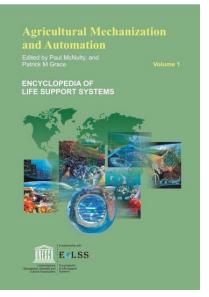
CONTENTS

AGRICULTURAL MECHANIZATION AND AUTOMATION



Agricultural Mechanization and Automation -Volume 1 No. of Pages: 524 ISBN: 978-1-84826-096-2 (eBook) ISBN: 978-1-84826-546-2 (Print Volume)

Agricultural Mechanization and Automation -Volume 2 No. of Pages: 524 ISBN: 978-1-84826-097-9 (eBook) ISBN: 978-1-84826-547-9 (Print Volume)

For more information of e-book and Print Volume(s) order, please **click here**

Or contact : eolssunesco@gmail.com

CONTENTS

VOLUME I

Agricultural Mechanization and Automation

Paul B. McNulty, Agricultural and Food Engineering Department, National University of Ireland, Dublin, Ireland

Patrick M. Grace, *Agricultural and Food Engineering Department, National University of Ireland, Dublin, Ireland*

- 1. Technology and Power
 - 1.1. Investment in Mechanization
 - 1.2. Selection and Operation of Equipment
 - 1.3. Performance of Agricultural Equipment
 - 1.4. Human and Animal Power
 - 1.5. Energy Sources
 - 1.6. Autonomous Power Supply
- 2. Machines and Implements
 - 2.1. Tractors
 - 2.2. Tillage and Seeding
 - 2.3. Fertilizer Application and Plant Protection
 - 2.4. Harvesting Equipment
 - 2.5. Post-harvest Technology
- 3. Mechanization and Livestock Production
 - 3.1. Design of Livestock Farms
 - 3.2. Cattle and Dairy Production
 - 3.3. Pig Production
 - 3.4. Sheep Production
 - 3.5. Poultry Production
 - 3.6. Automation and Electronics in Agriculture
- 4. Monitoring the Agricultural Environment
 - 4.1. Ecology and Technology in Agriculture
 - 4.2. Technology for Environmental Monitoring
 - 4.3. Erosion Control
 - 4.4. Health and Safety
 - 4.5. Fires and Explosions
- 5. Agricultural Wastes and By-products
 - 5.1. Animal Slurries
 - 5.2. Solid Manures
 - 5.3. Straw Assembly and Storage
 - 5.4. Straw Utilization
- 6. Livestock Slaughtering and Primary Processing
 - 6.1. Humane Slaughter and Safe Hygienic Handling of Meat
 - 6.2. Disease Control and Monitoring in the Meat Industry
 - 6.3. Non-meat Products from Livestock

Technology and Power in Agriculture

Charles L. Peterson, University of Idaho, USA

- 1. Technology
- 2. Power
 - 2.1. Transformation of Energy
 - 2.2. Efficiency of Energy Conversion
 - 2.3. Carnot Cycle
 - 2.4. Motive Force—Development of Power Source
- 3. Steam Power

- 4. Internal Combustion Engine
 - 4.1. Otto Cycle
 - 4.2. Diesel Cycle
 - 4.3. Comparison of Otto and Diesel Cycles
- 5. Fuel Sources
 - 5.1. Petroleum
 - 5.2. Alternative Fuels
 - 5.2.1. Biodiesel
 - 5.2.2. Ethanol
 - 5.2.3. Methane
 - 5.2.4. Economics of Biomass Fuels
 - 5.3. Carbon Cycle and Global Warming
- 6. Tractors
- 7. Agricultural Implements
- 8. The Moldboard Plow
- 9. Reaping, Threshing, and Combine Harvesters
- 9.1. Reaper
 - 9.2. Threshing Machines
 - 9.3. Binders
 - 9.4. Combine Harvester
 - 9.5. The Cotton Gin
- 10. Electric Power
- 11. The Computer Revolution
- 12. Precision Farming
 - 12.1. Agricultural Uses of GPS
 - 12.2. Mapping
 - 12.3. Spatially Variable Fertilizer Application
 - 12.4. Variable Variety Seeding Equipment
 - 12.5. Self-Guided Vehicles
- 13. Social Issues

Expenditures and Returns

Eric Audsley, Silsoe Research Institute, Silsoe, Beds, UK

94

- Introduction
 Direct Mach
 - Direct Machine Expenditure
 - 2.1. Capital Repayment
 - 2.2. Resale Values
 - 2.3. Replacement Interval
 - 2.4. Repairs
 - 2.5. Fuel Use
 - 2.5.1. Procedure for Estimating Fuel Use in General
- 3. The Effect of Labor and Cropping on Machinery Expenditure
 - 3.1. Number of Machines Needed
 - 3.2. Hours Needed
 - 3.2.1. Systematically Determining Work Rates
 - 3.2.2. Draft Operations
 - 3.2.3. Sowing and Chemical Applications
 - 3.2.4. Harvesting
 - 3.3. Hours Supplied
 - 3.4. Determining the Optimum Number of Machines
 - 3.4.1. Work Plan

Agricultural Equipment: Choice and Operation

John K. Schueller, Mechanical Engineering, University of Florida, USA

- 1. Importance of Agricultural Equipment Choice and Operation
- 2. Methods of Obtaining Access to Equipment
- 3. Equipment Costs
- 4. Equipment Selection
 - 4.1. Individual Equipment Selection
 - 4.2. Matching Equipment
- 5. Equipment Operation
 - 5.1. Equipment Operation Co-ordination
 - 5.2. Operation Productivity
 - 5.3. Equipment Safety
 - 5.4. Equipment Maintenance during Operation
- 6. Automation of Agricultural Equipment Operation
 - 6.1. Background and Categorization
 - 6.2. Operation Automation System Components
 - 6.3. Integrated Operation Systems
- 7. The Future of Agricultural Equipment Choice and Operation

Maintaining Working Conditions and Operation of Machinery Norén O, Swedish Institute of Agricultural Engineering, Uppsala, Sweden.

