THE CONCEPT OF VALUE CHAINS IN AGRICULTURE, CLIMATE ACTION AND ENVIRONMENTAL RESOURCES

GLOBAL ISSUES & LOCAL PERSPECTIVES

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SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

Published By:

Society for Agriculture, Environmental Resources & Management (SAEREM)

First published 2024

SAEREM World

Nigeria

Typeset in Times New Roman

SAEREM BOOK CHAPTERS First Published 2025 ISBN 978-978-60709-7-1

THE CONCEPT OF VALUE CHAINS IN AGRICULTURE, CLIMATE ACTION AND ENVIRONMENTAL RESOURCES (GLOBAL ISSUES & LOCAL PERSPECTIVES)

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Printed at: SAEREM World

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous ***The Concept of Value Chains in Agriculture, Climate Action and Environmental Resources*** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate change, food security, national security and environmental resources issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate change, food security, national security and environmental resources necessary in policy making process that will stimulate increase in food production and environmental sustainability.

The Concept of Value Chains in Agriculture, Climate Action and Environmental Resources: Global issues and Local Perspectives is organized in three parts. Part One deals with The Concept of Value Chains in Agriculture, Part Two is concerned with The Concept of Climate Actions and Part Three deals with the Concept of Value Chains and Environmental Resources.

Eteyen Nyong/ Ignatius Onimawo

April 2025

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Chapter Twenty

Food Systems, Nutrition, and Health: A Value Chain Approach to Addressing Malnutrition

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I. INTRODUCTION

Malnutrition is a widespread global issue affecting millions, regardless of age, background, or socioeconomic status. It includes undernutrition, micronutrient deficiencies, and overweight or obesity, with consequences that extend beyond health to impact economic productivity, education, and social development. According to the World Health Organization (2020), malnutrition accounts for nearly half of all deaths in children under five and costs the global economy approximately $3.5 trillion annually. The food we produce, process, and consume directly influences our nutritional status and overall health. Food systems, nutrition, and health are closely related, and a well-functioning food system is essential for ensuring access to nutritious food,

promoting healthy eating habits, and supporting economic growth. However, the current food system often suffers from inefficiencies, inequalities, and unsustainable practices that worsen malnutrition. A value chain approach presents a viable solution to combat malnutrition. By analyzing the entire food system from production to consumption, we can pinpoint key areas for enhancing nutritional value, reducing waste, and improving sustainability. This approach requires collaboration among stakeholders, including farmers, processors, retailers, and consumers, and a thorough understanding of the complex relationships between food systems, nutrition, and health. This chapter examines the value chain approach to addressing malnutrition. It discusses agricultural value chains, strategies for tackling malnutrition, the role of climate action and environmental resources, relevant case studies, and future directions for applying this approach. It concludes with a call to action for stakeholders to adopt the value chain approach in agriculture, climate initiatives, and environmental resource management.

1. Overview of Malnutrition and its Impact on Public Health

Malnutrition is a widespread and complex issue that affects millions of people worldwide. It encompasses a range of conditions, including undernutrition (e.g., stunting, wasting, and underweight), micronutrient deficiencies (e.g., iron, vitamin A, and iodine), and overweight and obesity. Malnutrition has severe consequences on public health, according to the World Health Organization (WHO, 2020), including:

- Impaired cognitive and physical development in children
- Increased risk of illnesses and infections
- Reduced productivity and economic growth
- Increased healthcare costs and burden on the healthcare system- Impaired cognitive and physical development in children
- Increased risk of illnesses and infections

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- Reduced productivity and economic growth
- Increased healthcare costs and burden on the healthcare system

2. Importance of Food Systems in Addressing Malnutrition

Food systems play a critical role in addressing malnutrition. A well-functioning food system can provide access to nutritious and safe food, which is essential for maintaining good health and preventing malnutrition. Food systems encompass all aspects of food production, processing, distribution, marketing, and consumption. Effective food systems can:

- Increase access to diverse and nutrient-rich foods

- Improve food safety and reduce the risk of foodborne illnesses

- Support local economies and promote sustainable agriculture practices

- Enhance nutrition education and awareness among consumers Fanzo, Rudie, Sigman,…Willett (2022).

