

# Sustainability in the Food Chain

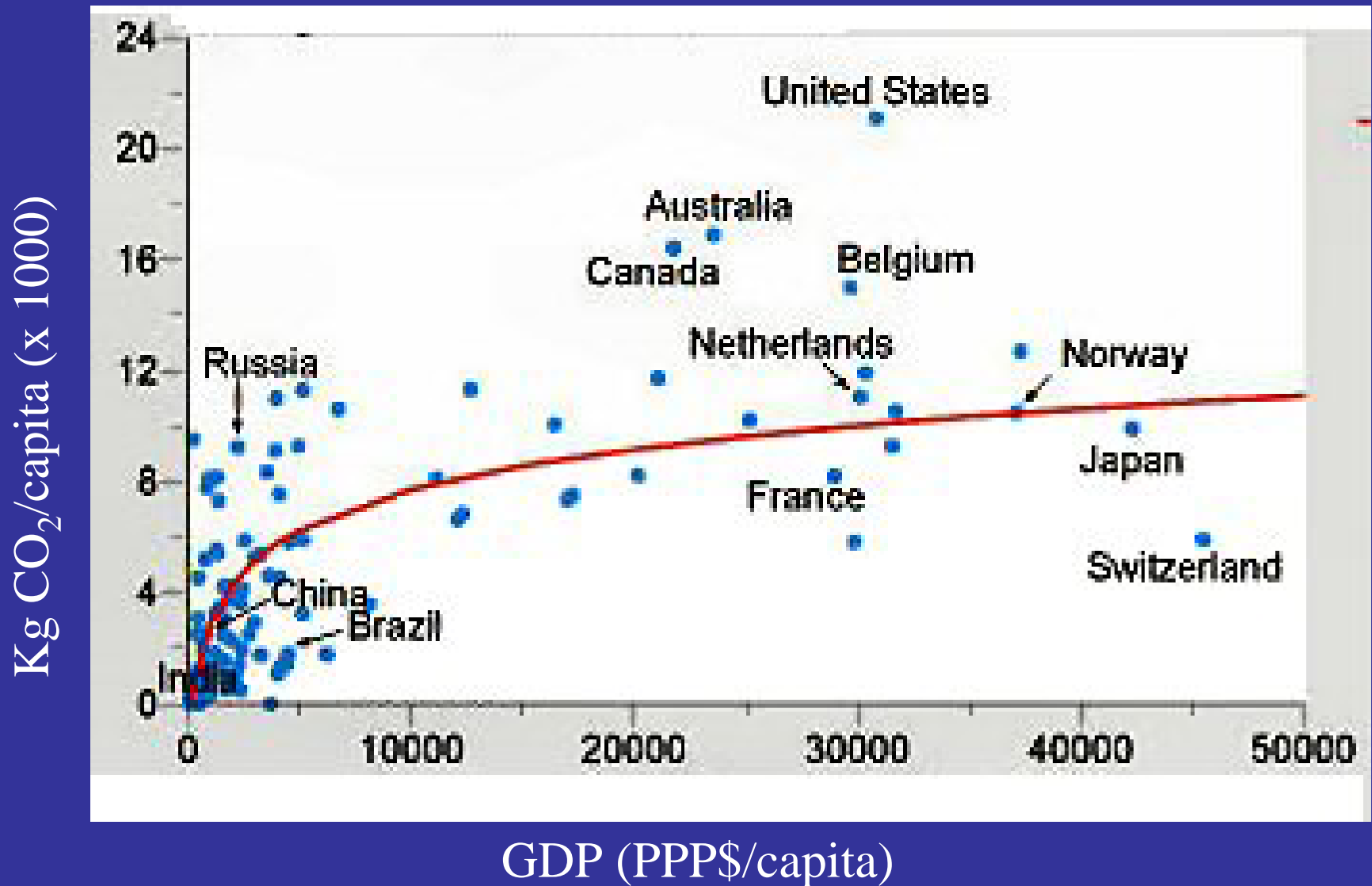
Peter Lillford

Dept. of Engineering,

Birmingham University and

Non-Food Crops Centre, York

# CO<sub>2</sub> emissions and prosperity



## Trends in Materials Use, United States<sup>2</sup>

(million tons and percentage)

