- **By Dr. Yuh-Yuan Shyy**

Contents

Seed Processing

- Basic Concepts & Techniques in Seed Processing

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Seed Processing – Why?

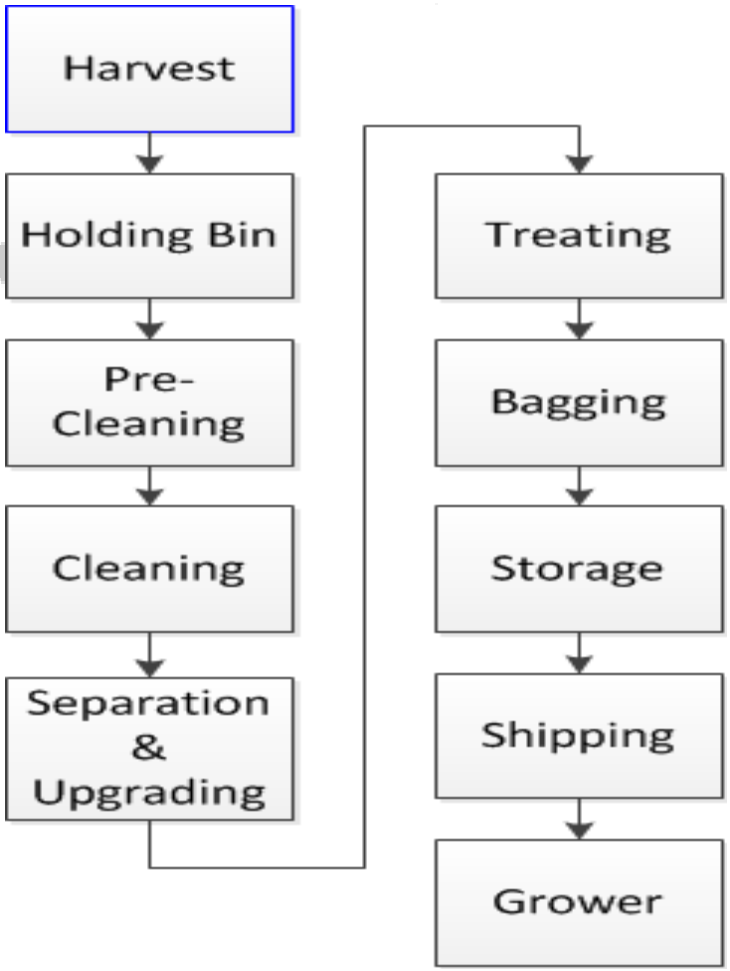
1. **Complete separation:**
   - Removal of all contaminating or undesirable material from the seed and improve appearance/uniformity
2. **Minimum seed loss:**
   - Keep good seed loss at a minimum
3. **Upgrading quality:**
   - Removal of bad, injured, or low quality crop seed
   - Add protective or remove moisture to maintain seed quality
4. **Efficiency:**
   - Highest capacity with effectiveness of separation
5. **Minimum labor requirement:**
   - Labor is direct operating cost and not recoverable

“Seed” vs “Grain”

SEED	GRAIN
Planted and reproduce	Consumption & industry
Embryonic structure is critical	Dry matter, foreign material, MC%
Germination, purity, health, and vigor	POS (Protein, Oil, Starch), and fiber
Slow drying to minimize heat damage	Fast drying to save cost
Chemical treatment to maintain quality	Hardly any chemical treatment
Sold by [illegible] corn)	Sold by [illegible]
Seed P[illegible]	**Food P[illegible]**

Flow Diagram for Seed Processing

- Limiting mechanical damage:
  - Reduce speed (RPM)!
  - Avoid at partial capacity
- Avoid varietal contamination
- Maintain quality in storage:
  - Limit incoming moisture
  - Limit FM or damaged seeds
  - Pre-clean seed before storage
  - Properly aerate
  - Careful drying to reach safe MC

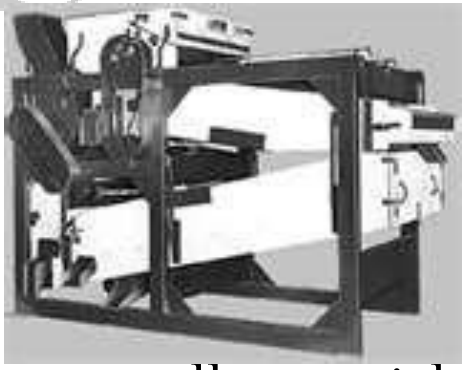


Basis of Separation:

- Seed processing is based on differences in physical properties between the desirable seed and the contaminating weed, other crop seeds or foreign material
- The "difference" can be in:
  - SIZE
  - LENGTH
  - WIDTH/THICKNESS
  - WEIGHT/SPECIFIC GRAVITY/TESTWEIGHT
  - SHAPE AND SURFACE TEXTURE
  - COLOR
  - OTHERS??

Basic of Separation - Size

- Size is the most common difference among seeds, and between seed and undesirable material
- The air-screen cleaner uses a series of perforated sheet metal or woven wire screens to separate seed of different sizes
- Seed size distribution and screen selection
- Two types of screen sizing are made:
  - SCALPING - Oversize material is removed
  - SIFTING – Undersize material is removed



- A series of scalping and sifting operations remove all material larger or smaller than the crop seed
- Factors effect "Screen efficiency" and "Capacity"
  - Openings, feed rate, slope, and RPM

Basic of Separation - Length

- Length differences are common among crop seed and weed seed, and are frequently used to upgrade and improve quality
- Both the indented cylinder (A) and the disc separator (B) make length separations.

A. Indented cylinder

B. Disc separator

Basic of Operation – Width/Thickness

- Width and thickness are special size dimensions used in operations such as sizing seed corn into specific widths and thickness for space-planting
- Thickness separations are made by turning the seed on edge or standing it on end to present its thickness dimension to perforations of specific size (A) cylinder
- Width separations are made by round-hole perforations at the cup-like depressions in cylinder (B)

A. Slot-hole cylinder

B. Round-hole cylinder

Basic of Separation - Weight

- Many seeds differ in weight, specific gravity, or test weight
- Weight or specific gravity is the effective separation principal in the air-blast separation in air-screen machines (TerminalVelocity?)
- Gravity separator, stoner, and the aspirator are all designed to make specific separations by differences in weight or specific gravity of seed (Fluidization? Specific Gravity of water=?)

Gravity Separator

Stoner

Aspirator

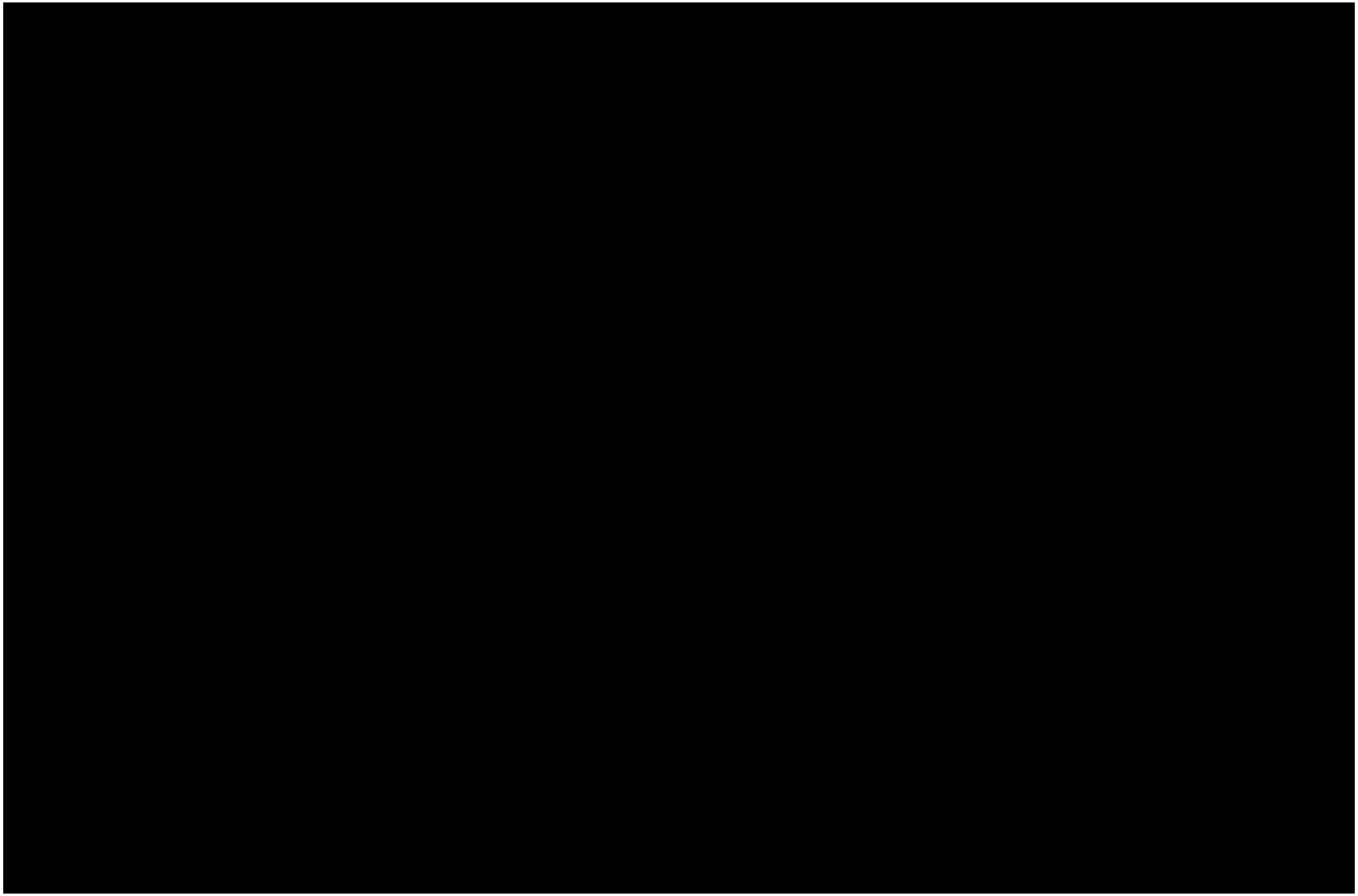
Basic of Separation – Shape & Texture

- Spiral separator is designed especially to separate round from flattened seed or round whole seed from the splits
  - A simple vertical series of spirals flights to allow seeds to roll or slide down by gravity. Round one will roll over the inclined edge of the inner flight of spirals

- Relative roughness or smoothness of the seed coat – surface texture – is a common difference between seeds.
  - The roll or dodder mill, the draper belt , the magnetic separator, the buckhorn machine and vibrator separator all effect separations of seeds differing in surface texture

Basic of Separation – Color

- Many seeds differ in color or reflectivity. Color separations are used more and more in processing, particularly with the larger crop seeds
- Electronic color sorters make color separations. These machines present each seed to electronic sensing devices which compare the seed with an electronic pattern or a given color background. If the seed is color hue or reflectivity is acceptable, it is allowed to continue to a discharge spout. Seeds not in the acceptable range of color hue or reflectivity are divided from the main stream by compressed air or other devices.



Pre-Cleaning and Air-Screen Cleaning

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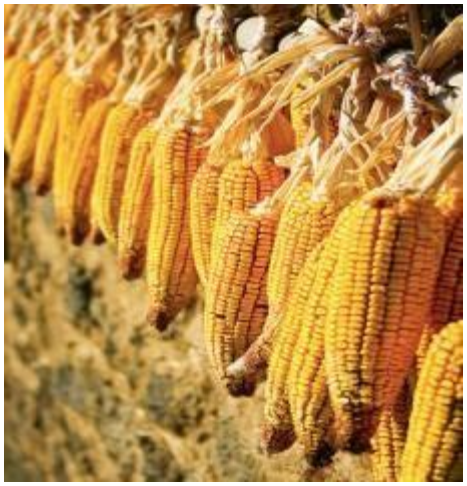
Pre-Cleaning Operation:



- Before harvest

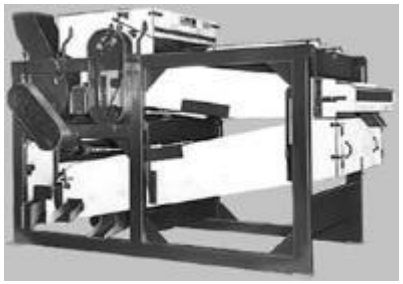
- Before cleaning

SEEDPROCESSING

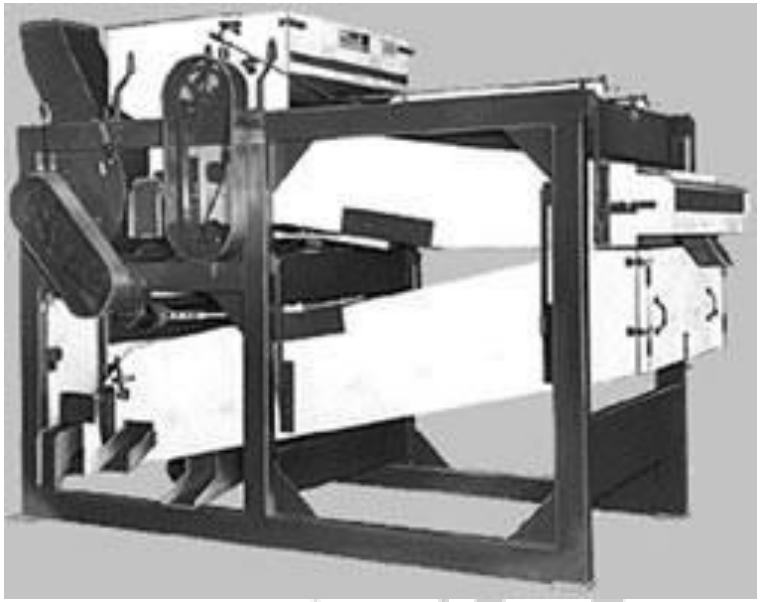
- After cleaning

Pre-Cleaning Operation:

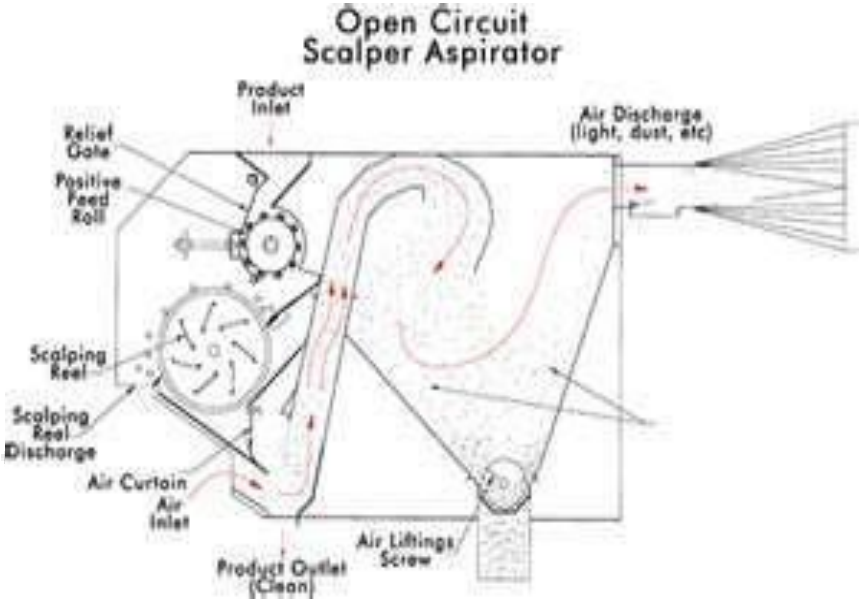
- Why?
  - Enough trash is removed to permit bulk storage and processing
  - Seed feed more evenly through down-stream equipment
  - High moisture, green material is removed decreasing time and cost of drying
  - Removal of bulk of trash permits finer top screens to be used resulting in precise separations
  - Cleaning machines are more efficient
  - Most commonly done by a **scalper**
- **What is a scalper?**



Pre-Cleaning Operation:



Pre-cleaning air-screen cleaner, is designed for high capacity pre-cleaning and market cleaning of seeds. This model is designed for effective removal of light, large, and small waste. It begins with two screens that allow the top screen always serves as a scalper and the bottom screen functions as a sifter.



Aspirator can be used with scalper for both before and/or after product enters to pre-cleaning cleaner. It is also designed for high capacity removal of trash from seed.