3. Rationale for Using a Value Chain Approach to Address Malnutrition

A value chain approach offers a promising solution to address malnutrition. This approach recognizes that malnutrition is often the result of a complex interplay of factors, including food availability, access, utilization, and stability. According to Gelli, Hawkes, Donovan, et al. (2015), value chains can positively impact nutrition through three key channels:

i. *Demand-side pathway:* Increasing access to and consumption of nutrient-dense foods.
ii. *Supply-side pathway:* Enhancing incomes for value chain actors, enabling them to purchase and consume more nutritious foods.
iii. *Value-addition pathway:* Incorporating nutrition-enhancing activities within the value chain, such as food fortification, biofortification, or improved food processing and preservation techniques.

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A value chain approach can help address malnutrition by:

- Identifying critical points in the food system where nutritional value can be enhanced
- Improving the efficiency and effectiveness of food systems
- Enhancing collaboration and coordination among stakeholders, including farmers, processors, distributors, and policymakers
- Promoting sustainable and equitable food systems that prioritize nutrition and health (Michel, Eldridge, Hartmann, Klassen, Ingram, Meijer, 2024).

II. The Intersection of Food Systems, Nutrition, and Health

The intersection of food systems, nutrition, and health is a complex and multifaceted relationship that plays a critical role in determining human well-being. According to Fanzo et al. (2022, p. 18), sustainable food systems are critical to achieving good nutrition and health. Understanding this intersection is essential for developing effective strategies to address malnutrition and promote healthy food systems.

1. Definition and Explanation of the Interconnection

The intersection of food systems, nutrition, and health refers to the dynamic relationships between:

- Food systems: the production, processing, distribution, marketing, and consumption of food
- Nutrition: the intake and utilization of nutrients by the human body
- Health: the overall well-being of individuals and populations

This intersection is influenced by a range of factors, including socioeconomic, environmental, and cultural determinants (WHO, 2022; Fanzo et al., 2022; High Level Panel of Experts [HLPE] 2017).

2. Key Factors Influencing the Intersection of Food Systems, Nutrition, and Health

Several key factors influence the intersection of food systems, nutrition, and health, according to the World Health Organization (WHO, 2020) and the Food and Agriculture Organization (FAO, 2017), including:

a. Food Availability and Access

Food availability and access refer to the physical and economic availability of nutritious food, particularly for vulnerable populations. This concept encompasses several dimensions:

i. Physical Availability

- *Food production:* The availability of nutritious food is influenced by factors such as agricultural productivity, crop diversity, and livestock production.
- *Food distribution:* The distribution of food from producers to consumers affects the availability of nutritious food in different regions and communities.
- *Food storage and preservation:* The ability to store and preserve food affects its availability throughout the year (FAO, 2017; WHO, 2020).

ii. Economic Availability (Access)

- Food affordability: The price of nutritious food affects its accessibility, particularly for low-income households.
- Food purchasing power: The ability of individuals and households to purchase nutritious food is influenced by factors such as income, employment, and social protection programmes.
- Food assistance programs: Government programs and social safety nets can improve access to nutritious food for vulnerable populations (FAO, 2017; WHO, 2020).

Vulnerable Populations

i. Low-income households: Households with limited financial resources may struggle to access nutritious food.
ii. Rural communities: Rural communities may face challenges in accessing nutritious food due to limited infrastructure, transportation, and market access.
iii. Indigenous populations: Indigenous populations may face unique challenges in accessing nutritious food due to cultural, linguistic, and geographical barriers.

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iv. Refugees and displaced persons: Refugees and displaced persons may face challenges in accessing nutritious food due to limited access to markets, infrastructure, and social services (FAO, 2017; WHO, 2020).

Consequences of Limited Food Availability and Access

i. Malnutrition: Limited access to nutritious food can lead to malnutrition, including undernutrition, micronutrient deficiencies, and overweight and obesity.
ii. Poor health outcomes: Limited access to nutritious food can contribute to poor health outcomes, including increased risk of chronic diseases, impaired cognitive function, and reduced productivity.
iii. Economic impacts: Limited access to nutritious food can have economic impacts, including reduced economic productivity, increased healthcare costs, and reduced economic growth (FAO, 2017; WHO, 2020).

b. Food Culture and Preferences

Food culture and preferences refer to the cultural and personal factors that shape food choices and consumption patterns. This concept encompasses several dimensions:

i. Cultural Influences
- Traditional cuisine: Cultural heritage and traditional cuisine influence food preferences and choices.
- Social norms: Social norms and expectations around food shape eating habits and food choices.
- Religious and spiritual practices: Religious and spiritual practices influence food choices and dietary restrictions (FAO, 2017; WHO, 2020).

ii. Personal Preferences
- Taste and flavor: Personal preferences for taste and flavor influence food choices.
- Food neophobia: Fear of new foods can limit dietary diversity and influence food choices.
- Emotional connections: Emotional connections to food, such as nostalgia or comfort, influence food choices (FAO, 2017; WHO, 2020).