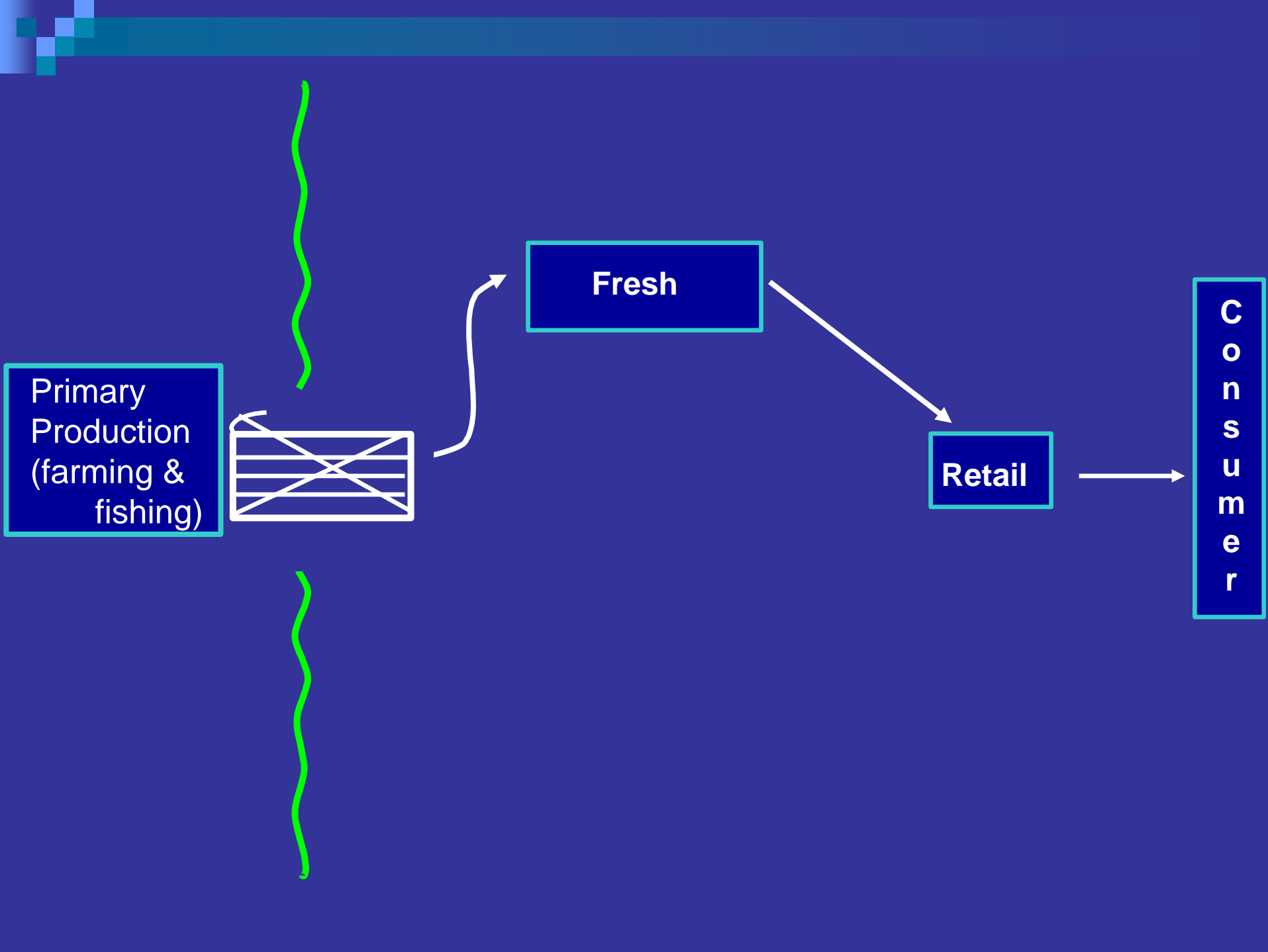
<b>Material</b>	<b>1925</b>	<b>Percentage</b>	<b>1989</b>	<b>Percentage</b>
Plant Matter	362	25.3	726	13.3
Organic Mineral	709	49.5	2229	40.8
Inorganic mineral	360	25.2	2508	46.0
Total	1431	100.0	5463	100

---

<sup>2</sup> David Morris and Irshad Ahmed, *The Carbohydrate Economy: Making Chemicals and Industrial Products from Plants*. Institute for Local Self-Reliance. Washington, D.C. 1993



