Introduction to Economics for Agri-Health Researchers

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ANH Academy Learning Lab
Kathmandu, Nepal
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FEED THE FUTURE
The U.S. Government's Global Hunger & Food Security Initiative

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Introduction to Economics for Agri-Health Researchers

Our agenda today

1. **Motivation**: Why economics?

2. **Methodology**: How economists explain and predict change
   -- Individual decisionmaking: Production possibilities, indifference levels and prices
   -- Societal outcomes: Supply, demand and trade with the rest of the world

3. **Discussion**: Applications to ANH issues in Nepal and around the world

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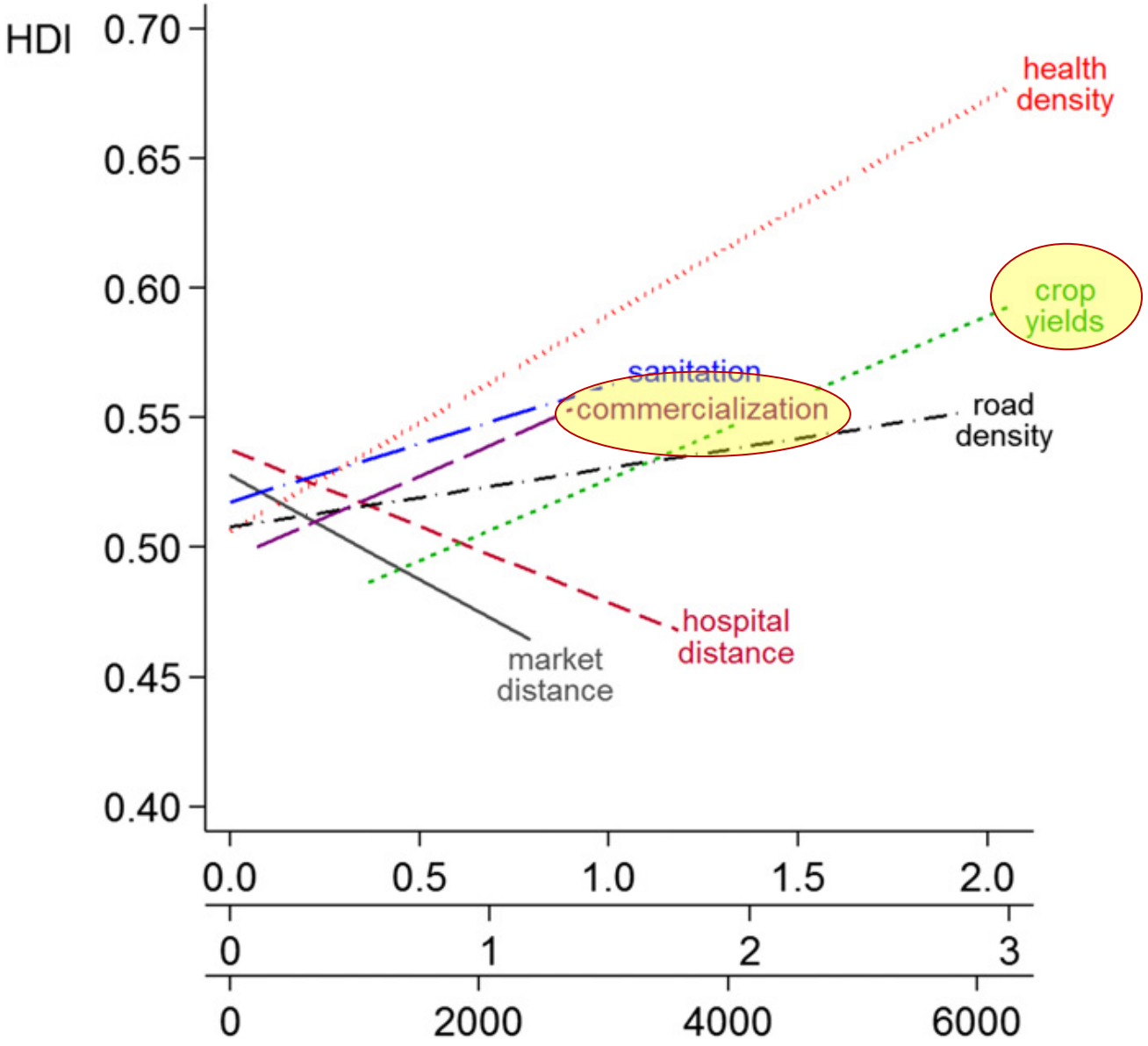
Motivation: Drivers of change over time and space

