.0	2.82	6,933
Textiles	37.23	5.02	27.11	3.11	0.27	0.28	25.0	1.98	6,595
Yard waste	23.29	2.93	17.54	0.89	0.13	0.15	45.0	10.07	4,005
Food waste	17.93	2.55	12.85	1.13	0.38	0.06	60.0	5.10	3,265

SOLID
Physical and Thermal Properties

Material	Density kg/m^3	Specific heat capacity kJ/kg K	Coef. of linear expansion K^{-1}	Melting point °C	Thermal conductivity W/m K
Metal					
Aluminum	2700	0.890	25×10^{-6}	660	240
Brass	8500	0.370	19×10^{-6}	900	100
Bronze	8600	-	18×10^{-6}	700	180
Chromium	7200	0.460	7×10^{-6}	1850	90
Copper	8900	0.385	17×10^{-6}	1083	390
Iron	7900	0.450	12×10^{-6}	1535	75
Lead	11300	0.130	29×10^{-6}	327	35
Magnesium	1700	1.025	25×10^{-6}	650	150
Nickel	8900	0.445	13×10^{-6}	1453	90
Silver	10500	0.235	19×10^{-6}	961	420
Steel	7800	0.480	10×10^{-6}	1400	35
Tin	7300	0.230	21×10^{-6}	232	65
Tungsten	19300	0.140	4.5×10^{-6}	3400	180
Zinc	7100	0.390	30×10^{-6}	420	110
Plastics					
ABS	1070	1.450	60×10^{-6}	-	-
Neoprene	1240	2.000	200×10^{-6}	-	0.20
Nylon	1150	1.700	80×10^{-6}	220*	0.30
Perspex	1190	1.500	85×10^{-6}	100*	0.18
Polystyrene	1200	1.350	80×10^{-6}	80*	0.17
Polythene	930	2.300	200×10^{-6}	90*	0.40
PVC plasticized	1250	1.650	150×10^{-6}	80*	0.16
Unplasticized	1400	1.050	100×10^{-6}	80*	0.14

The values for metal alloys and plastics are typical values.

* Softening temperature.

+ Decomposes.

SOLAR ENERGY
Typical Solar Transmission Factor

Type of Terrain	Solar Elevation				
	90 °	60 °	30 °	10 °	5 °
High Mountain	0.82	0.81	0.71	0.49	0.35
Flat country	0.77	0.74	0.61	0.35	0.22
Large City	0.69	0.66	0.51	0.24	0.12
Industrial Area	0.61	0.58	0.41	0.15	0.06

SOLAR ENERGY
Operating Range of Various Solar Energy Store

Type of Store	Storage Medium	Maximum Temperature (C)
Liquid Store	Warm water	100
	Hot water	200
	Thermal oil	430
Steam Store	Water vapor	250
Solid Matter Store	Grey cast iron	500
	Ceramics, concrete	600
	Magnesite	800
Latent Store	Salt hydrates	600
	Eutectic Mixture of Salts	850

SOLAR RADIATION
Estimate from Sunshine Duration and/or Cloud Amount (Langley/Day)

Place	J	F	M	A	M	J	J	A	S	O	N	D	Annual
REGION I													
Baguio	361	405	442	428	352	296	267	236	252	295	297	298	327
Bolinao	380	422	466	494	485	377	377	372	404	418	393	349	411
Dagupan	418	464	512	547	510	428	377	372	356	418	393	404	433
Laoag	404	495	555	593	513	433	382	375	401	431	380	387	446
San Fernando	380	464	512	544	510	428	377	422	404	418	393	367	435
Vigan	456	511	596	608	556	471	456	415	423	486	422	383	482
REGION II													
Aparri	257	350	387	459	404	404	404	350	330	341	266	246	350
Banawe	262	330	431	391	356	309	239	236	224	305	271	285	303
Basco	216	226	278	346	362	316	314	307	286	257	224	206	278
Calayan	220	285	336	391	406	362	359	306	287	298	239	219	312
Echague	228	255	325	391	356	355	309	304	288	264	182	170	286
Tuguegarao	291	326	383	459	474	404	406	350	330	341	266	246	357
REGION III													
Cabanatuan	364	404	446	473	408	351	298	294	281	353	315	313	359
Iba, Zambales	382	407	466	494	502	349	296	217	283	388	332	319	370
Olongapo	310	362	449	476	403	349	296	294	283	355	320	299	350
San Isidro	304	338	396	421	408	351	298	294	283	307	353	315	339
REGION IV													
Alabat	334	409	448	497	448	422	372	372	358	379	344	322	392
Ambulong	393	431	520	549	500	422	372	372	358	424	385	361	424
Baler	294	345	394	432	408	339	316	289	272	300	282	264	328
Batangas	373	431	520	549	500	472	372	472	406	424	385	361	439
Boac	366	412	478	547	500	469	420	469	409	382	352	331	428
Calapan	318	347	370	467	440	380	340	320	317	337	311	268	351
Casiguran	277	318	381	423	436	403	385	348	337	349	293	264	351
Coron	394	432	506	520	447	385	378	361	371	398	377	260	411
Corregidor	393	431	520	549	500	472	372	422	406	424	385	261	436
Cuyo	323	359	412	418	350	288	277	267	284	311	310	314	326
Infanta	177	218	271	288	283	269	245	220	219	214	186	162	229
Lucena	334	400	467	502	470	397	372	342	339	348	328	308	384
Manila	335	411	483	511	473	437	396	368	368	358	364	342	404