# What is the Food Chain?

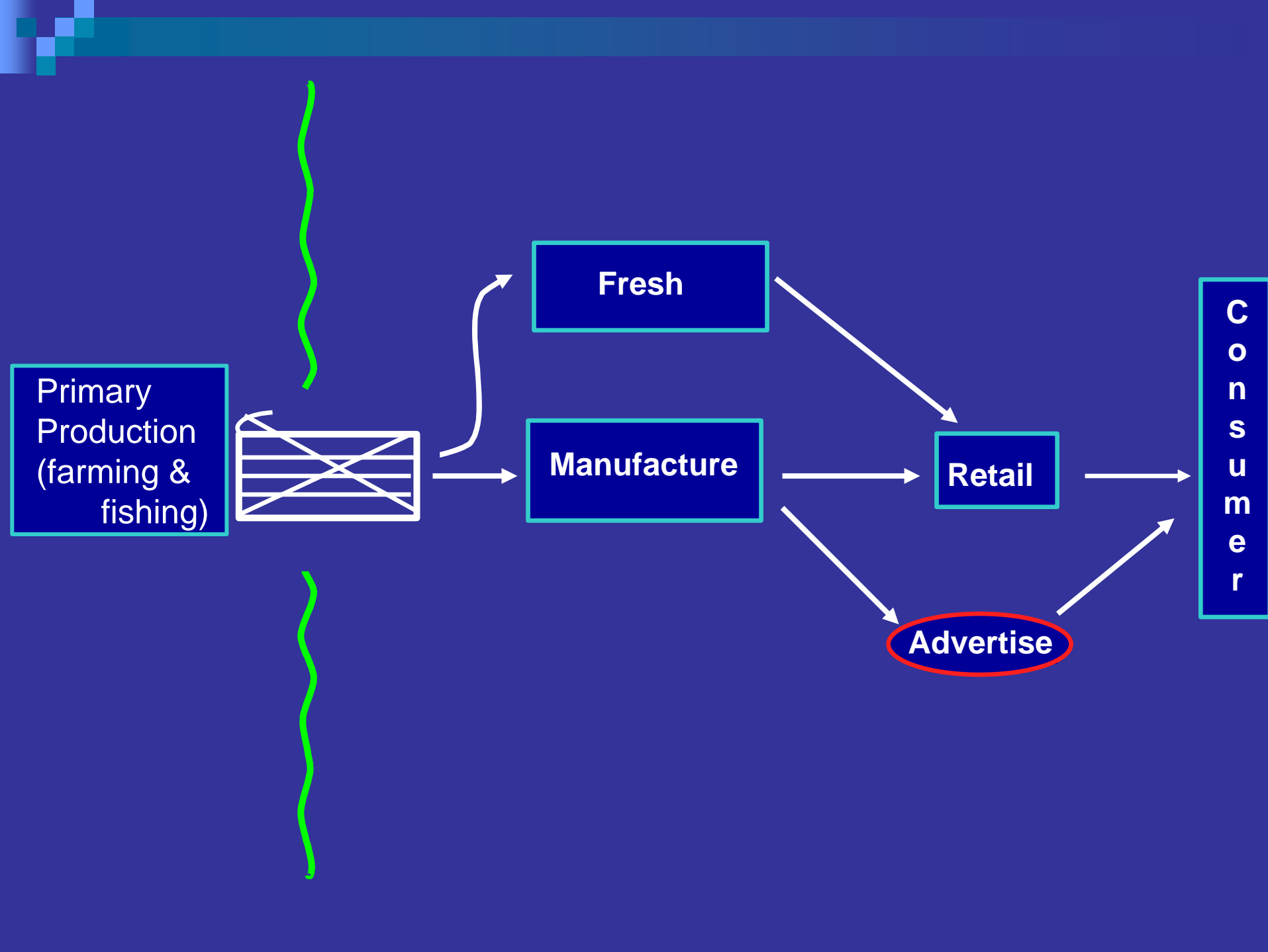


Primary  
Production  
(farming &  
fishing)

Fresh

Retail

C  
o  
n  
s  
u  
m  
e  
r



Primary  
Production  
(farming &  
fishing)

