# *Technology of Corn Cooking and Masa Flours*

## Presented by Kirk O'Donnell at TIA Tech 2015

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**AZTECA MILLING L.P.**

**Special thanks to Dr. Sergio Serna Saldivar and Dave Waters**

# TORTILLA / SNACK PRODUCTS PROCESSING FLOW

MASA

OPTION 1 - COOKING CORN

FORMING OF PRODUCT

BAKING / TOASTING

EQUILIBRATOR OR COOLER

COUNTER/ STACKER

PACKAGING OF TORTILLAS

FRYING OF CHIPS

PRE-COOLING OF CHIPS

SEASONING

PACKAGING OF TORTILLA CHIPS

FRYING OF TACOS

COOLING OF TACOS

PACKAGING OF TACOS

FRYING OF CORN CHIPS

PRE-COOLING OF CORN CHIPS

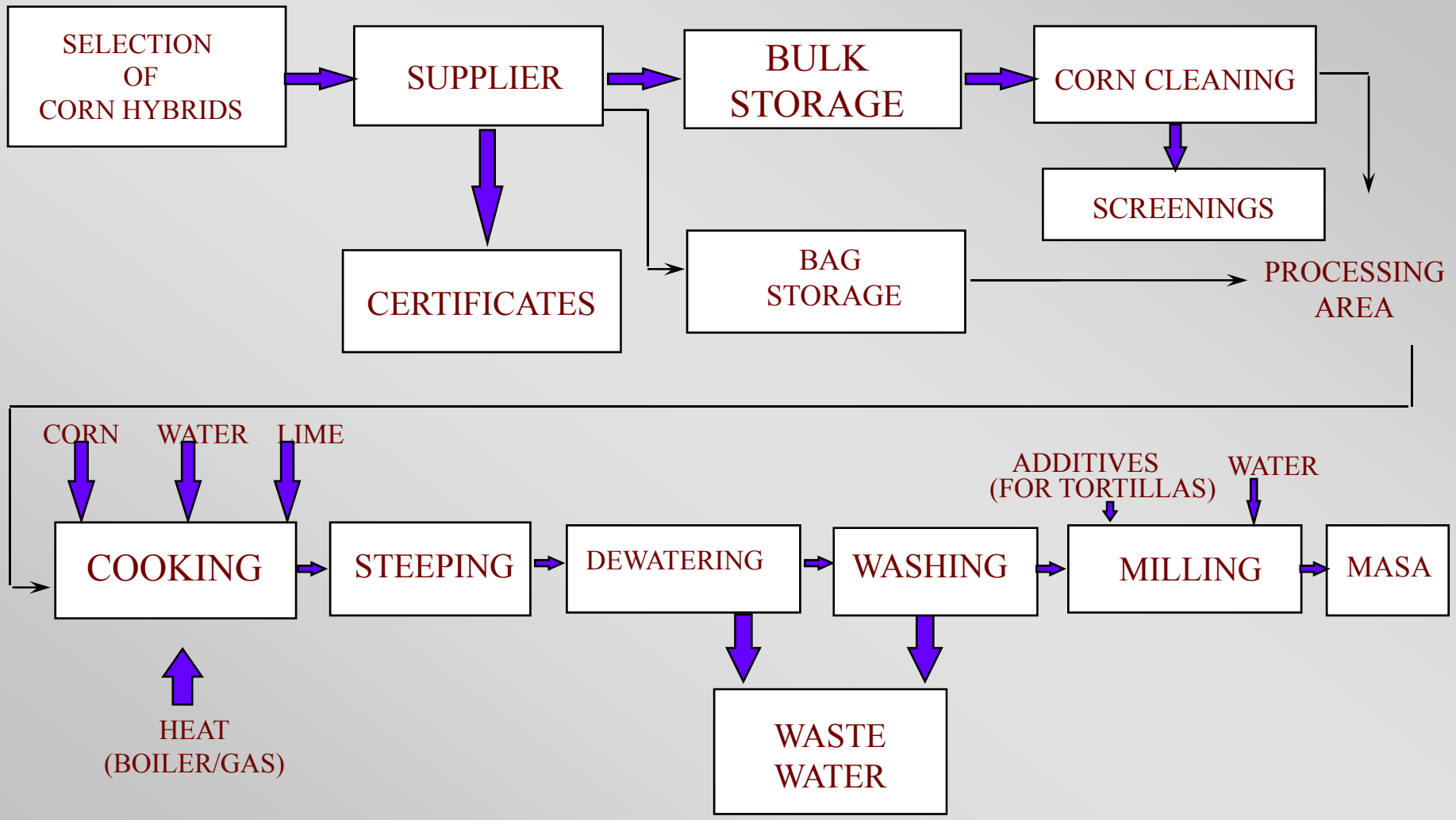
SEASONING

PACKAGING OF CORN CHIPS

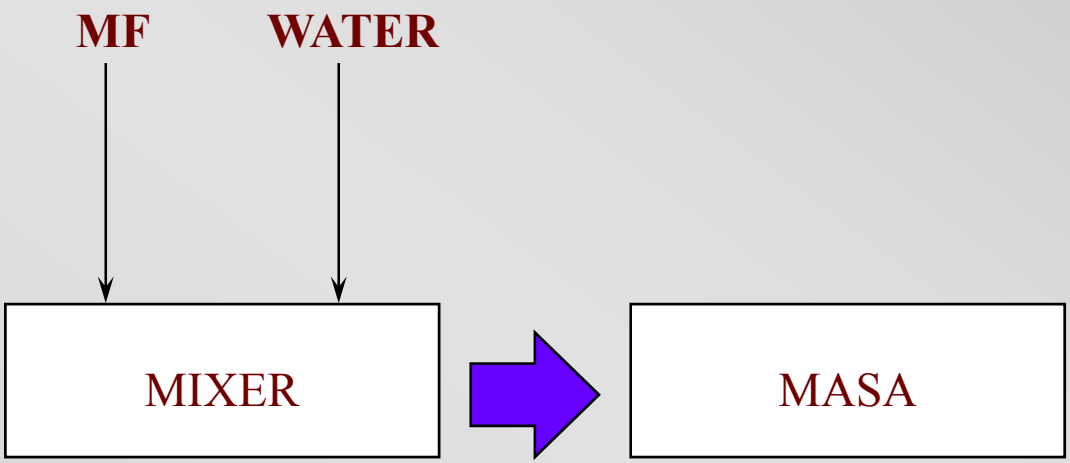
MASA

OPTION 2 - USING MF

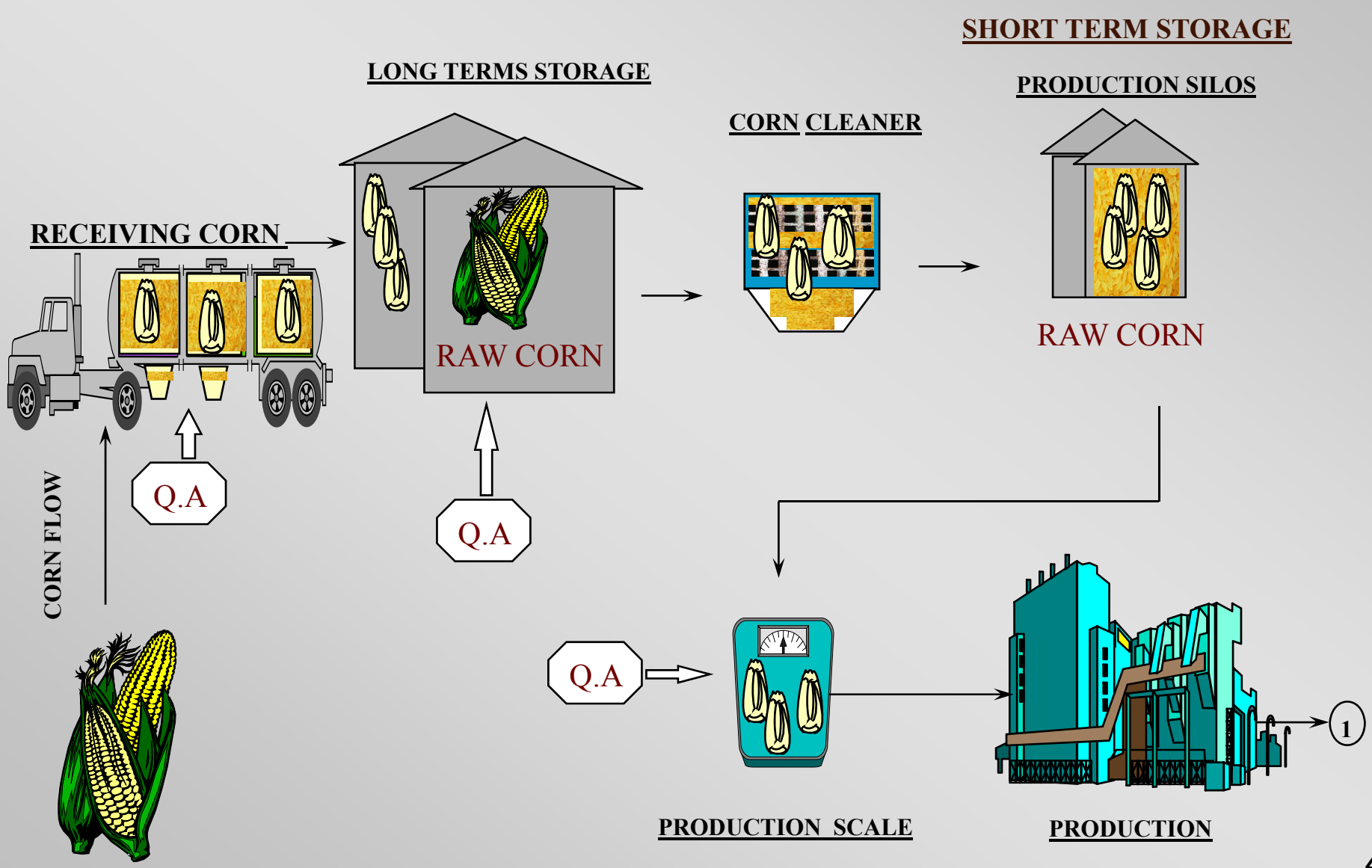
# OPTION 1: COOKING CORN



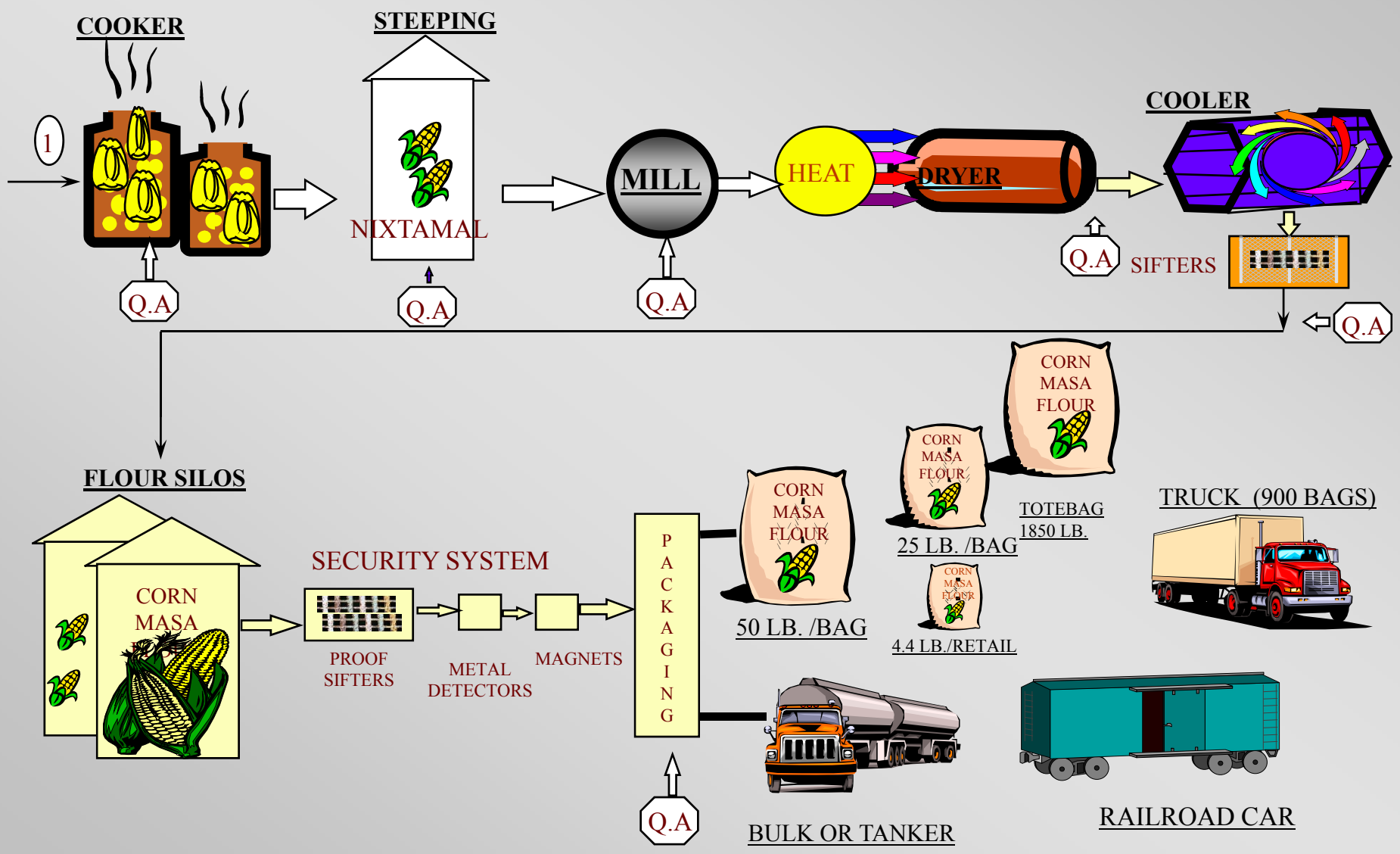
# OPTION 2 - USING INSTANT CORN MASA FLOUR (MF)



