Faculty of Tropical AgriSciences

Cambodia's Agrifood Systems & Priority Value Chains

Session1 of the training course *Processing, storage, packaging & marketing of plant-based products*

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Learning objectives

By the end of this session, participants will be able to:

- Describe the structure of Cambodia's agrifood system.
- Identify major plant-based value chains and their economic roles.
- Explain production and export trends for key crops.
- Recognize bottlenecks, postharvest loss points, and opportunities.
- Apply value chain mapping as a teaching and analytical tool.

Why value chains matter for universities?

Why Value Chains Matter for Universities

- Connect research and teaching to real agrifood challenges
- Identify opportunities for innovation and value addition
- Strengthen links with farmers, processors, local industry (SMEs), cooperatives, exporters
- Improve student skills with practical, system-based understanding
- Support national development goals and rural livelihoods

Cambodia’s agrifood system in brief

Cambodia’s Agrifood System in Brief

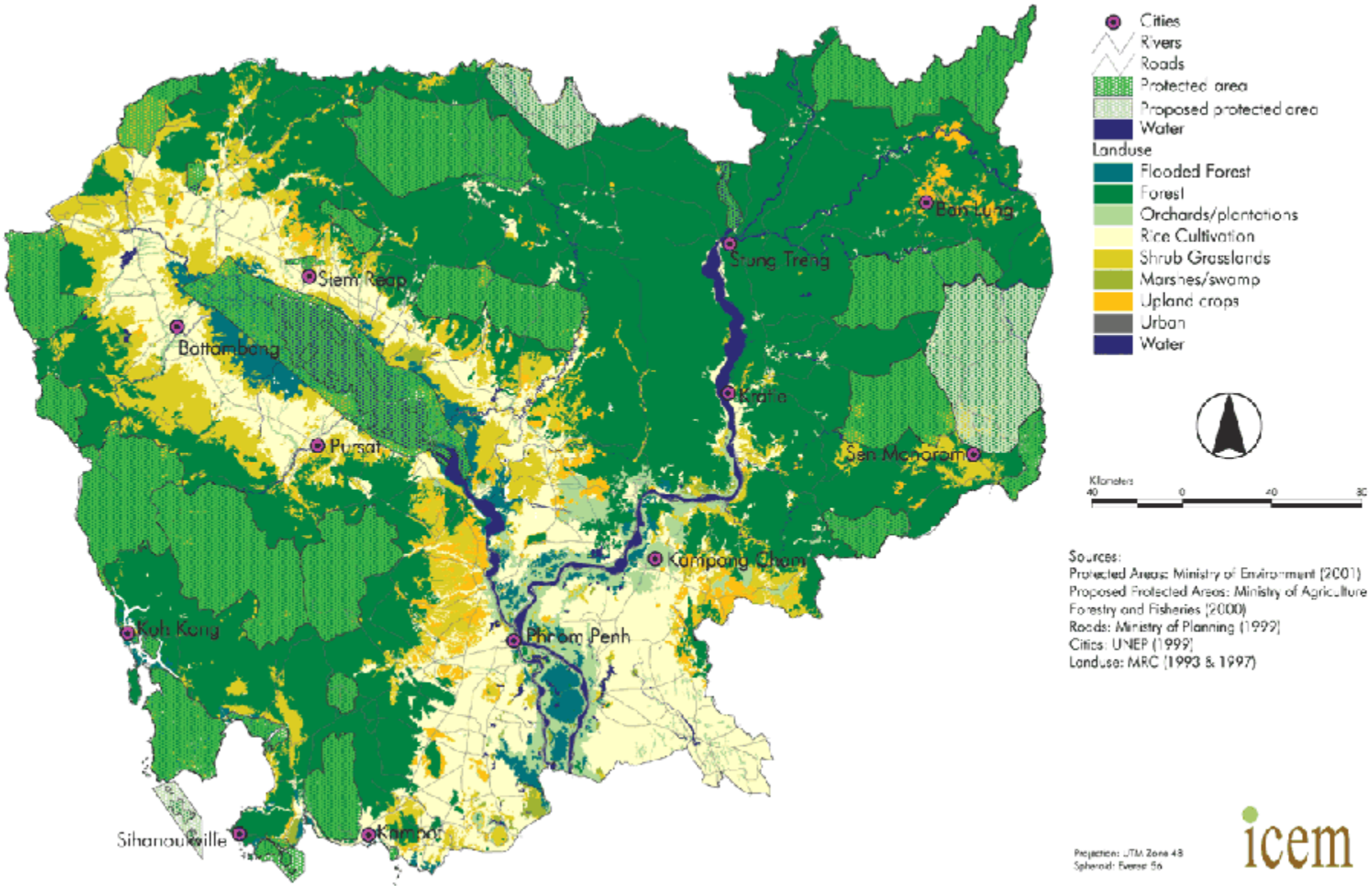
- Agriculture = major pillar of the economy
- Majority of rural households depend on farming
- Plant-based crops dominate national production
- Strong regional trade linkages (Thailand, Vietnam, China)
- High vulnerability to climate, market fluctuations, and postharvest losses

Agriculture’s role in national economy

Agriculture’s Role in the National Economy

- approx. 20–25% of national GDP (variable by year)
- approx. 70% of the population involved in agriculture/rural livelihoods
- crop production = major contributor to export earnings
- strong link to poverty reduction and rural development
- processing and value addition still limited but growing