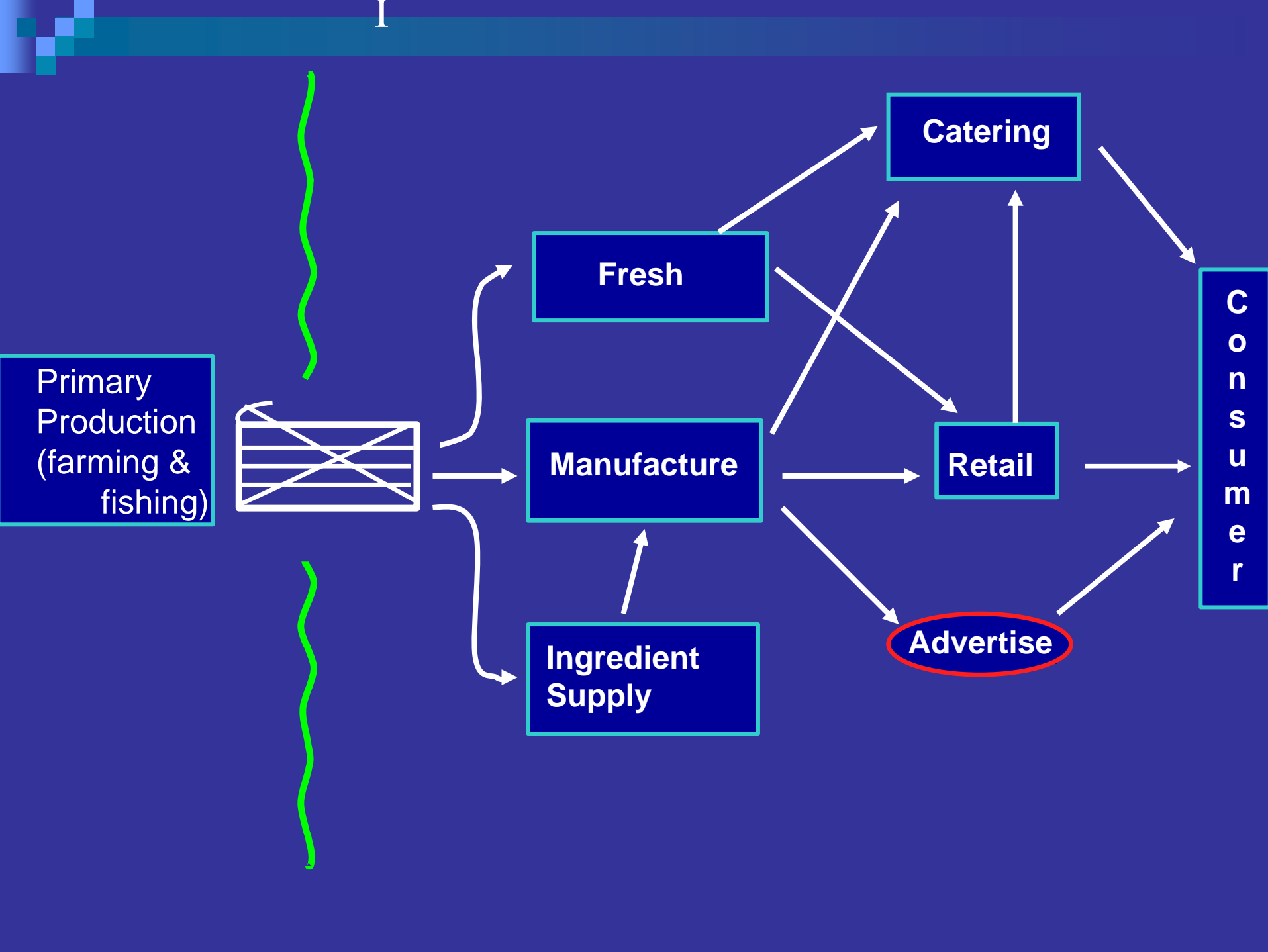
Fresh

Manufacture

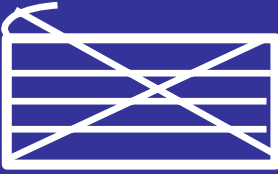
Retail

Advertise

C  
o  
n  
s  
u  
m  
e  
r



Primary  
Production  
(farming &  
fishing)



Fresh

Manufacture

Ingredient  
Supply

Catering

Retail

Advertise

C  
o  
n  
s  
u  
m  
e  
r



# On the Farm

- Inputs and Outputs

## CO<sub>2</sub>e Mass Balances (kgs/annum/h)

	Sugar Cane (Brazil)	Corn (USA)	Rain Forest
CO <sub>2</sub> fixed	40,000	22,000	10,000
CO <sub>2</sub> released			
■ Fertiliser	82	560	
■ Herb/pesticide	60	70	
■ Fuel	1850	590	
■ CH <sub>4</sub> /NO <sub>x</sub>	620	500	
Processing	225	2579	
Distribution	175	83	
Ethanol After burning	13,000	6,000	

# Relative contribution of cultivation practises to lifecycle greenhouse gas emissions from biofuels (Seed to Tank)

Process	Contribution to total lifecycle emissions (%)					
	OSR (biodiesel)		Wheat (bioethanol)		Sugar beet (bioethanol)	
Cultivation	<b>73.3</b>		<b>74.9</b>		<b>44.2</b>	
Fuel and Machinery	31.8		14		30.3	
Seed, fertilisers and soil treatments	<b>39.7</b>		<b>34.5</b>		<b>18.82</b>	
Herbicide, Pesticide, Fungicide	<b>0.15</b>		<b>0.13</b>		<b>0.07</b>	
Soil emissions (N <sub>2</sub> O)	11.86		34.6		8.26	
Reference system (Maintained set-aside)	-10.24		-8.3		-5.01	
Processing and transport	<b>26.6</b>		<b>25</b>		<b>55.8</b>	