Consequences of Food Culture and Preferences

- Dietary diversity: Cultural and personal preferences can influence dietary diversity and nutrient intake.

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- Food waste: Cultural and personal preferences can contribute to food waste and inefficient food use.
- Health outcomes: Food culture and preferences can influence health outcomes, including the risk of chronic diseases (FAO, 2017; WHO, 2020).

c. Socioeconomic Factors

Socioeconomic factors, including income, education, and occupation, influence food purchasing power and access to nutritious food. This concept encompasses several dimensions:

i. Income

Food affordability: Income influences the affordability of nutritious food.

Food purchasing power: Income affects the ability to purchase nutritious food.

ii. Education

- Nutrition knowledge: Education influences nutrition knowledge and understanding of healthy eating.
- Food literacy: Education affects the ability to make informed food choices.

iii. Occupation

- Work schedule: Occupation influences work schedule and time available for food preparation and consumption.
- Food environment: Occupation affects the food environment and access to nutritious food (FAO, 2017; WHO, 2020).

Consequences of Socioeconomic Factors

- Food insecurity: Socioeconomic factors can contribute to food insecurity and limited access to nutritious food.
- Health outcomes: Socioeconomic factors can influence health outcomes, including the risk of chronic diseases.
- Economic impacts: Socioeconomic factors can have economic impacts, including reduced economic productivity and increased healthcare costs (FAO, 2017; WHO, 2020).

d. Environmental Factors

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Environmental factors, including climate change, water scarcity, and soil degradation, impact food production and availability. This concept encompasses several dimensions:

a. Climate Change
   - Temperature and precipitation patterns: Climate change affects temperature and precipitation patterns, influencing crop yields and food production.
   - Extreme weather events: Climate change increases the frequency and severity of extreme weather events, impacting food production and availability (FAO, 2017; WHO, 2020).

iii. Water Scarcity
   - Water availability: Water scarcity affects water availability for irrigation and food production.
   - Water quality: Water scarcity can impact water quality, influencing the safety and nutritional value of food.

iv. Soil Degradation
   - Soil fertility: Soil degradation affects soil fertility, influencing crop yields and food production.
   - Soil erosion: Soil degradation can lead to soil erosion, reducing the availability of arable land for food production.

Consequences of Environmental Factors

- Food insecurity: Environmental factors contribute to food insecurity and limited access to nutritious food through climate change, water scarcity, soil degradation, extreme weather events, and loss of biodiversity, ultimately affecting crop yields, food availability, quality, and safety.
- Economic impacts: Environmental factors can have economic impacts, including reduced economic productivity, increased healthcare costs, and damage to infrastructure, ultimately affecting livelihoods, businesses, and national economies.
- Health outcomes: Environmental factors can influence health outcomes by increasing the risk of chronic diseases, such as respiratory problems, heat stress, and waterborne illnesses, ultimately affecting human well-being and quality of life (FAO, 2017; WHO, 2020).

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Food policies and regulations shape the food environment and impact consumer choices in several ways:

- Nutrition labelling: Labels enhance consumer awareness of nutritional content and health claims.
- Food advertising: Advertisements influence preferences and choices.
- Food safety regulations: These ensure the safety and quality of food.
- Food standards: Standards affect the nutritional quality of food products.
- Agricultural subsidies: These shape the production and availability of various food types.
- Agricultural support: Support affects farmers' livelihoods and the sustainability of food systems (Wang, 2024; FAO, 2017; WHO, 2020).