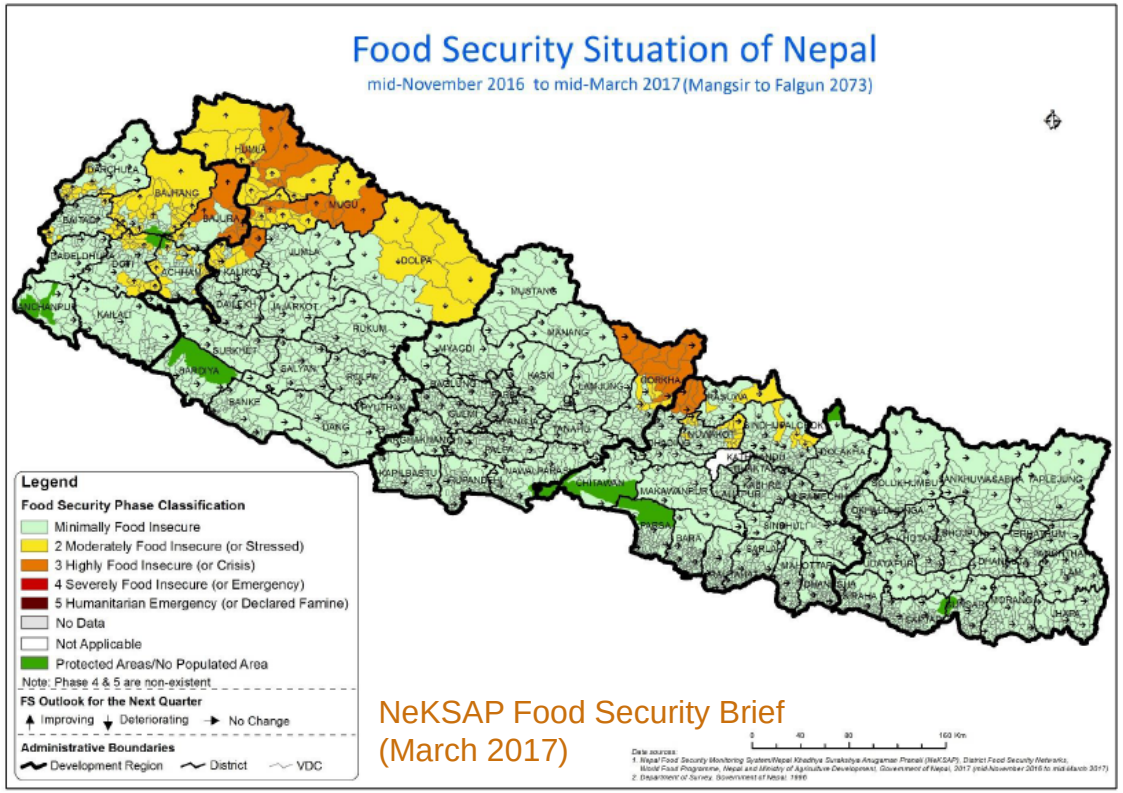
Contributors to district-level Human Development Index in Nepal



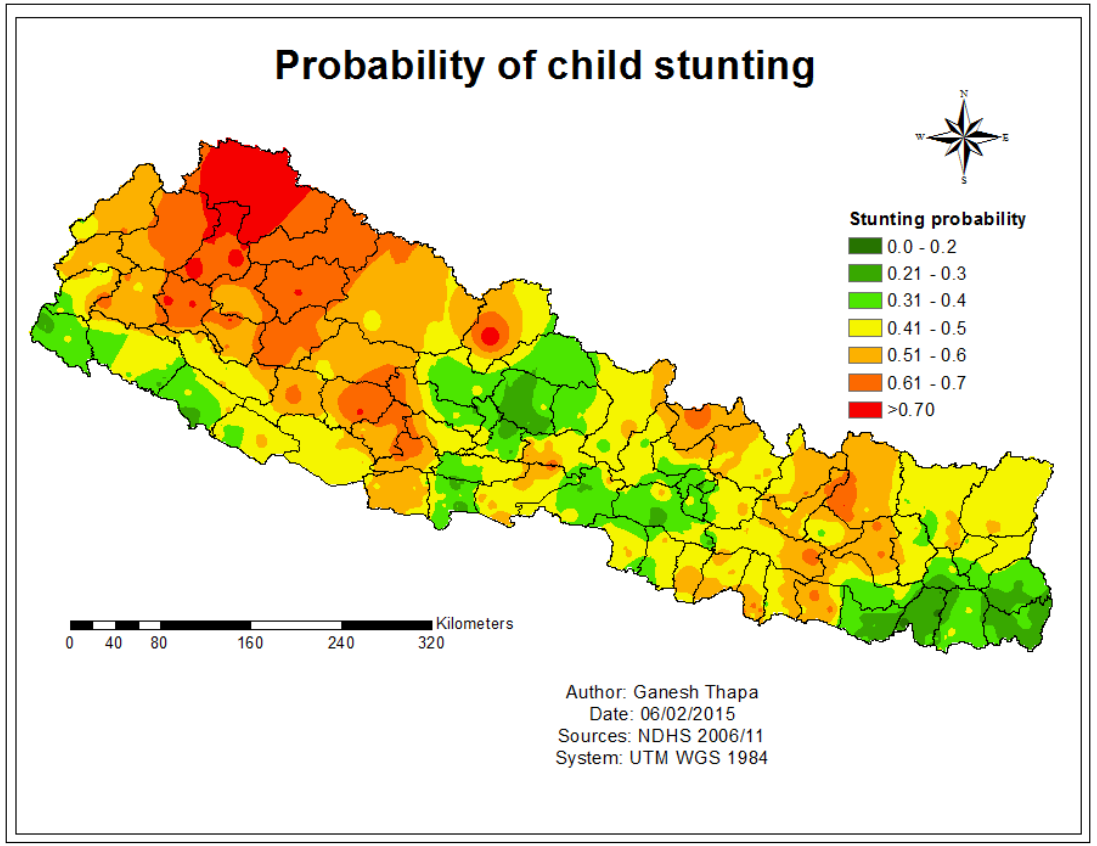
Source: Shively (2017) *PNAS* (doi.org/10.3886/E100387V1); HDI for 2014.