# Reduced Carbon Footprint Requires-

## Biorefineries

Biomass for energy

Biofuels

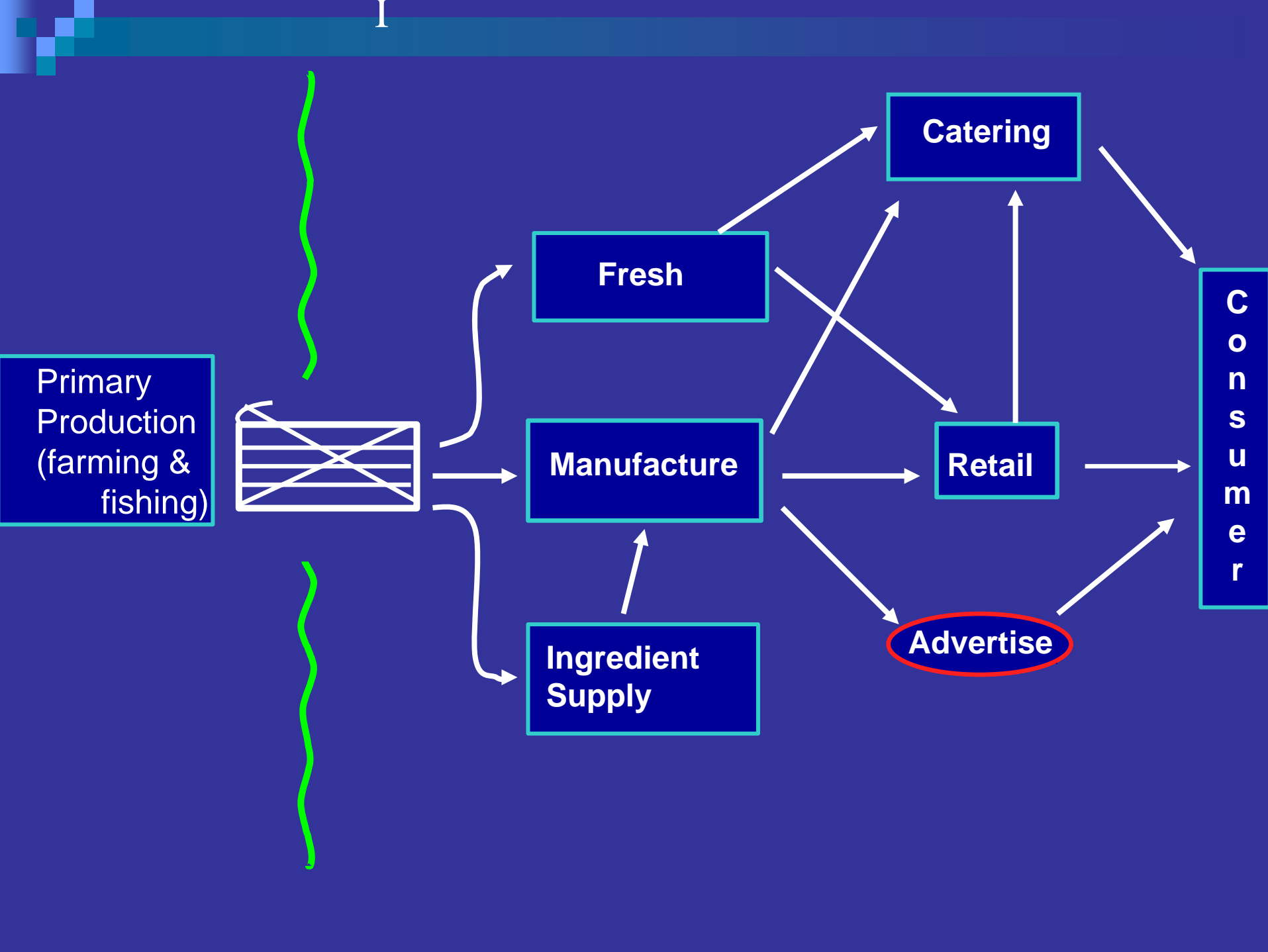
Sustainable Polymers

Construction Materials

Nutraceuticals

Biopharmaceuticals

Same Raw Material-  
competitive business to  
food ?



Primary  
Production  
(farming &  
fishing)

Fresh

Manufacture

Ingredient  
Supply

Catering

Retail

Advertise

C  
o  
n  
s  
u  
m  
e  
r

# Farmgate to Consumer

The food industry accounts for:

14% of energy consumption by UK business

7 million tonnes of carbon emissions per year

10% of all industrial use of the water supply

10% of the industrial and commercial waste stream

25% of all HGV vehicle kilometres in the UK

and

12.5% of the UK's workforce

**From Food Industry Sustainability Strategy (DEFRA)**

# Energy

- **Food and drink manufacturing, food retail and catering sectors** deliver 4% of the UK's annual greenhouse gas (GHG)
- These sectors emit around 26 million tonnes of CO<sub>2</sub>e per year.
- **The food chain as a whole** – from farm to plate, which includes domestic energy use from storing and cooking – is responsible for around 111 million tonnes CO<sub>2</sub>e or approximately 17% of the UK's GHG emissions.