SOLAR RADIATION
Estimate from Sunshine Duration and/or Cloud Amount (Langley/Day)

Place	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Puerto Princesa	347	380	436	472	406	362	353	355	356	350	332	315	371
Romblon	344	384	433	487	456	393	382	365	371	376	344	320	389
San Francisco	367	412	451	472	475	370	370	370	361	337	353	331	389
San Jose	365	410	446	460	438	394	356	359	352	374	376	356	391
Santa Cruz	294	366	448	472	425	472	372	372	358	334	304	285	375
UPLB	342	416	486	545	492	439	400	381	359	371	322	294	406
REGION V													
Daet	268	309	382	412	414	362	335	303	309	301	265	242	325
Legaspi	232	237	286	307	301	274	238	218	221	231	213	197	246
Masbate	238	283	338	367	351	284	352	238	248	257	240	217	276
Naga	186	203	287	303	305	235	235	235	226	211	191	180	223
Sorsogon	180	181	256	307	309	266	266	266	259	242	174	210	243
Virac	265	302	361	398	378	346	361	303	296	297	265	245	314
REGION VI													
Iloilo	352	393	446	460	400	356	356	301	352	338	344	325	369
Roxas	328	390	433	499	460	397	397	400	390	369	374	320	397
Victorias	312	361	424	461	418	357	358	374	361	353	321	292	366
REGION VII													
Cebu	306	329	392	402	359	298	298	301	298	340	315	299	328
Dumaguete	344	366	430	438	394	350	352	356	354	379	351	303	368
Ormoc City	202	269	292	341	300	296	239	340	236	281	258	244	367
Tagbilaran	306	329	430	441	397	354	354	359	354	340	315	299	357
REGION VIII													
Borongan	246	267	328	380	341	336	298	300	292	277	256	241	297
Calbayog	278	302	365	399	380	336	298	339	330	313	289	272	325
Catarman	295	331	381	438	402	377	339	339	330	344	285	267	344
Catbalogan	278	302	403	419	419	336	298	300	292	313	289	272	327
Maasin	254	273	332	341	336	332	294	298	294	283	262	248	296
Tacloban	282	304	368	399	377	334	296	298	292	317	291	276	320
REGION IX													
Dipolog	275	294	361	368	340	310	312	316	314	304	302	269	314
Jolo	288	304	321	330	319	295	301	312	307	310	292	279	305
Zamboanga	304	328	347	349	324	302	308	307	314	318	303	294	317

SOLAR RADIATION
Estimate from Sunshine Duration and/or Cloud Amount (Langley/Day)

Place	J	F	M	A	M	J	J	A	S	O	N	D	Annual
REGION X													
Butuoan	275	294	338	344	340	333	312	316	338	304	281	269	312
Cag. de Oro	292	307	352	368	335	310	310	307	307	308	294	281	314
Hinatuan	279	298	338	344	338	331	310	316	314	372	285	273	287
Malaybalay	300	320	361	368	314	308	275	281	314	304	281	269	308
Surigao	271	292	314	346	342	314	314	318	312	382	275	265	305
REGION XI													
Davao	283	315	337	342	317	295	299	305	307	306	294	277	306
Gen. Santos	322	356	361	363	347	318	322	331	335	336	313	300	334
REGION XII													
Cotabato	309	362	351	349	327	311	313	321	314	315	307	296	320

SPRAYER
Pest Control Machines, Types of Chemicals, and Diameter of Particels

Machines	Chemicals	Size distribution (μm)	Mean diameter of particles (μm)
Sprayer	liquid	150-440	200
Mist blower	liquid	30-100	40
ULV or LV sprayer	liquid	40-140	70
Fog machine	liquid	0.5-50	4
Sprinkler	liquid	1,500-3,000	2,000
Duster	powder	0.5-100	10
Granular spreader	granule	297-1,680	850

μm means 10^{-6} m

SPRAYER
CLASSIFICATION OF SPRAYING METHODS WITH SPRAYING VOLUME

spraying method	spraying volume (l/ha)	spraying machine
high volume	more than 500	power sprayer
semi low volume	100-500	mist machine
low volume	30-100	low volume sprayer
very low volume	6-30	
ultra low volume	less than 6	ULV sprayer

SPRAYER
Characteristics and Types

Type of agricultural chemicals	Characteristics
emulsion	Liquid. The main chemical, being insoluble in water, is dissolved by organic solvents; emulsifiers and adjuvants are added.
water solution liquid	Liquid. The main chemical is readily soluble in water. Surface activating agents, antifreeze agents and others are added.
oil solution liquid	Liquid. The main chemical is soluble in water. An organic solvent is used for dilution.
water dispersive powder	Powder. The main chemical is insoluble in water. Surface activating agents are increasers are added. Used as a suspension.
flowable sol	Solid. The main chemical is almost insoluble in solvents. Used as a suspension.
water soluble powder	Powder. The main chemical is water soluble and is mixed with a water-soluble increaser and adjuvant.
DL type powder	Dl means Drift-Less powder. It has little drift and scattering. The mean diameter of the powder is about 25μm. The quantity of grains with a diameter of under 10μm is less than 20 %. Its apparent specific gravity is a little higher than standard-type powder and its fluidity is good.
flow dust (FD)	Powder for horticulture. Its mean diameter is 2μm and its spreading quantity is about 300-500g/10a.
micro grain (F)	Powder protects the operator and prevents environmental contamination. Its mean diameter is in the range of 60-210μm.
dust	The grain size differs according to the objective. For rice plants, the diameter is in the range of 0.8-1.0 mm.
micro capsule	The active ingredients of chemicals are covered with a natural polymer (gelatin) or a synthetic polymer (polyvinyl alcohol). The diameter ranges from 5-6 to 500-600μm. The ingredients are extracted from the capsule under prescribed conditions.
aerosol	The active ingredients are dissolved by liquefied gas (Freon) and packed in a pressure vessel.
fumigant	The active ingredients evaporate at normal or high temperatures or with water.