135

1. Maintaining Working Conditions

- 1.1. Periodic Service and Maintenance
- 1.2. Wrong Use
- 1.3. Incorrect Service and Repair
- 1.4. Hydraulic System
- 1.5. Lubricants
- 1.6. Bearings
- 1.7. Changing of Wearing Parts
- 2. Operation of Machinery
- 3. Tillage
 - 3.1. The Soil
 - 3.2. Soil Compaction
 - 3.3. Objective of Soil Tillage
 - 3.4. Soil Tillage
 - 3.5. Seedbed for Grain
 - 3.6. Rootbed for Potatoes
- 4. Distribution of Nutrients
 - 4.1. Nutrient Requirements
 - 4.2. Sources of Nutrients
 - 4.3. Distribution of Solid Fertilizer
 - 4.4. Distribution of Liquid Fertilizer
 - 4.5. Spreading of Solid and Semisolid Manure
 - 4.6. Spreading of Liquid Manure
- 5. Crop Protection
 - 5.1. Weed Control
 - 5.2. Control of Fungi, Diseases, and Insects
 - 5.3. Application of Chemicals
 - 5.4. Handling and Storage of Pesticides
 - 5.5. Mechanical Weed Control
- 6. Irrigation
 - 6.1. Water Requirement
 - 6.2. Irrigation Practice
- 7. Forage Harvesting and Preservation
 - 7.1. Preservation Methods
 - 7.2. Haymaking
 - 7.2.1. Field Drying
 - 7.2.2. Baling of Completely Field-Dried Hay

7.2.3. Barn Drying

- 7.3. Silage Making
- 8. Grain Harvesting and Preservation
 - 8.1. Harvesting
 - 8.1.1. Combining
 - 8.2. Preservation
 - 8.2.1. Drying
 - 8.2.2. Other Methods
- 9. Harvesting, Handling, and Storage of Potatoes
 - 9.1. Introduction
 - 9.2. Harvesting
 - 9.3. Storage
- 10. Harvest and Handling of Sugar Beet
 - 10.1. Introduction
 - 10.2. Topping
 - 10.3. Lifting and Cleaning
 - 10.4. Storage and Loading
- 11. Risks of Accidents and Health Hazards
 - 11.1. Accidents
 - 11.2. Exposure to Harmful Substances
 - 11.3. Exposure to Gases and Dust
 - 11.4. Driver's Workplace

Human and Animal Powered Machinery

P.M.O. Owende, Department of Agricultural and Food Engineering, University College Dublin, Ireland

- 1. Introduction
- 2. Human Powered Operations and Equipment
 - 2.1. Optimum Human Load Capacity and Power
 - 2.2. Ergonomics, Occupational Safety and Health
 - 2.3. Work Output Measurement Systems
- 3. Animal Powered Operations and Machinery
 - 3.1. Harnessing of Draft Animals
 - 3.2. Pull Performance and Sustainability
 - 3.3. Measurement of Performance
 - 3.3.1. Implement Performance
 - 3.3.2. Draught Animal Performance
 - 3.4. Economics of Utilization
 - 3.5. Safety and Health Aspects in Relation to the Animal Powered Machinery
- 4. Future Perspectives in the Use of Human and Animal Power in Agricultural Production
 - 4.1. Role of Appropriate Equipment Selection in Sustainable Agricultural Production
 - 4.2. Integration of State-of-the-art Technologies
 - 4.3. Role of Information Technology and Extension Services
 - 4.4. Standards and Standardization

Energy Sources: Non Renewable and Renewable

H. Irps, Federal Agricultural Research Center (FAL), Braunschweig, Germany

200

- 1. Definition of Energy
- 2. Forms of Energy and Energy Retention
- 3. Energy Transformation, Energy Definition, Energy Supplies
 - 3.1. Primary Energy
 - 3.2. Secondary Energy
 - 3.3. Useable Energy
 - 3.4. End Energy
 - 3.5. Energy Supplies

- 4. Energy Transformation of Fossil Fuels
 - 4.1. Combustible Energy
 - 4.2. Power Plants/Carnot Process
 - 4.3. Gas and Steam Plants
 - 4.4. Desulfurization of Coal
 - 4.5. Coal Refining
 - 4.6. Petrochemicals
 - 4.7. Thermal Engines
- 5. Energy Transformation from Atom Splitting and Atomic Fusion
 - 5.1. Atomic Energy
 - 5.2. Atomic Splitting/Atomic Fusion
 - 5.3. Atomic Waste Removal
 - 5.4. Atomic Fusion
- 6. Energy Transformation from Renewable Energy Sources
 - 6.1. Radiation Equalization
 - 6.2. Types of Radiation Use
 - 6.3. Photosynthesis/Renewable Natural Resources
 - 6.4. Plant Oil/Energy Plant Cropping
 - 6.5. The Gasification of Biomass
 - 6.6. Anaerobic Fermentation/Biogas
 - 6.7. Photovoltaic
 - 6.8. Solar Cells/Solar Modules
 - 6.9. Solar Collectors
 - 6.10. Global Radiation/Concentrating Conductors
 - 6.11. Upwind Power Plants
 - 6.12. Hot Air Engine/Stirling Motor
 - 6.13. Hydrogen Technology
 - 6.14. Fuel Cells
 - 6.15. Wind Power
 - 6.16. Power of Resistance
 - 6.17. Principle of Lift Force
 - 6.18. Water Energy
 - 6.19. Water Powered Engines
 - 6.20. Pump Storage Power Plants
 - 6.21. Gravitation
 - 6.22. Geothermal Energy
- 7. Perspectives and Future Energy Policy
 - 7.1. The Millennium of Electrical Current and of Renewable Energy Sources