# TYPICAL PROCESS FOR PRODUCING MF



# TYPICAL PROCESS: CONT.



## SELECTING AND HANDLING THE RIGHT CORN HYBRIDS:

- **INTENSIVE PROGRAM:**

  -ACQUISITION OF QUALITY CORN FROM DIFFERENT GROWING AREAS

  -INVOLVES DIFFERENT INDIVIDUALS AND ORGANIZATIONS

  -LONG TERM

- **USE OF ONLY APPROVED HYBRIDS:**

  -TO PRODUCE THE HIGHEST QUALITY FINISH PRODUCT

  -TO OBTAIN THE PROPER MILLING CHARACTERISTIC

  -SHOULD HAVE GOOD AGRONOMIC CHARACTERISTICS

## SELECTING AND HANDLING THE RIGHT CORN HYBRIDS:

- **LONG TERM STORAGE OF CORN:**

  -PROPER MATURITY

  -SEGREGATION OF CORN BY ITS CHARACTERISTICS

  -PEST CONTROL PROGRAM

- **FIELD TEST PROGRAM:**

  -FOR NEW HYBRIDS AS WELL AS FOR APPROVED ONES

  -CONTINUOUS TESTING PROGRAM (LONG TERM)

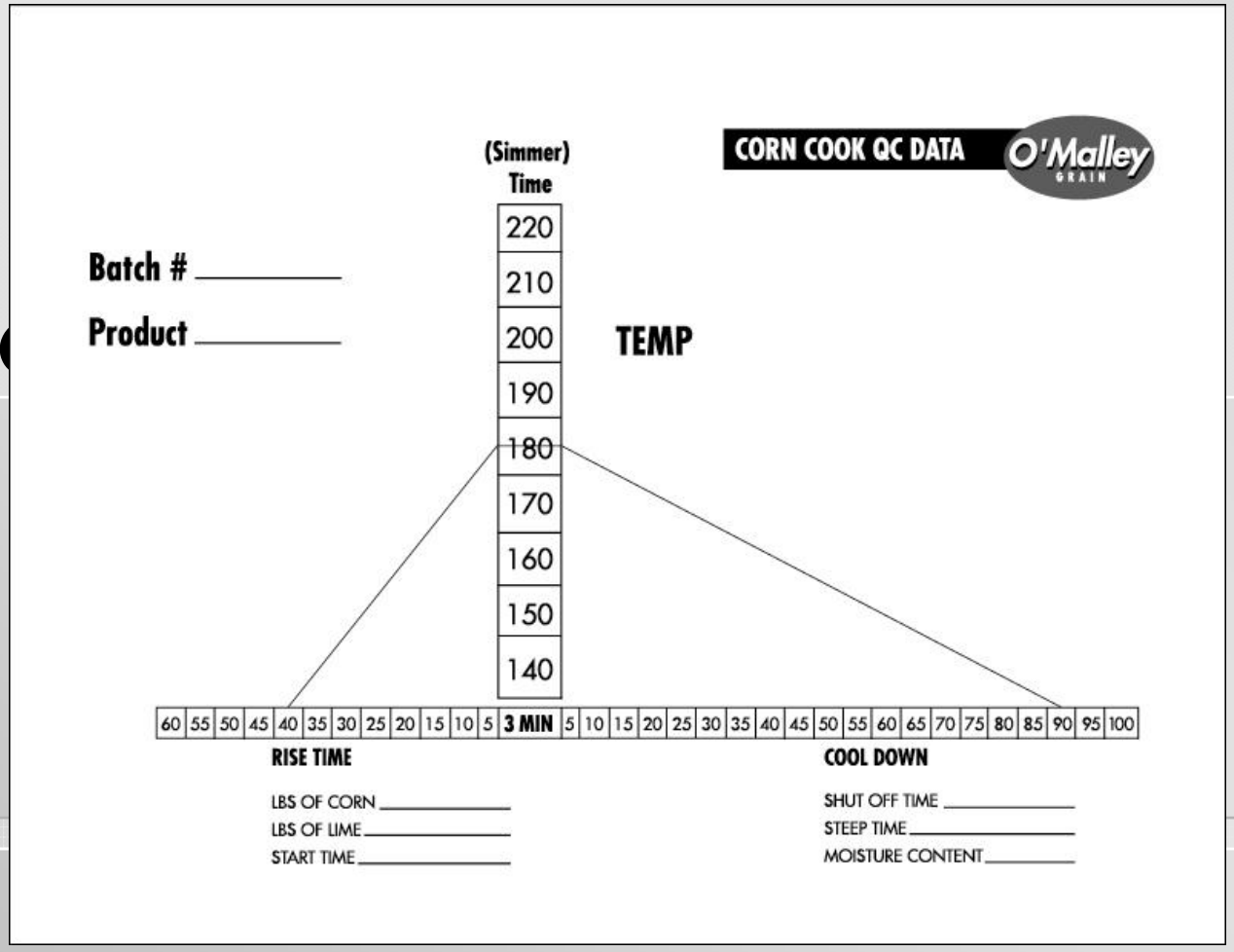
  -INVOLVES: MF MANUFACTURERS, SEED COMPANIES, UNIVERSITIES, GRAIN ELEVATORS AND FARMERS

(SLIDES)

# Cooking considerations

- In general, nixtamal should have 50% moisture- corn tortillas and 48% moisture- tortilla chips
  - Nixtamal for tortillas is cooked more thoroughly to achieve higher water absoprtion, starch gelatinization and a softer nixtamal texture.
  - Nixtamal for corn and tortilla chips is cooked less so to produce a coarser and less moist masa and less moist tortilla before frying. This is required to absorb less oil during frying.
  - Quenching or not?

# Control of Cook



# Production Issues

## Cooking for Corn Tortillas

- Relative overcook
- Relative underwash
- Quality
- Yield
- Moisture content/particle size dist.
- pH

# Production Issues

## Cooking for Chips

- Relative undercook
- Relative overwash
- Quality – oil absorption
- Oil degradation
- Moisture content/particle size dist.
- pH

# Steeping

- Step necessary to allow water and lime diffusion into the grain structure. Grain becomes softer and therefore is easier to grind it into masa.
- During steeping, the pericarp continues to degrade and detaches from the nixtamal.
- Steeping is necessary to enhance the liberation of starch granules during stone grinding.