STORAGE
Chung and Pfost Equilibrium Constant

Grain	Constant				
	A	B	C	D	E
Beans, edible	1334.93	14.964	120.098	0.480920	0.066826
Corn, Yellow dent	620.56	16.958	30.205	0.379212	0.058970
Peanut, Kernel	506.65	29.243	33.892	0.212966	0.034196
Peanut, Pod	1037.19	37.093	12.354	0.183212	0.026383
Rice, Rough	1181.57	21.733	35.703	0.325535	0.046015
Sorghum	2185.07	19.644	102.849	0.391444	0.050970
Soybean	275.11	114.967	24.576	0.375314	0.066816
Wheat, Durum	1831.40	18.077	112.350	0.415593	0.055318
Wheat, Hard	1052.01	17.609	50.998	0.395155	0.056788
Wheat, Soft	1442.54	23.607	35.662	0.308163	0.042360

STORAGE
Safe Storage Life at Different Moisture Levels and at Different Grain Temperatures (Beyond these limits, grain quality rapidly deteriorates)

Grain temperature (°C)	Safe Storage Life (days) at Indicated Moisture Content					
	14%	15.5%	17%	18.5%	20%	21.5%
38	8	4	2	1	0	
32	16	8	4	2	1	0
27	32	16	8	4	2	1
21	64	32	16	8	4	2

STORAGE
Hygroscopic Equilibrium for Paddy

Moisture (%)	Percent relative humidity at temperature of						
	21°C	24°C	27°C	29°C	32°C	35°C	38°C
10	45.4	46.8	48.2	49.6	51.0	52.4	53.9
12	61.1	52.2	63.3	64.4	65.5	66.6	67.7
14	74.0	74.8	75.6	76.3	77.1	77.8	78.6
18	90.1	90.4	90.6	90.9	91.2	91.5	91.8
20	94.2	94.4	94.6	94.7	94.9	95.0	95.2

STORAGE
Recommended Level of Moisture for Rice Storage

Purpose	Duration (months)	MC (% wb)
Seeds	11-23	13
	4-6	12
	7-12	11
Food	1-3	14
	4-6	13.5
	7-12	13
	0.5-0.75	18

SUBSTANCES
Heat of Combustion

Substance	Heating Value, Btu per lb, dry	Substance	Heating Value, Btu per lb, dry
Petroleum coke	15,800	Rags (linen)	7,132
#1 Gilsonite selects*	17,699	Rags (cotton)	7,165
Asphalt	17,158	Cotton batting	7,114
Pitch	15,120	Corrugated fiber carton	5,970
Soot (from oil)	11,787	Newspaper	7,883
Soot (from smokeless coal)	7,049	Wrapping paper	7,106
Soot (Island Creek)	5,425	Oats	7,998
Soot (Red Jacket Thacker)	10,569	Wheat	7,532
Soot (Crystal Block Winifrade)	4,951	Oil (cottonseed)	17,100
Wood sawdust (oak)	8,493	Oil (lard)	16,740
Wood sawdust (pine)	9,347	Oil (olive)	16,803
Wood sawdust (pine)	9,696	Oil (paraffin)	17,640
Wood sawdust (hemlock)	7,797	Oil (rape)	17,080
Wood sawdust (fir)	8,249	Oil (sperm)	18,000
Wood sawdust (spruce)	8,449	Candy	8,096
Wood shavings	8,248	Butter	16,560
Wood shavings ((hardwood auto bodies)	8,878	Casein	10,548

SUBSTANCES
Heat of Combustion

Substance	Heating Value, Btu per lb, dry	Substance	Heating Value, Btu per lb, dry
Wood bark (spruce)	8,817	Egg white	10,260
Wood bark (hemlock)	8,753	Egg yolk	14,580
Wood bark (fir)	9,496	Fats (animal)	17,100
Wood bark (fan)	7,999	Hemoglobin (blood)	10,620
Brown skins from peanuts	10,431	Waste hemp hurds	7,982
Corn on the cob	8,100	Cottonseed hulls (fusion 2342 F)	8,600
Rags (silk)	8,876	Pecan shells	8,893
Rags (wool)		Coffee ground	10,058
		Pecan shells (few meats left in them	10,144

SUBSTANCES
Specific Heat

Materials	Temperature, ˚F	Specific Heat, Btu/(1b) (˚ F)
Air	68	0.24
Ammonia (anhydrous)	32	0.983
Brine (calcium chloride, density 1.2	32	0.71
Concrete	-	0.25
Glass	50-122	0.16
Ice	32	0.50
Ice Cream Mix (12% Fat)	35	0.78
Milk	32-142	0.935
Steel	50	0.12
Water	55	1.00
Wood	50	0.44

