

# Handbook on Drying, Milling and Production of Cereal Foods (Wheat, Rice, Corn, Oat, Barley and Sorghum Processing Technology) 2nd Revised Edition

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Cereals, or grains, are members of the grass family cultivated primarily for their starchy seeds (technically, dry fruits). Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop; they are therefore staple crops. Oats, barley, and some food products made from cereal grains. They are used for both human and animal food and as an industrial raw material. India produces cereals like wheat, rice, barley (jau), buckwheat, oats, corn (maize), rye, jowar (sorghum), pearl millet (bajra), millet (ragi), Sorghum, Triticale, etc.

India is the world's second largest producer of Rice, Wheat and other cereals. The huge demand for cereals in the global market is creating an excellent environment for the export of Indian cereal products. India is not only the largest producer of cereal as well as largest exporter of cereal products in the world. India have been offering incredible opportunities as they have an abundant amount of raw materials and a wide availability of cheap labor.

The book provides comprehensive coverage of the Drying, Milling and information regarding production method of Cereal Foods .It also covers Plant Layout, Process Flow Sheets and photographs of plant & Machinery with supplier's contact details.

Some of the fundamentals of the book are origin of wheat classification of wheat, endeavors to find industrial uses for wheat, criteria of wheat quality, botanical criteria of quality, milling principles, extraction rate and its effect on flour composition, grain structure as affecting grinding, definition of flour extraction stone milling: yields of products, roller milling: flour extraction rates, rice production and utilization, origin of rice, comparison of rice with other cereal grains, composition of rice and cereal, breeding rice varieties with specific, industrial uses for rice and rice by products, caryopsis and composition of rice, gross structure of the rice caryopsis and its milling fractions etc.

This book is essential for those who are interested in cereal areas can find the complete information from manufacture to final uses of Cereal Foods. The present time is an era of information, one should know about what is happening in the world to be able to compete effectively. It will be very informative and useful to consultants, new entrepreneurs, startups, technocrats, research scholars, libraries and existing units.

## 1. Wheat

### Origin of Wheat

Classification of Wheat  
Moisture Consideration  
Comparison of Nutrient Values  
The Concept of Wheat Quality  
Feed Uses For Wheat  
Endeavors to Find Industrial Uses for Wheat  
Criteria of Wheat Quality  
Botanical Criteria of Quality  
Species  
Varieties  
Physical Criteria of Quality  
Weight Per Unit Volume  
Kernel Weight  
Kernel Size and Shape  
Kernel Hardness  
Vitreousness  
Color  
Damaged Kernels  
Impurities  
Milling Quality  
Chemical Criteria Of Quality  
Moisture Content  
Alpha-amylase Activity  
Fat Acidity  
Crude Fiber and Ash  
Wheat-Grading Systems  
Composition of Wheat  
Proteins  
Carbohydrates  
Lipids  
Minerals  
Vitamins  
Fiber  
Pigments  
Enzymes  
Milling Principles  
Extraction Rate and its Effect on Flour Composition  
Grain Structure as Affecting Grinding  
Definition of Flour Extraction  
Stone-milling: Yields of Products  
Roller-milling: Flour Extraction Rates  
Extraction Rate and Flour Color  
Some Factors Determining Commercial Extraction Rates  
Changes in Ash, Thiamine, and Color with Increasing Extraction Rate  
General Composition of Flours of different Extraction Rates  
Effect of Increasing Extraction on Baking Quality  
Roller-Milling Process  
Breaking Process  
Reduction Process  
Grouping of Flour Streams According to  
Composition: Effect of Change in Extraction Rate  
Some Recent Developments  
Characteristics of Individual Flour Streams in Milling of White Flour

Proportions and Ash Contents.  
Reduction Flours  
Minerals  
Phosphorus  
Other Minerals  
Flour Streams  
Gluten  
Protein Peptization, Proteolysis, Viscosity  
Fat  
Sugars and Maltose Figure  
Sugars  
Maltose Figure  
B-Vitamins  
Thiamine  
Riboflavin  
Niacin  
Pentosans  
Loaf Crumb Color  
Baking Quality  
Water-Absorption  
Bread  
Cookies (Biscuits)  
Dry-cleaning of Wheat  
Wheat Conditioning, Moisture Movement,  
    Temperature Effects  
Washing  
Pick-up of Water by Wheat in Washing  
Penetration Into Endosperm  
Conditioning In Practice  
Cold-Conditioning  
Warm-Conditioning  
Hot Conditioning  
Steam-Treatment  
Rolling Temperatures  
Protein Displacement  
Air Classification  
Special Grinding of Flour  
Usefulness of Products  
Damage to Starch Granules in Milling  
Factors In Individual Reductions  
Coarse Particle (A) Reduction  
Fine Particle Reduction  
Effects With Successive Reductions  
Effect of Wheat Type  
The Breaking System  
Quantitative Assessments  
Germ in Milling  
Path of the Germ in Milling  
Contribution to Oil of Flour  
Endosperm Structure as Affected by Milling  
Endosperm Cells  
Cell Walls  
Experimental Milling

