

FUNDAMENTALS OF AGRICULTURE



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Fundamentals of Agriculture

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Preface

Agriculture is the cornerstone of human civilization, the foundation upon which societies have evolved and prospered. As the global population continues to rise and natural resources face unprecedented pressure, the role of agriculture has become more critical than ever before. Understanding the fundamental principles that govern agricultural systems is essential not only for students and professionals in the field but also for policymakers, researchers, and all those who contribute to the stewardship of our planet's food systems.

The book **“Fundamentals of Agriculture”** has been designed to provide a comprehensive overview of the essential concepts, principles, and practices that form the backbone of agricultural science. It brings together knowledge from diverse disciplines including agronomy, soil science, horticulture, plant breeding, crop protection, and agricultural economics to present an integrated understanding of modern and traditional farming systems.

This book aims to bridge the gap between theoretical knowledge and practical application. It emphasizes both conventional wisdom and emerging innovations in sustainable agriculture, precision farming, biotechnology, and climate-smart practices. Each chapter has been developed to simplify complex ideas through clear explanations, illustrations, and real-world examples, ensuring that learners at all levels can grasp the key aspects of agricultural science.

In an era marked by rapid technological advancement and growing environmental concerns, this text also underscores the importance of sustainable resource management, biodiversity conservation, and ethical agricultural practices. By equipping readers with a strong foundation in the fundamentals, it seeks to inspire critical thinking, problem-solving, and innovation in addressing global agricultural challenges.

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Chapter 11

Vertical Farming, Controlled Environment Agriculture & Urban Farming

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Abstract

Vertical farming and controlled environment agriculture (CEA) represent a rapidly evolving set of approaches that move food production into engineered, often urban, spaces. By controlling light, temperature, humidity, nutrient delivery and air quality, these systems decouple crop growth from local weather and seasonality, offering year-round production, rapid crop cycles and high yields per unit footprint. It explains core system types, the physiology of crops in artificial environments, engineering components (lighting, HVAC, fertigation), resource flows and efficiencies, business models and economics, environmental trade-offs, social and policy dimensions and the research frontiers shaping the field. The piece aims to be academically rigorous without feeling dry centered on the day-to-day realities of operators, investors, planners and city residents who will steward the next wave of urban food systems.

Keywords: Vertical farming, controlled environment agriculture, urban agriculture, hydroponics, aeroponics, LED lighting, HVAC, life cycle assessment, food security, resource efficiency

Introduction

Imagine a pallet racked warehouse where rows of fragrant basil, butter head lettuce and sweet microgreens sit stacked six levels high under a pinkish glow.