# Nixtamal Washing

- Operation required to eliminate loose pericarp, excess lime and steep liquor or nejayote.
- The operation is usually done by nixtamal stirring or by spraying pressurized water.
- Washing affects nixtamal pH (tortilla microbial stability), tortilla flavor and color and yield.
- Nixtamal washing decreases nixtamal temperature in dry masa flour operations.

# Stone Grinding

- Objective: produce masa that meets particle size requirements, moisture and degree of starch gelatinization.
- Machinability
- Equipments: stone mills equipped with natural (volcanic) or artificial (aluminum oxide) stones.
- Control critical factors
  - Stone carving - Degree of nixamal cooking
  - Pressure between stones - Water addition

# Stone Grinding

- Quality Control: particle size distribution, masa moisture and texture (cohesiveness, stickiness etc)

# Masa Cohesiveness

- When nixtamal is ground into a masa its structure is disrupted by abrasion or friction:
  - A cohesive masa is form mainly due to the liberation of pregelatinized starch granules.
- Undercooked nixtamal yields a non-cohesive masa.
- Overcooked nixtamal yields a sticky masa

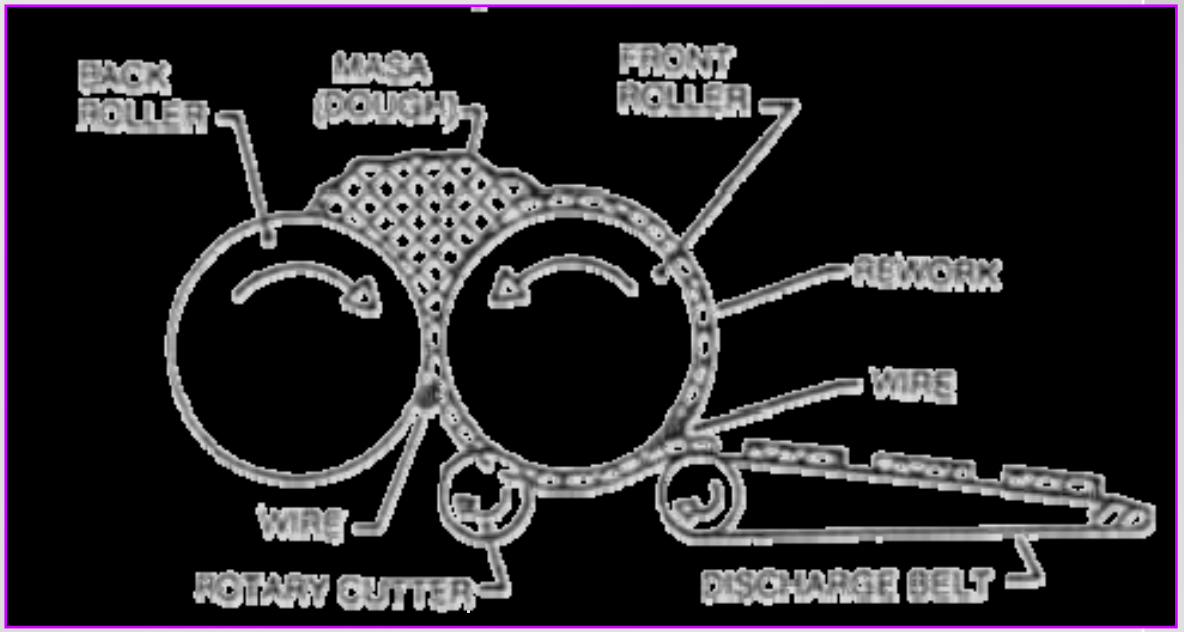
# Sheeting and Masa Forming

- Overworking masas in the hopper generally result in sticky doughs.
- Objective: necessary work required to form masa pieces with the desired size and thickness (weight) and the minimum number of defects.
- Faulty lime cooking and/or stone grinding are observed in this particular step.
- Equipment: extrusion and sheeting rolls.