Consequences of Food Policies and Regulations

The consequences of food policies and regulations are multifaceted, influencing various aspects of the food system and human health Hawkes, Jewell, Allen, 2015; International Food Policy Research Institute [IFPRI], 2016; Organisation for Economic Co-operation and Development [OECD], 2017; Swinburn, Sacks, and Ravussin, 2011; WHO, 2019).

i. Food choices: Food policies and regulations influence food choices and dietary patterns through clear labeling, advertising restrictions, taxes, subsidies, zoning regulations, food assistance programs, public education, food safety regulations, food standards, and infrastructure investments, all of which enable consumers to make healthier choices.
ii. Health outcomes: Food policies and regulations can impact health outcomes by influencing the risk of chronic diseases, such as obesity, diabetes, and heart disease, through the promotion of healthy food choices and environments.
iii. Economic impacts: Food policies and regulations can have economic impacts, affecting food prices, agricultural livelihoods, and the overall economy, with potential benefits

including increased employment and revenue, and potential costs including increased production expenses and reduced competitiveness.

e. Healthcare and Nutrition Education

Healthcare and nutrition education refer to the availability and accessibility of healthcare services and nutrition education programs that provide guidance on healthy eating and nutrition.

This concept encompasses several dimensions:

i. Food choices: Food policies and regulations influence food choices and dietary patterns through clear labelling, advertising restrictions, taxes, subsidies, zoning regulations, food assistance programs, public education, food safety regulations, food standards, and infrastructure investments, all of which enable consumers to make healthier choices (WHO, 2019; Hawkes et al., 2015).

ii. ii. Health outcomes: Food policies and regulations can impact health outcomes by influencing the risk of chronic diseases, such as obesity, diabetes, and heart disease, through the promotion of healthy food choices and environments (WHO, 2019; Swinburn et al., 2011).

iii. iii. Economic impacts: Food policies and regulations can have economic impacts, affecting food prices, agricultural livelihoods, and the overall economy, with potential benefits including increased employment and revenue, and potential costs including increased production expenses and reduced competitiveness (OECD, 2017; IFPRI, 2016).

Consequences of Limited Access to Healthcare and Nutrition Education

i. Impaired Nutrition Knowledge: Limited access to healthcare and nutrition education can lead to inadequate nutrition knowledge.

ii. Poor Nutrition Practices: Limited access to healthcare and nutrition education can contribute to poor nutrition practices.

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iii. Poor Health Outcomes: Limited access to healthcare and nutrition education can lead to poor health outcomes, including increased risk of chronic diseases (Swinburn et al., 2011; Hawkes et al., 2015; IFPRI, 2016; OECD, 2017; WHO, 2019)

III. Concept of Value Chain in Food Systems, Nutrition, and Health

The value chain is an essential framework for understanding the complex interactions within food systems, nutrition, and health (FAO, 2014). A value chain refers to the series of activities and processes that create value for consumers, from the production of raw materials to the delivery of final products (Kaplinsky & Morris, 2001).

Origins:

The value chain concept was first introduced by Michael Porter, a renowned American economist and Harvard Business School professor, in his 1985 book "Competitive Advantage: Creating and Sustaining Superior Performance". Porter's work revolutionized the field of strategic management and business competitiveness.

Porter's Value Chain Framework

Porter's original value chain framework consisted of five primaries and four support activities that create value for a company.

Primary Activities

1. Inbound Logistics: receiving, storing, and managing raw materials and inputs.

2. Operations: transforming inputs into products or services.

3. Outbound Logistics: storing, transporting, and delivering products or services to customers.

4. Marketing and Sales: promoting and selling products or services.

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5. Service: providing support and maintenance services to customers.

Support Activities

1. Procurement: purchasing raw materials, goods, and services.

2. Technology Development: developing and implementing new technologies.

3. Human Resource Management: recruiting, training, and managing employees.

4. Infrastructure: managing the company's physical and organizational infrastructure.

Since its introduction, the value chain concept has evolved significantly and is widely utilized across agriculture, manufacturing, services, and technology (Porter, 1985).

1. **Definition and Explanation of Value Chain in the Context of Food Systems, Nutrition, and Health**

A value chain is a series of interconnected activities and processes that enhance the value of a product or service. It encompasses all stages, from production to delivery, ultimately creating value for the end consumer.

Various authors have defined the value chain concept, all converging on the idea that it involves a series of value-adding activities. Some notable definitions include:

- Michael Porter (1985): A value chain comprises activities generating value for a product or service, spanning inbound to outbound logistics.
- Kaplinsky and Morris (2001): A value chain involves activities creating value from production to delivery to the end consumer.
- Gereffi et al. (2005): A value chain is a global network of organizations collaborating to deliver a product or service to consumers.