Agriculture and Autonomous Power Supply

232

Giovanni Riva, Department of Agricultural and Environmental Biotechnology (Dibiaga), University of Ancona, Italy

- 1. Introduction
- 2. Power Production and Aspects Concerning the use of Renewable Sources
 - 2.1. Basic Concepts
 - 2.2. Existing Plants: Criteria for Action
 - 2.3. Selection of the Most Suitable Sources and Power Plants (New Plants)
- 3. Technologies for Electricity Production at Farm Level From Renewable Energy Sources
- 4. Internal Combustion Engines Combined with Generators (IC Generator-sets)
- 5. External Combustion Engines/Turbines Combined with Generators (EC Generator-sets)
- 6. Hydraulic Engines Combined with Generators (Water Wheels and Turbines)
- 7. Photovoltaic Solar Plants
- 8. Wind Generators
- 9. Combined Production of Electric and Thermal Energy (Co-generators; CHP)

Farm Machinery

Gajendra Singh, Asian Institute of Technology, Bangkok, Thailand

- 1. Introduction
- 2. Trends in Farm Machinery Adoption
 - 2.1. Arable Land and Agricultural Workers
 - 2.2. Farm Machinery in Use
- 3. Machinery for Tillage
- 4. Seeding and Planting Machinery
- 5. Fertilizer Application and Plant Protection Equipment
- 6. Machinery for Crop Harvesting and Threshing
- 7. Machinery for Transport
- 8. Horticultural Machinery
- 9. Standardization and Testing of Farm Machinery

Tractors and Transport Vehicles

du Plessis H.L.M, University of Pretoria, South Africa

- 1. Mechanization, Tractor Development and Tractor Performance
 - 1.1. Mechanization and Tractors
 - 1.2. The Development of the Agricultural Tractor
 - 1.3. Tractor Types
 - 1.4. Future Development of Tractors
 - 1.5. Concepts of Force, Torque, Work, and Power for Tractors
 - 1.6. Performance Criteria for Tractor Engines
 - 1.7. Dynamometers and the Measurement of Engine Power
 - 1.8. Drawbar Power and Drawbar Dynamometers
 - 1.9. Standardized Tractor Tests
- 2. Thermodynamics and Cycles for Internal Combustion Engines
 - 2.1. Compression Ratio and Displacement Volume of an Engine
 - 2.2. Cycles and Processes for Two- and Four-Stroke Engines
- 3. Fuels and Combustion
 - 3.1. Engine Knock, Octane, and Cetane Rating of Fuels
 - 3.2. Alternative Fuels for Internal Combustion Engines
- 4. Engine Components
 - 4.1. The Engine Block, Cylinder Head, and Cylinder Liners
 - 4.2. The Connecting Rod, Pistons, Rings, and Bearings
 - 4.3. The Crankshaft, Flywheel, and Timing Gears
 - 4.4. Valve Systems
 - 4.5. Camshaft, Valve Lifters, Valve Rotators, and Timing Gears
 - 4.6. Intake and Exhaust Manifolds and Air Cleaners
 - 4.7. Intake Pipe, Precleaner, Cyclone and Paper-Element Air Cleaners
 - 4.8. Oil-Bath Air Cleaners
 - 4.9. Turbochargers and Intercoolers
- 5. Electrical Systems for Tractors
 - 5.1. The Battery, Starting Motor, and Charging System
 - 5.2. Future Trends In Electronic Applications
- 6. Carburetor Engines and Ignition Systems
 - 6.1. Carburetors and the Low-Pressure Fuel Pump
 - 6.2. Battery or Magneto Ignition Systems
- 7. Diesel Engines
 - 7.1. General Layout of the Fuel System
 - 7.2. Plunger-Type High-Pressure Injection Pump and Injectors
 - 7.3. The Distributor-Type High-Pressure Injector Pump and Injectors
 - 7.4. Improved Ignition for Diesel Engines
 - 7.5. Maintenance of the Diesel Pump and Injectors
- 8. Engine Cooling, Coolants, and Cooling Systems

- 8.1. Radiator, Pressure Cap, Water Pump, and Cooling Fan
- 9. Lubricants and Lubrication Systems
 - 9.1. Oil Classification, Oil Filters, and Lubrication Systems
- Mechanics of the Tractor Chassis and Tractor Safety
 10.1. Forces for a Tractor, the Center of Gravity, and Stability
 10.2. Longitudinal Stability and Handling Characteristics of Tractors
- 11. Tractor Hydraulics, Hitches, and Steering Systems
 - 11.1. Components for Hydraulic Systems
 - 11.2. Hydraulic-Powered Tractor Hitch Systems
 - 11.3. Operation of Position- and Draft-Control Systems on Tractors
 - 11.4. Wheel Alignment, Steering Geometry, and Power Steering
- 12. Power Trains
 - 12.1. Clutches and Brakes
 - 12.2. Principles of Transmissions
 - 12.3. Manual Shift and Synchromesh Transmissions
 - 12.4. Power-Shift and Planetary Transmissions
 - 12.5. Continuously Variable, Hydrostatic, or Kinetic Transmissions
 - 12.6. Differentials, Final Drives, and Power-Take-Off Drives
- 13. Ergonomics and the Operator Environment
- 14. Traction Modeling and Tractor Draft Performance
 - 14.1. Traction Prediction Based on the Bekker Analytical Model
 - 14.2. Practical Applications of Traction Theory
 - 14.2.1. The Influence of Wheel Load and Drawbar Pull
 - 14.2.2. Influence of the Type of Ballast and Tire Pressure
 - 14.2.3. Influence of Wheel Diameter, Tire Width, and Wheel Configuration
 - 14.2.4. Influence of the Tire Tread Pattern
 - 14.2.5. Influence of Tire Construction
 - 14.2.6. The Influence of Traction Aids
 - 14.2.7. Comparison of Tires and Steel or Rubber Tracks
- 15. The Transportation of Farm Produce
 - 15.1. Simulation of the Transport of Farm Produce