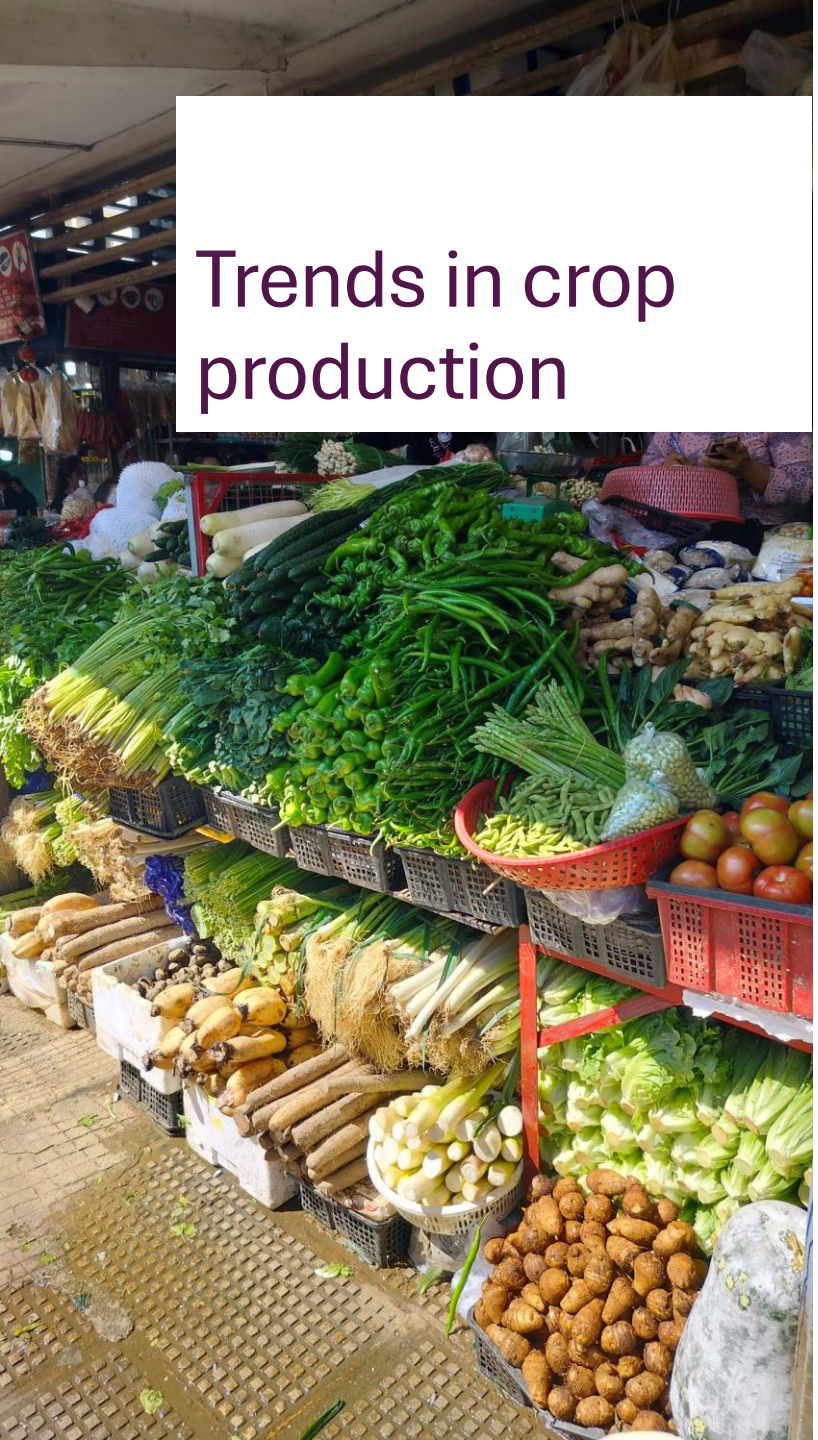
Key production regions



Key Production Regions in Cambodia
(Map Showing Main Crop Areas)

- Rice: Battambang, Pursat, Prey Veng, Takeo
- Cassava: Pailin, Kampong Cham, Steung Treng
- Mango: Kampong Speu, Battambang, Kampong Thom
- Cashew: Kampong Thom, Ratanakiri, Mondulkiri
- Pepper: Kampot, Tbong Khmum
- Vegetables: Siem Reap, Battambang, Kandal, peri-urban areas

Trends in crop production



Trends in Crop Production (last 10–15 years)

- Rice:
  - relatively stable area
  - improved milling quality
  - growth in fragrant & premium segments
- Cassava
  - rapid expansion, strong demand from Vietnam/Thailand/China
- Mango
  - growth driven by export
  - processing opportunities?
- Cashew:
  - expanding area
  - more local shelling & drying, but kernel export still dominated by Vietnam
- Vegetables
  - rising demand from urban consumers
- Pepper
  - growth then stabilization after price correction

Export markets & trade flows

Export Markets & Trade Flows

- Rice: China, EU, ASEAN
- Cassava: Vietnam, Thailand, China
- Mango: China (fresh), Vietnam/Thailand (processing)
- Cashew: Vietnam (kernels and semi-processed)
- Pepper: EU, USA, regional specialty markets
- Dependence on neighbouring countries for processing and trade

Challenges & opportunities

Challenges:

- High postharvest losses (20–40% for perishables)
- Limited cold chain and storage capacity
- Quality variability and inconsistent grading
- Reliance on neighbouring processors and traders

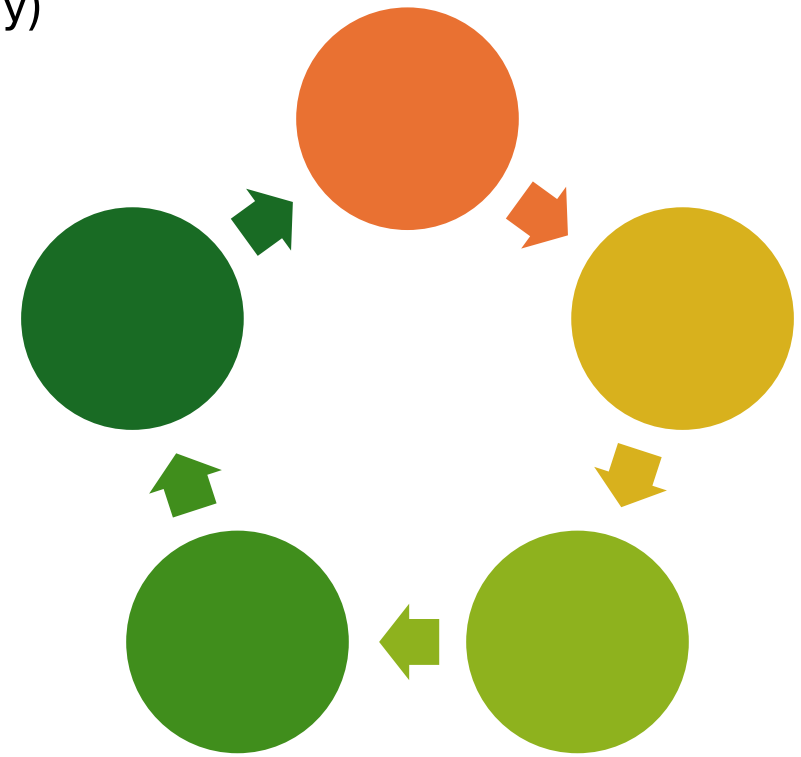
Opportunities:

- Growth in drying, packaging, and small-scale processing
- Expanding export channels for mango, cashew, pepper
- Demand for food safety and quality improvements
- Innovation and research from universities

Typical Value Chain Structure

Generic Plant-Based Value Chain Stages

- Input supply (seed/cuttings, fertiliser, agrochemicals, advisory)
- Production (smallholders, larger farms, contract farms)
- Harvesting & postharvest handling
  - Maturity, cutting, field packing
- Aggregation & primary processing
  - Drying, cleaning, grading, storage
- Secondary processing
  - Milling, extraction, fermentation, frying, packaging
- Distribution & marketing
  - Wholesalers, retailers, online shops, exporters
- End markets
  - Domestic consumers, regional trade, niche premium markets