From Food Industry Sustainability Strategy (DEFRA)

# Transport

- “Food Miles”  
30 billion vehicle kilometres in 2002, ( 82% in the UK )  
1.8% of the total annual UK CO2 emissions.  
(10 million tonnes in the UK and the remainder overseas)
- “Food Miles”,
- ***costs, and emissions are not related.***  
Transportation of food by sea represents around 65% of all food movements but accounts for only 12% of total external costs.  
Air freight of food accounts for only 0.1% of the vehicle kilometres and 1% of the food miles tonnes
- BUT
- *“From supplier to shelf”* the total cost are £1.9 bn., comprising  
Congestion (£780m) -----42%  
Infrastructure (£380m) ----- 20%, and  
Accidents (£360m) -----19%

From Food Industry Sustainability Strategy (DEFRA)

# WASTE

- **Manufacturing**

- 7.2 million tonnes

- 4.1 million tonnes as food waste.

- **Retail**

- 1.6 million tonnes of food waste per annum;

- **In Home**

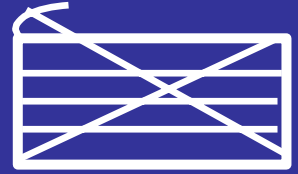
- 5.2 million tonnes of food related packaging waste and

- 6.7 million tonnes of food waste each year.

From Food Industry Sustainability Strategy (DEFRA)

# New technology required

Primary Production (farming & fishing)