Tillage and Seeding Machines

Pierluigi Febo, Department of Engineering and Technology for Agriculture and Forestry (ITAF), University of Palermo, Italy

- 1. Tillage Machines
- 2. Primary Tillage Implements
 - 2.1. Plows
 - 2.1.1. Moldboard Plows
 - 2.1.2. Disk Plows
 - 2.1.3. Chisel Plows and Subsoilers
 - 2.2. Listers, Ridgers, Bedders, and Grubbers
 - 2.3. Rotary Tillers and Rotary Plows
 - 2.4. Reciprocating Spading Machines
- 3. Secondary Tillage Implements
 - 3.1. Rotary Cultivators or Rotary Tillers
 - 3.2. Rigid or Spring Tine Cultivators and Harrows
 - 3.2.1. Rigid and Spring Tine Cultivators
 - 3.2.2. Rigid and Spring Tine Harrows
 - 3.3. Disk Harrows
 - 3.4. Power Harrows 3.4.1. Reciprocating H
 - 3.4.1. Reciprocating Harrows3.4.2. Rotary Harrows
 - 3.5. Rotary Hoes and Ground Driven Rotary Harrows
 - 3.6. Rollers and Land Levellers
 - . Seeding Machines
 - 4.1. Broadcast Seeding

- 4.2. Drilling
- 4.3. Precision Planting
- 4.4. Direct Drilling, Punch Planting, and Transplanting
- 4.5. Seeding Machines for Special Purposes

Fertilizer Applicators and Plant Protection Equipment

358 Palaniappa Krishnan, Bioresources Engineering Department, University of Delaware, USA

- 1 Introduction
- 2. Dry Fertilizer Application Methods and Equipment
 - 2.1. Placement of Fertilizers
 - 2.2. Types of Equipment
 - 2.3. Performance Parameters
 - 2.4. Centrifugal Broadcasters
 - 2.5. Aircraft Broadcasters
- 3. Liquid Fertilizer Applicators
 - 3.1. Nonpressure Liquid Applicators
 - 3.2. Anhydrous Ammonia and Low-Pressure Liquid Applicators
- 4. Granular Pesticide Applicators
 - 4.1. Metering Devices for Granular Applicators
- 5. Sprayers
 - 5.1. Sprayer Types
 - 5.2. Particle Size Distributions
 - 5.3. Hydraulic Nozzles
 - 5.4. Pumps for Sprayers
 - 5.4.1. **Piston Pumps**
 - 5.4.2. **Rotary Pumps**
 - 5.4.3. Centrifugal Pumps
 - **Diaphragm Pumps** 5.4.4.
 - 5.5. Agitation of Spray Materials
 - 5.5.1. Mechanical Agitation
 - Hydraulic Agitation 5.5.2.
 - 5.6. Hydraulic Sprayers
 - 5.6.1. Basic Components of a Hydraulic Sprayer
 - Booms and Nozzles on a Field Sprayer 5.6.2.
 - Uniformity of Spray Distribution 5.6.3.
 - 5.6.4. Calculation of Application Rate
 - 5.7. High-Pressure Orchard Sprayers
 - 5.8. Airblast Sprayers
 - 5.9. Electrostatic Sprayers
 - 5.10. Aircraft Sprayers
- 6. Dusters
- Future Trends 7.

Harvesters

M.A.Neale, 6 St Edmond Road, Bedford MK40 2NQ,, England, UK

- 1. Introduction
- **Classification of Crops** 2.
- 3. Seed Harvesting Machines
 - 3.1. The Reaper Binder
 - 3.2. Combine Harvester
 - 3.3. Crop Gathering
 - 3.3.1. The Cutting Header
 - The Stripper Header 3.3.2.
 - The Australian Header 3.3.3.

- 3.3.4. The Pickup Header
- 3.3.5. Maize Cob Header
- 3.4. Threshing and Separating Mechanisms
- 3.5. Asian Stripping Combines and Whole Crop Harvesters
- 3.6. Computers on Combines
- 3.7. Swathing Machines
- 3.8. Green Crop Viners
- 3.9. Specialist Seed Harvesters
- 4. Root Crop Harvesters
 - 4.1. Removal of above ground plant material
 - 4.2. Digging the Roots
 - 4.3. Separating the Crop from the Soil
 - 4.4. Elevating, Final Cleaning and Delivery to Transport
 - 4.5. Belt lifters
- 5. Green Plant and Leaf Harvesters
 - 5.1. Mowing machines
 - 5.1.1. Cylinder mower
 - 5.1.2. Finger bar mower
 - 5.1.3. Disk mower
 - 5.1.4. Drum mower
 - 5.1.5. Flail mowers
 - 5.1.6. The strimmer
 - 5.2. Crop Conditioning
 - 5.3. Forage Harvesters
 - 5.3.1. Flail forage harvester
 - 5.3.2. Precision choppers
 - 5.4. Self Loading Wagons
 - 5.5. Leaf Strippers
 - 5.6. Leaf Clippers
 - 5.7. Pod harvesters
 - 5.8. Sugar cane harvesters
 - 5.9. Specialist Vegetable Harvesters
- 6. Fruit Harvesters
 - 6.1. Tree shakers
 - 6.2. Computer Controlled Pickers
 - 6.3. Specialist Platforms
 - 6.4. Shakers and Combers
 - 6.5. Cut and Separate
 - 6.6. Special Solutions
- 7. Fiber Crop Harvesters
 - 7.1. Cut, Dry and Gather
 - 7.2. Flax Pullers
 - 7.3. In Field Decorticating
 - 7.4. Cotton Harvesters
- 8. Timber Harvesters
 - 8.1. The Chain Saw
 - 8.2. Tree Harvesters
 - 8.3. Coppice Harvesters
 - 8.3.1. Cut and chop machines
 - 8.3.2. Whole stem harvesters