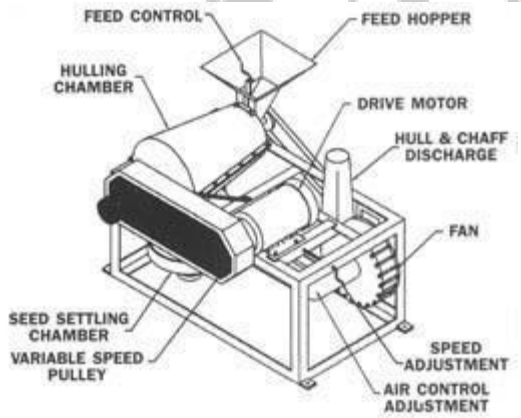
Pre-Cleaning Operation: 1,500 AC China

Pre-Cleaning Operation:

Debeaders:

- Seeds with awns, hairs or other chaffy appendages reduce flowability in cleaning equipment
- It removes these unwanted appendages with rotary and beating arms

Huller-Scarifier



- Removes hull or pods and scarifies hard seeds
- Throws seed against sandpaper or rubber concaves
- Harsh process with potential for seed damage

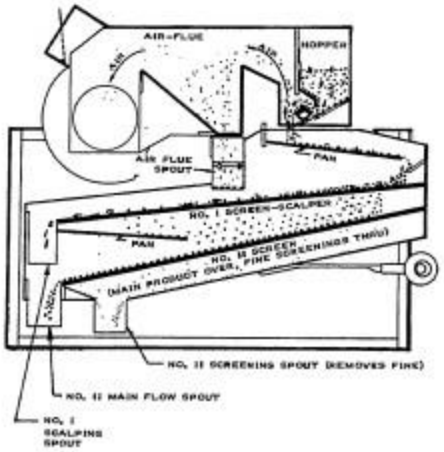
Products after Pre-Cleaning:



- Seeds need to be precisely cleaned for improving quality and make it legal to sale as 'seed' - Germination, purity, health, and vigor
- Air-Screen Separator is the most common machine in the seed processing operation
- It combines the principles of screen and air separation. This combination of principles separates the over/under size and fine/light debris from the seed

Air-Screen Cleaning

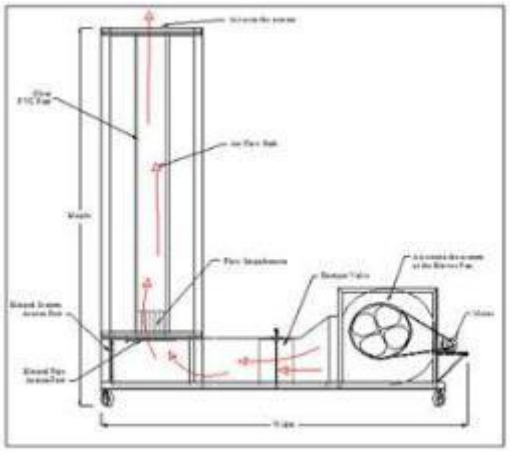
- Basic machine in most seed processing plants
- Combines air separation with sieve operations
- Based on differences in size and weight of seeds
- Three cleaning elements:
  - Aspiration: Removal of *light material* from the seeds
  - Scalping: Removal of *oversize material* from seeds
  - Sifting: Removal of *undersize material* from seeds

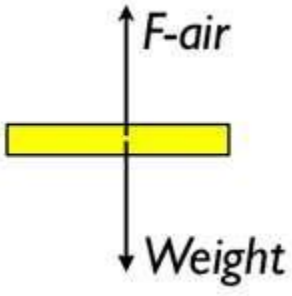


Air-Screen Cleaning - AIR

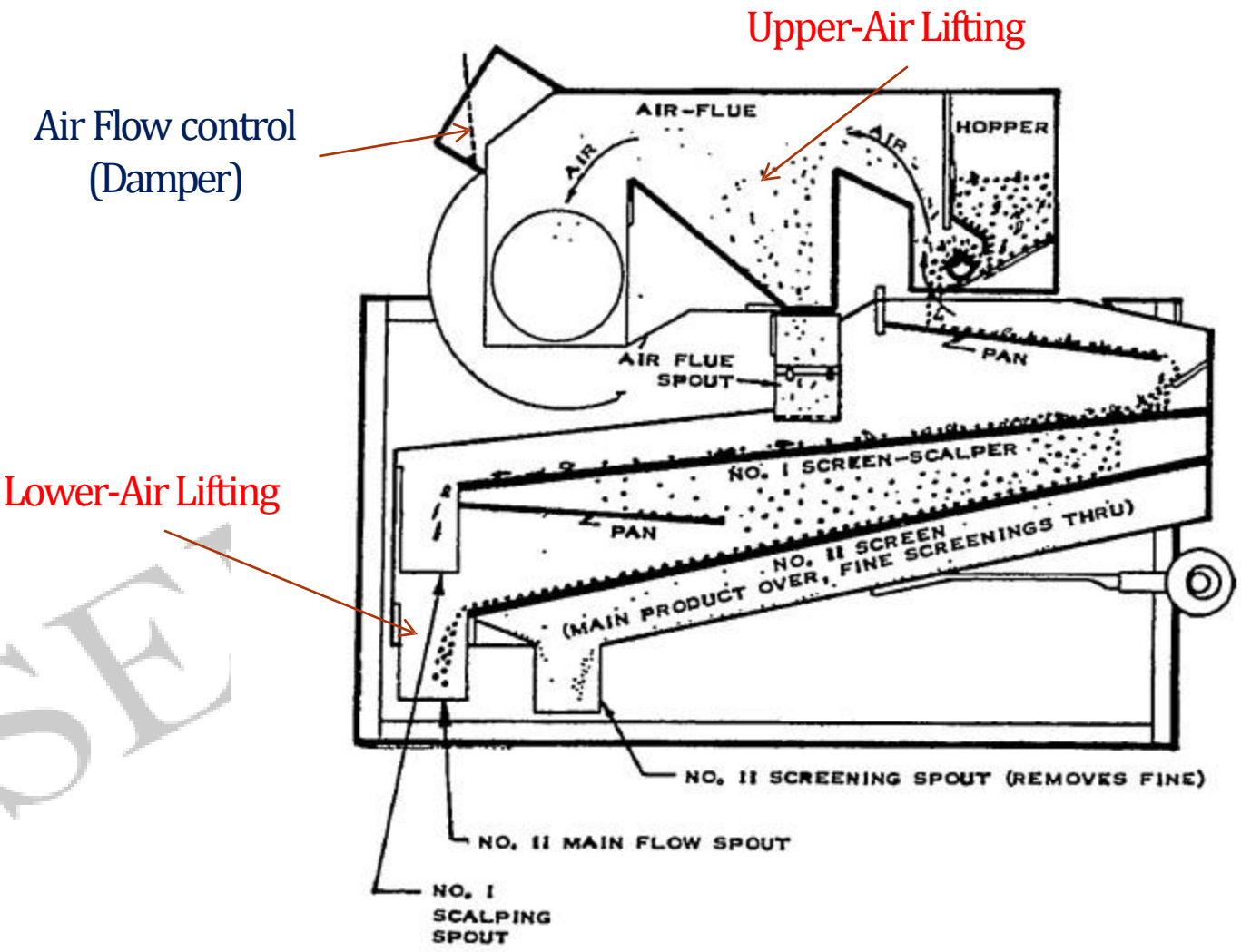
Air Separation, 1,500 AC China

- The air separation is based upon the terminal velocity difference of material
- The light material is removed from the seed by air flow since it has smaller terminal velocity
- How to measure 'Terminal Velocity' ?

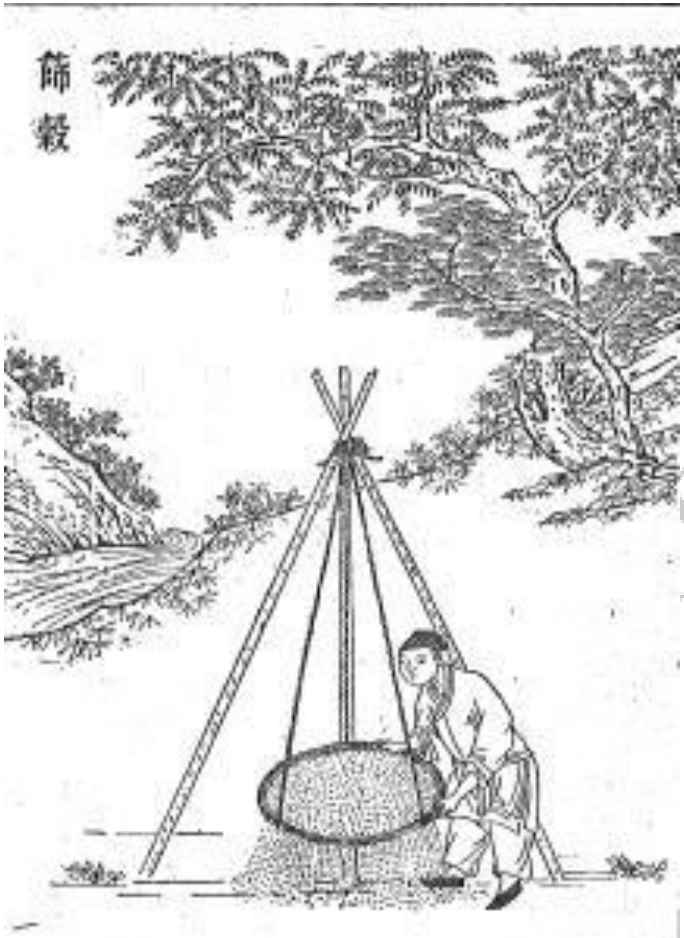




Air-Screen Cleaning - AIR

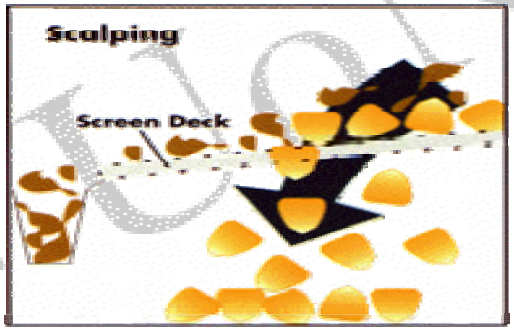


Air-Screen Cleaning - SCREENING

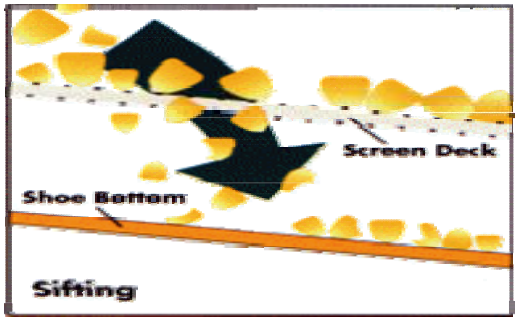


Screen Separation, 1500 AC, China

- Scalping: Good seeds are dropped through screen openings, larger material carried over screen



- Sifting: Good seeds ride over screens while small seeds drop through screen and moved to separate spout by shoe bottom

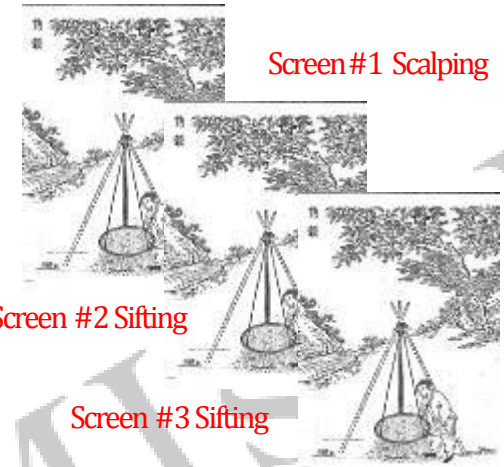


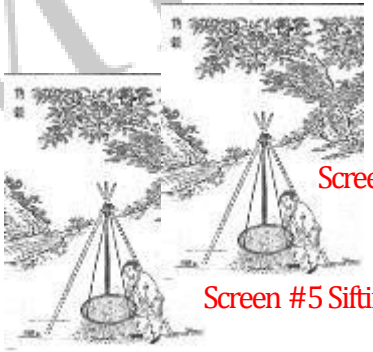
Air-Screen Cleaning - Cleaner

Upper Air

Lower Air

Air Separation



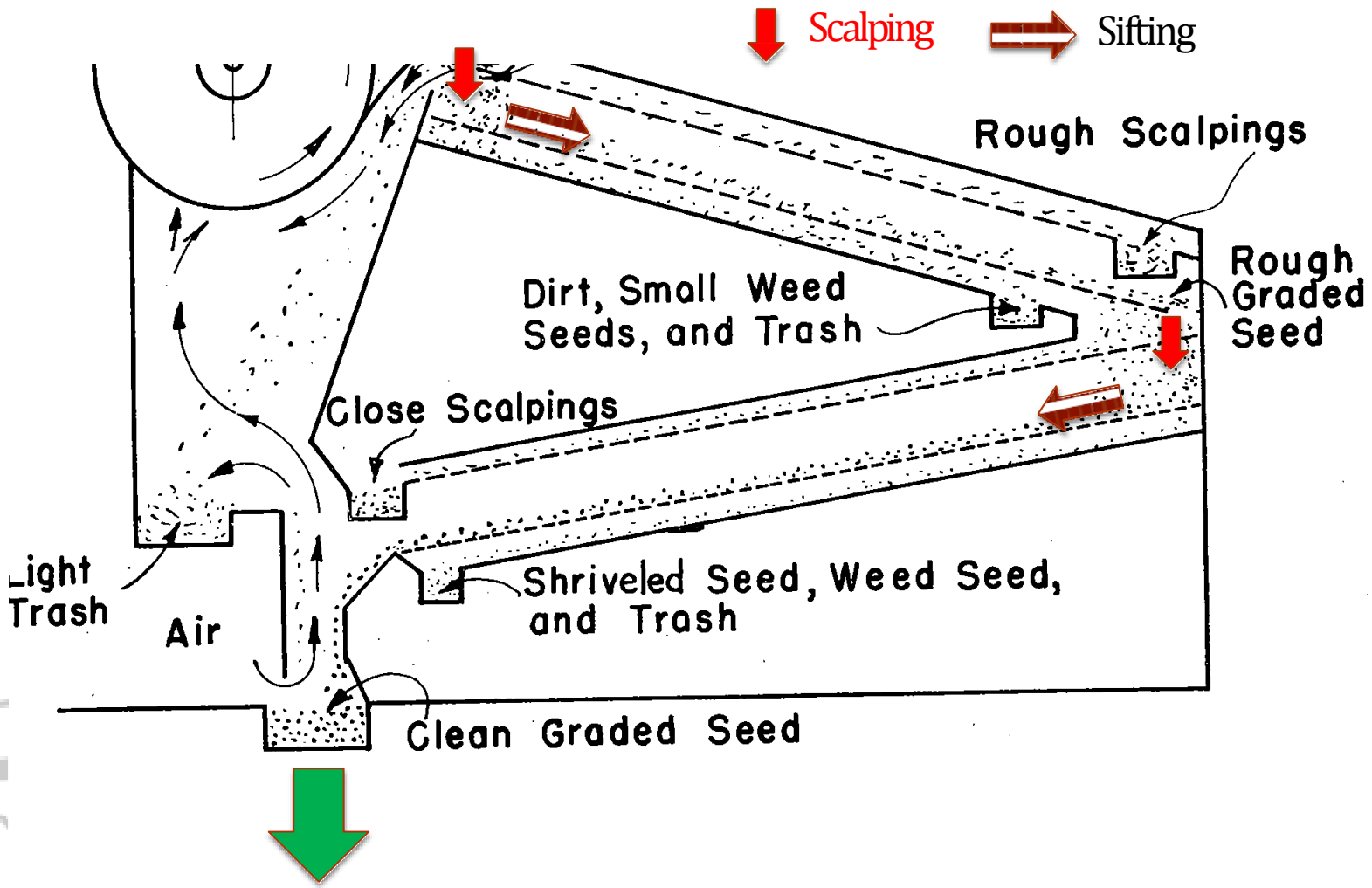


Screen Separation

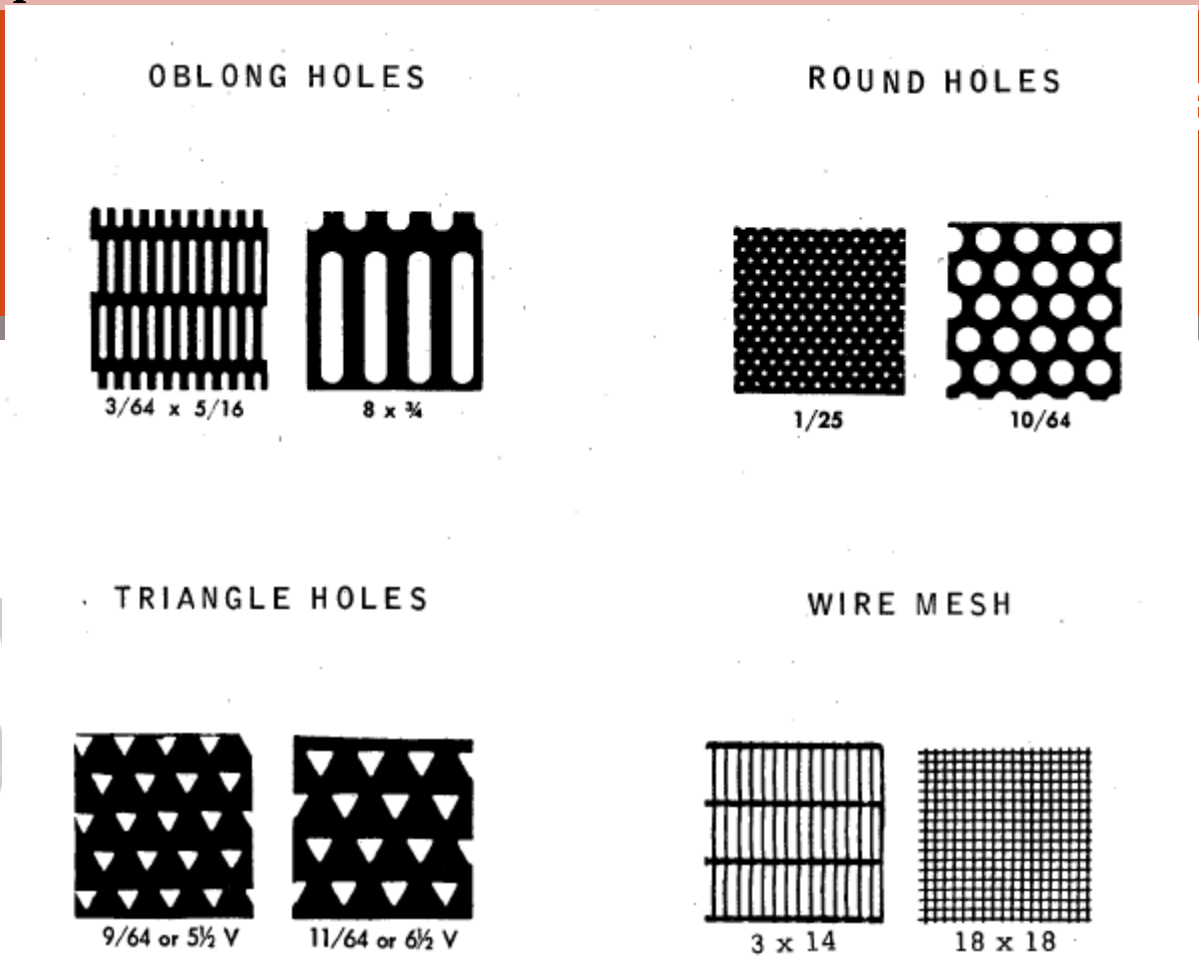
A 5T/H 2-Air, 5-Screen Air-Screen Cleaner

Modern Air-Screen Cleaner

Air-Screen Cleaning – Clean seed flow



Shape:


OBLONG HOLES
3/64 x 5/16
8 x ¾
ROUND HOLES
1/25
10/64
TRIANGLE HOLES
9/64 or 5½ V
11/64 or 6½ V
WIRE MESH
3 x 14
18 x 18

Air-Screen Cleaning – Screen Selection

- Size:

PERFORATED METAL SHEET

ROUND HOLES

Fractions	64ths	
1/25	5½	24
1/24	6	25
1/23	7	26
1/22	8	27
1/21	9	28
1/20	10	29
1/19	11	30
1/18	12	31
1/17	13	32
1/16	14	34
1/15	15	36
1/14	16	38
1/13	17	40
1/12	18	42
	19	44
	20	48
	21	56
	22	64
	23	72
		80

OBLONG HOLES

Fractions	64ths
1/24x½	5x¾
1/22x½	5½x¾
1/22x½ Diag.	6x¾
3/64x5/16	6½x¾
1/20x½	7x¾
1/18x¾	8x¾-D
1/18x¾	9x¾
1/16x¾-A	10x¾-E
1/16x½	11x¾-F
1/15x½	12x¾-G
1/14x¾-B	13x¾-H
1/14x½	14x¾-I
1/13x½	15x¾-J
1/12x½-C	16x¾-K
	17x¾
	18x¾
	19x¾
	20x¾
	21x¾
	22x¾
	24x¾-L

TRIANGLES

64ths
5
8
9
10
11

OBLONG CROSS SLOT

Finished Screens Made Only in "9" and "8" Model Widths. Sheet Sizes 36" x 61⅛" and 36" x 83¼"

6x¾
7x¾
8x¾
9x¾
10x¾
11x¾
12x¾
13x¾
14x¾
15x¾
16x¾
18x¾
10½x¾
11½x¾
12½x¾

ROUND HOLE HALF SIZES

6½
7½
8½
9½
10½
11½
12½
13½
14½
15½
16½
17½
18½
19½
20½
21½
22½

OBLONG HALF SIZES

8½x¾
9½x¾
10½x¾
11½x¾
12½x¾
13½x¾
14½x¾

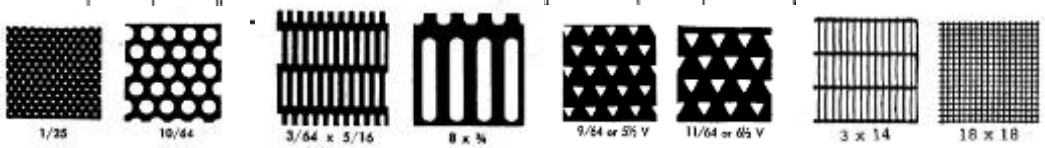
WIRE CLOTH

SQUARE OPENINGS

3x3
4x4
5x5
7x7
8x8
9x9
10x10
12x12
14x14
15x15
16x16
17x17
18x18
20x20
22x22
24x24
26x26
28x28
30x30
32x32
34x34
36x36
38x38
40x40
45x45
50x50
60x60

OBLONG OPENINGS

2x8	4x8½	6x14
2x9	4x15	6x15
2x10	4x16	6x16
2x11	4x18	6x18
2x12	4x19	6x19
3x14	4x20	6x20
3x16	4x22	6x21
3x16 SP.	4x24	6x22
3x18	4x24 SP.	6x23
3x20	4x26	6x24
3x21	4x28	6x25
	4x30	6x26
	4x32	6x28
	4x34	6x30
	4x36	6x32
		6x34
		6x36
		6x38
		6x40
		6x42
		6x50
		6x60
		18x20
		20x22

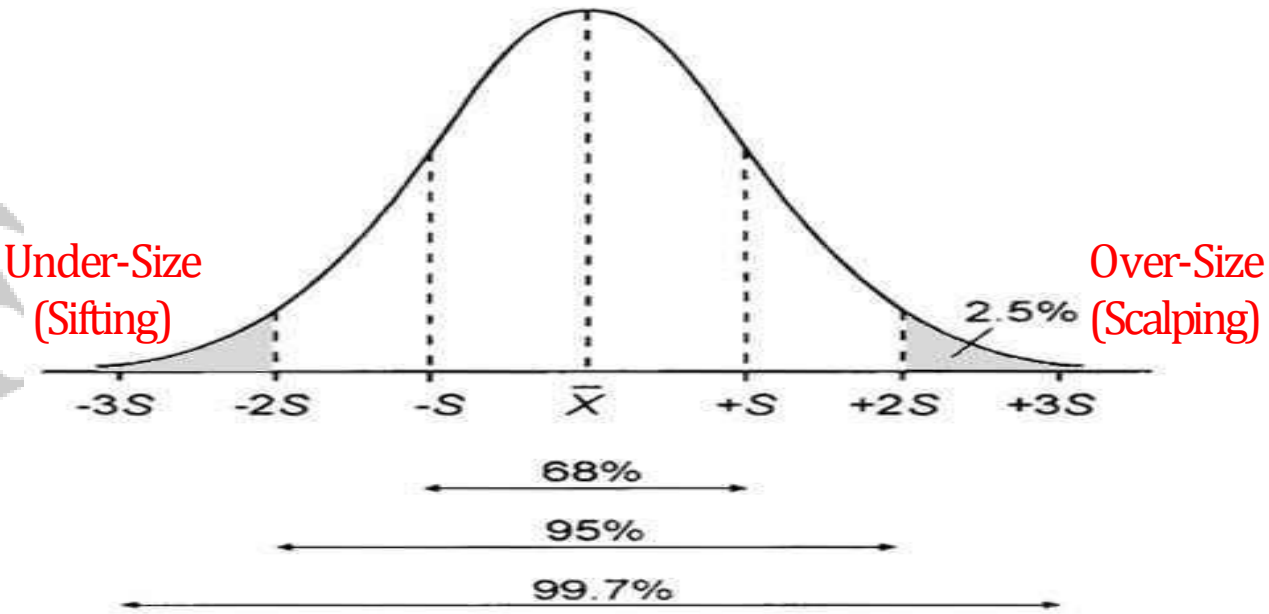


Air-Screen Cleaning – Screen Selection

- Screen must be selected according to the shape of the crop seed being cleaned -
  - Round seeds: A round-hole top screen and a slotted bottom screen are generally used to clean round-shaped seeds. The round-hole top screen prevents straw, trash, pods and other large and long material (*bolts/nuts, tools*) from dropping through while the slotted bottom screen drops broken seeds and weed seeds thinner than the round crop seeds.
  - Oblong seeds: An oblong top screen and an oblong bottom screen are generally used to clean long seeds. (how?)
  - Lens-shaped seeds: An oblong top screen and a round-hole bottom screen are generally used to clean lens-shaped seeds.

Air-Screen Cleaning – Screen Selection

- Screen size must be selected according to the result from hand-screen analysis. The bottom line is that to remove most of undesirable material without losing too much good seeds
- The shape of hand-screen should match the screen on the machine
- How much to cut??



Air-Screen Cleaning - Adjustments

- Rate of feed: Although the feed gate on a feed hopper is adjustable for large changes of rate of feed, the basic adjustment is made by increasing or decreasing the speed of the feed roll
- Screen knockers and tappers: An adjustable knocker or tappers that slightly tap the screens which vibrates screens so that seeds will pass through close and small openings, and will jar loose long weed seeds that wedge so tightly in the perforations that the brushes can't remove them
- Upper and lower air suction: The suction is regulated by an adjustable damper in the air passage
- Variable screen shake: This permit the operator to adjust the screen vibration speed from slow to very rapid
- Screen pitch: Common range in pitch adjustment is from 4 to 20 degrees

Air-Screen Cleaning - Installation

- It should be installed properly on and securely fastened to a firm foundation.
- Proper air ducting from the cleaner is extremely important. Sharp turns, improper junctions, poor connections and poor collectors all contribute to poor air separations in a cleaner. Improper air exhaust also causes a very dirty, dusty plant
- A good system to manage good seeds and different discards – both air-lifting and screening products.
- Operator safety and friendly environment!
- Computerized Air-Screen Cleaner (Dr. Shyy's US patent)….

Dr. Shyy's US Patent on Automation of Air-Screen Cleaner - 1991

United States Patent [19]

Misra et al.

[11] **Patent Number: 4,991,721**

[45] **Date of Patent: Feb. 12, 1991**

[54] **AUTOMATION OF AN AIR-SCREEN SEED CLEANER**

[75] Inventors: **Manjit K. Misra; Yuh-Yuan Shyy,** both of Ames, Iowa

[73] Assignee: **Iowa State University Research Foundation, Inc.,** Ames, Iowa

[21] Appl. No.: **231,946**

[22] Filed: **Aug. 15, 1988**

[51] **Int. Cl.**[5] **B07B 9/00;** B07B 4/02; G05B 13/02

[52] **U.S. Cl.** **209/31;** 209/37; 209/139.001; 209/257; 209/546; 209/557; 364/502; 364/552

[58] **Field of Search** 209/21, 30–37, 209/44.1, 44.2, 134–139.1, 146, 147, 149, 153, 154, 237, 238, 255, 257, 546, 549, 552, 555, 557, 629, 639; 55/215, 218, 270, 279, 413, 423–426; 364/500, 502, 552, 555, 406/28, 168, 169, 173

[56] **References Cited**

U.S. PATENT DOCUMENTS

289,316	11/1883	Smith	406/169
696,870	4/1902	Kessler	209/37
996,155	6/1911	Speroni	209/37
2,070,530	2/1937	Gallagher et al.	209/257
2,762,506	9/1956	Fine	209/139.1 X
2,973,861	3/1961	Jager	209/1
3,079,079	2/1963	Phister, Jr. et al.	364/502
3,494,217	2/1970	Tanaka et al.	209/1 X
3,551,897	12/1970	Cooper	364/502 X
3,606,745	9/1971	Goodet	209/1 X
4,149,415	4/1979	Harbour	73/865.5
4,252,071	6/1980	Horowitz et al.	366/152
4,318,806	3/1982	Satake	209/496
4,321,134	3/1982	Leschonski et al.	209/30
4,330,400	5/1982	Schmidt	209/34 X
4,490,247	12/1984	Forsberg et al.	209/20
4,588,091	5/1986	Wade	209/546
4,634,522	1/1987	Edholm et al.	209/154
4,657,144	4/1987	Martin et al.	209/546
4,658,964	4/1987	Williams	209/552
4,687,105	8/1987	Edholm et al.	209/546

FOREIGN PATENT DOCUMENTS

0150859	9/1981	Fed. Rep. of Germany	209/257
2605252	4/1988	France	209/237
0268881	8/1970	U.S.S.R.	209/1
0618133	6/1978	U.S.S.R.	209/1
0667258	6/1979	U.S.S.R.	209/552
1125069	11/1984	U.S.S.R.	209/237

OTHER PUBLICATIONS

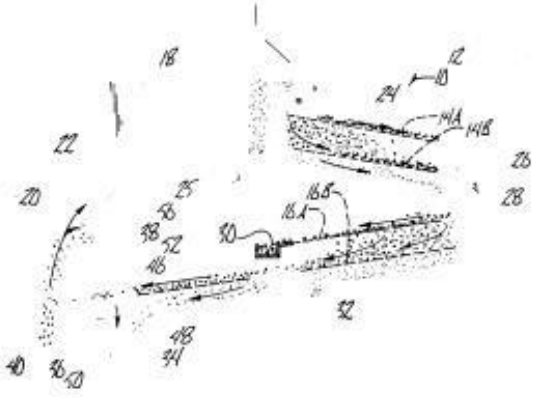
"Profitability Through Computerized Conditioning", Misra et al., Eighth Annual Seed Technology Conference, Feb. 25–26, 1986.

Primary Examiner—Margaret A. Focarino
Assistant Examiner—Edward M. Wacyra
Attorney, Agent, or Firm—Zarley, McKee, Thomte, Voorhees & Sease

[57] **ABSTRACT**

A cleaning system is provided for separating desired material from undesirable material in a mixture of particulate materials. The system includes an inlet for receiving the mixture of materials and an outlet for discharging the desired materials. At least one screen is provided for separating undersized material from oversized material within the mixture, and at least one vacuum air-lift is provided for separating the lighter material from the heavier material within the mixture. A first sensor is mounted below the discharge end of the screen for sensing the quantity of undersized material separated by the screen and a second sensor is mounted in the air-lift for sensing the quantity of lighter materials separated by the air-lift. The signals generated by the sensors can be received by a processing unit which adjusts the extent of separation by the screen and by the air-lift to achieve the desired efficiency of the cleaning system.

16 Claims, 23 Drawing Sheets



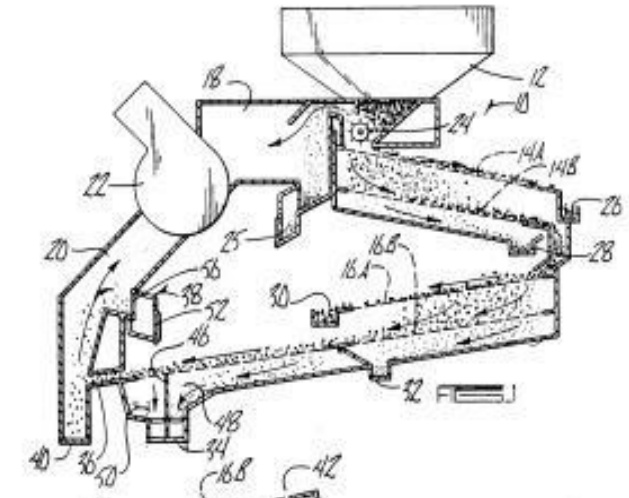


FIG. 1

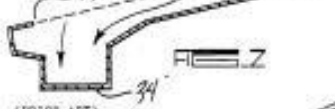


FIG. 2

(PRIOR ART)

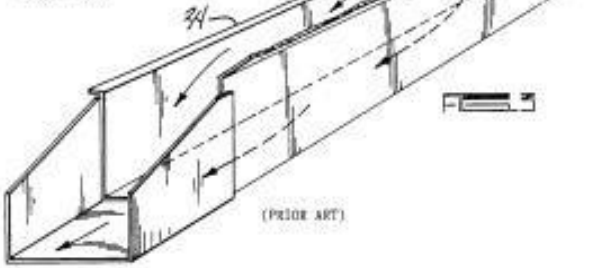
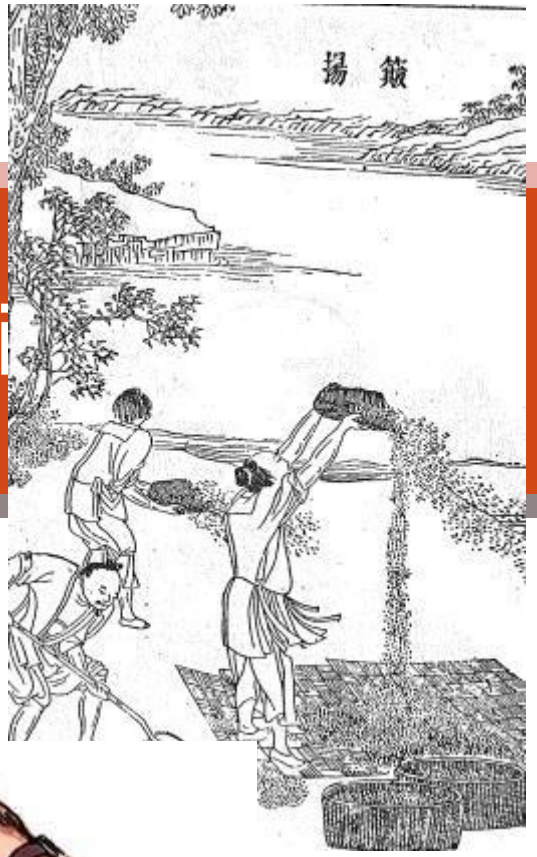


FIG. 3

(PRIOR ART)

Air S

Questions?



Basic of Separation:

Questions?

PD01 ANNEXE A. PRODUCT COST ANALYSIS REPORT TEMPLATE

Prepared by:	Date:
Crop:	
Variety or hybrid:	
Parents (if applicable):	
Grower premium:	
Bag:	
Conditioning:	
Treatment:	
Labels:	
Basic seed:	
Bag pallet:	
Royalties:	
Re-bagging:	
Seed transport:	
Sales:	
Advertising:	
Certification/Inspection:	
Cleanout:	
Interest:	
Other direct costs:	
Total product cost:	

PD01 ANNEXE B. SELLING PRICE LIST BY VOLUME/LOCATION TEMPLATE

Form number: Date:	Version number:	
Crop:	Variety:	
Base price/ton:	Weight:	Sales zone:
	Weight discount (1):	Price increment by location (2):

1) Weight discounts

AGRO-DEALER DISCOUNT		
From	To	%
1	10	1%
11	20	2%
21	30	3%
31	40	4%
41	50	5%
51	60	6%
61	70	7%
71	80	8%
81	90	9%

2) Price increment by location*

ZONE	INCREMENT
1	0%
2 and 3	0.5%
4	1.2%
5	2.0%
6	2.6%

* Location increments to be determined by considering distance and accessibility of roads.