Criteria of Flour Quality  
Definition of Flour Quality  
Flour Quality and Strength  
Components of Quality  
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Flour Viscosity  
Enzyme Content  
Amylase  
Protease  
Lipase  
Absorption  
Ash and Flour Color  
Granulation Or Particle Size  
Response to Additives  
Color-Removing Agents  
Maturing Agents  
Enzyme Supplementation  
Starch Damage  
Methodology  
Microbiology  
Summary  
Wheat Pigments and Flour Colour  
Chemical Nature of Wheat Pigments  
Xanthophyll  
Carotene  
Flavones  
Pigments in Wheat and Flour  
Pigments in the Developing Grain  
Determination of the Total of Yellow Pigments  
    In Flour Expressed as Carotenoids  
Flour Color  
Sources of Flour Colour  
Methods of Measuring Flour Color  
Technology of Flour Color  
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Comparison of Rice with Other Cereal Grains  
Composition of Rice and Cereals  
Breeding Rice Varieties With Specific  
    Industrial Uses for Rice and Rice by-Products  
Caryopsis and Composition of Rice  
Gross Structure of the Rice Caryopsis and its Milling Fractions  
Gross Structure  
Pericarp and Tegmen  
Aleurone Layer  
Embryo  
Starchy Endosperm  
Milling Fractions  
Changes In Structure During Grain Development  
Structure and Composition  
Structure of the Rice Kernel  
Important Components

Proteins  
Starch  
Lipids  
    Vitamins  
Minerals  
Other Constituents  
Criteria of Rice Quality  
Objective Versus Subjective Measurements of Criteria  
Varieties  
Grain Size, Shape, Weight, and Uniformity  
Color and Translucence  
Test Weight  
Moisture Content  
Impurities and Damaged Rice  
Dockage  
Damaged Kernels  
Chalky Grains  
Red Rice  
Seeds or Kernels  
Odours  
Milling Quality  
Milling Yield  
Degree of Milling  
Physicochemical Tests  
Rice Drying  
Harvesting Methods  
Optimum Harvest Time  
Preharvest Chemical Drying  
Rice-Drying Terminology and Fundamentals  
Kinds of Rice  
Milling Yields  
Weights  
Moisture Content  
Equilibrium Moisture Content  
Drying-Rate Computation  
Drying Methods  
Forced-Air Drying  
Deep-bed Driers  
Supplemental Heat  
Materials-Handling for Bin Driers  
Continuous-flow, Heated-Air Driers  
Tempering  
Combination System of Drying  
Batch Driers  
Other Drying Methods  
Commercial Rice Drying  
Types of Enterprise  
Receiving and Storing Undried Rice  
Method for Increasing Drier-Facility Capacity  
Sun and Shade Drying  
Threshing and Winnowing  
Mechanical Drying  
Seed Rice

Rice Milling Technology  
Removal of Foreign Matter from Rough Rice  
Removal of Hulls  
Removal of Bran  
Sizing of Milled Rice  
Solvent Extractive Rice Milling  
The X-m Concept  
The Development of X-M  
Process Description  
X-M Products  
X-M Milled Rice  
X-M Bran  
X-M Rice Oil  
Rice Milling Yields  
Technology Expansion Prospects  
Rice Storage  
Deterioration of Stored Rice by Fungi  
Fungi Associated with Rice Deterioration  
Effect on Economic Value  
Effect on Nutritive Value  
Mycotoxins  
Factors Influencing Deterioration  
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Rice Storage Structures  
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Aeration  
Aeration-System Design  
Measuring Airflow  
Operation for Dry Rice  
Operation for Undried Rice  
Pest Control  
Stored-grain Insects  
Other Pests  
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Genetics and Breeding  
Inheritance and Heritability  
Biotechnology  
Breeding  
Population Breeding Methods  
Hybrid Barley  
Plant  
Spike  
Kernel  
Soil and Climatic Requirements  
Rotations  
Planting  
Fertilizing and Water Use  
Harvesting  
Pest Control  
Diseases  
Weeds  
Insects  
Chemical Composition