Equipment for Post-Harvest Preservation and Treatment of Produce

419

D. C. Joyce, Post-harvest Technology Group, Silsoe College, Cranfield University, Silsoe, UK B. Clarke, Post-harvest Technology Group, Silsoe College, Cranfield University, Silsoe, UK

- 1. Introduction
- 2. Historical Perspective

- 3. Science, Engineering, and Technology
- 4. Field-based versus Shed-based Operations
- 5. Receipt of Produce
- 6. Conveying
- 7. Cleaning
- 8. Sorting and Grading
- 9. Treatment
- 10. Packaging and Labeling
- 11. Unitization
- 12. Storage
- 13. Dispatch
- 14. Transport
- 15. Wholesaling
- 16. Retailing
- 17. Consumption
- 18. Policy
- 19. Post-harvest Systems Management
- 20. Future Directions

Index

443

453

1

About EOLSS

VOLUME II

Facilities and Equipment for Livestock Management

Yuanhui Zhang, Department of Agricultural Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, USA Ted L. Funk, Department of Agricultural Engineering, University of Illinois at Urbana-Champaign, Urbana, IL, USA

- 1. The Evolution of Livestock Production
- 2. Fundamentals for Equipment Design
 - 2.1. Heating/Cooling and Ventilation Systems
 - 2.2. Penning and Fencing
 - 2.3. Feeders
 - 2.4. Waste Management Systems
 - 2.5. Handling
- 3. Challenges, Needs, and Future Perspectives
 - 3.1. The Challenges
 - 3.2. Needs
 - 3.3. Perspectives

Planning and Building of Stock-Raising Farms

Riskowski, G. L, Agricultural Engineering Department, University of Illinois, USA

- 1. Site selection considerations
- 2. Space and distance requirements
 - 2.1. Livestock Areas
 - 2.2. Clearance Between Buildings
 - 2.3. Manure Facilities
 - 2.4. Roads
 - 2.5. Clean Water Drainage
 - 2.6. Feed Storage and Processing Area
 - 2.7. Living/Management Area

- 2.8. Biosecurity Barrier
- 2.9. Windbreaks/Sight Barriers
- 2.10. Machinery Storage/Repair Area
- 2.11. Regulated Set Back Areas
- 2.12. Fresh Water Pond
- 2.13. Livestock Isolation/Receiving/Load Out Areas
- 2.14. Future Expansion
- 3. Topography
- 4. Climate
- 5. Utilities
- 6. Safety and security
- 7. Biosecurity
- 8. Malodors from livestock facilities
- 9. Combining buildings into a production system
- 10. Developing a site plan
- 11. Building a production facility
 - 11.1. Consulting Engineer
 - 11.2. Total Project Cost
 - 11.3. Choosing a Builder or Contractor
 - 11.4. Preparing a Contract
 - 11.5. Checklist Before Final Payment and Accepting Building

Equipment for Cattle Production

Toby T. Mottram, Silsoe Research Institute, Bedford, UK.

- 1. Introduction
- 2. Types of cattle production
 - 2.1. Range Beef
 - 2.2. Intensive Beef
 - 2.3. Extensive Dairying
 - 2.4. Intensive Dairying
- 3. Methods of feeding
 - 3.1. Fodder
 - 3.2. Concentrate feeding
- 4. Cattle housing
 - 4.1. Methods of bedding
 - 4.2. Waste product handling
 - 4.3. Methods of animal control
- 4.4. Thermal environment5. Cattle health and welfare
 - Cattle nealth and we
 - 5.1. Mastitis
 - 5.2. Lameness
- 6. Milking equipment6.1. Round the shed (RTS)
 - 6.2. Yard and milking parlour
 - 6.3. Robotic milking
- 7. Management tools
 - 7.1. Physical devices
 - 7.2. Information devices
 - 7.3. Technological systems
- 8. New developments and discussion

Equipment for Pig Production

Cees E. van 't Klooster, Institute for Agricultural and Environmental Engineering (IMAG), Wageningen, The Netherlands

1. Introduction

55

- 2. Environmental Impact of Pig Production
 - 2.1. Minerals
 - 2.2. Greenhouse Gases
 - 2.3. Eutrophication and Acidification Factors
 - 2.4. Dust
 - 2.5. Odor
- 3. Equipment to Minimize Environmental Impact
 - 3.1. Nutrition
 - 3.2. Housing and Manure Handling
 - 3.3. Climate Control
- 4. Conclusions

Equipment for Sheep Production

Hirning, H. J, Professor Emeritus, North Dakota State University, Fargo, ND, USA

1. Sheep production options

- 2. Equipment for pasture systems
 - 2.1. Pasture Fences
 - 2.2. Electrified Fences
 - 2.3. Corral Fences
 - 2.4. Windbreak Fences
- 3. Watering troughs
- 4. Feeding equipment
 - 4.1. Creep Feeders
 - 4.2. Bunk Feeders
 - 4.3. Hay Feeders
- 5. Lambing equipment
 - 5.1. Artificial Rearing
 - 5.2. Supplemental Heat
- 6. Confinement production
- 7. Handling facilities
 - 7.1. Associated Handling Equipment
 - 7.2. Computer Identification
 - 7.3. Milking Facilities
- 8. Buildings for sheep production
 - 8.1. Lighting