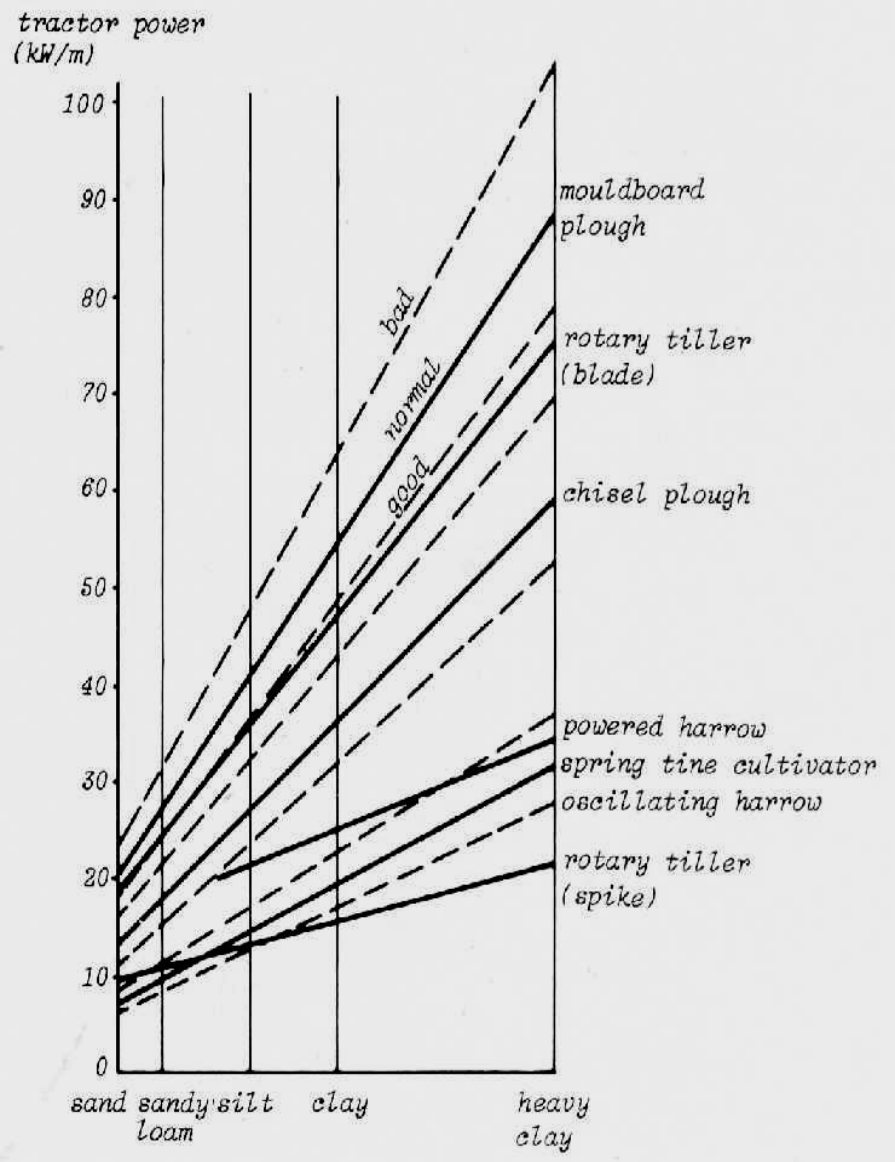
SUNFLOWER OIL (SFO) BLEND WITH DIESEL FUEL (DF) PROPERTIES (Gross Heating Value and Kinematic Viscosity)

Blend	Gross Heating Value (MJ/kg)	Kinematic Viscosity (cSt) at 40°C	60°C	80°C
Diesel Fuel	45.28	2.91	2.12	1.22
SFO, Raw oil	41.45	18.60	11.21	4.90
SFO, Refined Oil	39.42	31.31	17.53	7.49
SFO/DF:				
20/80	44.65	5.53	3.66	1.99
30/70	43.72	7.26	15.21	7.21
50/50	42.47	9.43	6.17	3.25
60/40	41.42	11.57	7.21	3.94
70/30	40.75	16.16	9.32	4.43
80/20	40.10	17.84	13.09	4.89
90/10	39.46	23.05	14.02	5.89

TOOLS
Typical Tempering Temperatures for Various Tools

Degrees °F (°C)	Temper Color	Tools
380 (193)	Very light yellow	Tools that require maximum hardness: lathe centers and cutting tools for lathes and shapers.
425 (218)	Light straw	Milling cutters, drills and reamers.
465 (241)	Dark straw	Taps, threading dies, punches, dies, and hacksaw blades.
490 (254)	Yellowish brown	Hammer faces, shear blades, rivets sets, and wood chisels
525 (274)	Purple	Center punches and scratch awls.
545 (285)	Violet	Cold chisels, knives, and axes.
590 (310)	Pale blue	Screwdrivers, wrenches, and hammers.

TRACTOR
Power Requirement per Meter of Tillage Implement



TRACTOR
Transmission Efficiency

Location	% of the Net Engine Power
Transmission Box	0.96 – 0.98
Power Take Off Power	0.87 – 0.90
Drawbar Power	0.75 – 0.81
Axle Power	0.82 – 0.87

TRACTOR
Coefficient of Traction of Wheel Tractor

Condition of Ground Surface	Coefficient of Traction (%)	Slippage (%)
Concrete road	75-57	5
Dry clay	66-52	16
Sandy loam	58-45	16
Dry fine sand	42-29	16
Gravel road	41-32	5
Meadow	41-33	8

TRACTOR
Plow Capacities of Tractor

Engine Horsepower	Number of Moldboard Plow Bottoms
8 - 12	One 12 in.
15 - 20	One 16 in. or two 10 in.
25 – 30	Two 14 in.
35 - 45	Three 14 in. or 16 in.
50 - 60	Four 14 in.
65 - 75	Five 16 in.
80 - 130	Six 16 in.