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- Food and Agricultural Organization, FAO (2014): In agriculture, a value chain involves activities creating value for a product or service, from production to delivery to the consumer.

1. Key Components of the Value Chain in Food Systems, Nutrition, and Health

According to FAO (2014): the agricultural value chain extends from production to consumption, encompassing the following key components:

****Production****: This involves cultivating crops and raising livestock while ensuring the quality and nutritional content of the final products. Sustainable practices like organic farming and conservation agriculture can enhance both sustainability and nutritional value.

****Processing****: This stage transforms raw materials into consumable products, influencing their nutritional value and safety through activities such as cleaning, sorting, grading, packaging, and preservation.

****Marketing****: Marketing facilitates sales to wholesalers, retailers, and consumers, impacting demand and profitability through branding, advertising, and pricing strategies.

****Distribution****: This ensures timely and efficient delivery of products through logistics and transportation, including storage and handling.

****Consumption****: purchasing and using products by consumers, influenced by nutrition knowledge and dietary preferences

These activities collectively form the agricultural value chain, which is crucial for creating value and delivering agricultural products to consumers. Understanding the agricultural value chain is essential for identifying opportunities to improve nutritional value, sustainability, and efficiency

in food systems. By analyzing each stage, stakeholders can work together to create a more equitable, sustainable, and nutritious food system.

Benefits of the Value Chain Approach in Food Systems, Nutrition, and Health

The value chain approach in food systems, nutrition, and health offers significant benefits, including:

1) Improved Efficiency

This approach streamlines processes, reduces waste, and optimizes resources (FAO, 2014). By examining each stage of the value chain, stakeholders can:

- Minimize post-harvest losses through better handling and storage
- Optimize input use, such as water and fertilizers
- Improve logistics and transportation, cutting transit times and costs
- Enhance communication and coordination among actors, reducing errors

Improving efficiency lowers costs, increases productivity, and strengthens competitiveness (Porter, 1985; Kader, 2005; Taylor, 2005; Arnold, 2009; Pretty, Toulmin, and Williams, 2011; FAO, 2014;)

2) Increased Income

A value chain approach can boost profitability for farmers and other participants. By identifying ways to add value to products, actors can:

- Enhance product quality and safety, driving demand and prices
- Develop new products and markets, expanding sales opportunities
- Improve branding and marketing, increasing product visibility
- Negotiate better prices and terms with buyers and suppliers

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Higher income allows value chain actors to improve their economic stability, invest in their businesses, and build resilience against shocks (Henson & Traill, 2007; Sutton-Vermeulen, 2017; Kotler & Keller, 2016; Consultative Group on International Agricultural Research [CGIAR], 2019).

3) Enhanced Food Security

This approach also increases access to nutritious food, thereby enhancing food security. By improving the efficiency of the value chain, actors can:

- Boost the availability of nutritious food, especially for vulnerable groups
- Improve food quality and safety, reducing foodborne illness risks
- Make nutritious food more affordable for low-income consumers
- Promote sustainable agricultural practices, minimizing environmental impacts

By enhancing food security, value chain actors contribute to better health and well-being outcomes for vulnerable populations (WHO, 2018; Codex Alimentarius, 2018; ILO, 2018; IPCC, 2019).

III. Value Chain Approach to Addressing Malnutrition

1. Identifying Critical Points in the Value Chain

Malnutrition is a complex issue that requires a multifaceted approach. A value chain approach can help address malnutrition by identifying critical points where nutritional value can be enhanced, from production to consumption (FAO, 2013). This approach recognizes that each stage of the value chain offers opportunities to improve the nutritional quality of food products.

2. Strategies to enhance nutritional value of food products

Some strategies to enhance nutritional value through the value chain approach include:

1. *Fortification*: Adding micronutrients to food products during processing can help address micronutrient deficiencies. Fortification can be applied to various food products, such as staple crops, dairy products, and snack foods. For example, iron fortification of flour has been shown to reduce iron deficiency anemia in many countries (WHO, 2018).
2. *Biofortification*: Breeding crops to enhance their nutritional content can provide a sustainable solution to addressing micronutrient deficiencies. Biofortification can be applied to various staple crops, such as sweet potatoes, maize, and wheat. For example, vitamin A-enriched sweet potatoes have been shown to improve vitamin A status in children (Low, Arimond, Osman, Cunguara, Zano, and Tschirley, 2007).
3. *Breeding for nutrition*: Developing crop varieties with improved nutritional profiles can help address micronutrient deficiencies. This approach involves identifying and breeding crop varieties that are rich in essential micronutrients. For example, researchers have developed zinc-enriched wheat varieties that can help address zinc deficiency in many parts of the world (Cakmak, 2008).