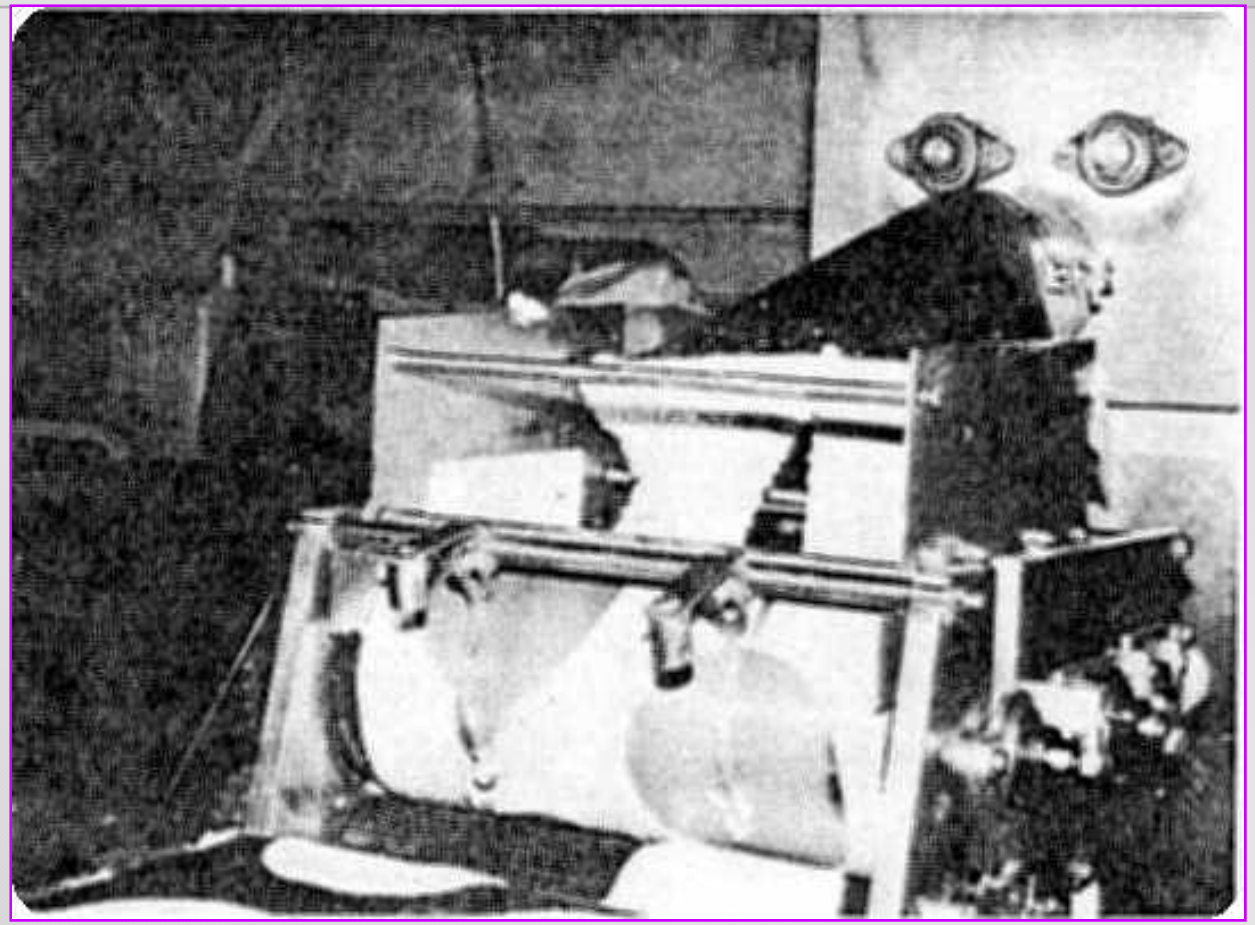
# *Masa Feeder*

# Sheeting and Tortilla Forming

- Sheeting rolls (teflon coated)
  - Different cutters
  - Thickness control



# Masa Sheeter and Tortilla Forming



# Baking

- Objective: heat treat the pre-formed masa to yield tortillas (cohesive, flavor development).
- Equipment: three-tier gas-fired oven.
- Control Factors: residence time, temperature on each tier and moisture.
- Operation is considerably different when baking table tortillas and chips.
- Chemical changes:
  - Moisture loss
  - Starch gelatinization (tortilla texture).
  - Flavor and color development (Maillard Reactions)
  - Death of all microorganisms.