TRACTOR
Coefficient of Rolling Resistance

Condition of Ground Surface	Coefficient of Rolling Resistance	
	Wheel type	Crawler type
Asphalt road	0.04	0.05
Dry hard ground	0.07	0.07
Hard grassland	0.10	0.07
Mown meadow	0.01	0.08
Soft sandy road	0.12	0.10
Field just after cultivation	0.20-0.30	0.10-0.12
Deep mud	0.20-0.30	0.10-0.12
Fine sand	0.30-0.40	0.10

TRACTOR
Power Take-Off Shaft Dimension

	Type 1	Type 2	Type 3
Nominal diameter	35 mm	35 mm	45 mm
Standard Operating Speed	5540 rpm	1000 rpm	1000 rpm
No. of Splines	6	21	20

TRACTOR
PTO Thrust Forces

	PTO Power		Thrust	
	KW	hp	KN	Lbf
35 mm PTO	15-25	20.1 - 33.5	7	1575
	Over 25-40	33.5 - 53.6	9	2025
	Over 40-60	53.6 - 80.5	11	2475
	Over 60-110	80.5 - 147.5	13	2925
	Over 110	147.5	14	3150
45 mm PTO	Over 110	147.5	18	4050

TRACTOR
Tractor Requirements for a Chisel Plow (PTO hp/shank)

Depth (cm)	Speed (Kph)	PTO hp/shank		
		Sandy Loam	Loam	Clay
16	8	3.0	6	10
20	8	4.5	8	14
25	8	5.5	10	17
30	8	6.5	12	20

TRACTOR
Tractor Requirements for a Field Cultivator (PTO hp/shank)

Depth (cm)	Speed (Kph)	PTO hp/shank		
		Sandy Loam	Loam	Clay
13	8	2.7	3.7	5

TRACTOR
Tractor Requirements for a Subsoiler (PTO hp/shank)

Depth (cm)	Speed (Kph)	PTO hp/shank	
		Loam	Clay
30	6.5	17	25
45	6.5	26	38
60	6.5	35	50

TRACTOR
Tractor fuel Consumption

Tractor Type	Fuel consumption (gal per hour-rated drawbar hp)
Wheel-type, gasoline	0.085
Wheel-type LP gas	0.105
Wheel-type, diesel	0.065
Track-type, gasoline	0.090
Track-type, diesel	0.075

TRACTOR
Standard Three-Point Free-Link Attachment for Hitching Implement to Agricultural Wheel Tractors

	Category I		Category II		Category III		Category IV	
	15-35 KW		30-75 KW		60-168 KW		136-300 KW	
Upper Hitch Point	min	max	min	max	min	max	min	max
Width Inside	44.5	-	52.3	-	52.3	-	65	-
Width Outside	-	85.9	-	95.3	-	96.3	-	132
Clearance radius for upper link	57.2	-	57.2	-	57.2	-	76.2	-
Hitch pin hole diameter	19.3	19.56	26.65	25.91	32.0	32.26	45.2	46.5
Lower Hitch Point								
Stud diameter	21.84	22.10	28.19	28.45	36.32	36.58	49.7	50.8
Linchpin hole distance	38.86	-	46.52	-	48.52	-	68	-
Linchpin hole diameter	11.68	12.19	11.68	12.19	11.68	12.19	17.5	18
Lower hitch point spread	681.0	684.3	822.5	625.5	963.7	966.7	1165	1168
Clearance radius to lower link	63.5	-	73.2	-	82.6	-	82.6	-
Implement encroachment in front of lower hitch point if implement extends laterally behind tire		12.7		12.7		12.7		12.7
Implement Mast Height	457		483		559		686	

VEGETABLES
How to Freeze

Asparagus	Wash very well. Cut about 2 inches long and remove the tender portion of stalks. Tie loosely into bunches. Boil blanch small stalks for 2 minutes and large stalks for 4 minutes. Cool at once, drain and dry. Pack, seal, label and freeze.
Carrot	Choose very young carrots. Wash very well to get rid of dirt. Scrape the skin. Small carrots may be frozen whole while large ones may be cut into sticks or cubes depending on intended use. Boil blanch whole carrots for 5 minutes and cut or sliced ones for about 2 minutes. Cool at once, drain and dry. Pack, seal, label and freeze.
Cauliflower	Choose white, well-formed heads. Wash very well. Cut stem close to the head and break into flowerets about 1 inch across. Soak in salt solution (1/4 cup of salt per quart of water) to remove insects. After 30 minutes, wash again to remove salt. Boil blanch for 3 minutes. Cool immediately, drain and dry. Pack, seal, label and freeze.
Corn, Cut	Remove husk and silk. Wash and boil blanch for 6-10 minutes depending on size of ears. Cool at once. Cut down corn from cobs halfway through their kernels and milk juice. Pack in rigid containers. Leave ½-inch head space. Cover the containers, label and freeze.
Corn, on the cob	Remove husk and silk. Wash and boil blanch for 6-10 minutes depending on size of ears. Cool at once. Wipe dry. Pack in plastic bags or cellophane and freeze.
Green Beans (*Abitsuelas)*	Wash very well. Sort out according to size. Small *abitsuelas* may be frozen whole while the large ones should be cut into pieces, 1-2 inches long. Boil blanching will take 3 minutes while steam blanching will take 4 minutes. Cool at once. Drain very well and dry. Pack, seal, label and freeze.
Eggplant	Wash very well. Cut into 2-inch sticks or 1-inch cubes. Immediately, soak in water to prevent discoloration. It is advised to have a bowl of water ready where pieces are dropped as they are cut. Boil blanch for about 3 minutes. Cool at once. Drain very well and dry. Pack, seal and freeze.
Hyacinth Beans *(Bataw)*	Wash very well. Remove the stems. Sort out according to size. Boil blanch for 3 minutes. Steam blanch for 4 minutes. Cool at once. Drain very well and dry. Pack, seal, label and freeze.
Leafy Greens	Wash very well. Discard bruised leaves. Boil blanch for 2 minutes. Cool at once. Drain very well and dry. Pack, seal, label and freeze.
Okra	Choose young tender pods. Remove the stems. Sort out according to size and cut into two if large. Boil blanch for 2 minutes or steam blanch for 3-1/2 minutes. Cool at once. Drain very well and dry. Pack, seal, label and freeze.