In addition to these strategies, other approaches can be applied throughout the value chain to enhance nutritional value, including:

Agronomic practices: Implementing good agronomic practices, such as crop rotation and organic farming, can help improve the nutritional quality of crops.

Post-harvest handling: Proper post-harvest handling and storage can help reduce nutrient losses and maintain the nutritional quality of food products.

** *Food processing***: Food processing techniques, such as drying and fermentation, can help preserve nutrients and enhance the nutritional quality of food products.

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Consumer education: Educating consumers about the importance of nutrition and how to prepare nutritious meals can help promote healthy eating habits.

Stakeholders can work together to create a more nutritious and equitable food system through collaborative efforts that prioritize nutrition and sustainability throughout the value chain.

3. Role of value chain actors in promoting nutrition

Value chain actors play a crucial role in promoting nutrition. For example:

1. Farmers: Can adopt practices that enhance nutritional content, such as using organic fertilizers and crop rotation to improve soil health.
2. Agricultural Cooperatives: Can provide education, resources, and support to farmers, helping them understand the benefits of sustainable agriculture.
3. Researchers: Can conduct studies to identify high-nutrient crops, develop new technologies, and promote their cultivation, contributing to food systems that prioritize health and wellness.
4. Governments: Can implement policies that support sustainable farming practices, offer incentives for environmentally-friendly methods, and grant access to research that promotes innovation in nutrition-rich agriculture.
5. Consumers: Can demand more nutrient-dense options by choosing local and organic produce, supporting farmers who prioritize sustainability and better nutrition in their products.
6. Processors: Can fortify products, use nutrient-rich ingredients, and adopt processing techniques that preserve nutrients.
7. Retailers: Can promote nutritious products, provide nutrition education to consumers, and create an enabling environment for healthy food choices.
8. Food Distributors: Can ensure that nutritious foods reach underserved communities, reducing food deserts and improving access to healthy options.

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9. Policymakers: Can create regulations and incentives that encourage the production and sale of nutritionally enhanced foods, supporting agricultural practices that prioritize health.
10. NGOs and Advocacy Groups: Can raise awareness about the importance of nutrition, collaborate with various actors in the value chain, and implement programs that promote better dietary choices.
11. Educators: Can integrate nutrition education into school curriculums, providing the next generation with knowledge on the importance of balanced diets and healthy eating habits.

Collaboration among these actors can establish a sustainable, health-oriented food system that benefits individuals and communities. Their joint efforts promote economic growth and cultivate a culture that values nutrition for everyone.

IV. Climate Action and Environmental Resources in the Value Chain

Climate change and environmental degradation pose significant threats to agricultural value chains, impacting food security, nutrition, and the livelihoods of millions of people. Rising temperatures, changing precipitation patterns, and increased frequency of extreme weather events can have far-reaching consequences.

1. Impact of Climate Change on Agricultural Value Chains

According to some researchers (CABI, 2017; CBD, 2019; FAO, 2015, 2016; IPCC, 2019; WWAP, 2019), the effects of climate change on agricultural value chains can be severe:

1. *Reduced Crop Yields*: Changes in temperature and precipitation patterns can lead to reduced crop yields, impacting food security and nutrition.
2. *Altered Growing Seasons:* Shifts in temperature and precipitation patterns can disrupt traditional farming practices, requiring farmers to adapt to new growing seasons.

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3. *Increased Pest and Disease Pressure:* Warmer temperatures and changing precipitation patterns can increase the spread of pests and diseases, requiring increased use of pesticides and other chemicals.
4. *Water Scarcity:* Changes in precipitation patterns can lead to water scarcity, impacting crop growth and food production.
5. *Loss of Biodiversity:* Climate change can lead to the loss of biodiversity, reducing the resilience of agricultural ecosystems.
6. *Soil Degradation:* Increased temperatures and changing precipitation patterns can lead to soil degradation, reducing soil fertility and affecting crop yields.