Motivation: Agriculture, nutrition and health

Map 1: Food security situation of Nepal (mid-November 2016 to mid-March 2017)



NeKSAP Food Security Brief (March 2017)



Motivating questions

- What kinds of production are possible?
- What is needed to produce?
- What motivates households?
- What constrains households?

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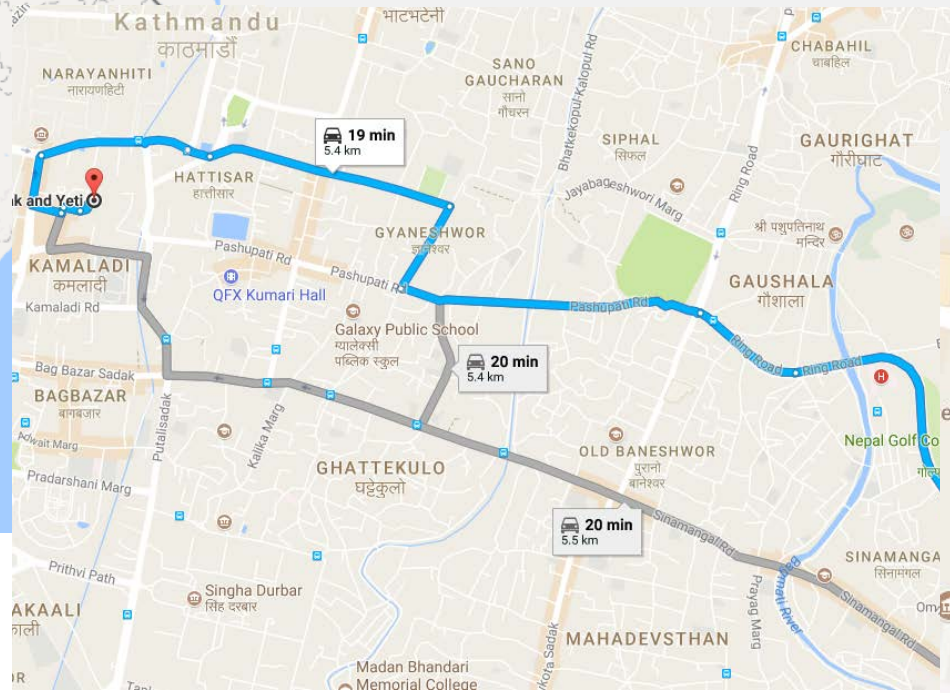
Methodology:

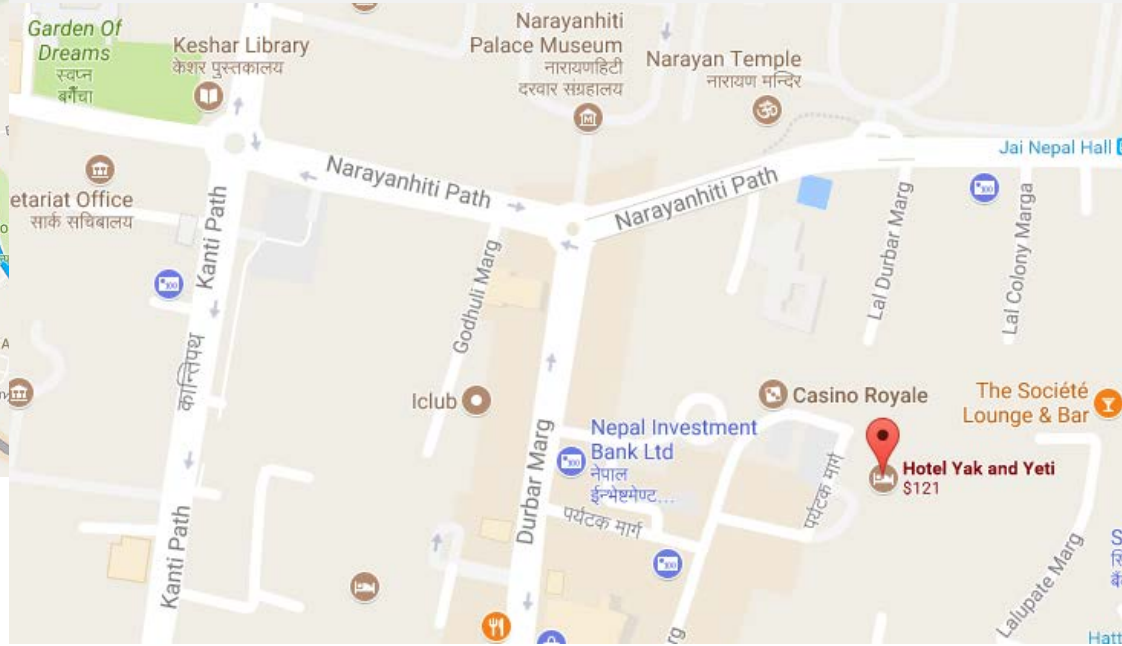
To guide decisions, we need useful models of the world