PD01 ANNEXE C. PRICE ANALYSIS REPORT TEMPLATE

TOTAL PRODUCT COST (from PD01 Annexe A):	$
OTHER COSTS:	
– Carryover costs (interest, storage, re-conditioning)	$
– Management overhead (salaries, rent, training)	$
– Financial overhead (interest on investment and capital)	$
TOTAL COSTS: (Total Product Cost + Other Costs)	$
Total Income: Base Price/ton x Number of tons (from PD01 Annexe B)	$
Gross Profit:	$
Taxes:	$
NET PROFIT: (Gross Profit minus Taxes)	$

SC01 ANNEXE B. SAMPLING CARD TEMPLATE

Crop species:
Variety:
Field number:
Seed lot number assigned:
Contract Grower:
Class: □ Pre-basic □ Basic □ Certified (1st generation) □ Certified (2nd generation)
Seed lot total weight at reception (Kg): Seed lot total weight after conditioning (Kg): Number of bags in seed lot: Weight per bag (Kg): Number of certified seed tags requested: Seed lot storage location:

Sampler: _____
Signature Date

Conditioning Plant Leader: _____
Signature Date

SC01 ANNEXE D. SEED CONDITIONING OPERATION TEMPLATE

Crop:
Variety:
Field number:
Lot number:
Contract Grower:
Initial weight (kg):
Final weight (kg):
Final number of bags:
Pre-cleaning discards (kg):
Drying notes:
Moisture content reduced from_____% to_%
Cleaning discards (kg):
Treatment material name and amount:
Labeling number of tags from tag number_____to tag number___:
Storage location number:
Additional remarks:

Conditioning Plant Leader:_____

Signature Date

Production and Quality Manager: _____

Signature Date

Crop:	
Variety name:	
Lot number:	
Sample number:	
Tests requested:	
Contract Grower:	
Date sample received: Signature:	Date tests concluded: Signature:
Test results Purity: Germination: Moisture: Stress: Seed health:	
Remarks:	

Production and Quality Manager: _____

Signature Date

SC01 ANNEXE A. SEED RECEIPT AT CONDITIONING PLANT TEMPLATE

Receipt number:

Contract Grower information
Name:
Address:
Field location:
Production in hectares:
Crop:
Variety:
Class of seed:
Planting date:
Harvest date:
Weight:
Moisture content:
Notes:

Conditioning Plant Leader: _____

Signature Date

Sizing and Texture/Surface Separation

Dr. Yuh-Yuan Shyy

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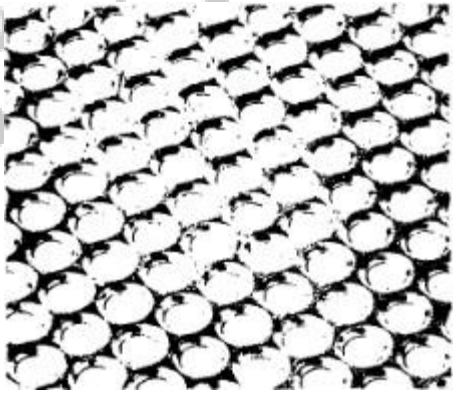
Sizing and Texture/Surface Separation

- Size between different crops and seed quality

- Texture/surface difference of good and bad seeds

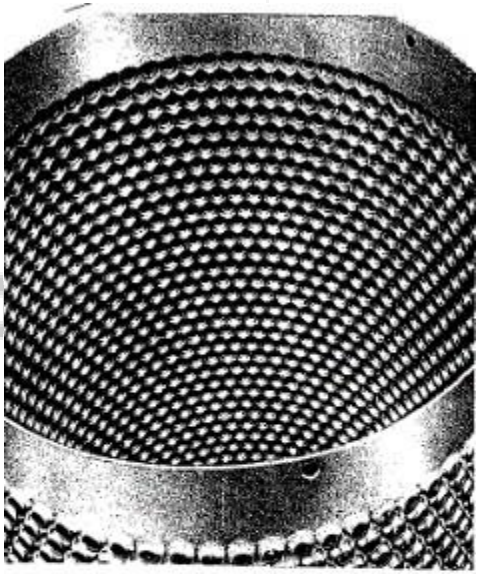
Sizing – Width and Thickness

- Width and thickness separators are commonly referred to as 'graders' or'sizers'
- The separation is similar to, but generally more accurate than, the separation performed on the screens inAir-Screen Cleaner
- Two principles apply:
  - Seeds are sized for width by using round-hole screen openings
  - Seeds are sized for thickness by using slotted screen openings



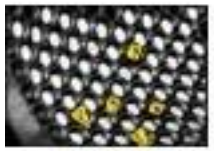
Sizing – Width Separator

- The indented round hole screen is used for width sizing, and differs from the perforated round hole screens used in air-screen cleaner in that the hole is ringed by a 'seat'.Why?
- If the seed is narrower than the diameter of the hole, it passes through and is termed a 'through'. Conversely, the wider seed is termed'over'
- Machine fraction and total fraction:
  - Through % = 100*Through/Total
  - Through (Size) % ofTotal



Sizing – Width Separator

Flat Screen Separator -Vibration



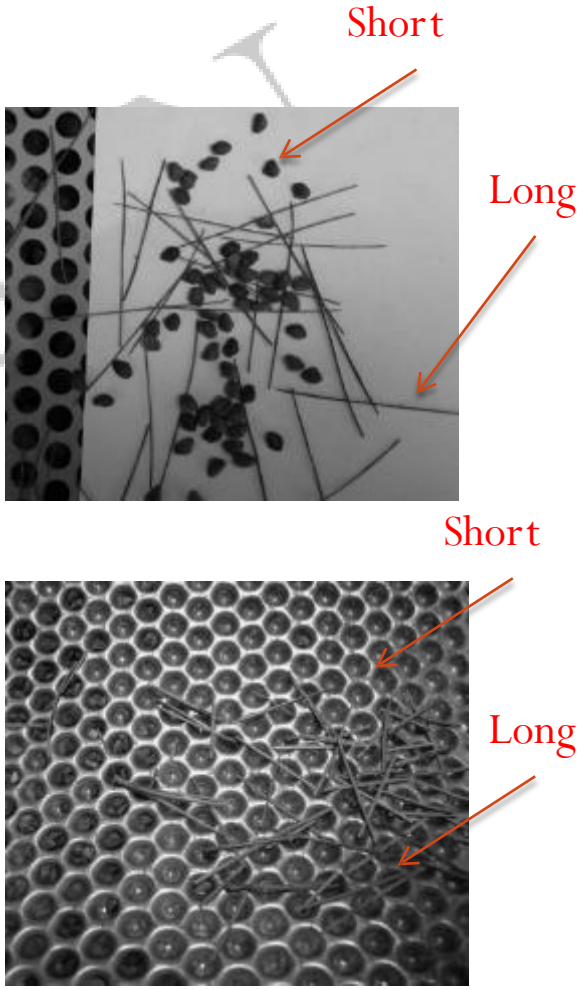
Cylindrical Screen Separator - Rotation

Flat Screen Separator -Vibration

Cylindrical Screen Separator - Rotation

Sizing – Length Separator

- Length separators are specifically designed to effect separations of particles differing in length
- Cylinder and disk separators are machines to separate seed on a pure length difference basis
- Both machines effect this separation by lifting the short particles out of a mixture containing both log and short particles
- Efficiency of length separation?



Sizing – Length Separator/Cylinder

A: Indented Cylinder
B: Short
C: Long
D: Mixture

long rejected material out of the cylinder. Interior surface of cylinder is shown at right.

Indent sizes are listed in 64ths of an inch and come in a wide range. For example, a cylinder designated by the number 22 has indents 22/64th inch in diameter. There are no other figures or letters used to describe the indents. Also, there is no way to determine the shape or depth of the indent from the number. Examples of cylinder sizes used for some separations are given in an accompanying table.

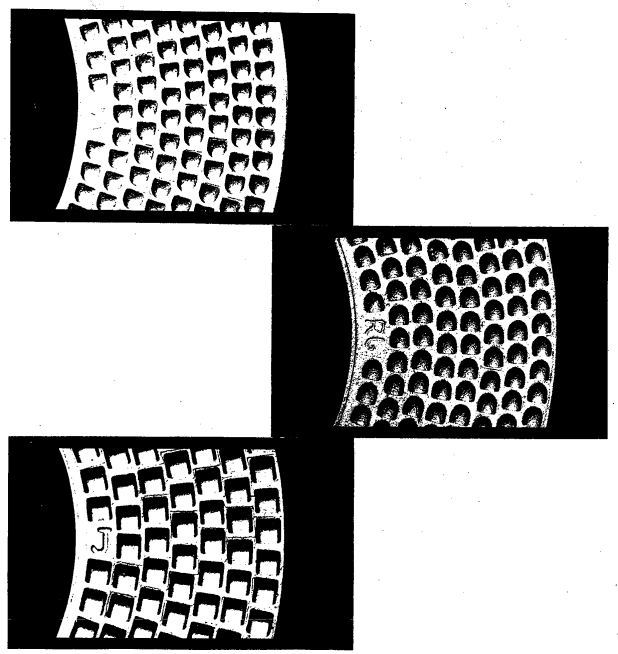
Receiving trough: The receiving trough is a device to receive the liftings. The configuration of the receiving trough varies from machine to machine, but its function remains the same

Sizing – Length Separator/Disk

Figure D15. Face and cross-section of a single disc.

lifting edge of the pocket (the bottom of the pocket is cup-shaped) so they tip out of the pocket.

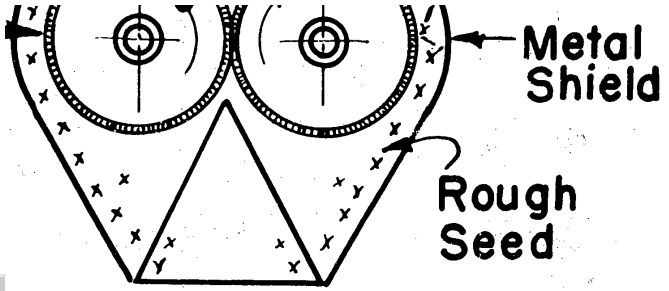
The letter designation "V" is always followed by a number, such as V4, V5 1/2 or V6. The number indicates the width dimension in millimeters, i.e., a pocket designated as V4 is a pocket with a round lifting edge which is 4 mm. wide. "V" pockets seldom exceed 6 millimeters in width.



Type of disc pockets: V, R, and S

Texture/Surface Separation

- Texture separator will separate mixtures of crop seed and contaminants that differ in surface texture
- Rough-surfaced, irregular contaminants – seed or inert material – are separated from the mass of smooth surfaced, regular shaped crop seed
- Roller or belt covered with velvet fabric can be used



ıre F4. Cross-section of a pair of rolls illustrating movement of rough seed over rolls.

eed must contact the velvet so all rough seed can be of the mixture. Over-feeding will flood the rolls, or crowd tween the rolls and the shield and interfere with free move- idual particles. This reduces the percentage of rough seed

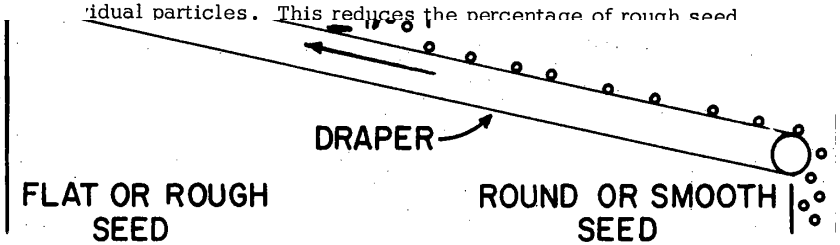


Figure F8. Schematic view of inclined draper illustrating principle of separation.

ing device which distributes seed in a thin layer across the of the moving inclined draper belt at a point near the center of its dimension. As the belt travels up-hill, the round or smooth seed

Texture/Surface Separation

- Texture separator is a finishing machine and shall be used on seed that have already been processed on air-screen cleaner or other machines.
- There are used to clean smooth seed such as clovers, alfalfa and beans that are contaminated with rough surface weed seed, immature seeds that are wrinkled or shriveled, broken, chipped or damaged seed that have irregular surfaces, and rough and irregular shaped inert material.
- Examples of some separations made on texture separator:

Crop Seed	Contaminant Removed by Roll Mill
Crimson Clover	Cutleaf Cranesbill, Dock
Alsike Clover	Timothy
Whole Seed	Broken Seed
Beans	Dirt Clods
Vetch	Wild Winter Peas
Hulled Lespedeza	Unhulled Lespedeza
Clovers	Sorrel, Peppergrass, Foxtail
	Catchfly, Mustard, Cockle,
	Wild Carrot

Questions?

Gravity Separation

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Gravity Separation – Gravity Table

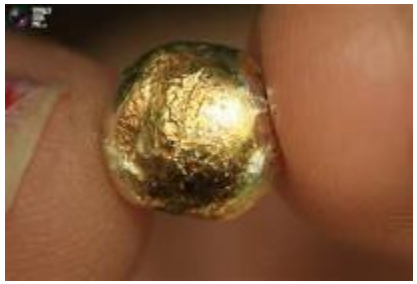
- Undesirable seed and contaminants are often so similar to the "good" seeds in size, shape, and surface textures that efficient separations cannot be achieved.
- Contaminating seeds or materials differing from the crop seed in *test weight* or *specific gravity* can be separated with a Gravity Separator/Table.

Oliver GT

Forsberg GT

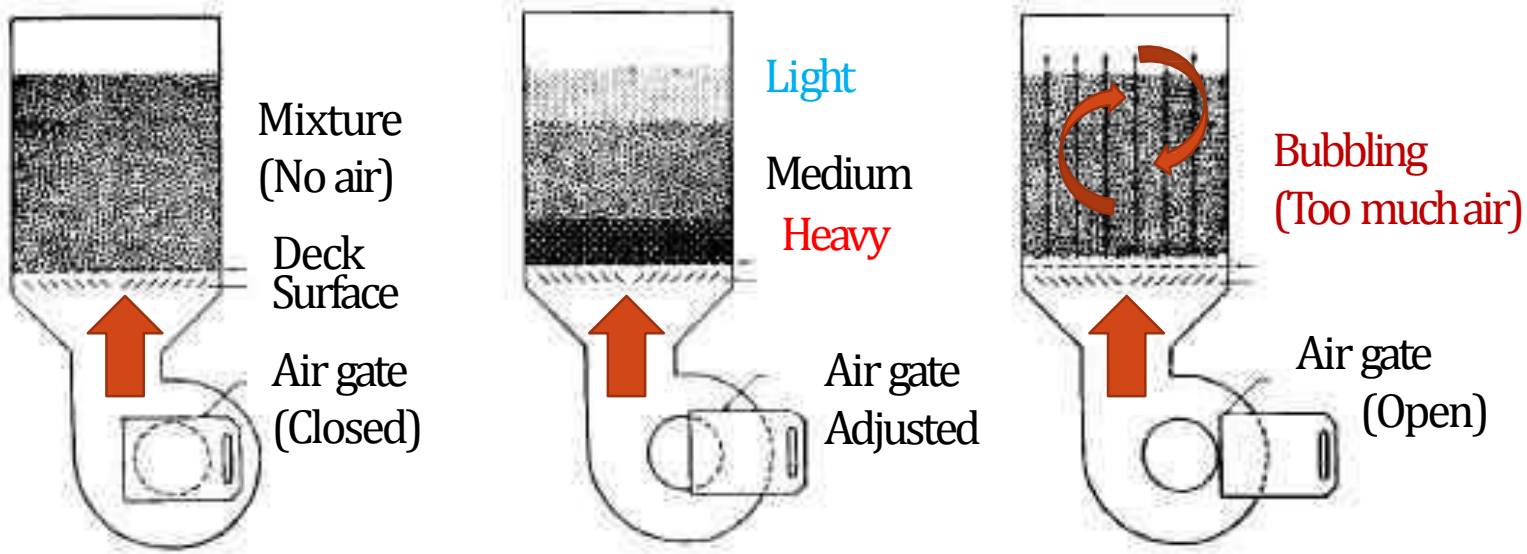
LMC GT

Gravity Separation - Fluidization



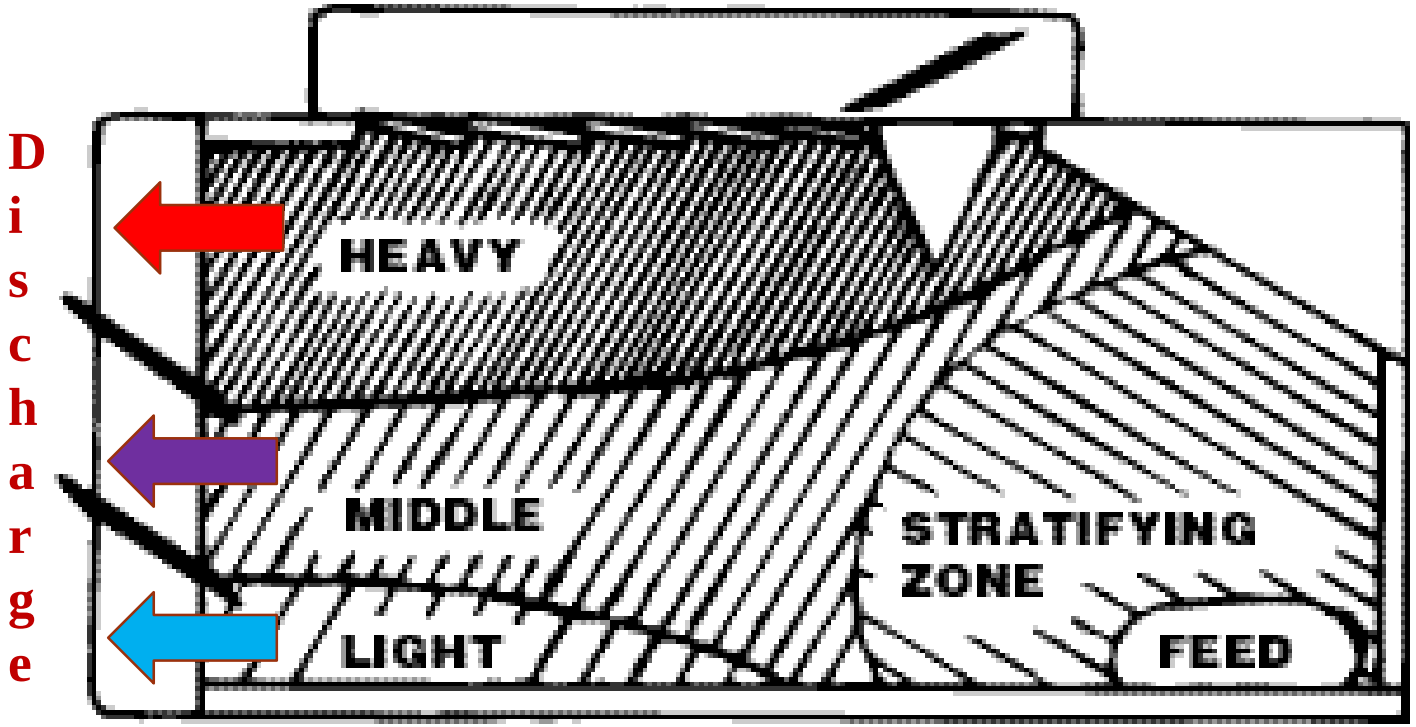
Gravity Separation – Principles

- ***Fluidization*** (Water vs Air?): Mixture is vertically stratified so that the heavier seeds are at the bottom and the lighter seeds are at the top.



Gravity Separation – Principles

- ***Separation***: The light seeds are fluidized on a cushion of air and flow almost like a liquid, they flow toward the discharge end because of the downhill slope. And the heavier seeds move uphill with deck motion.