Carbohydrates  
Starch  
Soluble Sugars  
Nonstarch Polysaccharides  
Protein  
Fats  
Minerals  
Vitamins  
Phenolic Compounds  
Processing and Utilization  
Feed and Food Barley  
Animal  
Human  
Malting Barley  
Uses  
Marketing  
Classification and Prices Received  
Storage

#### 4. Corn

Anatomical Structure, Composition, and Properties  
Corn Types and Their Compositions  
Corn Quality and Grading Standards  
Corn Utilization  
Corn as Livestock Feed  
Direct Utilization of Corn as Food  
Alkali-Cooked Corn-based Foods  
Sweet Corn  
Popcorn, the Original Snack Food  
Separation of Corn Into its Component Fractions  
Dry Corn Milling  
The Tempering-Degerming Milling Process  
Products from the Tempering-Degerming Process  
Wet Corn Milling  
The Wet-Milling Process  
Wet Corn Mill Products  
Conversion of Raw Fractions into Value-Added Ingredients and Chemicals  
Modified Starches  
Corn Sweeteners  
Furfural Production from Corncobs

#### 5. The Millets

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Structure and Physical Properties  
Composition  
Polyphenols and Antinutritional Factors  
Postharvest Technology  
Milling  
Wet Milling  
Food Uses  
Nutritional Value  
Feed Use  
Nutritional Value  
Human Studies  
Effect of Decortication on Nutritional Value

## 6. Oats

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Origin of Cultivated Oats

Genetics and Breeding

Cytogenetic Relationship of Species within Avena

Genetic Markers

Utilization of Germplasm Resources

Breeding

Breeding Objectives

Breeding Procedures

The Oat Plant

The Mature Grain

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Solubility Classification

Amino Acid Composition and Distribution

Lipids

Lipid Content and Distribution

Lipid Composition

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Starch

B-glucan

Minerals

Vitamins

Processing and Utilization

Utilization

Processing

Cleaning

Drying and Cooling

Hulling

Cutting and Flaking

Oat Flour

## 7. Rye

Rye Breeding

Morphology and Kernel Characteristics

Growing Conditions

Rye Storage and Rye Grain Reserves and Disappearance

Rye Milling

Rye Flours

Nutrient Composition of Rye

Antinutritional Factors in Rye

Food Uses of Ryes

Industrial Uses of Rye

Rye As Animal Feed

## 8. Sorghum

Introduction

Origin

Structure and Physical Properties

Appearance of Sorghum Grain and its Genetics

Composition

Tannins and Polyphenols: Effects on Sorghum

Quality and Nutritional Value



- Industrial Utilization
- Wet Milling
- Sorghum Starches
- Dry Milling
- Alcohol Production
- Use of Sorghum for Beer and Malt
- Lager Beer
- Sorghum Malt
- Clear Sorghum Beer
  - Sour, Opaque Beer
  - Processing For use in Feeds
  - Processing for Food
  - Traditional Food Systems
  - Sorghum in Baked and Pasta Products
  - Sorghum Syrup, Molasses, and Sugar
  - Nutritional Value
  - Nutritional Value of Sorghum as Livestock Feed
  - Human Digestibility Studies
  - Effect of Processing

## 9. Triticale

- History
- General Characteristics
- Grain Development and Structure
- Genetics and Breeding
- Production
- Quality Factors
- Damaged Kernels
- Defects
- Dockage
- Foreign Material
- Heat-Damaged Kernels
- Other
- Shrunken and Broken Kernels
- Basis of Determination
- Ergoty Triticale
- Garlicky Triticale
- Light Garlicky Triticale
- Light Smutty Triticale
- Smutty Triticale
- Composition and Nutritional Factors
- Utilization
- Future

10. Photographs of Plant & Machinery with Supplier's Contact Details

11. Sample Plant Layout and Process Flow Sheets

## About NIIR

**NIIR PROJECT CONSULTANCY SERVICES (NPCS)** is a reliable name in the industrial world for offering integrated technical consultancy services. NPCS is manned by engineers, planners, specialists, financial experts, economic analysts and design specialists with extensive experience in the related industries.

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