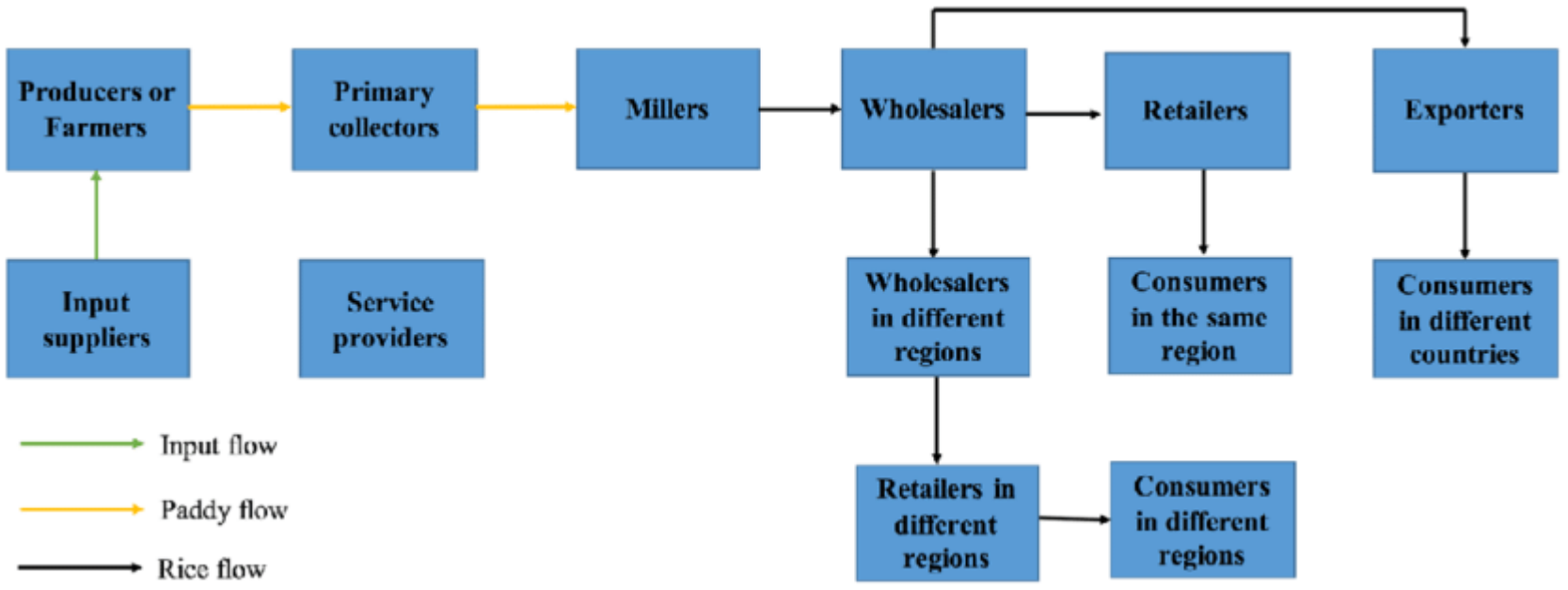


Overview of priority crops

Cambodia’s Priority Plant-Based Crops

- Rice
- Cassava
- Mango
- Cashew
- Pepper
- Banana
- Vegetables

Rice value chain



Key issues:
moisture control · quality grading · milling yields · market access

Rice Value Chain Overview

Main stages:

- Input supply
- Production
- Harvesting & postharvest handling
- Drying & storage
- Milling
- Traders and wholesalers
- Export markets & domestic consumption

DOI:10.1186/s40100-019-0128-6

Rice issues

Lipid oxidation (rancidity)

- Rice bran contains **lipase, lipoxygenase**, and unsaturated lipids.
- When rice is milled or stored improperly, these enzymes generate **off-aromas and rancid flavours**.
- This is one of the main quality limitations of brown rice.

Phenolic compounds in the bran (anti-nutritional but not toxic)

- Rice bran contains **phytic acid**, **phenolics**, and **tannins**.
- Phytic acid is sometimes considered an anti-nutrient because it binds minerals, but it is not toxic.

Arsenic accumulation (environmental, not plant-derived)

- **rice can accumulate inorganic arsenic** from flooded paddy soils, especially in:
  - areas with natural geogenic arsenic
  - land irrigated with contaminated groundwater
- This is a **food safety issue**, particularly for polished rice and rice-based infant foods

Pest- and mould-related issues during storage

- Rice grains can suffer from:
  - **insect infestation**, leading to grain breakage and heating
  - **mould growth**, especially *Aspergillus* and *Penicillium*
  - in rare cases, **mycotoxin contamination**, but much lower risk than maize or nuts
- These problems relate to moisture and storage conditions.

Aflatoxins in rice

- What are aflatoxins?
  - secondary metabolites produced mainly by *Aspergillus flavus, A. parasiticus,* and *A. nomius*
- Major types: AFB1, AFB2, AFG1, AFG2
- AFB1 is the most toxic and classified as a Group-1 human carcinogen
- Why rice is vulnerable
  - grown in hot, humid tropical climates – ideal for fungal development
  - flooding, heavy rainfall near harvest, inadequate sun-drying and poor storage increase contamination risk
- Worldwide occurrence
  - Asia: high prevalence; contamination ranges from <LOD to >300 µg/kg depending on country (India, Pakistan, Malaysia, Vietnam)
  - Africa: often significantly higher, e.g., Nigeria samples up to 309 µg/kg AFB1
  - EU: limit is **2 µg/kg ,** generally lower but imported rice can exceed limits

Aflatoxins in rice

Health effects of aflatoxins

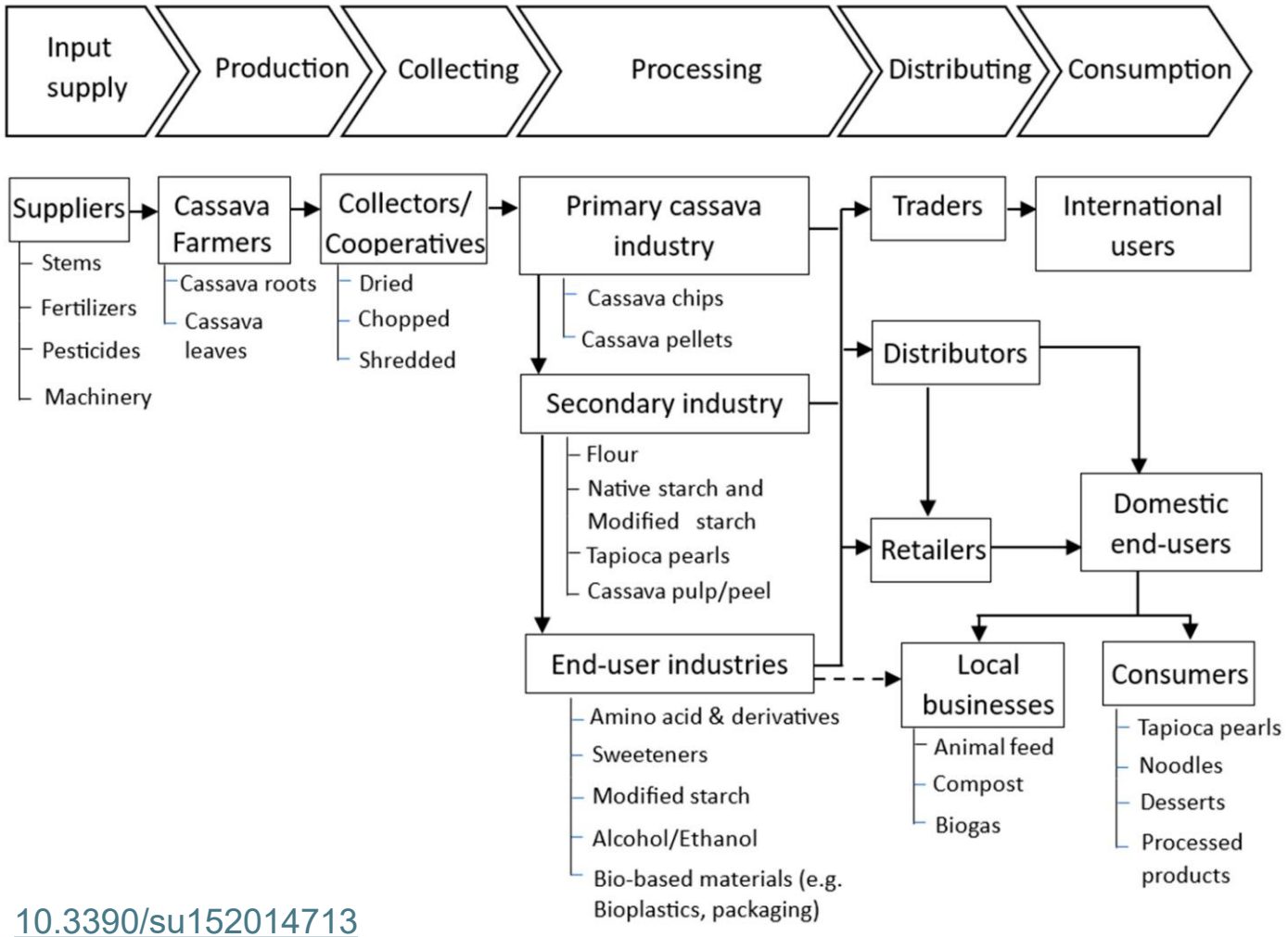
- AFB1 → metabolised to AFB1-8,9-epoxide, binds DNA → hepatocellular carcinoma
- synergistic interaction with hepatitis B virus (HBV) increases liver-cancer risk
- chronic exposure → immune suppression, growth impairment, and possible contribution to kwashiorkor