2. Strategies to promote climate-resilient agriculture

To promote climate-resilient agriculture, value chain actors can adopt sustainable practices that reduce greenhouse gas emissions, improve soil health, and enhance resilience to climate change. The following strategies can be employed:

A. Sustainable Agriculture Practices

- *Conservation Agriculture:* Reducing tillage, retaining crop residues, and using cover crops to reduce soil erosion, improve soil health, and promote biodiversity (Hobbs et al., 2008).
- *Agroforestry:* Integrating trees into farming systems to enhance biodiversity, reduce erosion, and promote ecological interactions (Nair, Kumar and Nair, 2009).
- *Organic Farming:* Using natural methods to control pests and diseases, and promote soil fertility (Lotter, 2003).
- *Regenerative Agriculture:* Focusing on regenerating soil health, biodiversity, and ecosystem services through practices like no-till or reduced-till farming, cover cropping, and integrating livestock grazing (Griscom, Adams, Ellis, Houghton, Lomax, Miteva., ... & Woodbury, 2017).

- *Integrated Pest Management (IPM):* Using a combination of techniques to manage pests and diseases, reducing the use of chemical pesticides and maintaining ecosystem balance (FAO, 2015).

B. Climate-Smart Agriculture

- Climate Information Services: Providing farmers with climate information and forecasts to inform planting, harvesting, and other decisions (Hansen, Mason, Sun and Tall, 2011).
- Climate-Resilient Crop and Animal Varieties: Developing and using crop and animal varieties that are tolerant to extreme weather events, such as droughts and floods (Ceccarelli, Grando, Maatougui, Michael, Slash, Haghparast, R., ... & Nachit, 2010).
- Soil Conservation and Management: Implementing practices that reduce soil erosion, improve soil health, and promote water retention (Lal, 2004).
- Water Harvesting and Conservation: Collecting and storing rainwater, and using efficient irrigation systems to reduce water waste (Oweis, Hachum, and Kijne, 2012).
- Ecosystem-Based Adaptation: Restoring and preserving natural ecosystems, such as wetlands and forests, to provide ecosystem services and reduce vulnerability to climate change (MEA, 2005).

C. Other Strategies

- Crop Diversification: Planting multiple crops to reduce dependence on a single crop and promote ecological interactions (Lin, 2011).
- Livestock Grazing Management: Implementing practices that promote soil health, reduce erosion, and maintain ecosystem balance (Braun, Thiele, and Fernández, 2000).
- Farmers' Field Schools: Providing training and education to farmers on climate-resilient agriculture practices (Braun et al., 2000).

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- Climate Insurance: Providing insurance products that protect farmers from climate-related risks, such as crop failure or livestock death (Greatrex, Hansen, Garvin, Diro, Blakeley, Le Guen... & Suarez, 2015).
- Policy and Regulatory Support: Encouraging policy and regulatory frameworks that support climate-resilient agriculture practices (FAO, 2017).

3 Role of environmental resources (water, soil, biodiversity) in maintaining healthy and sustainable value chains

Environmental resources, including water, soil, and biodiversity, are vital for healthy and sustainable value chains, underpinning agricultural productivity, food security, and ecosystem health. Value chain actors can adopt practices that conserve these resources, thereby reducing the environmental impact of agricultural production and fostering sustainable development.

A. Water Resources

Water is essential for agriculture, and its conservation is crucial due to increasing water scarcity and competition for this limited resource. Practices include:

- Water Harvesting: Collecting and storing rainwater for irrigation to lessen reliance on groundwater.
- Drip Irrigation: Efficient systems that deliver water directly to plant roots, minimizing evaporation and runoff.
- Drought-Tolerant Crop Selection: Choosing crops that require less water to decrease demand on water resources.

B. Soil Resources

Soil conservation is critical for agriculture and sustainable value chains, as soil degradation can lead to reduced fertility and increased erosion. Practices include:

- Conservation Tillage: Reducing tillage frequency and intensity to minimize erosion and enhance soil health.

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- Cover Cropping: Planting cover crops to prevent soil erosion, improve soil health, and support beneficial insects.
- Crop Rotation: Rotating crops to enhance soil fertility, control pests and diseases, and promote beneficial insects (Snapp, Swinton, Labarta, Mutch, Black, Leep, Nyiraneza, & O'Neil, 2005)

C. *Biodiversity Resources*

Biodiversity is essential for sustainable ecosystems and agricultural productivity, providing ecosystem services like pollination and pest control. Practices include:

- Agroforestry: Integrating trees into farming systems to boost biodiversity and reduce soil erosion.
- Crop Diversification: Growing various crops to enhance biodiversity and mitigate pests and diseases.
- Ecological Restoration: Reviving degraded ecosystems to support biodiversity and provide habitats for beneficial insects.