# Three Tier Gas Fired Oven

# Cooling

- Objective: decrease product temperature in preparation for frying or packaging.
- Equipment: cooling racks or moving bands.
- Tortilla shelf life is greatly affected by this operation:
  - Cool down tortillas to 86$^{o}$F
  - A good equipment sanitation and personnel hygiene is required.
- Critical operation for tortilla chip production

## Quality Considerations for Using Masa Flour (MF):

**USING MF OFFERS THE FOLLOWING ADVANTAGES:**

- **PROCESS IS EASIER TO CONTROL (SIMPLER)**
- **UNIFORMITY IN FINISH PRODUCT:**

***FOR FRIED PRODUCTS:***

OIL ABSORPTION, BLISTERING, TEXTURE, pH, COLOR AND MOISTURE

***FOR TORTILLAS:***

HIGHER WATER RETENTION

BETTER RETENTION OF WATER THROUGHOUT SHELF-LIFE

SOFTER PRODUCT

## QUALITY CONSIDERATIONS:

- **QUICKER RESPONSE TO PROCESS ADJUSTMENTS**

- **NO UNCERTAINTIES**:

  DUE TO CHANGES IN RAW MATERIAL LOTS:

  FROM SEASON TO SEASON

  FROM SHIPMENT TO SHIPMENT

- **QUALITY ASSURANCE CERTIFICATES PER SHIPMENT**

- **QUALITY PROGRAM**

(SLIDES )

## DIRECT IMPACT ON OPERATIONAL COSTS:

**USING MF ALSO OFFERS THE FOLLOWING ADVANTAGES:**

- **REDUCTION IN MANPOWER REQUIREMENTS:**

  -LESS LABOR MANUFACTURING

  -LESS LABOR IN SUPPORT (MAINT., SANITATION, CORN CONSERVATION, ETC.)

  -LESS SKILLED LABOR

- **REDUCTION IN UTILITIES COSTS:**

  -LESS CONSUMPTION OF WATER

  -LESS CONSUMPTION OF GAS

  -LESS USAGE OF ELECTRICITY

## DIRECT IMPACT ON OPERATIONAL COSTS:

- **REDUCTION IN EQUIPMENT INVESTMENT COST**

  -REDUCTION ON SPARE PARTS

  -REDUCTION IN PROCESSING SPACE

  -ELIMINATION OF WASTE TREATMENT COSTS

- **IMPACT ON CASH FLOW** (FINANCIAL BURDEN DUE TO CORN, EQUIPMENT, INSTALLATIONS, PAYROLL)

- **BETTER YIELD** (RAW MATERIAL TO FINISH PRODUCT)

## DIFFERENCE IN YIELDS:

**TYPICAL YIELD FOR TORTILLA CHIP PRODUCTION:**

COOKING CORN: 1 TO 1.06 -1.11

USING ICMF: 1 TO 1.18 - 1.23

**TYPICAL YIELD FOR TABLE TORTILLAS:**

COOKING CORN: 1 TO 1.45 - 1.50

USING ICMF: 1 TO 1.70 - 1.80

**+ MOISTURE CONTENT IN RAW MATERIAL**

CORN : 14 - 15 %

MF: 10 - 11 %

**+ LOSS OF CORN SOLIDS IN WASTE WATER: UP TO 5 -10 %**

**+ FOR TORTILLAS: HIGHER WATER CONTENT IN FINISH . PRODUCT: 48 % VS. 44 %.**

## OTHER IMPORTANT CONSIDERATIONS:

- SIMPLER PROCESS
- BETTER SANITATION ENVIRONMENT
- REDUCTION IN DAILY START-UP TIME
- FLEXIBILITY OF PRODUCTION PLANNING:
  - -SHORT LEAD TIMES
  - -SHORT RUNS
- FLEXIBILITY TO PRODUCE SPECIALTY PRODUCTS:
  - -VITAMINS
  - -OTHER INGREDIENTS
- TECHNICAL SUPPORT:
  - -DEVELOPMENT OF MF TO SUIT CUSTOMER NEEDS
  - -TROUBLESHOOTING