Regulatory limits

- EU limits: AFB1 ≤ 2 µg/kg, total aflatoxins ≤ 4 µg/kg
- Asian limits vary: China, Japan, Korea = 10 µg/kg AFB1

Prevention & mitigation strategies

- good agricultural practices: avoid delayed harvest, ensure rapid sun-drying to safe moisture (<14%)
- control humidity & temperature during storage
- use HACCP from farm to mill to retail
- promote regular surveillance & biomarker monitoring (urine AFM1, serum AFB1-lysine), especially in high-risk populations



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Cassava Value Chain Overview

Stages:

- Input supply (cuttings, fertilizer)
- Production
- Harvest & transport
- Chipping or whole-root sale
- Drying (sun or mechanical)
- Processing (starch, flour, chips)
- Export to Vietnam/Thailand/China

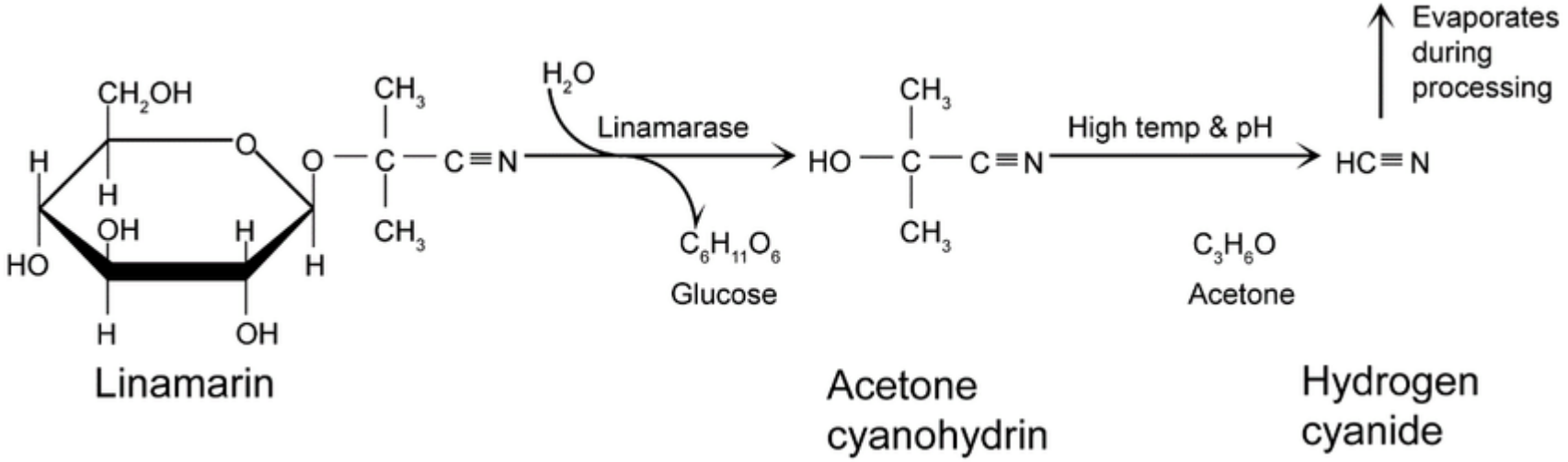
Key issues:

rapid deterioration · cyanogenic compounds · drying delays · price volatility

Principle of cassava toxicity

- cassava contains cyanogenic glycosides, primarily linamarin and lotaustralin
- tissue damage (peeling, grating, mastication) releases the endogenous enzyme linamarase
- enzymatic hydrolysis forms acetone cyanohydrin and methyl ethyl ketone cyanohydrin
- cyanohydrins decompose, especially under heat or high pH, releasing hydrogen cyanide (HCN)

highly volatile toxic liquid



Cassava toxicity

- toxicity depends on cultivar (bitter vs sweet), maturity, plant stress, and processing conditions
- chronic low-level exposure is associated with several deseases
  - konzo, tropical ataxic neuropathy, and disturbances in thyroid and sulphur amino acid metabolism
- proper processing reduces cyanogenic potential by >90%
- regulatory limits: 10 mg HCN/kg for ready-to-eat cassava products
- well-processed cassava flour typically achieves < 2–6 mg/kg

- Typical content:
  - **Sweet cassava (low-cyanide varieties)**
    - 10–50 mg HCN/kg fresh weight
  - **Bitter cassava (high-cyanide varieties)**
    - 50–400 mg HCN/kg fresh weight
  - **Stress-affected or wild varieties (rare extremes)**
    - 500–1 000+ mg HCN/kg under drought, nutrient stress, or pest pressure
    - Some wild bitter types can reach >2 000 mg/kg

Cassava detoxication

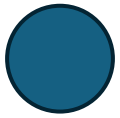
- proper processing (grating, fermenting, drying, retting, boiling) reduces cyanogenic potential by >90%

Efficiency of detoxication

- combined methods (e.g., grating + fermentation + drying) remove 90–98% of cyanogenic potential
- boiling alone removes about 40–60%
- peel removal essential: peels contain 2–5× higher cyanogen content

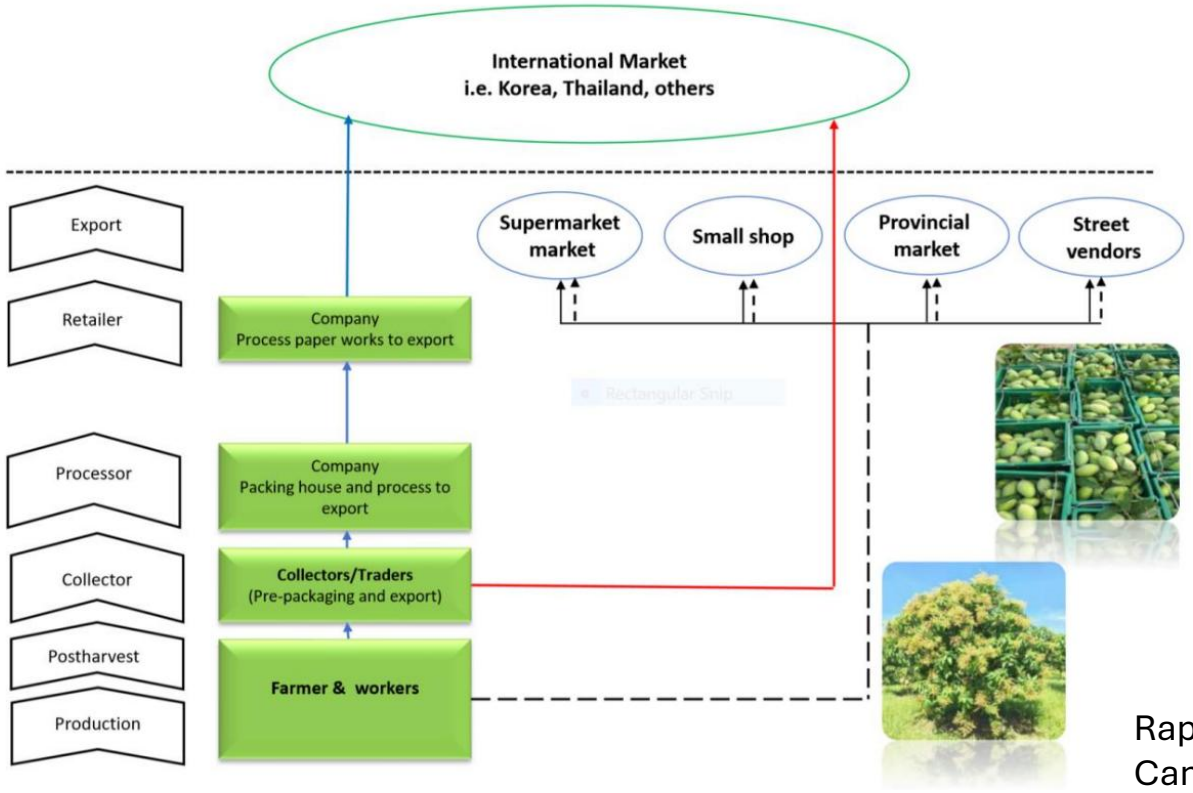
Effective processing methods

- **grating or crushing**: maximises enzyme–substrate contact
- **fermentation** (solid or submerged): microbial β-glucosidases + acidification accelerate cyanogen breakdown
- **pressing/dewatering**: removes cyanogenic liquid fraction
- **sun-drying or oven-drying**: promotes HCN volatilisation
- **boiling, soaking, retting**: leaching + thermal decomposition of cyanohydrins
- **chipping + thin slicing**: increases surface area for hydrolysis and evaporation