Good for flights in/out of KTM

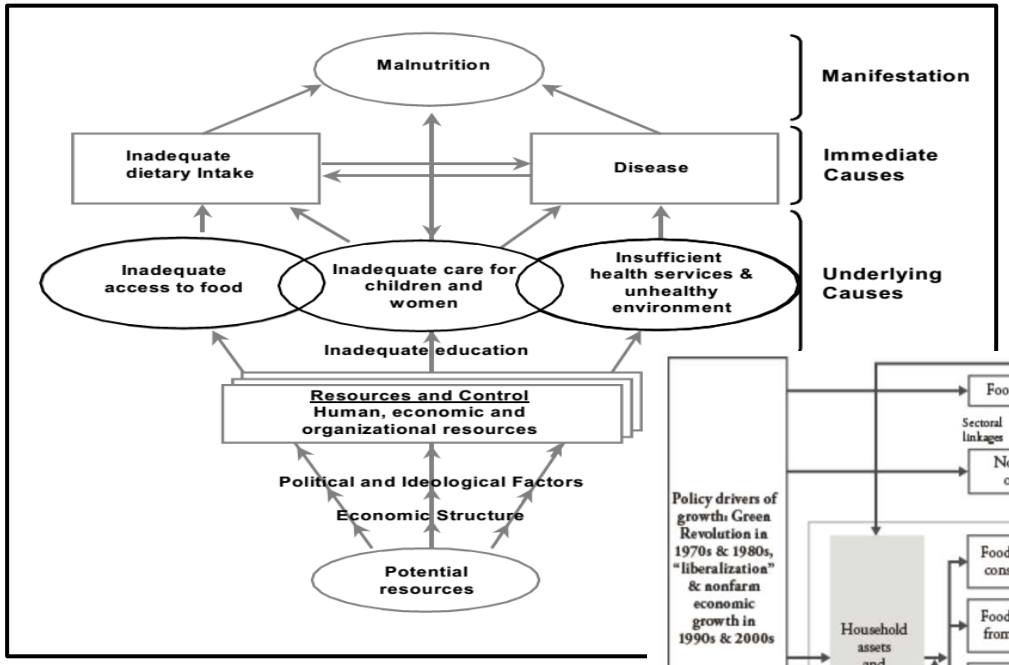
Good for taxi from KTM to ANH meeting



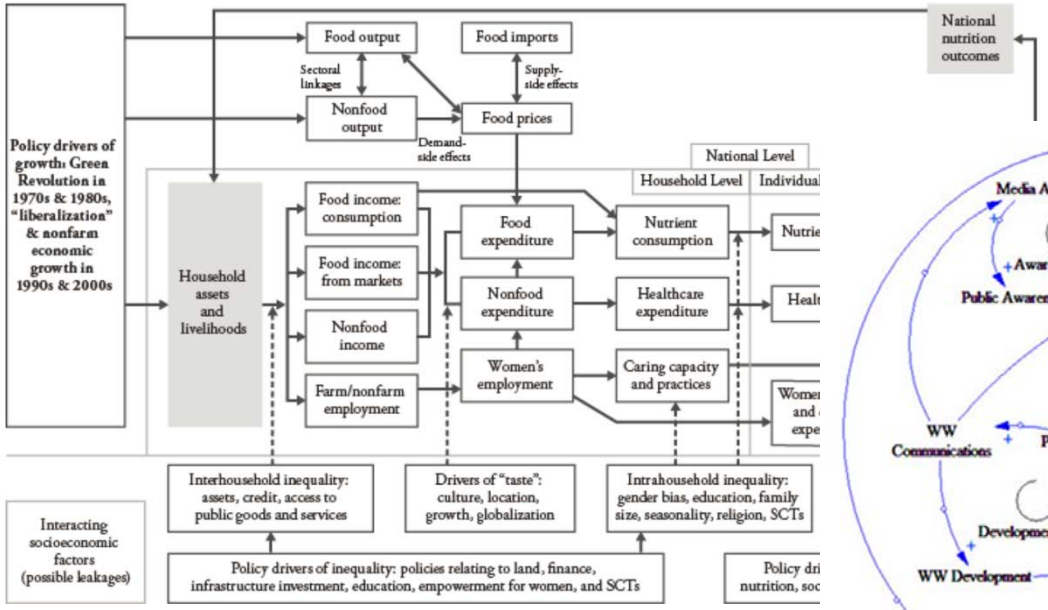
Good for walking around the hotel



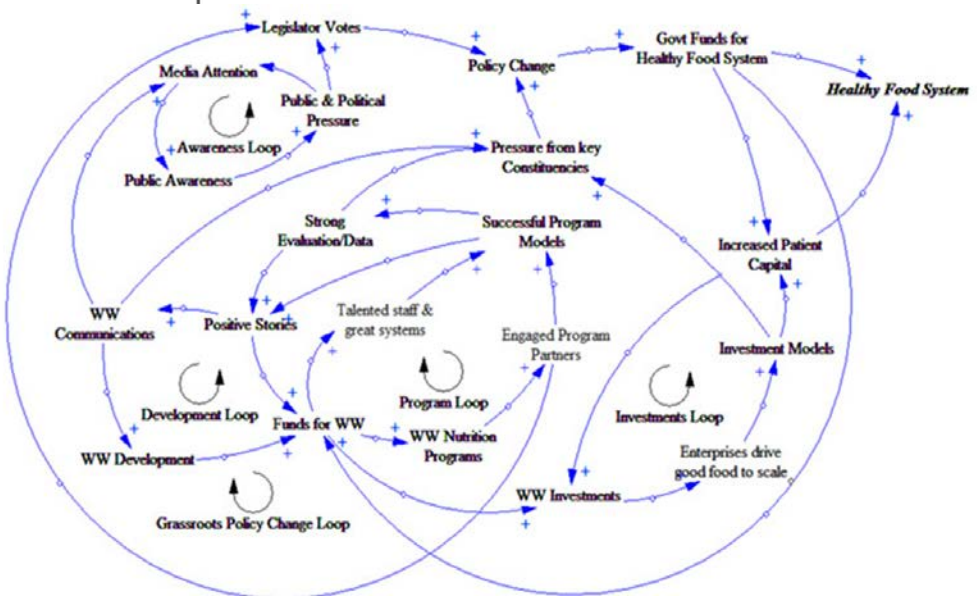
Different models of the same world are useful for different purposes