Equipment for Poultry Production

Gates, R.S, Biosystems and Agricultural Engineering, University of Kentucky, USA

87

- 1. Introduction
- 2. Types of poultry
- 3. Types of chicken housing systems
- 4. Economic Impact of Poultry Production
 - 4.1. Factors Affecting Production
 - 4.2. Economic Structure of Industry
- 5. Housing Systems
- 6. Feeding Equipment
- 7. Watering Equipment
 - 7.1. Water Sources
 - 7.2. Water Delivery to Birds
- Medication Equipment
 Ventilation and Heating
 - Ventilation and Heating
 - 9.1. Fundamentals of Ventilation
 - 9.2. Ventilation Systems for Broilers9.3. Ventilation Systems for Layers

- 9.4. Heating Equipment
- 9.5. Air Distribution
- 9.6. Control Systems for Heating and Ventilation
- 10. Lighting
 - 10.1. Need for Lighting in Layer Houses
 - 10.2. Need for lighting in broiler houses
 - 10.3. Lighting Sources
- 11. Harvesting
 - 11.1. Broilers
 - 11.2. Eggs
- Waste from Poultry Systems
 12.1. Solid Waste Management
 12.2. Waste Handling Equipment

Automation and Electronic Equipment

Cattaneo M, University of Milan, Italy

- 1. Introduction
- 2. Automation
- 3. Automatic Identification of Animals
- 4. Automatic Feeding
 - 4.1. Automatic Concentrate Feeding
 - 4.2. Automatic Roughage Feeding
 - 4.3. Self-Feeders for Calves
- 5. Automatic Monitoring of Physiological Yield Parameters
 - 5.1. Measurement of Milk Yields
 - 5.2. Detection of Estrus
 - 5.3. Automatic Detection of Mastitis
 - 5.3.1. Measurement of the Average Value for the Quarters
 - 5.3.2. Measurement by Individual Quarters
- 6. Software
- 7. Robotics
- 8. Milking Robot
 - 8.1. System for Identifying and Admitting the Cows
 - 8.2. Animal Containment Stall
 - 8.3. Robotic Arm
 - 8.4. Locating the Position of the Teats
 - 8.5. Teat Cup Attachment System
 - 8.5.1. Fully Independent Teat Cups
 - 8.5.2. Teat Cups Incorporated into the End-Effector
 - 8.6. Teat Cleaning
 - 8.7. Economic Considerations

Environmental Monitoring

R.S. Kanwar, Iowa State Water Resources Research Institute and Iowa State University, Ames, Iowa, USA

A. Bakhsh, Iowa State Water Resources Research Institute and Iowa State University, Ames, Iowa, USA

- 1. Introduction
- 2. Loss of Ecology due to Agricultural Development
- 3. Environmental Monitoring
- 4. Equipment for Environmental Monitoring
- 4.1. Water Monitoring
 - 4.1.1. Selection of Sampling Sites
 - 4.1.2. Sampling Frequency
 - 4.1.3. Selection of Monitoring Variables

147

- 4.1.4. Equipment Used for Water Monitoring
- 4.2. Soil Monitoring
 - 4.2.1. Soil Erosion
 - 4.2.2. Soil Salinity
 - 4.2.3. Soil Quality
 - 4.2.4. Soil Sampling
 - 4.2.5. Plant Sampling
 - 4.2.6. NO3-N, Phosphorus, and Silica Analyses
 - 4.2.7. Fecal Coliform Bacteria Sample Collection and Enumeration
- 4.3. Air-Quality Monitoring
 - 4.3.1. Sampling Strategies for Air-Quality Measurements
- 4.4. Ocean Monitoring
 - 4.4.1. Pollutants in Coastal Waters, their Impacts, and Control
 - 4.4.2. Organic Compounds and Bacteria
 - 4.4.3. Plastics

Ecology and Technology

166

Vellidis, G,Biological & Agricultural Engineering Department, University of Georgia, Tifton, USA Gattie, D.K, Biological & Agricultural Engineering Department, University of Georgia, Athens, USA Smith, M.C,Biological & Agricultural Engineering Department, University of Georgia, Athens, USA

- 1. Introduction
- 2. The Interconnection of Human Beings and the Natural Environment
- 3. Designing with Ecological Constraints
- 4. The Issue of Sustainability
 - 4.1. Sustainable Agriculture
 - 4.1.1. Soil and Water Resources
 - 4.1.2. Agronomic and Horticultural Production
 - 4.1.3. Animal Production
 - 4.1.4. The Economic, Social and Political Context
- 5. What is an Ecosystem Service?
 - 5.1. Ecosystem Health
 - 5.2. Quantifying Ecosystem Services
- 6. Ecological Engineering the Merging of Ecology and Technology
- 7. Key Technologies for Sustainable Ecosystems
 - 7.1. Geographic Information Systems (GIS)
 - 7.2. Global Positioning Systems (GPS)
 - 7.3. Remote Sensing
 - 7.4. Precision Farming
 - 7.5. Ecological Simulation Models
- 8. Implementing Ecology and Technology
- 8.1. Case Studies
 - 8.1.1. Precision Farming
 - 8.1.2. Restoration of Riparian Ecosystem Services
 - 8.1.3. A Landscape Approach to Protecting Water Quality

Erosion Control Equipment

Randall C. Reeder, Ohio State University, Columbus, Ohio, USA

- 1. Introduction
- 2. No-Till Systems
 - 2.1. No-Till Drills
 - 2.1.1. Coulters and Seed-Furrow Openers
 - 2.1.2. No-till Drills without Coulters
 - 2.1.3. Furrow Spacing, Weight, and Down Pressure
 - 2.1.4. Depth Control