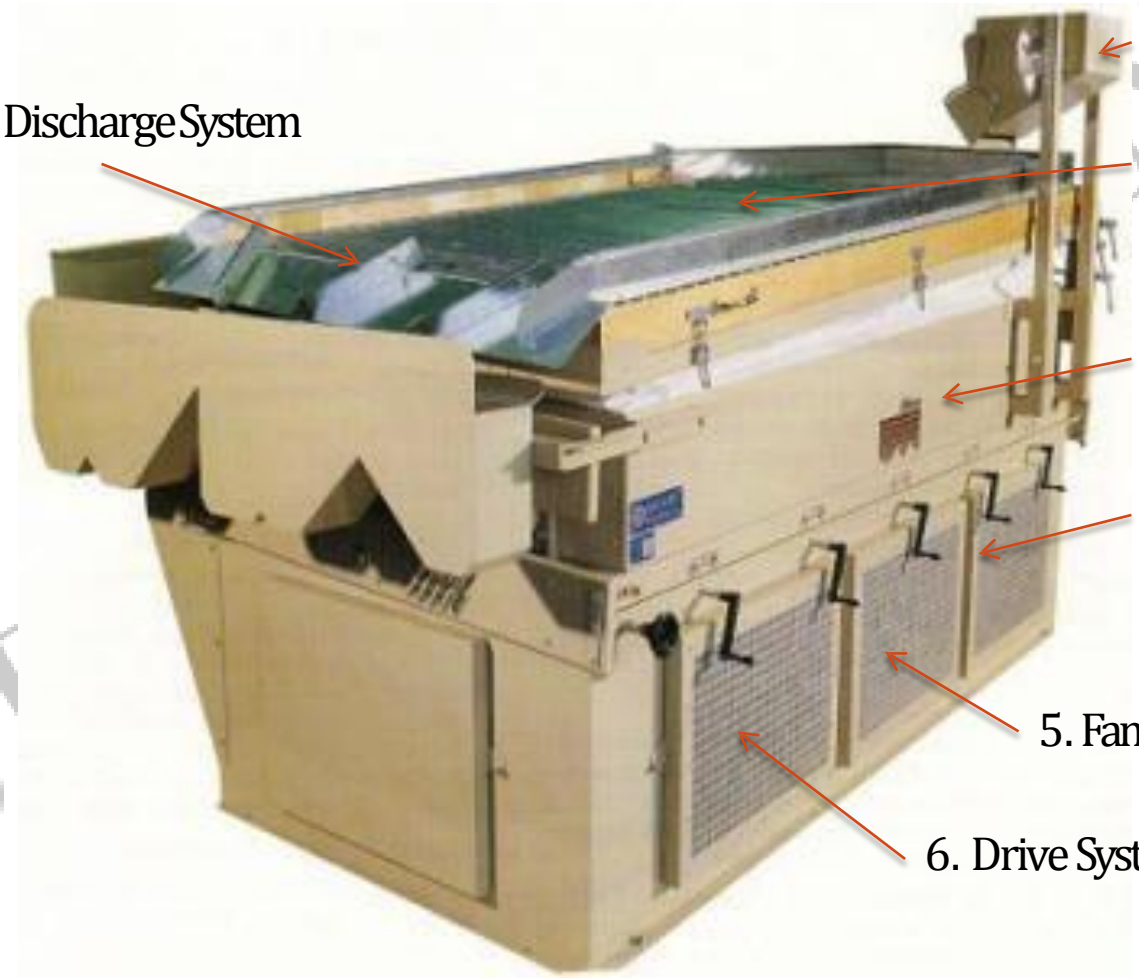
Gravity Separation – Rules

- Rule 1. Particles of the same size but differing slightly in specific gravities can be separated.

- Rule 2. Particles of the same specific gravities but differing in the size will be graded according to the size of the particles.

- Rule 3. Particles differing in specific gravities and also differing in size cannot be efficiently separated!

Gravity Separation – Machine



Gravity Separation – Parts

1. Feed Hopper: Seed flow from a surge bin to a feed hopper which meters a uniform stream of seed onto the corner of the deck opposite the discharge side. The feed hopper is adjustable for different feed rates.

2. Porous Deck: The deck is a lightweight removable and interchangeable frame which provides the surface on which seeds are separated. The deck is covered with a porous material such as cloth, wire screen, perforated sheet which allows air to pass through.

Gravity Separation – Parts

3. Air Chest: It is an airtight, shallow, boxlike plenum chamber mounted inside the frame and beneath the deck. Air pressure built up in the air chest forces air up through the porous deck.

4. Base and Frame: The base section is bolted to a solid foundation to keep the machine from shaking (walking machine?) The frame provides structural support for all other parts of the machine

Gravity Separation – Parts

5. Fan(s): One or more fans pull air from outside the machine and force it into the air chest. Pressure and vacuum gravity separators operate on the same principle, but the fan is mounted _____(where?)

6. Drive System: The upper part of the air chest to which the deck is attached is mounted on rockers which allows it to rock back and forth with the deck. The speed of the motion can be controlled by a variable speed drive.

7. Discharge System: The banking rails hold the seeds on the deck until they reach the discharge end.

Gravity Separation – Controls

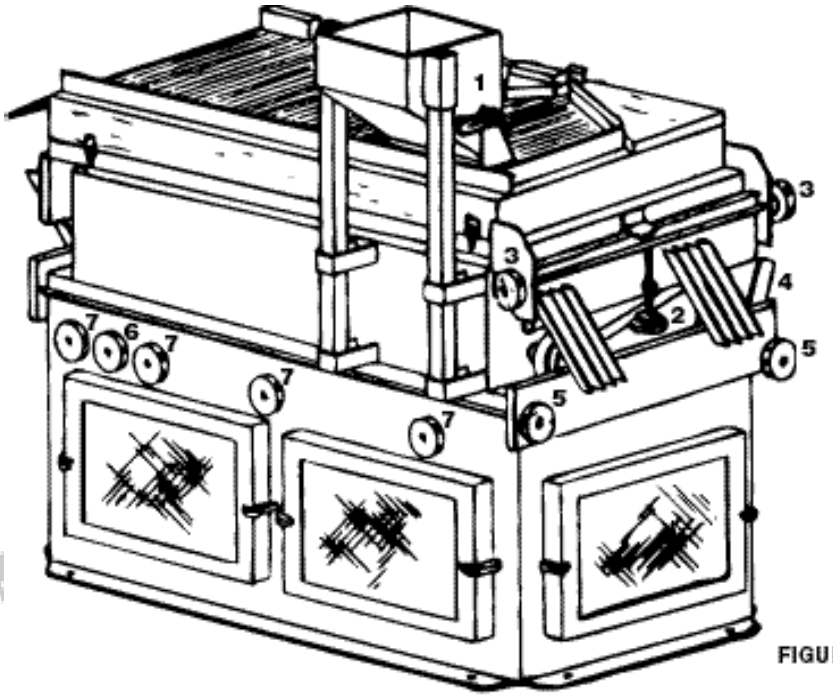
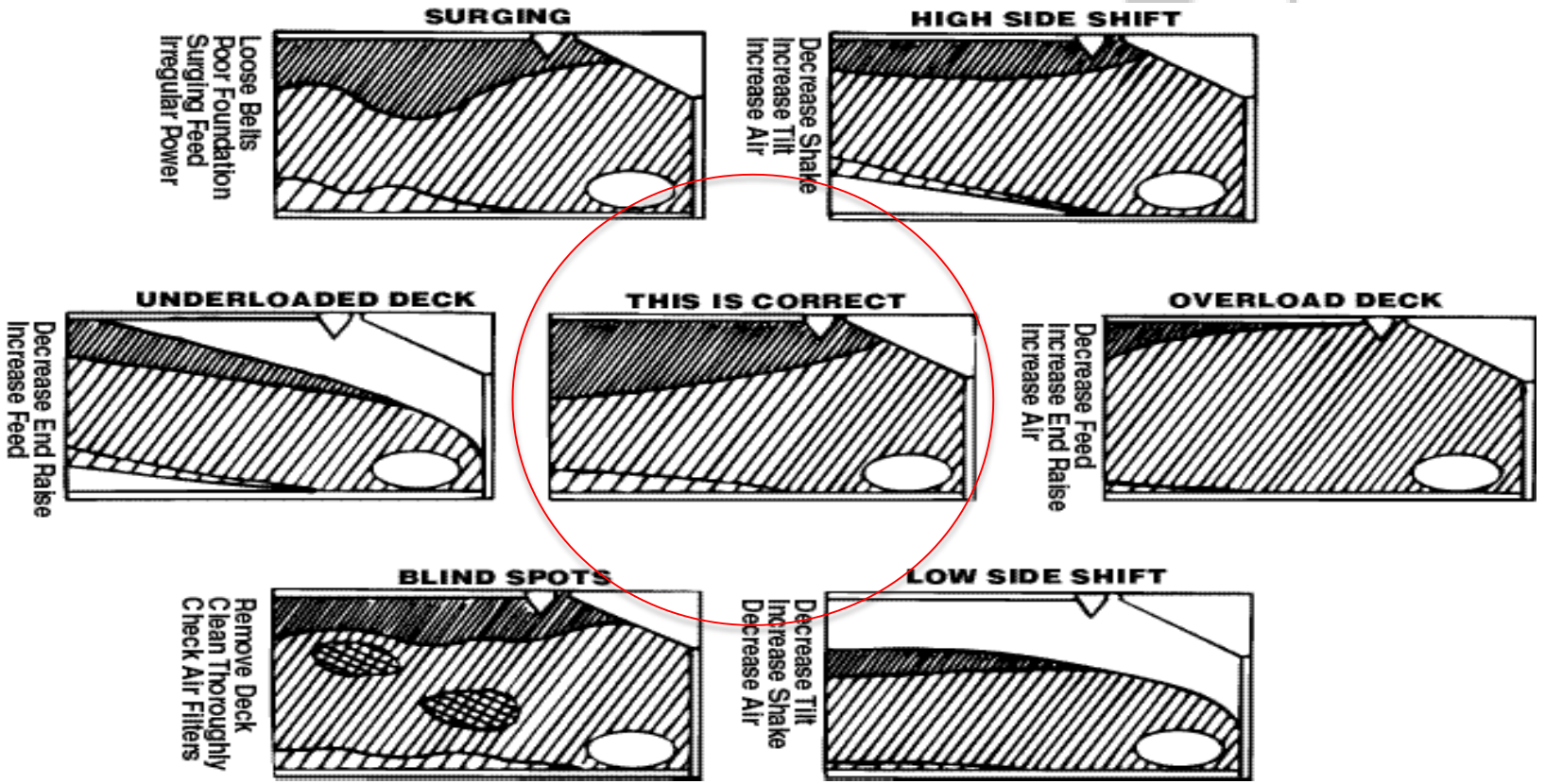


FIGURE 5

LEFT HAND MODEL

1. Feed Rate Control
2. End Raise Control
3. Clamping Knob, End Raise
4. Side Tilt Adjustment Handle
5. Side Tilt Clamping Knob
6. "More Speed" Control Knob
7. "More Air" control Knob

Gravity Separation – Adjustments



Gravity Separation – Adjustments

Same separation results can be achieved with different adjustments, it is an ART!

Rectangular, Multiple Fans

- Feed Rate
- Air Volume
- Eccentric Speed
- Deck Side Slope
- Deck End Slope
- Variable Airflow Levels
- Discharge Dividers

Trapezoidal, Adj. Pitch Posts

- Feed Rate
- Air Volume
- Eccentric Speed
- Deck Elevation
- Deck Run-off
- Feed, End, and Cull Post Pitch
- Discharge Dividers

- Eccentric Displacement is also adjustable on a few machines, and is used to help compensate for seed size variations

Gravity Separation – Deck Surface

- Deck surface is critical for traction needed to convey seed up deck slope
- Deck opening size must prevent plugging of deck openings
- Use Proper Mesh Size for Product
  - 8 or 10 Mesh - large seeds
  - 12 mesh – soybean/wheat
  - 16 mesh – small grains
  - 30 mesh – small seeds
  - Cloth deck – very small seeds
- Urethane coatings for large seeds
  - High Wear Applications
  - Better Traction, Lower Shake Speed

- Riffle strips may be used for large seeds

Gravity Separation – Automation (Dr. Shyy's US Patent)

United States Patent [19]

Misra et al.

[11] **Patent Number: 5,024,334**

[45] **Date of Patent: Jun. 18, 1991**

[54] **METHOD AND MEANS FOR GRAVITY TABLE AUTOMATION**

[75] Inventors: **Manjit K. Misra; Yuh-Yuan Shyy,** both of Ames, Iowa

[73] Assignee: **Iowa State University Research Foundation, Inc.,** Ames, Iowa

[21] Appl. No.: **363,727**

[22] Filed: **Jun. 9, 1989**

[51] **Int. Cl.**[5] **B07C 5/342;** B03B 4/00

[52] **U.S. Cl.** **209/557;** 209/467; 209/472; 209/489; 209/491; 209/502; 209/503

[58] **Field of Search** 209/557, 567, 571, 576, 209/577, 580, 586, 587, 589, 592, 598, 552, 484, 489, 491, 496, 502, 499, 422, 691, 694, 695, 471, 472, 458, 459, 490, 479, 477, 503, 474-476, 467

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,406,824	10/1968	Forsberg .	
3,693,794	9/1972	Oetiker	209/467
3,888,351	6/1975	Wilson .	
3,888,352	6/1975	Kulseth .	
3,933,249	1/1976	Welsh et al.	209/557
4,265,744	5/1981	Weiffen	209/496 X
4,316,799	2/1982	Satake	209/580 X
4,652,362	3/1987	Mueller	209/44.2
4,765,489	8/1988	Satake	209/557

FOREIGN PATENT DOCUMENTS

623481	5/1979	U.S.S.R.	209/491
1258487	9/1986	U.S.S.R.	209/489

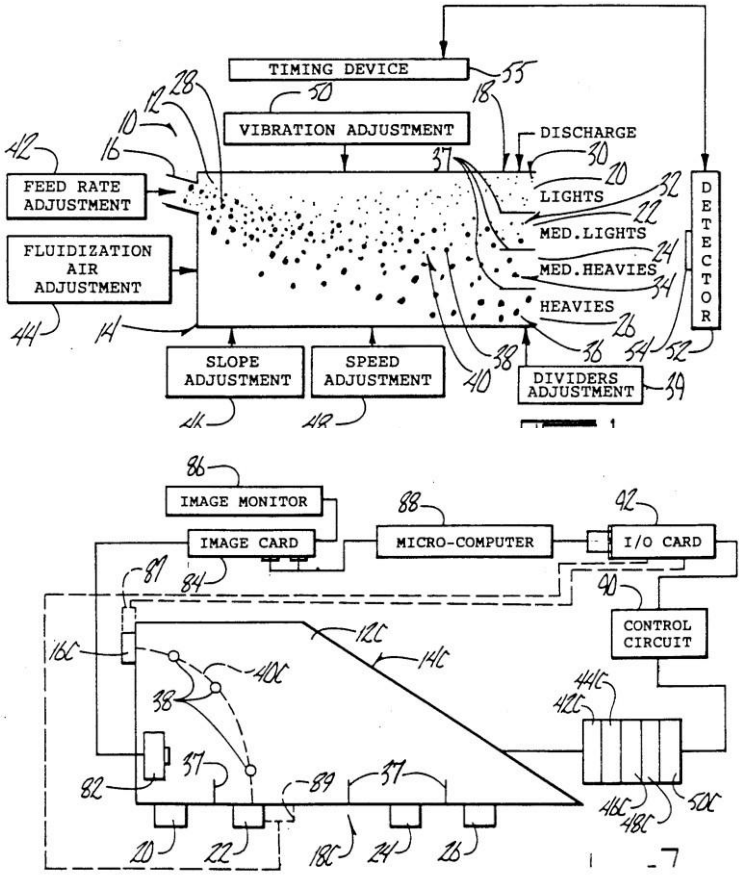
Primary Examiner—Donald T. Hajec

Attorney, Agent, or Firm—Zarley, McKee, Thomte, Voorhees & Sease

[57] **ABSTRACT**

A system for gravity table separation including a gravity table for separating materials and a detector operatively associated with the gravity table for detecting the movement of control particles with respect to the gravity table during its operation. The control particles are of a known characteristic. By calibrating the desired movement of the control particles through the table, any misalignment or deviance of that movement during operation is detected, and adjustments can be made to the operation of the table to bring the control particles back to the desired movement. The separation process can then be controlled to bring about optimum efficiency. Also, the detector can be interfaced with a control component which can automatically adjust the operation of the table in response to whether the control particles are following the desired movement through the table.

13 Claims, 6 Drawing Sheets



Gravity Separation – ISU Video

Questions?