The UNICEF framework of immediate vs. underlying causes



Causal pathways and flow charts



Causal loops for system dynamic models

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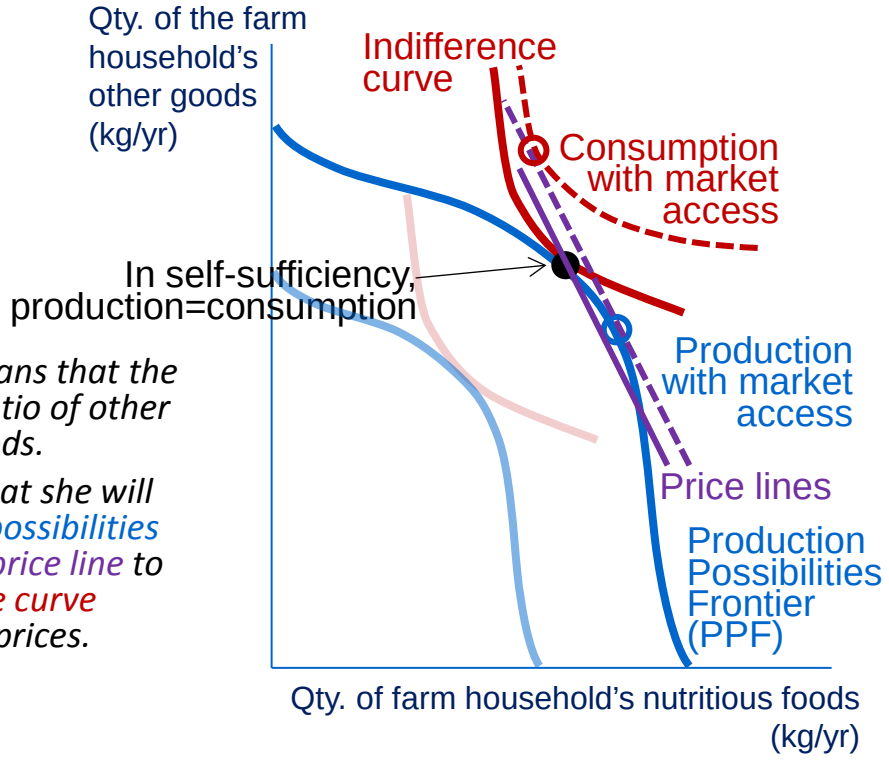
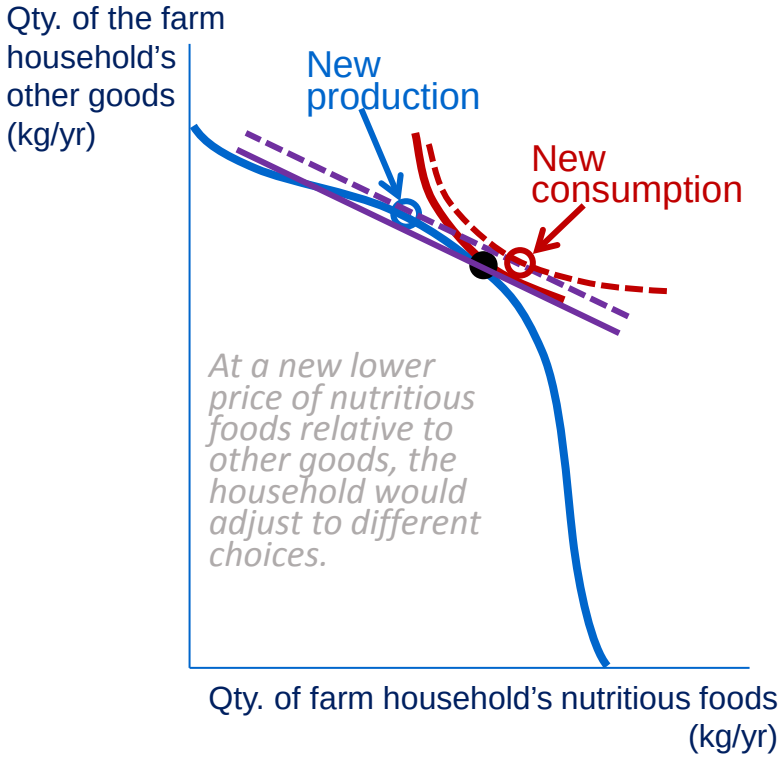
The economists' model of individual decisions

Production possibilities, indifference levels and price lines

An individual household
(here, a "net seller" of nutritious food)



That same household, when nutritious foods become much less expensive
(so becomes a "net buyer" of nutritious food)



Having access to markets means that the farmer can trade at a fixed ratio of other goods per kg of nutritious foods.

Economic analysis predicts that she will adjust along her production possibilities and buy/sell along a market price line to reach the highest indifference curve reachable given her PPF and prices.

"Separability" means that, whenever households and regions are actively selling or buying, production is "separated" from consumption by market prices and income.