Mango value chain

3.1.2 Value Chains Mapping of Mango in Kampong Speu, Battambang and Pailin Provinces



Mango Value Chain & Export Trends

Stages:

- Production (Keo Romeat, Nam Dok Mai)
- Harvesting & latex management
- Sorting & grading
- Hot-water treatment or vapor heat (export)
- Packaging & transport
- Export to China/Thailand/Vietnam
- Processing: puree, dried mango

Key issues: latex burn · bruising · hot-water treatment standards · export specifications

Rapid Assessment of Fruit Value Chain in Cambodia,2020 by Grow Asia and CPSA

Mango latex

- **What is mango latex?**
  - viscous exudate from laticifer canals in pedicel and peel
  - released when the fruit–pedicel junction is broken
  - physiologically designed to seal wounds and deter herbivores
- **Biochemical composition**
  - phenolic compounds (catechols, anacardic acids, cardols)
  - proteolytic enzymes, mainly *polyphenol oxidase* (PPO) and *peroxidase*
  - resins, gums, terpenoids, organic acids
  - small quantities of lipids and volatile aromatics

Mango latex

- **Why latex burns and stains fruits**
  - phenolics oxidised by PPO → brown–black stains
  - sap acids + enzymes damage epidermal cells → surface necrosis
  - latex penetrates lenticels → deep, irreversible pulp discolouration
  - heat + moisture accelerate enzymatic browning and resin polymerisation

- **How to minimise latex contamination**
  - harvest at mature-green stage; avoid early-morning harvest
  - de-sap immediately: invert fruits (stem down) for 20–30 minutes
  - trim pedicel to about 0.5 cm to reduce sap pressure
  - wash with clean water or mild alkaline solution to neutralise residues
  - handle fruits gently, avoid squeezing, bending stems, or dropping fruit
  - use harvest trays, not plastic bags; allow proper drainage
  - maintain shade and cool conditions during harvest and packing

Cashew, pepper & banana (emerging)

Cashew, Pepper & Banana – Emerging and Niche Markets

Cashew:

- Production expanding in Kampong Thom, Ratanakiri
- Processing increasing (shelling, drying, peeling)
- Heavy dependence on Vietnam buyers

Pepper:

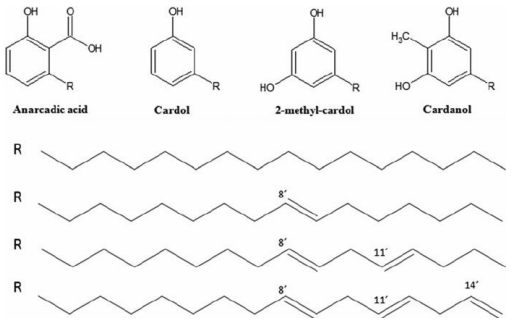
- Kampot pepper: GI product, premium markets
- Requires careful drying and grading

Banana:

- China export market expanding
- Needs strict quality, sorting, and packaging

Toxic components in raw cashew

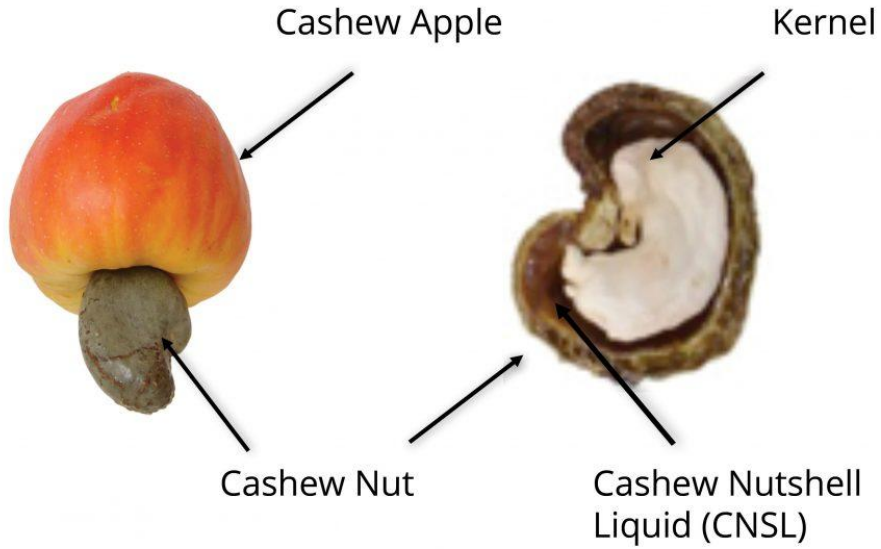
- cashew nut shell contains **Cashew Nut Shell Liquid (CNSL)** = mixture of phenolic lipids:
  - anacardic acids (60–70%)
  - cardols & cardanols (20–30%)
  - these compounds have long alkyl side-chains → lipophilic, penetrate skin easily
  - phenolic OH groups cause protein denaturation, inflammation and necrosis
  - structurally related to urushiol in poison ivy
- raw nut + adhering testa may contain residual CNSL
- heat, pressure, and handling can release CNSL