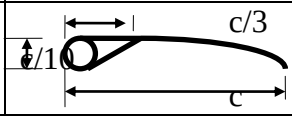
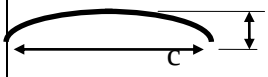
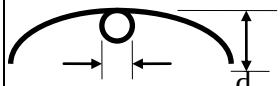
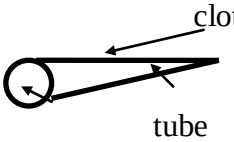
WAREHOUSE
Optimum Recommended Stack Height

Type of grain	Stack height in layers	Stack height in meters
Wheat, barley and Maize	18	4.57
Paddy	16	4.27
Rice	16	4.27

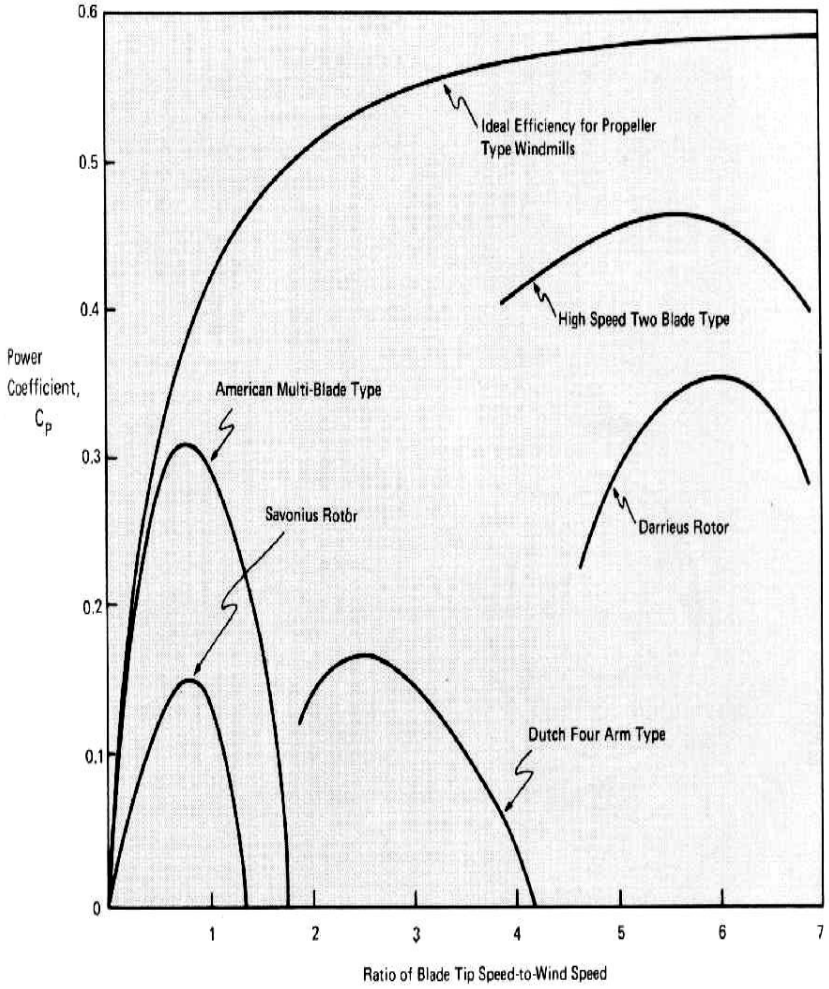
WAREHOUSE
Recommended Dimension Based on Capacity

Number of Cavans	Dimension
10,000	10 m x 30 m
50,000	20 m x 48 m
100,000	25 m x 78 m
500,000	75 m x 142 m

WIND ENERGY
Design Values for Various Airfoils

Airfoil	Geometrical Description	(Cd/Cl) min	Angle of Attack	Cl
Sail and Pole		0.1	5	0.8
Flat Steel Plate		0.1	4	0.4
Arched Steel Plate	 f/c = 0.70 f/c = 0.10	0.02 0.02	4 3	0.9 1.25
Arched Steel Plate with Tube on Concave Side	f/c = 0.07  f/c = 0.10 d <0.1 c	0.05 0.05	5 4	0.9 1.1
Arched Steel Plate with Tube on Convex side	 f/c = 0.1	0.2	14	1.25
Sail Wing		0.05	2	1.0