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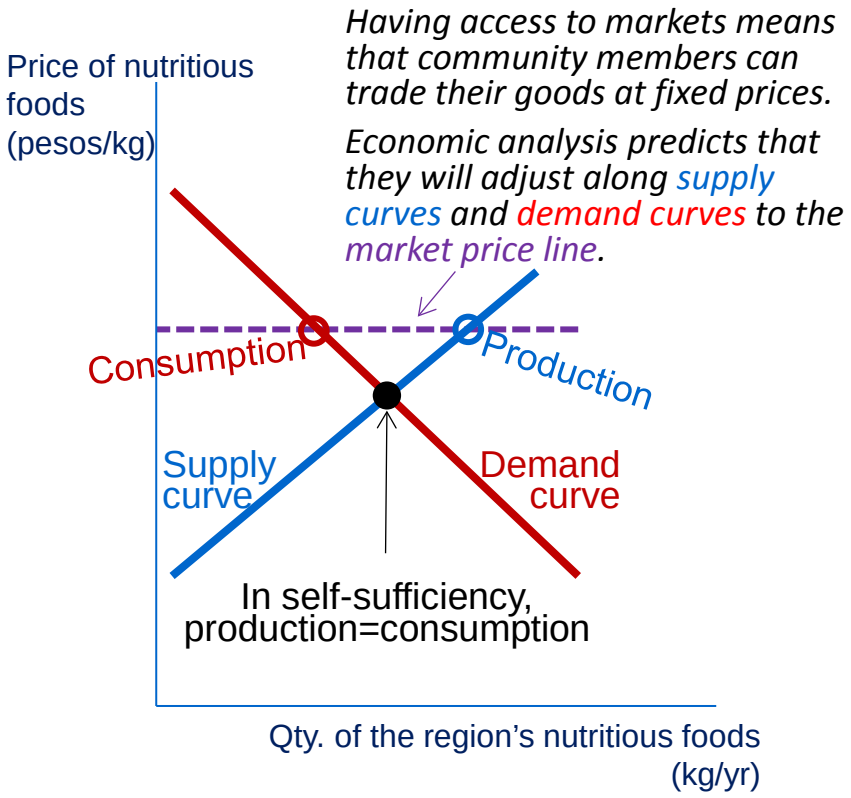
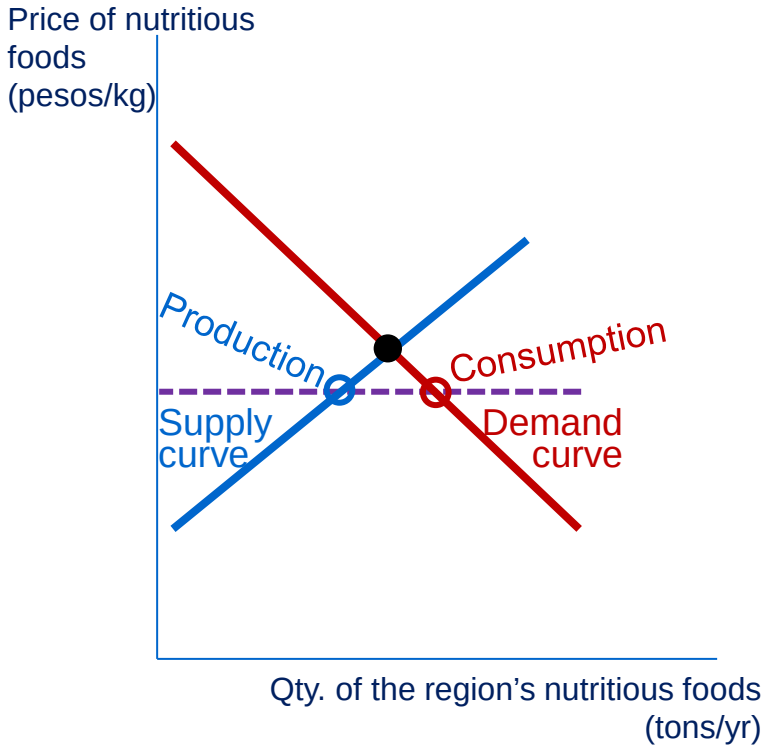
The economists' model of social outcomes

Supply, demand and trade with the rest of the world

A community of farm households
(here, they export nutritious food)



That same community, when nutritious foods become much less expensive
(so they import the nutritious food)



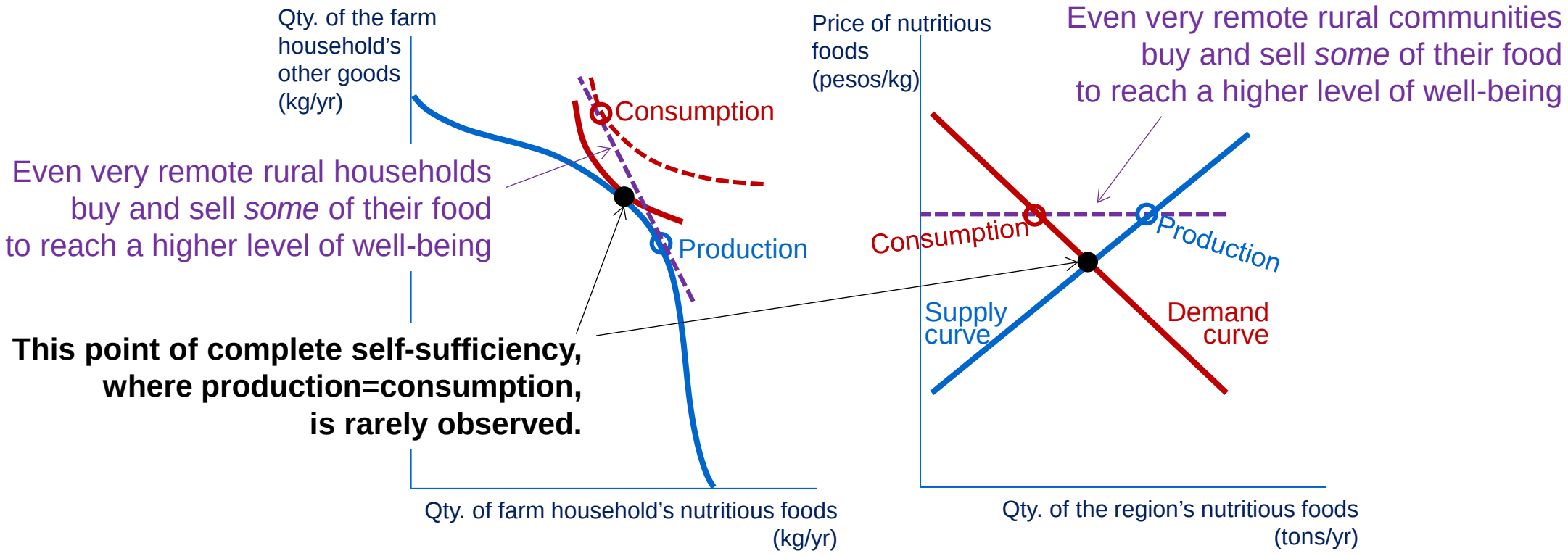
The concept of separability applies whether a household or a region are net sellers or buyers: whenever households and regions are actively selling or buying, production is "separated" from consumption by market prices and income.