Oliver GT

Forsberg GT

LMC GT

Seed Plant Design

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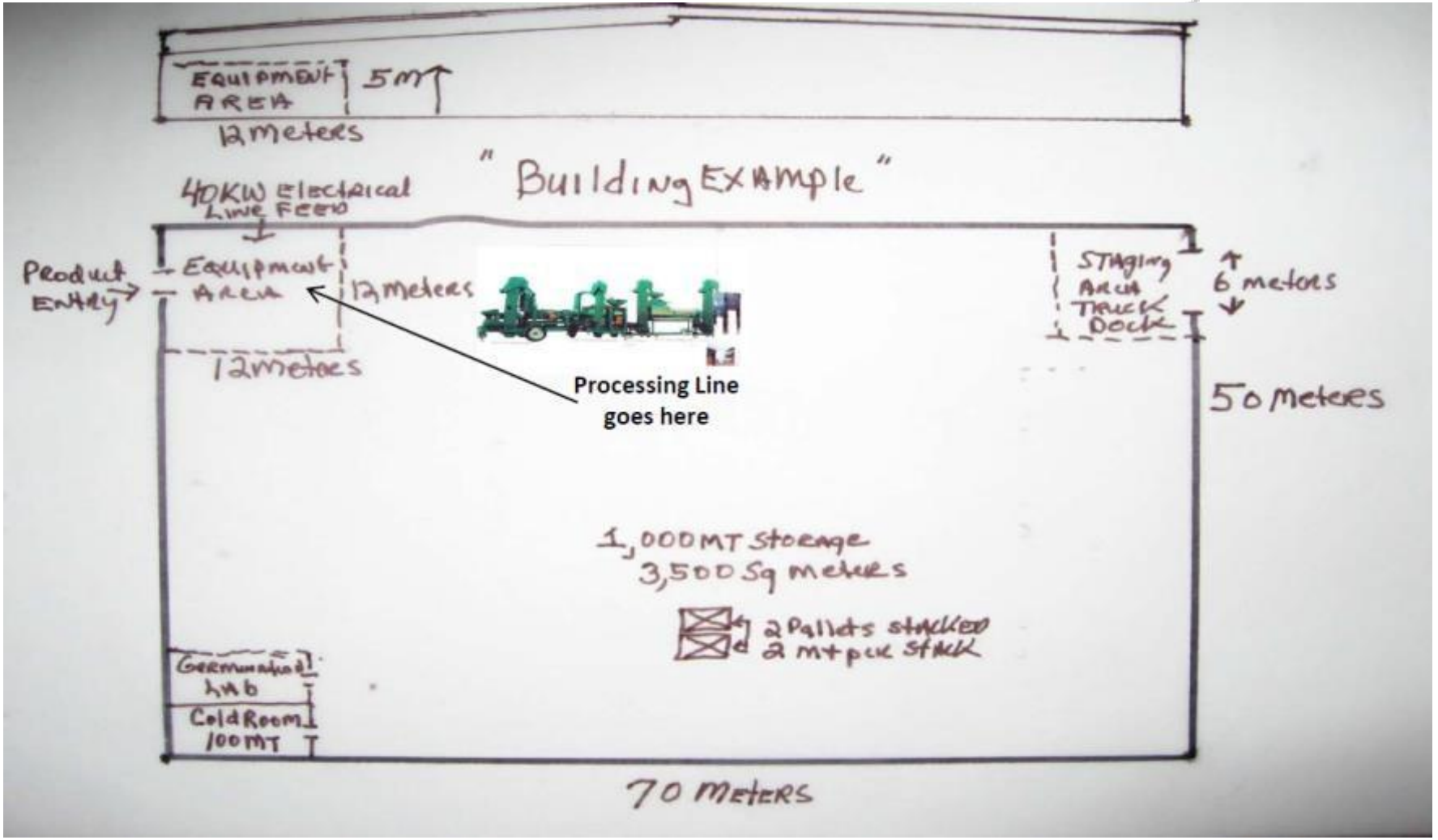
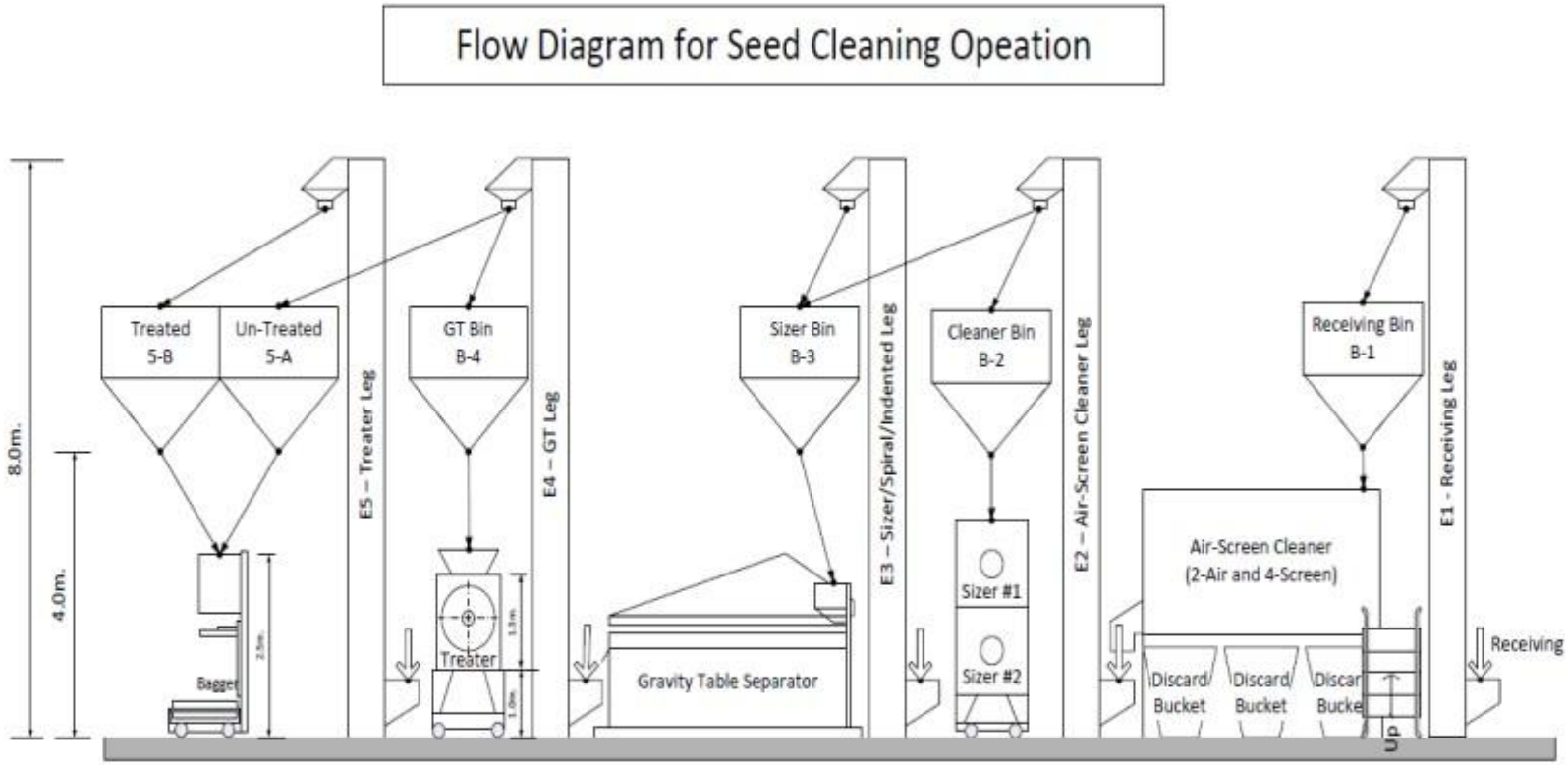
Seed Plant Design – List of Equip.

Crop Description	Seed Processing Operation													
	Drying	Shelling or Threshing	Pre-clean (air)	Pre-clean (scalp)	Debeard or Brush	Air Screen Cleaner	Spiral or Belt	Indent or Disc (l)	Sizing (w/t)	Polisher	Destoner	Gravity Separator	Color Sorter	Seed Treater
Corn (Maize)														
Beans														
Groundnut														
Cow Peas														
Millet														
Grain Sorghum														
Wheat														
Sunflower														
Spider Plant														
Solanum (African nightshade)														
Crotalaria														
amaranthus														
Urgent Need:														
Optional / Future:														
Food Grade Only:														

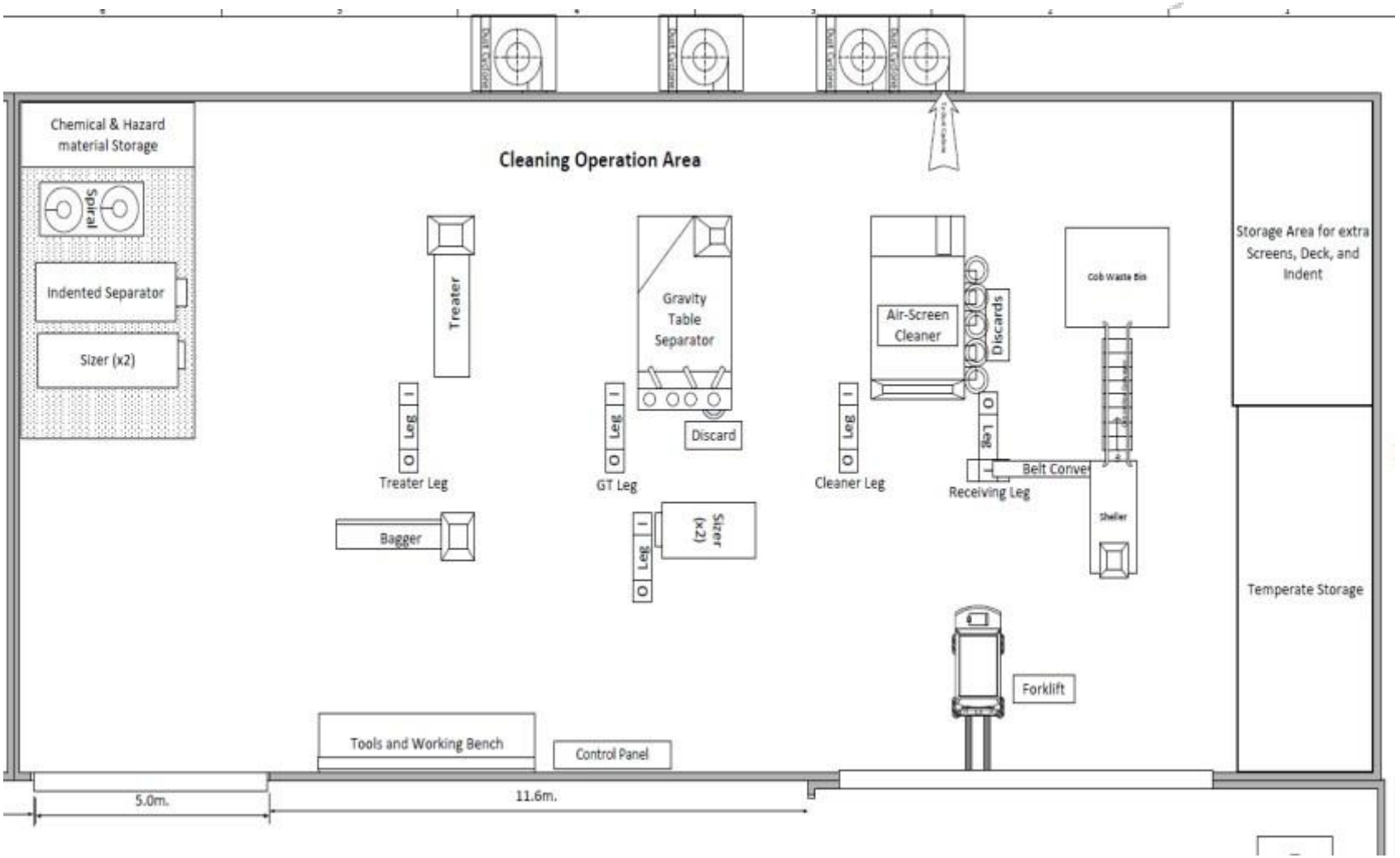
Seed Plant Design – Freehand drawing



Seed Plant Design - Flow Diagram



Seed Plant Design – Equipment Layout



Questions?

示意图一

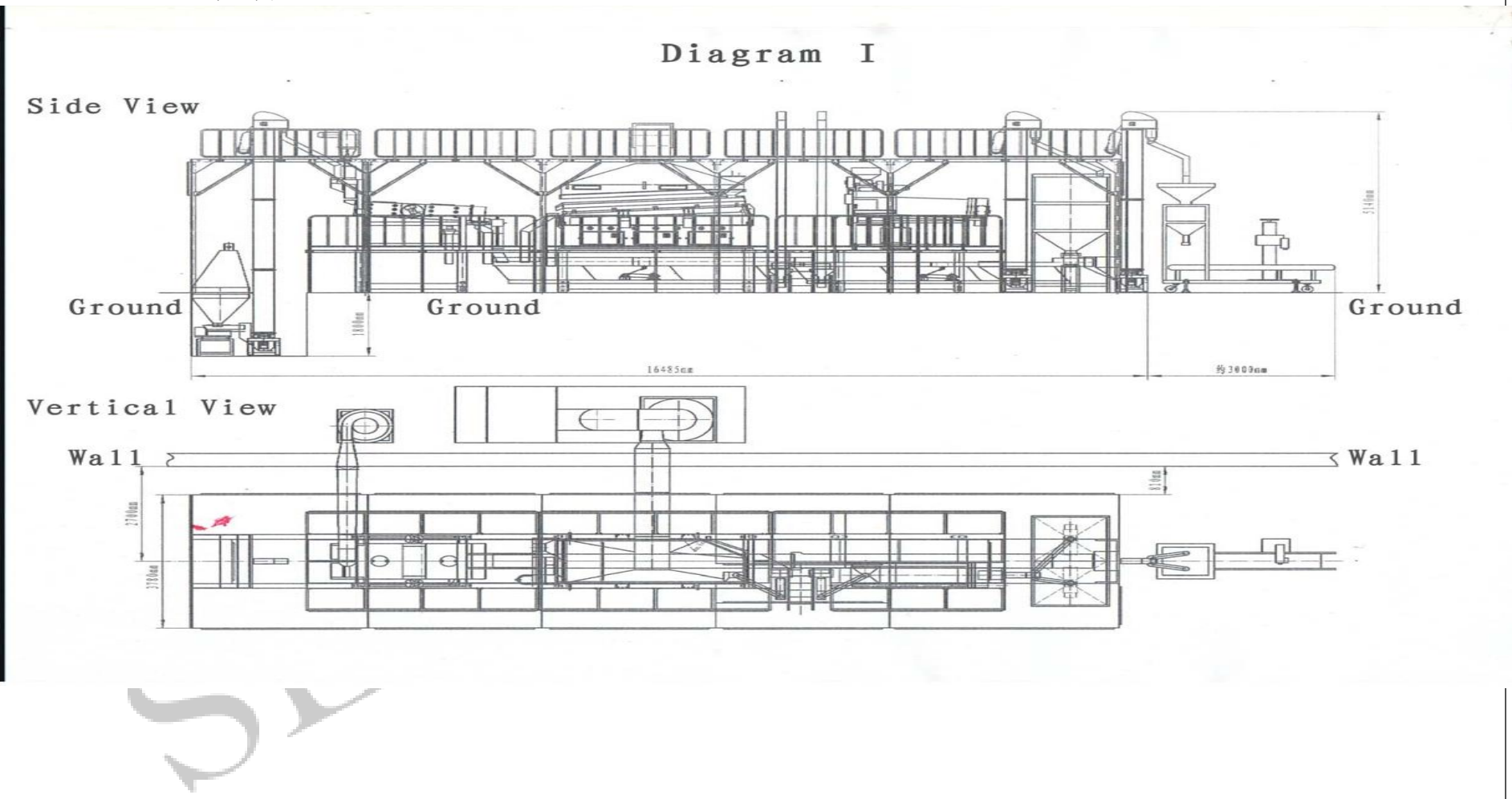
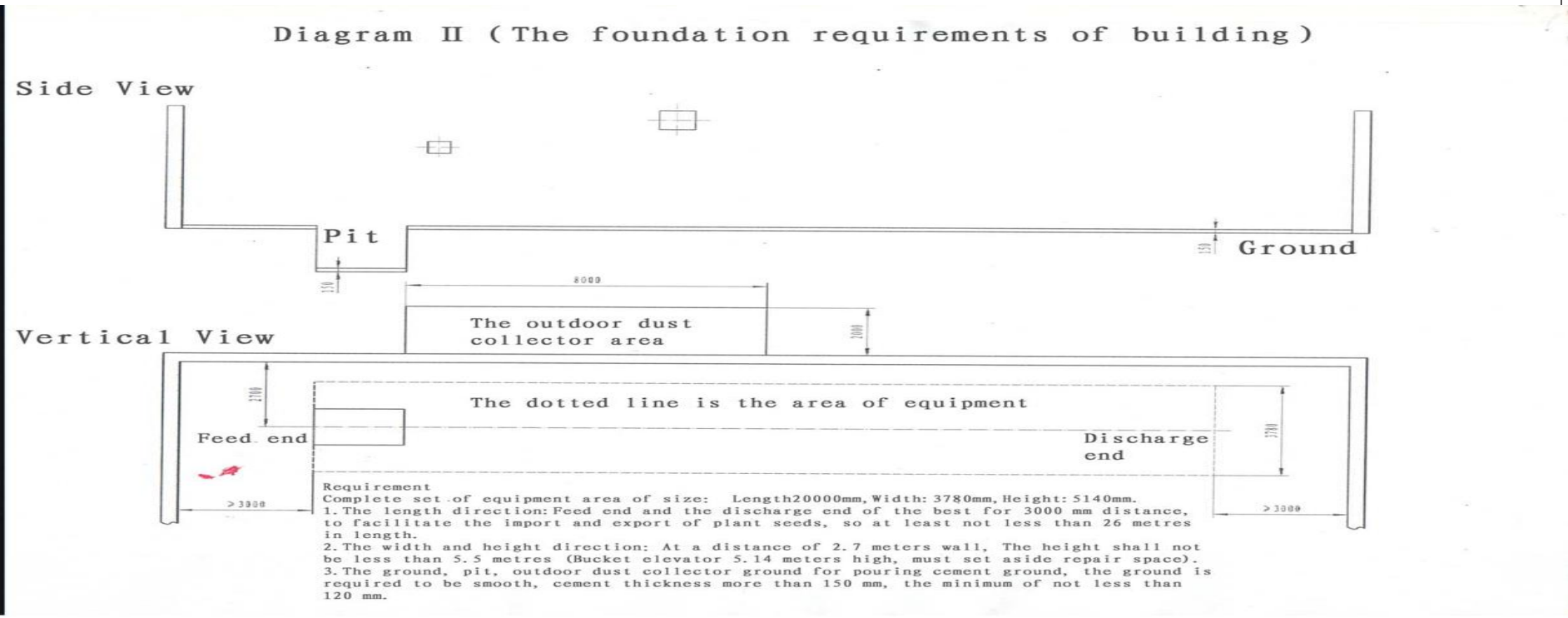


Diagram I
Side View
Ground
Ground
Ground
Vertical View
Wall
Wall

示意图二



要求：Requirement

整套设备占地尺寸为 Complete set of equipment area of size: Lenght20000mm,Width:3780mm,Height:5140mm.

1. 长度方向 The length direction

喂入端以及出料端最好预留 3000 毫米以上距离，以方便种子的运进运出，所以厂房长度最少不要小于 26 米。

Feed end and the discharge end of the best for 3000 mm distance, to facilitate the import and export of plant seeds, so at least not less than 26 metres in length.