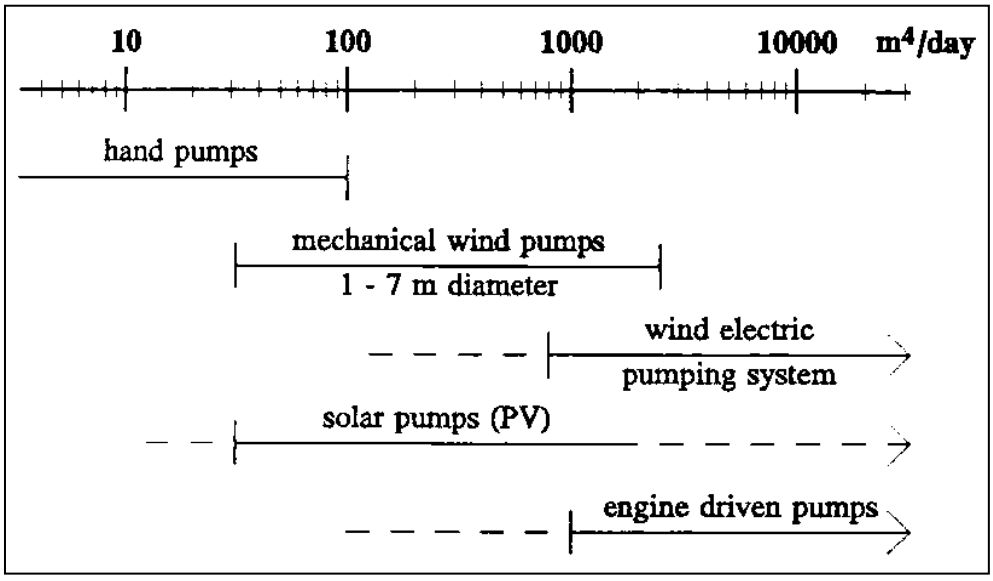
WIND ENERGY
Coefficient of Performance of Wind Machine



WIND ENERGY
Tip Speed Ratio for Horizontal Wind Machines for Various Number of Blades

Tip Speed Ratio	Number of Blades
1	6 – 20
2	4 – 12
3	2 – 6
4	2 – 4
5 - 8	2 – 3
8 – 15	1 – 2

WIND ENERGY
Windpumping Niches Versus Other Pumping Technologies



WIND ENERGY
Mean Monthly Wind Velocity (m/s)

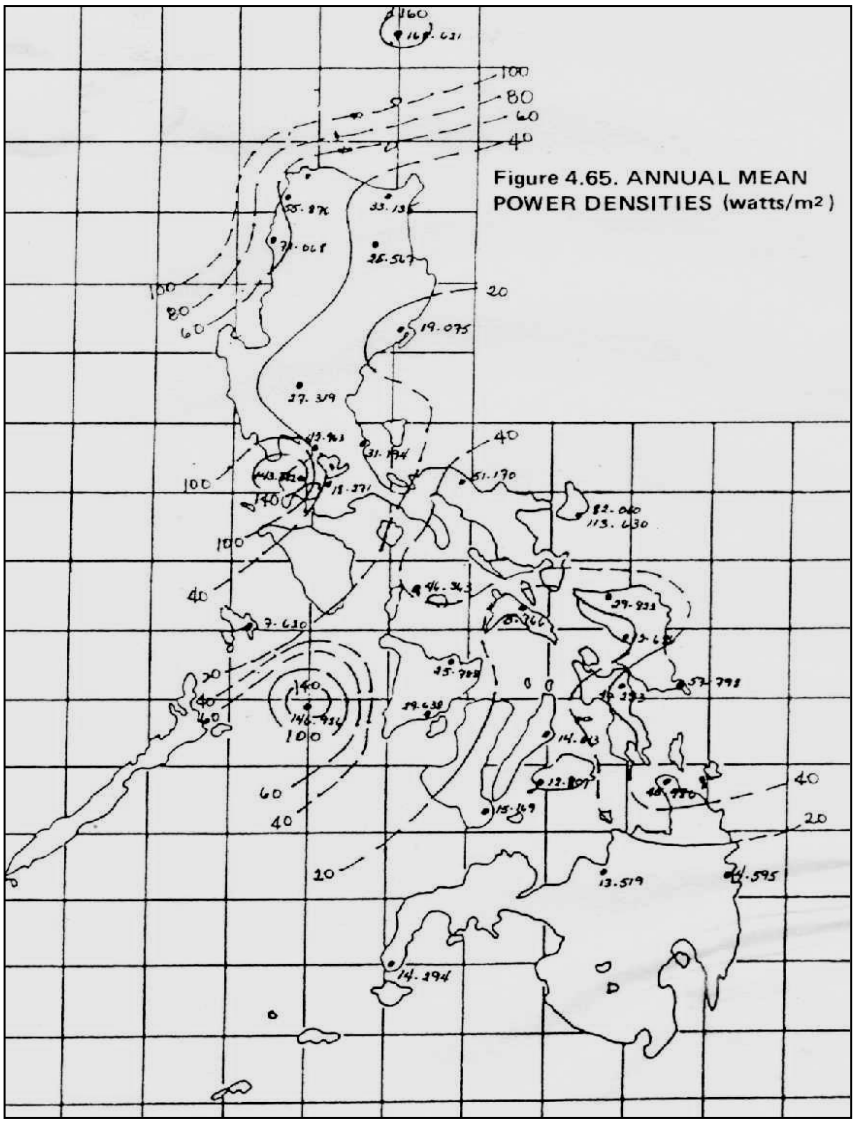
Station	J	F	M	A	M	J	J	A	S	O	N	D
Alabat	4	4	3	3	2	2	3	2	2	3	5	4
Aparri	4	4	3	3	3	3	3	3	3	4	4	4
Baguio	2	2	2	2	2	3	3	3	2	3	3	2
Basco	5	5	5	4	4	4	5	5	4	4	6	6
Borongan	3	3	2	2	2	2	2	2	2	2	2	2
Cagayan de Oro	1	1	1	1	1	1	1	1	1	1	1	1
Calapan	2	2	3	3	3	2	2	2	2	2	3	3
Calayan	3	3	3	3	2	2	2	3	3	3	4	4
Catbalogan	2	2	2	2	2	2	2	2	2	2	1	2
Cebu	3	3	3	3	2	2	2	2	2	2	2	3
Cuyo	9	8	6	5	2	2	2	4	3	5	7	9
Daet	3	3	3	3	2	2	2	2	2	2	4	4
Dagupan	3	3	4	4	3	3	3	3	3	3	3	3
Davao	3	3	3	2	2	2	2	2	2	2	2	2
General Santos	3	3	3	3	3	3	2	3	3	3	3	3
Iba	2	3	3	3	2	3	2	3	2	2	2	2
Iloilo	6	6	5	5	4	3	4	4	3	3	4	5
Infanta	3	3	3	2	2	2	2	2	2	2	4	4
Itbayat	3	4	3	3	2	3	3	3	3	3	4	4
Laoag	3	3	3	3	3	3	3	3	3	3	4	4
Legaspi	4	4	4	4	3	3	3	3	3	3	4	4
Lucena	3	3	3	3	3	3	3	3	3	3	3	3
Lumbia	3	3	3	3	3	2	2	2	2	2	2	3
Masbate	3	3	3	2	2	3	3	3	3	3	3	3
Munoz	4	4	3	3	2	2	2	2	2	3	3	3