- 2.1.5. Press Wheels
- 2.1.6. General Operation of No-Till Drills (Disk Drills and Hoe Drills)
- 2.2. Air Seeders
- 2.3. No-Till Row-Crop Planters
 - 2.3.1. Seed-Furrow Openers
 - 2.3.2. Coulters
 - 2.3.3. Row-Cleaning Devices
 - 2.3.4. Seed Covering
 - 2.3.5. Weight and Down-Pressure Springs
- 3. Ridge Tilling
 - 3.1. Getting Started in Ridge Tilling
 - 3.2. Planters
 - 3.3. Guidance Systems
 - 3.4. Deep In-Row Tillage
 - 3.5. Other Equipment Considerations
- 4. Cultivators for Heavy Residue
- 4.1. Ridge-Till Cultivators
- 5. Fall Strip-Till Systems
 - 5.1. Advantages Compared to No-Till Systems
 - 5.2. Equipment Needed
 - 5.3. Time of Strip Tillage
 - 5.4. Cropping Systems
- 6. Mulch-Till Systems
- 7. Controlled Traffic
- 8. Wind Erosion
 - 8.1. Reducing Wind Erosion
 - 8.2. Comparing Residue Effectiveness
 - 8.3. Soil Differences and Field Conditions
 - 8.4. Emergency Tillage Measures

Health and Safety of Personnel in Agriculture

M.A. Purschwitz, Department of Biological Systems Engineering, University of Wisconsin - Madison, USA

- 1. Introduction
- 2. Tractors
- 3. Other Farm Machinery
- 4. Animals
- 5. Confined Spaces and Storage Structures
 - 5.1. Grain Bins
 - 5.2. Silos
 - 5.3. Manure storages
- 6. Slips and Falls
- 7. Overhead Power Lines and Electricity
- 8. Chain Saws and Woodcutting
- 9. All-Terrain Vehicles
- 10. Fires
- 11. Chemicals
- 12. Respiratory Hazards
- 13. Noise
- 14. Skin Cancer
- 15. Repetitive Motion and Back Injuries
- 16. Maintenance, Repair, and Construction
- 17. Child Safety on the Farm
- 18. Stress and Depression
- 19. Regulations and Management

XV

Agricultural-Related Fires and Explosions

W. E. Field, Department of Agricultural and Biological Engineering, Purdue University, West Lafayette, Indiana, USA

- 1. Introduction
- 2. Fundamentals of Fires and Explosions
- 3. Fires in Stored Agricultural Crops
- 4. Agricultural Machinery Fires
- 5. Fuel Storage
- 6. Agricultural Chemical Fires
- 7. Grain Dust Explosions
- 8. Fire Detection and Suppression Systems

Storage, Handling and Disposal of Animal Slurries

Willers, Hans C, Institute of Agricultural and Environmental Engineering (IMAG), Wageningen-UR, The Netherlands Derikx, Piet J.L, Institute of Agricultural and Environmental Engineering (IMAG), Wageningen-UR, The

- 1. Introduction
- 2. Composition
- Storage

Netherlands

- 3.1. Lagoons
 - 3.2. Storage under livestock confinements
 - 3.3. Storages Above Ground Level
- 4. Transport
- 5. Treatment
 - 5.1. Separation of Solids
 - 5.2. Evaporation of Water
 - 5.3. Additives
 - 5.4. Electrochemical Treatment
 - 5.5. Stripping of Ammonia
 - 5.6. Cultivation of Algae or Duckweed
 - 5.7. Aeration and Aerobic Treatment
 - 5.8. Anaerobic Treatment and Biogas Production
 - 5.9. Other Treatments
 - 5.10. Integrated Treatment Processes
- 6. Application and utilization
 - 6.1. Application Techniques
 - 6.2. Other Ways of Utilization
- 7. Environmental and legal aspects
 - 7.1. Air
 - 7.2. Water
 - 7.3. Soil
 - 7.4. Health Risks
 - 7.5. Legislation

Animal Solid Manure: Storage, Handling and Disposal

José R. Bicudo, Department of Biosystems and Agricultural Engineering, University of Kentucky, USA

- 1. Introduction
- 2. Solid Manure Characteristics
 - 2.1. Handling Properties
 - 2.2. Manure Production
 - 2.3. Nutrient Content

xvi

265

232

- 2.4. Nutrient Losses
- 3. Solid Manure Handling Alternatives
- 4. Collection and Transfer Systems
- 5. Storage
 - 5.1. General
 - 5.2. Semi-Solid Manure Storages
 - 5.3. Solid Manure Storages
- 6. Treatment
- 7. Land Application

Baling, Transportation, and Storage of Straw

J. Hahn, Faculty of Agriculture and Horticulture at Humboldt-University Berlin, Germany A. Herrmann, Institute for Agricultural Engineering and Land Use Management, Martin-Luther University, Halle-Wittenberg, Germany

- 1. Introduction
- 2. Baling
 - 2.1. Conventional Balers
 - 2.2. Roundbalers
 - 2.3. Square Balers
- 3. High Pressure Compaction
- 4. Transport and Handling
 - 4.1. Transport Vehicles
 - 4.2. Loading and Unloading Technique
 - 4.3. Procedural Organization and Optimization
- 5. Storage
- 6. Logistic Chains

Commercial Uses of Straw

Ruihong Zhang, Biological and Agricultural Engineering Department, University of California, Davis, USA

Bryan M. Jenkins, Biological and Agricultural Engineering Department, University of California, Davis, USA