Yields versus emissions

Fresh

Manufacture

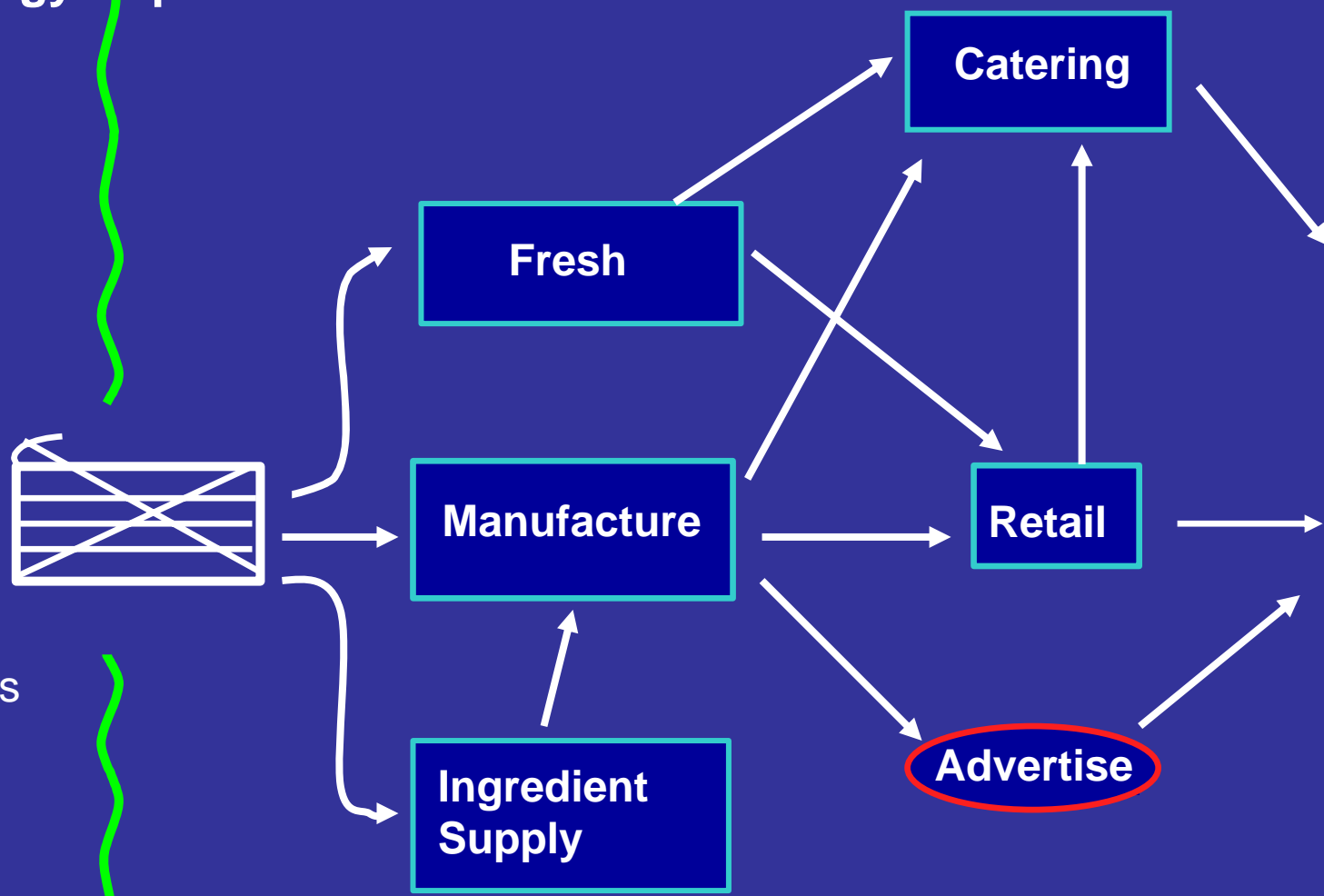
Ingredient Supply

Catering

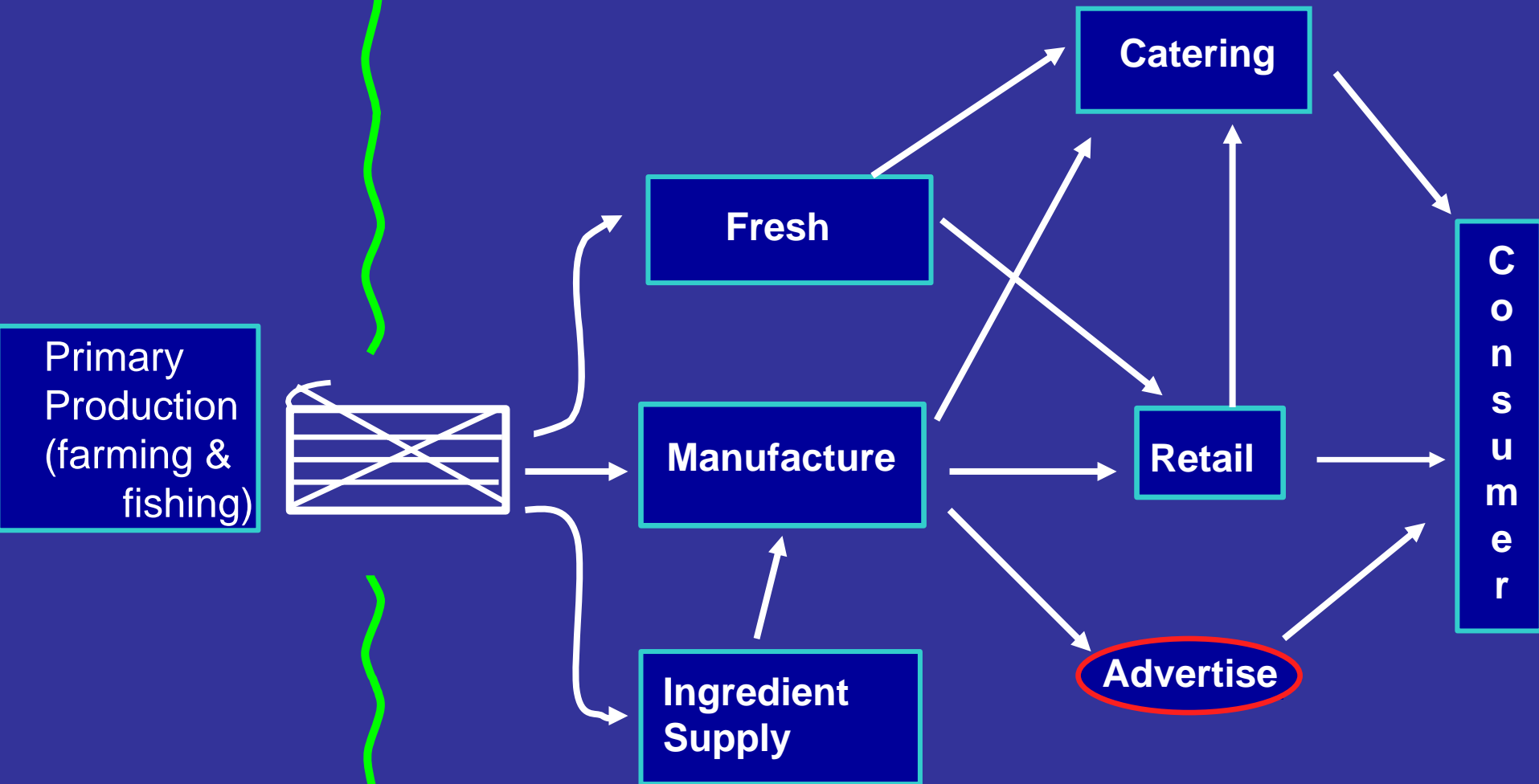
Retail

Advertise

C  
o  
n  
s  
u  
m  
e  
r



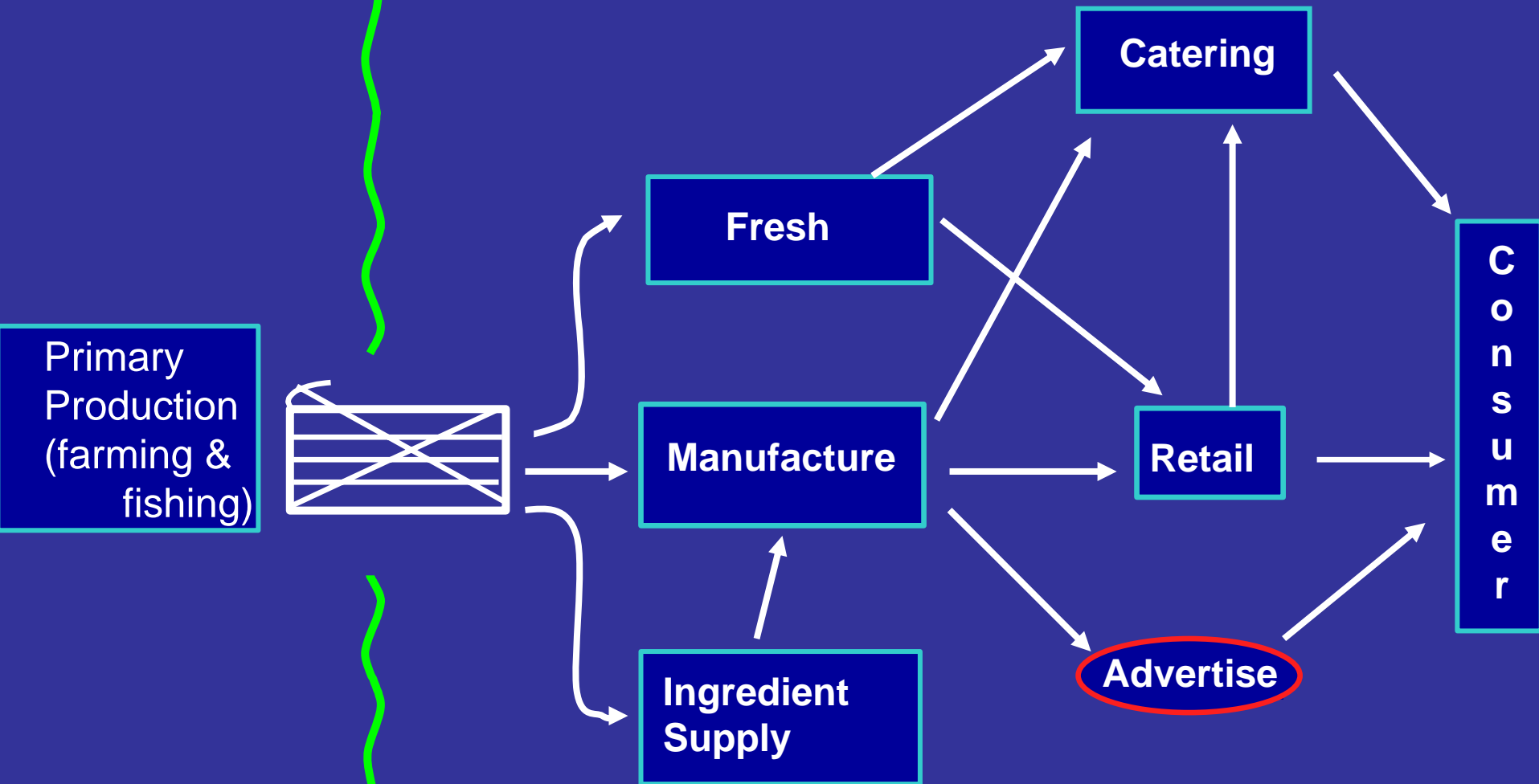
# OPTION 1 - GO LOCAL



Move onto farm  
Integrate waste management

Source locally  
Recycle

# OPTION 2 – GO GLOBAL



Optimise chosen crop

large scale biorefineries ,at source

bulk transport

# So What?

- Knowing the Supply Chain System is important
- Innovative Inputs are everywhere
- Innovation is necessary for competitive survival
- Better Life Cycle data is required
- The Consumer is confused
- Governments regulate, but don't make food

# Summary

## ■ Agriculture

“yield versus emissions” needs new science and technology

## Manufacturing

“Biorefineries” need both Up and Downscaling

## Distribution

Depends on the option

## Retail

Depends on the Option

## Consumer

Still wants maximum choice, wants to help, and is confused

## **Selected Plant Matter Derived Industrial Products<sup>3</sup>** (Percentage of Domestic Production, 1990)

<b>Product</b>	<b>Percentage</b>
Wall Paints	3.5
Special paints	2.0
Pigments	6.0
Dyes	6.0
Inks	7.0
Detergents	11.0
Surfactants	35.0
Adhesives	40.0
Plastics	1.8
Acetic Acid	17.5
Fatty Acids	40.5
Carbon black	12.0