WIND ENERGY
Mean Monthly Wind Velocity (m/s)

Station	J	F	M	A	M	J	J	A	S	O	N	D
Pag-asa Palawan	4	5	3	3	4	4	5	6	4	4	4	5
Puerto Princesa	2	2	2	2	1	1	1	1	1	1	2	2
Romblon	4	4	4	3	3	3	3	4	3	3	4	4
Roxas	4	3	3	3	3	2	2	2	2	3	3	4
San Francisco	3	3	2	2	2	3	3	3	3	2	3	3
Tacloban	3	3	3	3	3	3	3	3	3	3	3	3
Tuguegarao	2	2	2	2	2	2	2	2	2	2	2	2
Vigan	4	4	3	3	3	3	3	3	3	3	3	3
Virac	3	3	3	3	3	3	3	3	3	3	3	3
Zambaonga	2	2	2	2	2	2	2	2	2	2	2	2

Source: Climatological Division, PAG-ASA, Philippines

WIND ENERGY
Wind Power Densities (watts/m^2)



WIND ENERGY
Beufort Scale

Description of Wind	Observation	Speed, Mph
Calm	Smoke rises vertically.	0.1
Light air	Smoke drifts slowly.	1-3
Light breeze	Wind felt on face. Leaves rustle.	4-7
Gentle breeze	Leaves and small twigs in constant motion. Flags or streamers extend.	8-12
Moderate breeze	Raises dust. Small branches move.	13-18
Fresh breeze	Small trees begin to sway.	19-24
Strong breeze	Large branches in motion. Umbrellas difficult to hold	25-31
Moderate gale	Whole trees in motion.	32-38
Fresh gale	Breaks twigs off trees. Difficult to walk.	39-46
Strong gale	Slight structural damage to roofs and signs possible.	47-54
Full gale	Trees uprooted. Considerable structural damage occurs.	55-63
Storm	Widespread damage	64-72

WOOD
Specific Gravity of Various Wood Specie

Specie	Specific Gravity
Coconut Wood Hard Outer layer	0.59
Coconut Wood Inner portion	0.26
Apitong	0.82
Yaka- Gisok	0.76

WOOD
Approximate Moisture Content Range for Various Timber Uses

Uses	Moisture Content (%)
Furniture	11 - 17
Flooring	11 – 17
Framing Timber (houses)	15 – 20
Joinery Interior	12 – 16
Mouldings	12 –1 6
Sporting goods	8 – 12
Agricultural Implements	15 – 20
Boxes and Crates	15 – 18
Pole and Railroad ties	25 – 30
Motor Body Building	15 – 18
Veneer and Plywood	8 – 14
Weatherboard	15 - 17

WOOD
Uses of Coconut Timber for Building Construction

Uses	Portion of Coconut Timber
Post	Solid – round form
Flooring	Hard
Trusses	Hard
Floor Joist	Hard
Stairs and Railings	Hard
Door Panels	Hard
Rafters	Hard
Window Jambs	Hard
Sidings	Hard with soft
Ceiling	Hard with soft
Jalousies	Hard with soft
Studs	Medium
Purlins	Medium
Roof shingles	Medium
Exterior walls	Medium
Panels	Soft
Interior walls	Soft

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