Through the adoption of these sustainable practices, value chain actors can minimize their ecological footprint, foster sustainable growth, and ensure the long-term viability of their value chains (United Nations Environment Programme [UNEP], 2011).

V. Case Studies and Examples

Several successful value chain initiatives have addressed malnutrition and promoted sustainable agriculture practices. These initiatives demonstrate the potential for value chain approaches to improve nutrition, enhance sustainability, and promote equitable economic growth. Some examples include:

a) Biofortification Initiatives

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Programmes that promote biofortified crops, such as vitamin A-enriched sweet potatoes, iron-enriched beans, and zinc-enriched wheat, have been successful in addressing micronutrient deficiencies. For instance:

- The HarvestPlus programme, led by the International Food Policy Research Institute (IFPRI) and the International Center for Tropical Agriculture (CIAT), has developed and disseminated biofortified crops in several countries, including Uganda, Rwanda, and Bangladesh.
- The Vitamin A-enriched sweet potato initiative in Mozambique, supported by the International Potato Center (CIP) and the Mozambican Ministry of Agriculture, has improved vitamin A intake among rural communities.
- The Biofortification Initiative in Nigeria, supported by the International Institute of Tropical Agriculture (IITA) and the Nigerian Federal Ministry of Agriculture has promoted the adoption of biofortified crops, such as vitamin A-enriched cassava and maize, among smallholder farmers.

b) Sustainable Agriculture Programmes

Initiatives that promote conservation agriculture, agroforestry, and other sustainable practices have enhanced climate resilience and reduced environmental degradation. Examples include:

- The Conservation Agriculture Scaling-Up (CASU) project in Zambia, supported by the African Conservation Tillage Network (ACTN) and the Zambian Ministry of Agriculture, has promoted conservation agriculture practices among smallholder farmers, improving soil health and reducing erosion.
- The Agroforestry and Sustainable Agriculture Practices (ASAP) project in Indonesia, supported by the World Agroforestry Centre (ICRAF) and the Indonesian Ministry of Agriculture, has promoted agroforestry practices among smallholder farmers, improving biodiversity and reducing deforestation.

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- The Sustainable Agriculture Programme in Nigeria, supported by the Nigerian Federal Ministry of Agriculture and the African Development Bank, has promoted sustainable agriculture practices, such as conservation agriculture and agroforestry, among smallholder farmers in several states.

c) Value Chain Development Programmes

Projects that support smallholder farmers and other value chain actors to improve productivity, quality, and market access have been successful in enhancing the competitiveness and sustainability of value chains. Examples include:

- The African Cashew Initiative (ACI), supported by the German Agency for International Cooperation (GIZ) and the African Cashew Alliance (ACA), has improved the productivity and quality of cashew production among smallholder farmers in several West African countries.
- The Sustainable Coffee Program (SCP) in Colombia, supported by the Colombian Coffee Growers Association (FNC) and the International Coffee Organization (ICO), has promoted sustainable coffee production practices among smallholder farmers, improving their livelihoods and reducing environmental impacts.
- The Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL) program, supported by the Central Bank of Nigeria and the Nigerian Federal Ministry of Agriculture, has provided financing and technical support to smallholder farmers and agribusinesses, improving their productivity and market access.

These case studies and examples demonstrate the potential for value chain initiatives to address malnutrition, promote sustainable agriculture practices, and enhance the competitiveness and sustainability of value chains.

VI. Conclusion

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The application of the value chain approach to address malnutrition is a critical step towards achieving sustainable development goals. This report has highlighted the importance of integrating nutrition, agriculture, climate action, and environmental resources to address malnutrition.

Recap of Key Points

The key points from this report can be summarized as follows:

- Malnutrition is a significant development challenge that requires a multi-faceted approach.
- The value chain approach offers a framework for integrating nutrition, agriculture, climate action, and environmental resources to address malnutrition.
- Sustainable agriculture practices, such as conservation agriculture and agroforestry, can improve agricultural productivity and reduce environmental degradation.
- Climate action and environmental resources are critical for maintaining healthy and sustainable value chains.
- Successful value chain initiatives have been implemented in various countries, including Nigeria.

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