Poison ivy, *Toxicodendron* sp., Anacardiaceae

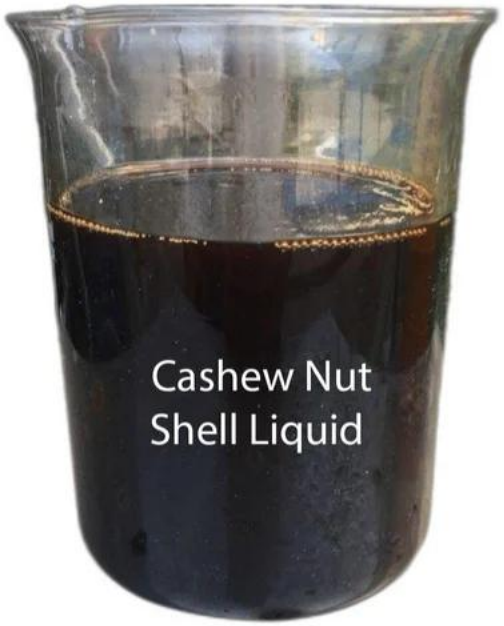
Processing is essential

- raw cashew kernels are *not edible*
- detoxication aims to deactivate skin irritants, remove shell oil, and sterilise the kernel



Cashew detoxication

- steam roasting (100–120°C) – degrades anacardic acids, softens shells
- oil-bath roasting (200–210°C) – burns off CNSL; more efficient but risky
- microwave / drum roasting – controlled CNSL degradation with minimal fumes
- cooling + drying – reduces residual volatiles
- shell removal + peeling – removing testa eliminates residual irritants
- final oven-drying (60–80°C) – stabilises kernel, prevents moulds



In 2022, 471,520 tonnes of raw cashew nuts were exported in total, with just 1,557 tonnes of them processed in Cambodia, according to MAFF reports.

Khmer Times

Banana bruises

Why bananas bruise easily

- fruit has high turgor, thin peel, soft parenchyma
- mechanical impact → cell rupture, polyphenol oxidase (PPO) activation
- oxidation of phenolics → brown/black discoloration

Common causes of bruising & wounds

- dropping bunches during harvesting; friction between hands/fingers
- compression in overfilled baskets, sacks, or motorcycle transport
- poor de-handing technique → crown wounds, latex leakage
- inadequate padding in field trailers & packing houses

Physiological consequences

- increased respiration & ethylene → faster ripening
- pathways for infection → anthracnose & crown rotskin browning reduces market grade, export rejection
- wound latex oxidises → black “latex stain” markings

Minimise damage of banana

- cut bunches with two-person harvesting to avoid dropping
- field handling:
  - use padded crates (not sacks)
  - avoid stacking >2 layers
- gentle de-handing with sanitised knives & wet crowns
- rapid cooling to **14–16°C** after harvest
- avoid sun exposure
- worker training in packing-house hygiene & soft handling

Vegetable chains & cold-chain gaps

Vegetable Value Chains & Cold-Chain Gaps

- Production in peri-urban and rural areas
- Short supply chains to wet markets
- Increasing demand for safe, pesticide-aware produce
- Limited cold storage and refrigerated transport
- High postharvest losses from water loss, heat, and handling

Key opportunities:

- improved washing · grading · low-cost cooling · packaging

Postharvest loss points across major crops

Postharvest Loss Points Across Major Crops

- Rice: high moisture at harvest · poor drying conditions
- Cassava: rapid deterioration · delayed chipping/drying
- Mango: latex burn · bruising · heat exposure
- Vegetables: wilting · water loss · mechanical damage
- Bananas: handling bruises · premature ripening
- Pepper/Cashew: improper drying · contamination

(Losses often 20–40% for perishables)

Introduction to value chain mapping

What Is Value Chain Mapping?

A visual tool that shows:

- Key actors from input supply to consumption
- Product flows and transformations
- Services: finance · transport · storage · certification
- Bottlenecks and opportunities
- Where value is added or lost

Value chain mapping

What is Value Chain Mapping?

- Value chain mapping is a simple visual method for showing how a product moves from its origin to the final consumer, including all key actors, activities, inputs, and flows involved.

- A value chain map helps you:
  - Understand who is involved at each step of production, processing, and distribution
  - See how value is created, transformed, and captured along the chain
  - Identify bottlenecks, risks, and power dynamics
  - Spot opportunities for improving efficiency, equity, or sustainability

- In this exercise, you will create your own value chain map for a tropical agricultural product using only the knowledge already in the room.

Group activity

Objective: Create a basic value chain map for a selected tropical agricultural product.

- Your tasks:
  - Identify all actors in the chain
  - Arrange them in sequence
  - Draw product flows
  - Add inputs, services, and outputs
  - Mark loss points (red)
  - Mark opportunities (green)

Group activity

Objective: Create a basic value cha
agricultural product.

- Your tasks:
  - Identify all actors in the chain
  - Arrange them in sequence
  - Draw product flows
  - Add inputs, services, and outputs
  - Mark loss points (red)
  - Mark opportunities (green)

You can use these questions to guide your mapping:

- Who provides planting material, inputs, or services?
- Who grows, harvests, or collects the product?
- Who processes or transforms it (dries, ferments, or packages)?
- Who transports it from place to place?
- Who buys and sells it along the way?
- How is the product transported, and by whom?
- Who buys and sells it at each stage?
- Where does quality control, grading, or certification occur?
- At which step is value added (e.g., cleaning, processing, labelling)?
- Who benefits most from these value-adding steps?
- Where do delays, losses, or quality problems commonly happen?
- Are some actors at a disadvantage (e.g., limited market access, low prices, few buyers)?
- Where might bottlenecks and risks?