- 1. Introduction
- 2. Animal Feeding
 - 2.1. Physical Treatment
 - 2.2. Chemical Treatment
 - 2.3. Biological Treatment
- 3. Electrical Power and Fuel Generation
 - 3.1. Combustion
 - 3.2. Gasification and Pyrolysis
 - 3.3. Ethanol Fermentation
 - 3.3.1. Pretreatment
 - Hydrolysis Saccharification 3.3.2.
 - 3.3.3. Fermentation
 - 3.4. Anaerobic Digestion
- 4. Composting and Mushroom Cultivation
- 5. Building Construction and Structural and Paper Product Manufacturing
 - 5.1. Building Construction
 - 5.2. Composite Material Manufacturing
 - 5.3. Paper Making
- 6. Environmental Mitigation and Farm Use
- 7. Other Uses

292

Slaughtering and Processing of Livestock

J. D. Collins, Faculty of Veterinary Medicine, University College Dublin, Ireland

- 1. Background
- 2. Pre-Harvest Aspects
 - 2.1. Animal Production Aspects
 - 2.2. Animal Diseases of Concern
 - 2.3. Food Safety Control in the Pre-Harvest Phase
- 3. Post-Harvest Aspects
 - 3.1. Slaughtering and Processing Procedures
 - 3.2. Food Safety Control in the Meat Plant
 - 3.2.1. Role of the Regulatory Veterinary Food Hygienist in the Meat Plant
 - 3.2.2. Tuberculosis in Cattle
 - 3.3. Cold Line Control
 - 3.4. Further Processing of Meat
 - 3.5. Carcass Decontamination
 - 3.5.1. Chemical Decontamination of Carcasses
 - 3.5.2. Physical Decontamination of Carcasses
 - 3.6. In-plant Sanitation3.6.1. Assessment of Sanitation Procedures
- 4. Health Certification of Meat and Meat Products Entering Trade
- 5. Education and Food Safety
- 6. Future Needs
- 7. Conclusion

Animal Welfare and Humane Slaughter

Temple Grandin, Department of Animal Sciences, Colorado State University, Fort Collins, Colorado, USA

Gary C. Smith, Department of Animal Sciences, Colorado State University, Fort Collins, Colorado, USA

- 1. Introduction
- 2. Comparisons of electrical stunning and CO2 stunning
- 3. Electrical Stunning
- 4. Captive Bolt Stunning
- 5. Carbon Dioxide Stunning
- 6. Assessing Insensibility
- 7. Insensibility in Poultry and Gas Stunned Animals
- 8. Ritual Slaughter
- 9. Objective Scoring of Animal Welfare
 - 9.1. Electrical Stunning And Electrode Placement Efficacy Criteria
 - 9.2. Captive-Bolt Stunning Efficacy Criteria
 - 9.3. Considerations For Penetrating Captive-Bolt Stunning, Bleed-Out Interval
 - 9.4. Considerations For Cardiac Arrest Electrical Stunning Bleeding Interval
 - 9.5. Considerations For Head-Only, Reversible Electrical Stunning Bleeding Interval
 - 9.6. Bleeding Rail Insensibility Efficacy Criteria
 - 9.7. Considerations For Slipping And Falling
 - 9.8. Slipping And Falling In The Stunning Chute-Area Efficacy Criteria (All Species)
 - 9.9. Considerations For Vocalization Scoring Of Cattle
 - 9.10. Vocalization Scoring Of Cattle In The Crowd Pen, Lead-Up Chute, Stunning Box Or Restraining Device Efficacy Criteria
 - 9.11. Considerations For Vocalization Scoring Of Pigs
 - 9.12. Vocalization Scoring Of Pigs In The Restrainer Or During Stunning
 - 9.13. Restraint Device Principles Which Reduce Stress On Animals And Help Reduce Vocalization
 - 9.14. Considerations For Use Of Electric Prods
 - 9.15. Use Of Electric Prods Efficacy Criteria
 - 9.16. Handling Recommendations To Reduce Electric Prod Use And Maintain Efficient Handling
 - 9.17. Considerations For Movement To Stunning/Sticking Of Non-Ambulatory Animals

- 9.18. Considerations For Pen Stocking Density
- 9.19. Considerations For Maintenance Of Facilities And Equipment
- 9.20. Conclusion
- 10. Stunning Methods and Blood Splash

The Role of Slaughter Hygiene in Food Safety

John N. Sofos, Center for Red Meat Safety, Department of Animal Sciences, Colorado State University, Fort Collins, CO 80523-1171, USA Gary C. Smith, Center for Red Meat Safety, Department of Animal Sciences, Colorado State University, Fort Collins, CO 80523-1171, USA

- 1. Introduction
- 2. Animal cleaning and washing
- 3. Chemical dehairing
- 4. Knife-trimming and steam-vacuuming
- 5. Carcass decontamination by spraying, rinsing or exposure to steam
 - 5.1. General
 - 5.2. Chemical solutions
 - 5.3. Hot water
 - 5.4. Pressurized steam
 - 5.5. Other technologies
 - 5.6. Multiple treatment decontamination
 - 5.7. Safety and meat quality
- 6. Carcass chilling
- 7. Carcass cutting and meat storage
- 8. Further processing and preparation for consumption
- 9. Overview

Processing and Marketing Non-meat Products from Livestock R. C. Oberthür, *Labor Dr. Oberthür GmbH, Bawinkel, Germany*

413

393

- 1. Introduction
- 2. Historical background
- 3. Physicochemical, ecological and economic background of the utilization of non-meat products from livestock
- 4. Mass balance of world meat production and non-meat products from livestock
- 5. Non-meat products from fallen stock and emergency culling
- 6. Ethical consideration in the utilization of non-meat products from livestock
- 7. Animal raw materials versus plant and "synthetic" raw materials
- 8. Total quality management in non-meat products from livestock
- 9. Outlook

Index 441

About EOLSS