2. 宽度方向和高度 The width and height direction

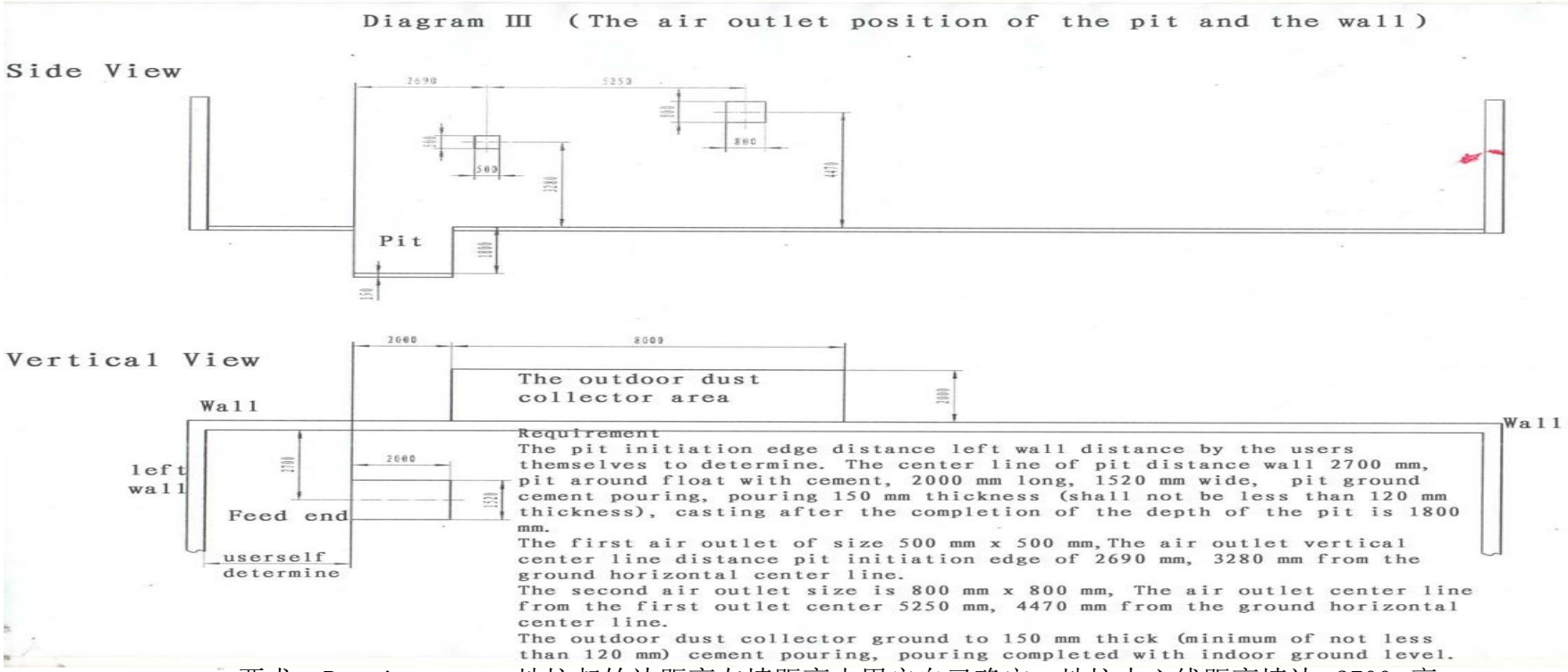
厂房宽度不得小于 6 米。Plant width shall be not less than 6 metres 在距离墙边 2.7 米处，高度不得小于 5.5 米（提升机高 5.14 米，必须要留出维 修空间）

At a distance of 2.7 meters wall, The height shall not be less than 5.5 metres (Bucket elevator 5.14 meters high, must set aside repair space)

3. 地面、地坑、室外除尘器地面要求为水泥浇筑的地面，地面要求平整，水泥厚度在 150 毫米以上，最低不得低于 120 毫米。

The ground, pit, outdoor dust collector ground for pouring cement ground, the ground is required to be smooth, cement thickness more than 150 mm, the minimum of not less than 120 mm.

示意图三



要求：Requirement 地坑起始边距离左墙距离由用户自己确定，地坑中心线距离墙边 2700 毫米，地坑四周用水泥抹平后，长 2000 毫米，宽 1520 毫米；地坑地面用水泥浇筑，浇筑厚度 150 毫米（最小不得小于 120 毫米），浇筑完成后地坑深度为 1800 毫米。 第一个出口口尺寸为 500 毫米×500 毫米，出风口垂直中心线距离地坑起始边 2690 毫米，水平中心线距离地面 3280 毫米。

The pit initiation edge distance left wall distance by the users themselves to determine. The center line of pit distance wall 2700 mm, pit around float with cement, 2000 mm long, 1520 mm wide, pit ground cement pouring, pouring 150 mm thickness (shall not be less than 120 mm thickness), casting after the completion of the depth of the pit is 1800 mm.

The first air outlet of size 500 mm x 500 mm, The air outlet vertical center line distance pit initiation edge of 2690 mm, 3280 mm from the ground horizontal center line.

第二个出风口尺寸为 800 毫米×800 毫米，出风口中心线距离第一个出风口中心 5250 毫米，水平中心线距离地面 4470 毫米。

The second air outlet size is 800 mm x 800 mm, The air outlet center line from the first outlet center 5250 mm, 4470 mm from the ground horizontal center line

室外除尘器需要 150 毫米厚（最小不得小于 120 毫米）水泥浇筑，浇筑完成后室 内地面齐平。

The outdoor dust collector ground to 150 mm thick (minimum of not less than 120 mm) cement pouring, pouring completed with indoor ground level.

Seed Treating Equipment

Dr. Yuh-Yuan Shyy

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Seed Treating Equipment

- The application of seed treatment materials is a specialized operation and is usually the last step in seed processing.
- Treatment materials are applied as dusts, slurries, or liquids.
- The equipment used to apply chemicals to seed are classed as seed treaters and the design can be divided into *Continuous Treating* and *Batch Treating*.

Seed Treating

The basis of selecting treatment materials, and characteristics of treatment materials will not discussed here, it is beyond the scope of this class.

Seed Treating Equipment - Treatment

- Common Seed Treatment Products:
  - Fungicides
  - Insecticides
  - Nematicides
  - Avicides
  - Polymers
  - Inoculants
  - Colorants
  - Others?

- Chemical Forms
  - Powder (Dust)
  - Slurry (Suspension)
  - Liquid film coating

** Treated seed MUST be colored and labeled to distinguish it from seed intended for human or animal consumption!!

Seed Treating Equipment – Safety

- Protective Gloves – Chemicals
  - Minimum 14 mil Thickness
  - DO NOT USE disposable Latex gloves
- Goggles – Splash & Dust Protection
  - Standard safety glasses are NOT adequate
- Face Shield – Eye & Face Protection
  - Typically used in addition to goggles
- Respirator
  - Must be rated for chemical type in use
  - Periodic fit test and employee physicals may be required for many applications

Seed Treating Equipment – Designs

- Continuous Flow System:
  - Apply treatment at a predefined rate to the *continuous* flow of seed.
  - High capacity.
  - Low to medium application rates.
  - Single treatment chemical layer.

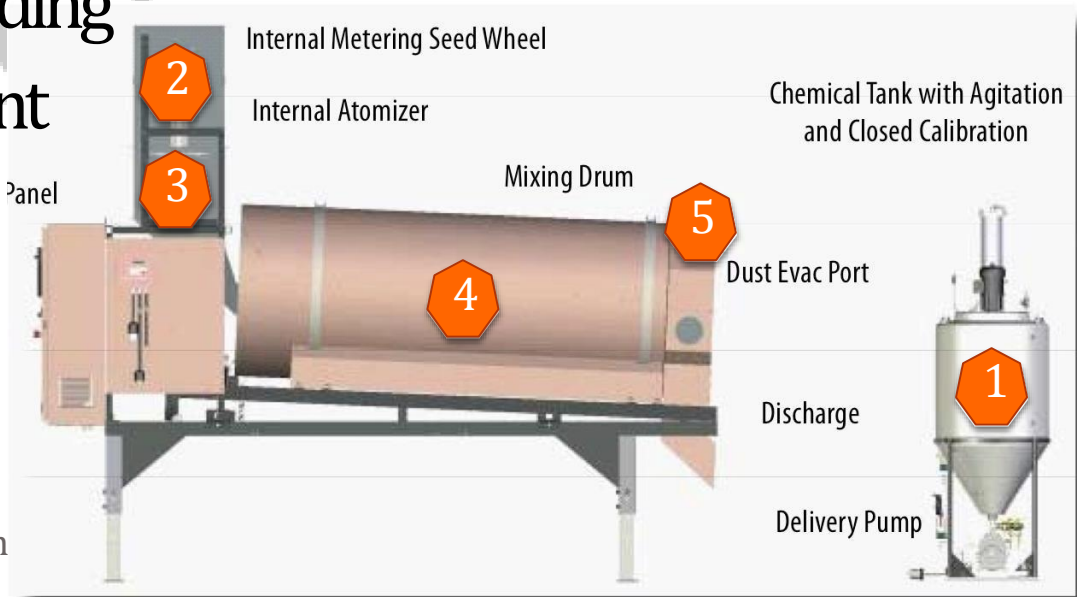
- Batch System:
  - It delivers a predetermined *batch* size into a mixing chamber.
  - Low capacity.
  - High chemical application rates.
  - Flexible – multiple chemical layers.

Open System

Closed System

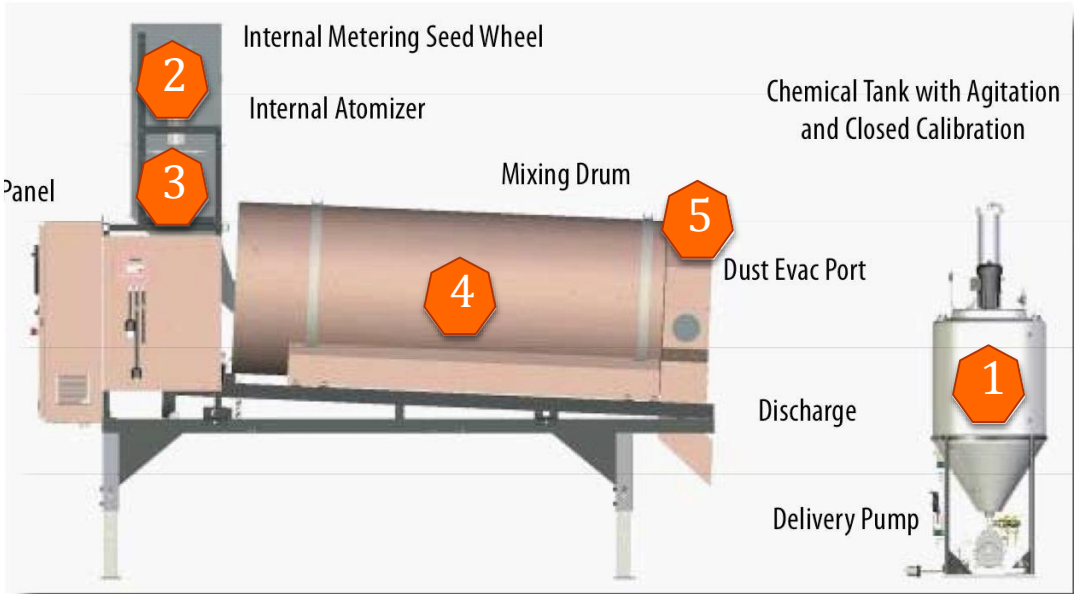
Seed Treating Equipment – Elements

- A closed treating system, batch or continuous, consist of five process elements:
  1. Storage and transfer
  2. Delivery and metering of seed
  3. Delivery and application of treatment
  4. Mixing and blending
  5. Dust containment



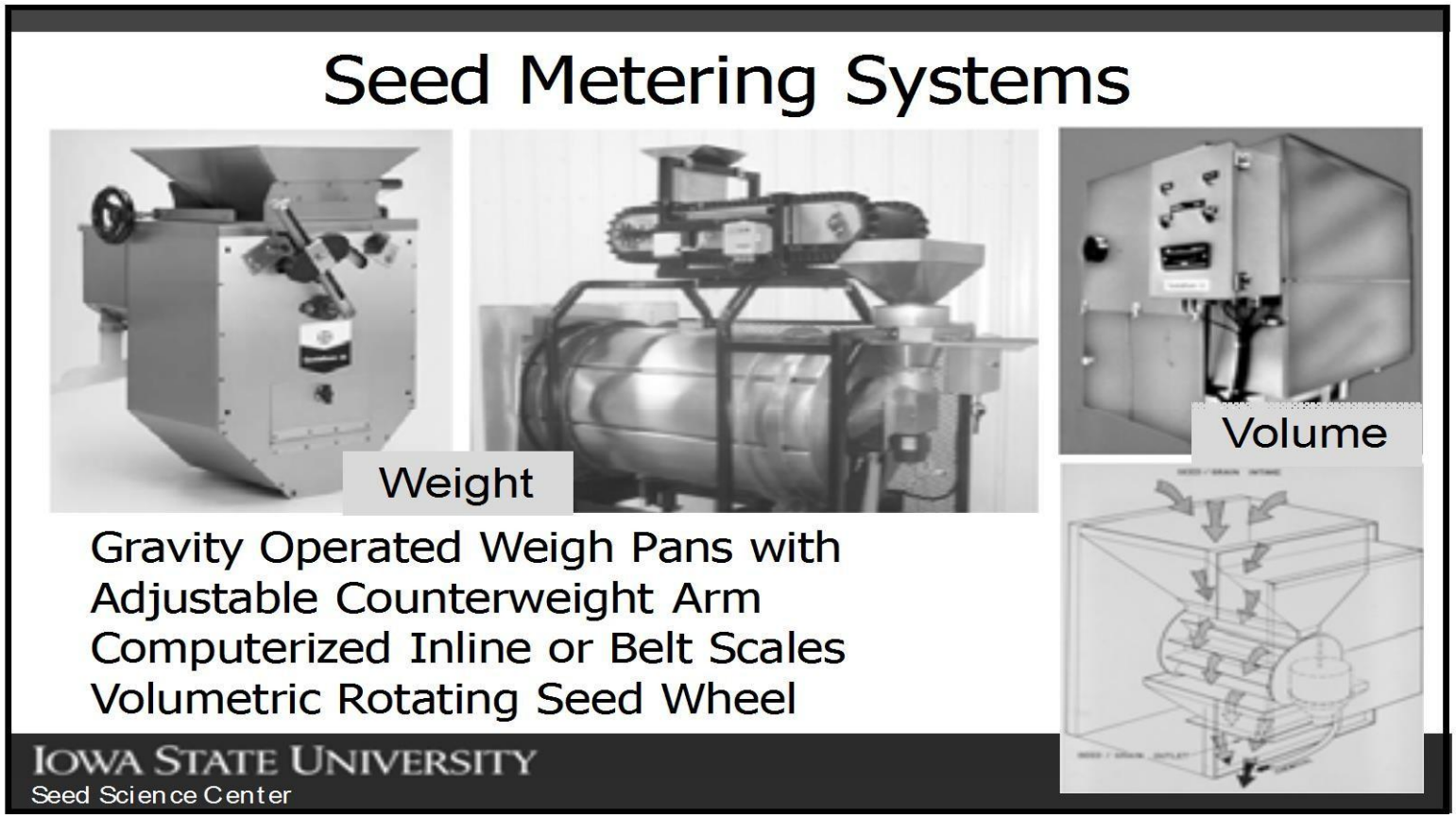
Seed Treating Equipment – Elements

- 1. Storage and transfer:
  - Seed – Holding bin
  - Chemical – Bulk container, transfer pump, and mixing tank



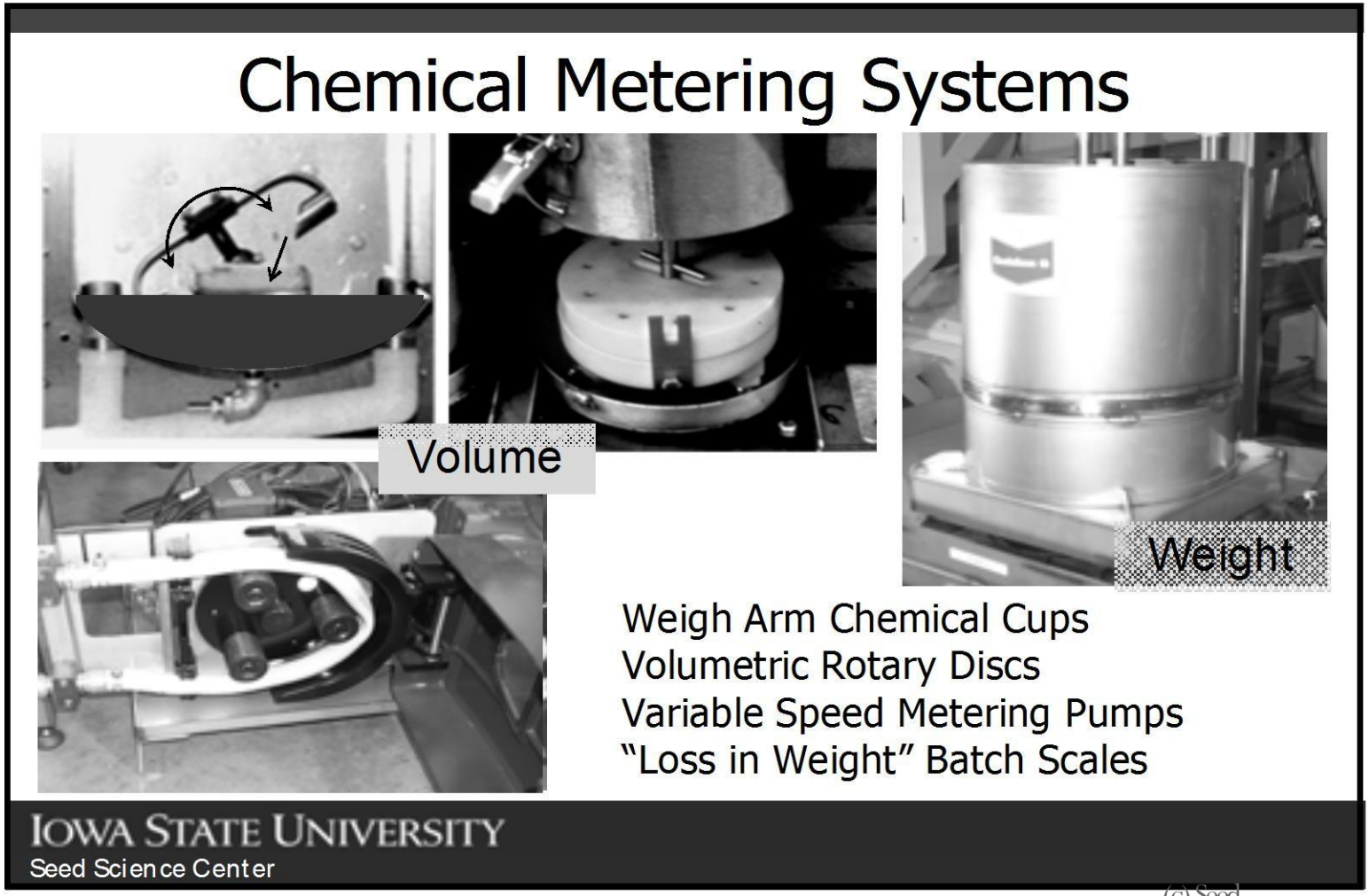
Seed Treating Equipment – Elements

- 2. Delivery and metering of seed:



Seed Treating Equipment – Element

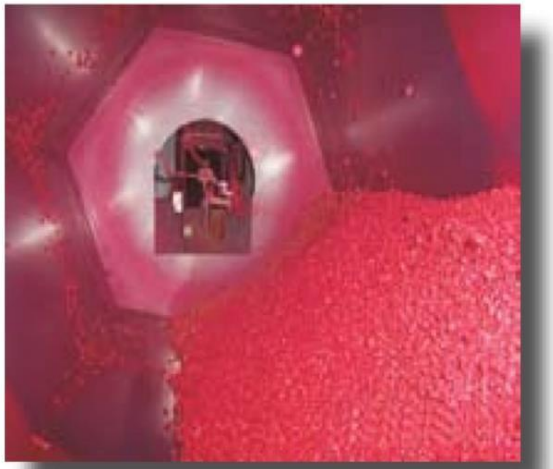
- 3. Delivery and application of treatment:



Seed Treating Equipment – Element

- 4. Mixing and blending:

Mixing Drum
(shown with treating head)



Mixing Drum
(view inside drum)

Mixing Bowl
(shown inside CBT Bowl)

- Primary Mixing: Direct application to seed
- Secondary Mixing: Seed contact transfer, blending action effects
- Drying and absorption: Ambient or artificial drying equipment

Seed Treating Equipment – Element

Dust Evacuation Port

Dust Evacuation System

Fan/Blower Motor

Seed Treating Equipment – Calibration

Weigh Arm Calibration Example

- Label Rate Range: 10-12 Fluid Oz/Cwt
- Converted Range: 296-355.2 CC/Cwt
- Trip Count for 100 lbs = 20 Trips/Cwt
- Seed/trip:

$$\frac{\mathbf{100\ Lb}}{\mathbf{1\ Cwt}} \times \frac{\mathbf{1\ Cwt}}{\mathbf{20\ Trip}} = \frac{\mathbf{5\ Lb}}{\mathbf{Trip}}$$

- Cup Size:

$$\frac{\mathbf{296\ CC}}{\mathbf{1\ Cwt}} \times \frac{\mathbf{1\ Cwt}}{\mathbf{20\ Trip}} = \frac{\mathbf{14.8\ CC}}{\mathbf{Trip}}$$

$$\frac{\mathbf{355.2\ CC}}{\mathbf{1\ Cwt}} \times \frac{\mathbf{1\ Cwt}}{\mathbf{20\ Trip}} = \frac{\mathbf{17.8\ CC}}{\mathbf{Trip}}$$

- Chemical Cup Size: 15 CC/Cup

Images courtesy of Gustafson (BCS)

Seed Treating Equipment – On Farm

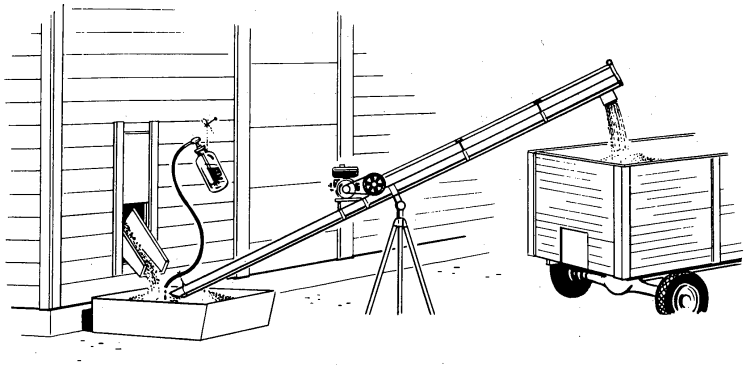


Figure J6. The application of seed treatment during conveying of seed.

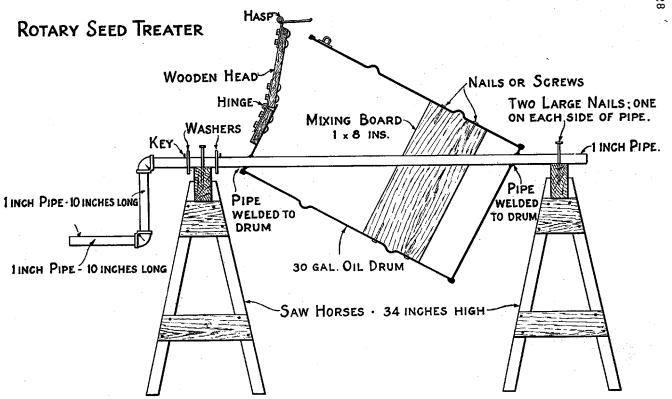


Figure J5. On-the-farm rotary seed treater used to apply seed treatment materials.

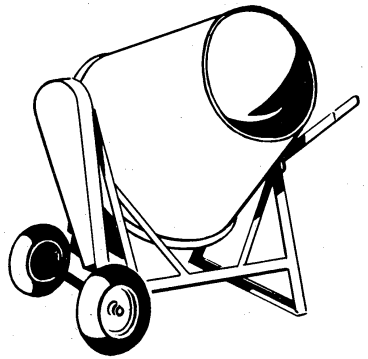
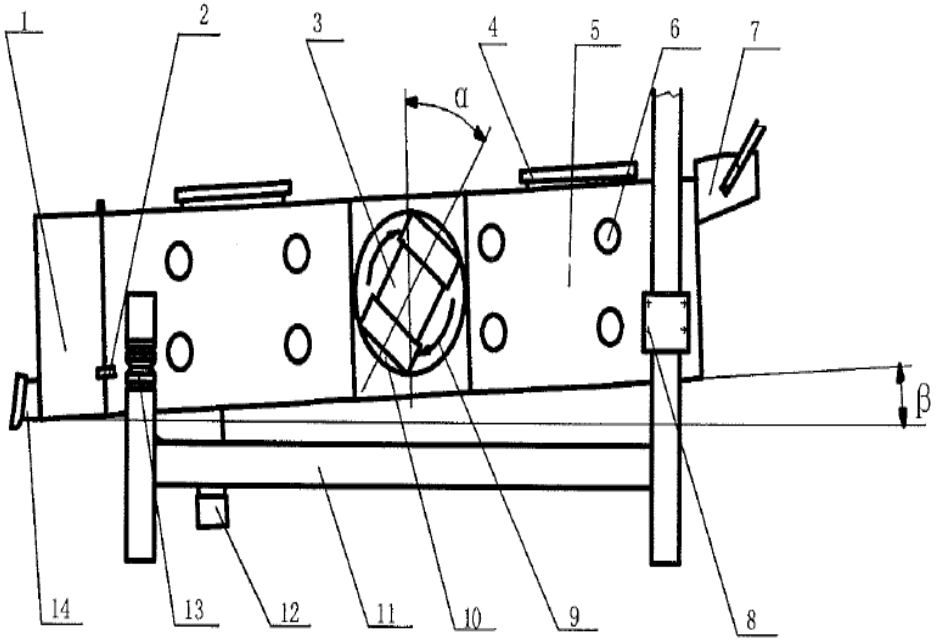


Figure J7. A small cement mixer can be used as a seed treater.

Questions?

5XZC-5BX Air-Screen Cleaner

5XZC-5BX种子加工车



1.出料箱 2.出料箱锁紧机构 3.振动电机 4.观察窗 5.振幅指示牌 6.大旋钮 7.进料箱
8.螺栓 9.螺栓 10.调向盘 11.机架 12.小杂出口 13.橡胶弹簧 14.合格种子出口

筛选机结构示意图 图三

5XZC-5BX Air-Screen Cleaner

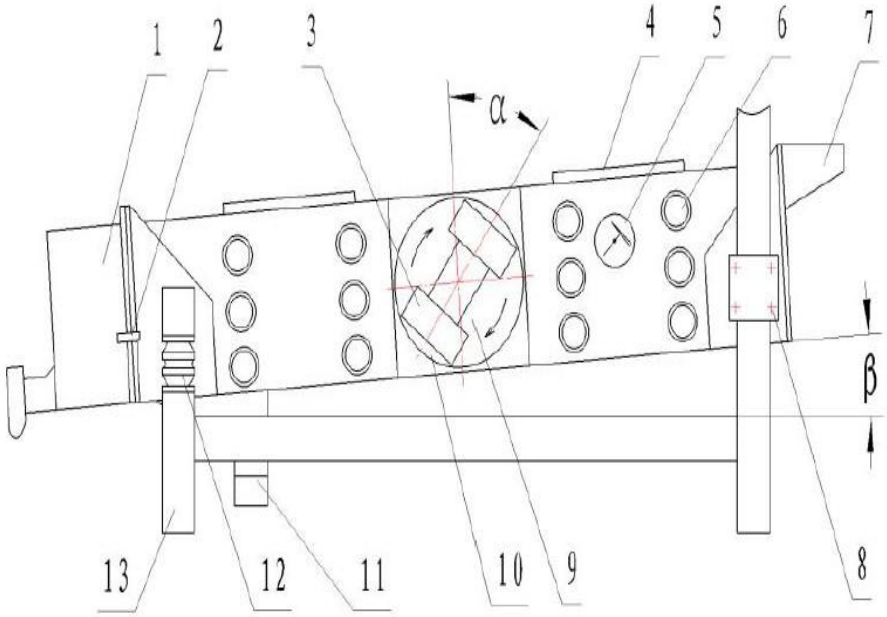


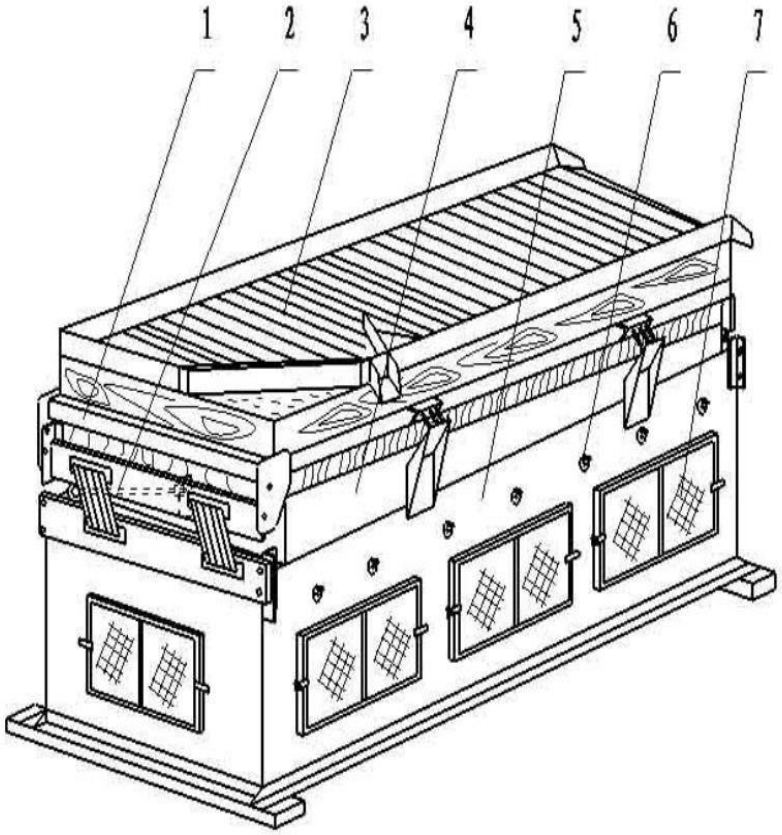
Figure 3 Screen machine instruction sketch

1.Material output-box 2.Locking device 3.Vibration motor 4.Observation window 5.Amplitude signs 6.Large knob 7.Material input box 8.Screw bolt 9.Screw bolt 10.Adjustment direction brand 11. Small impurity exit 12.Rubber spring 13. Rack

5XZ Gravity Table Separator

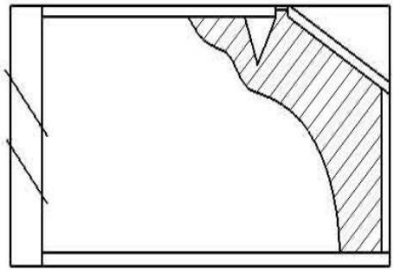
5XZ Gravity Table Separator

The structure of the total machine（Figure 1）

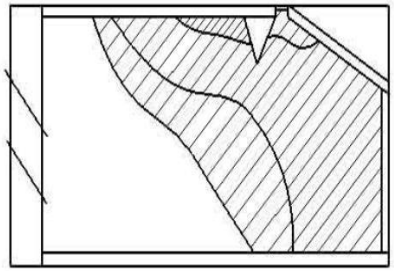


1. Brackets 2. Off center eccentricity-driven 3. Screen 4. Air chamber 5.Fan chamber
6. Air volume adjusting handle 7. Dust screen

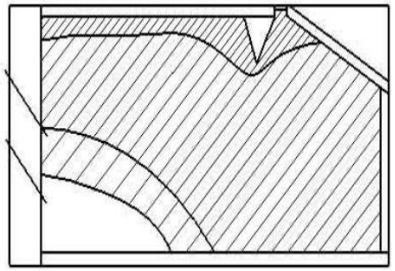
5XZ Gravity Table Separator



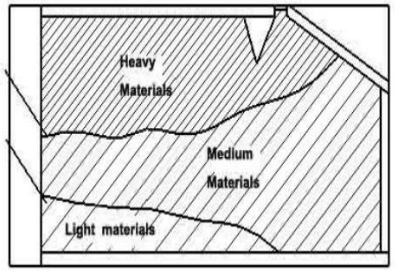
The first step



The second step



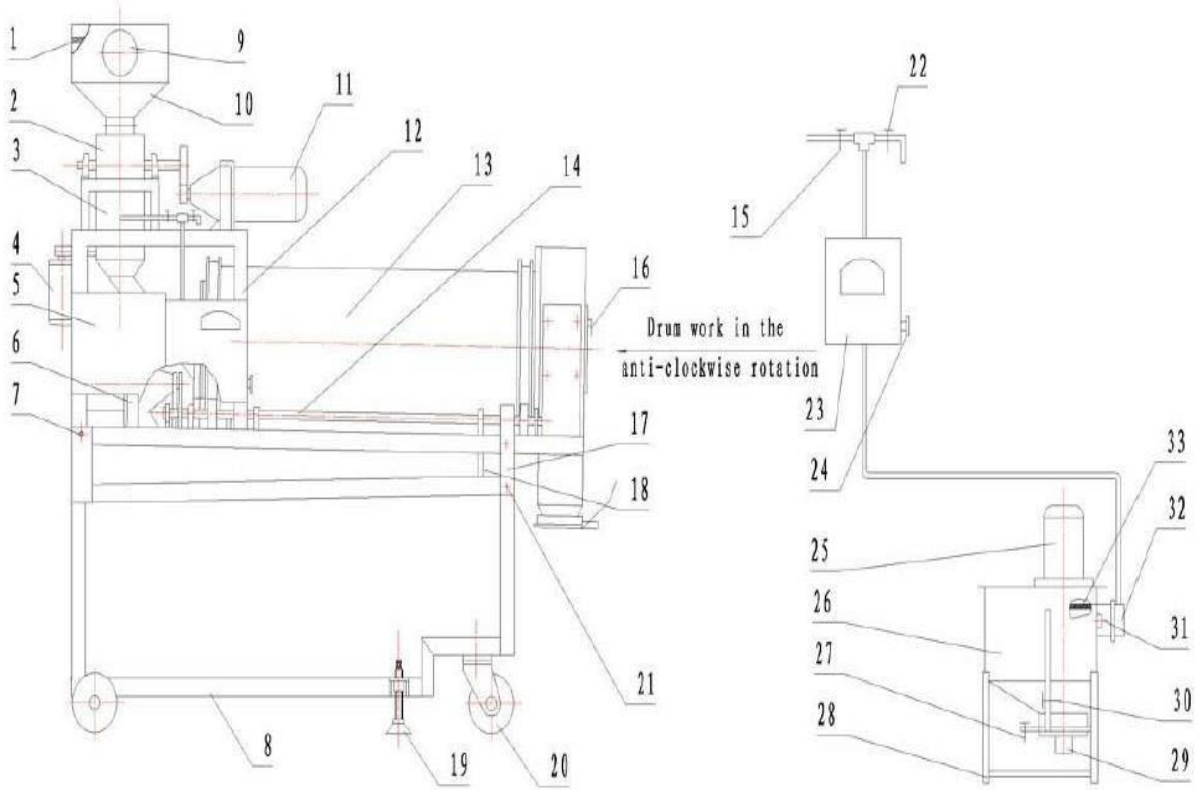
The third step



The fourth step

5BXY-5 Seed Coating Machine

5BXY-5 Seed Coating Machine



1. Baffle guard 2. Rotation input plate 3. High speed centrifugal throw disk atomizing drug material mixed device
4. Throw disk motor 5. Power distribution box 6. Drum reducer 7. Pivot pin 8. Supporting structure
9. Observation glass 10. Seeds box 11. Feeding reducer motor 12. Feeding bracket 13. Drum 14. Driven system
15. Drug maxture input ball-valve 16. Tool box 17. Securing plate 18. Adjustment-pole 19. Support post 20. Wheel
21. Securing plate bolt 22. Drug volume test ball-valve 23. Flowing control box 24. Flowing adjustment handle
25. Motor of drug liquid pump 26. Drug liquid box 27. Drug liquid ball-valve 28. Bracket 29. Drug liquid pump
30. Return liquid ball-valve 31. Fix bolt for filter box 32. Drug liquid filter box 33. Drug liquid filter screen

Structure diagram of 5BXY-5 type seed coating machine

5BXY-5 Seed Coating Machine