Economics links social outcomes to individual choices

A community-level or national outcome is the sum of many peoples' individual decisions

An individual household
(here, a "net seller" of nutritious food)

A community of farm households
(here, they "export" nutritious food)

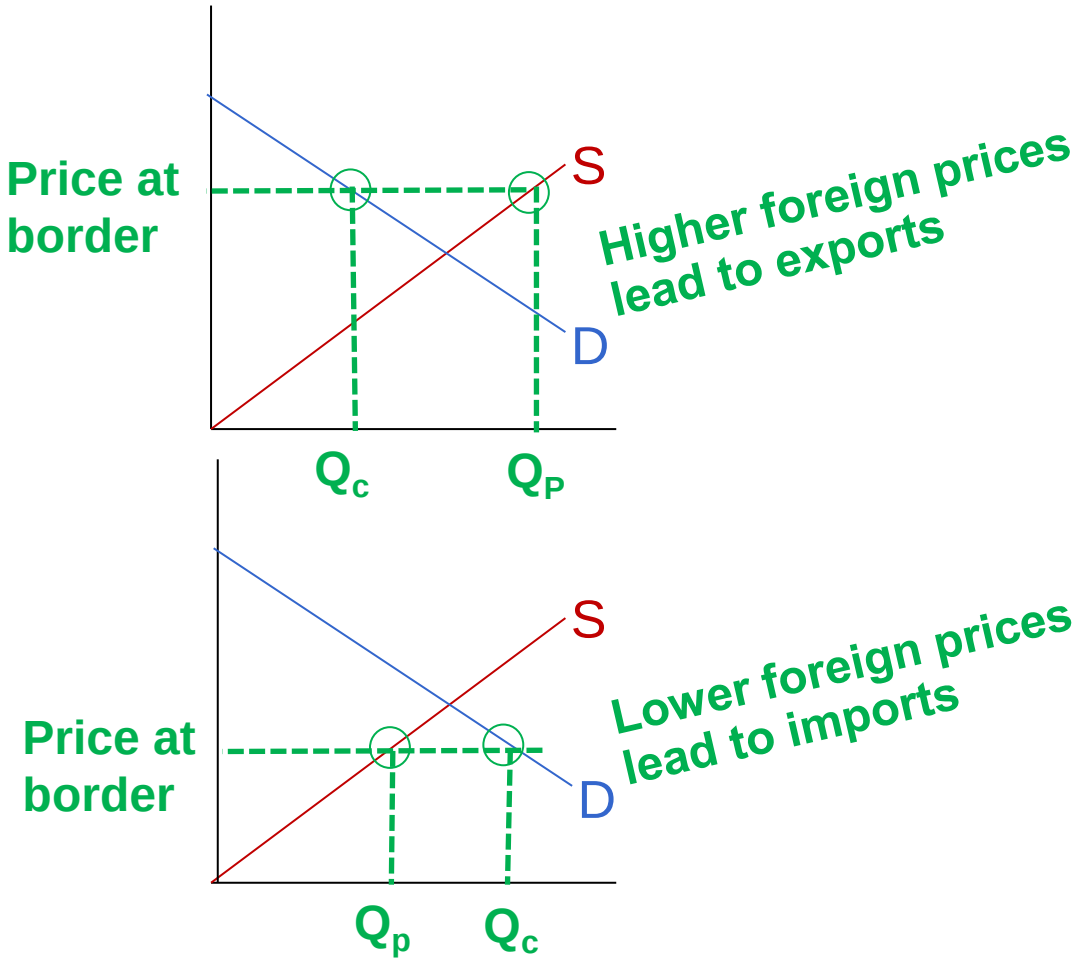


This model reveals how agriculture-nutrition linkages depend on food systems and markets

Economics offers surprising predictions

For most foods, local prices are usually set by opportunities to trade with others

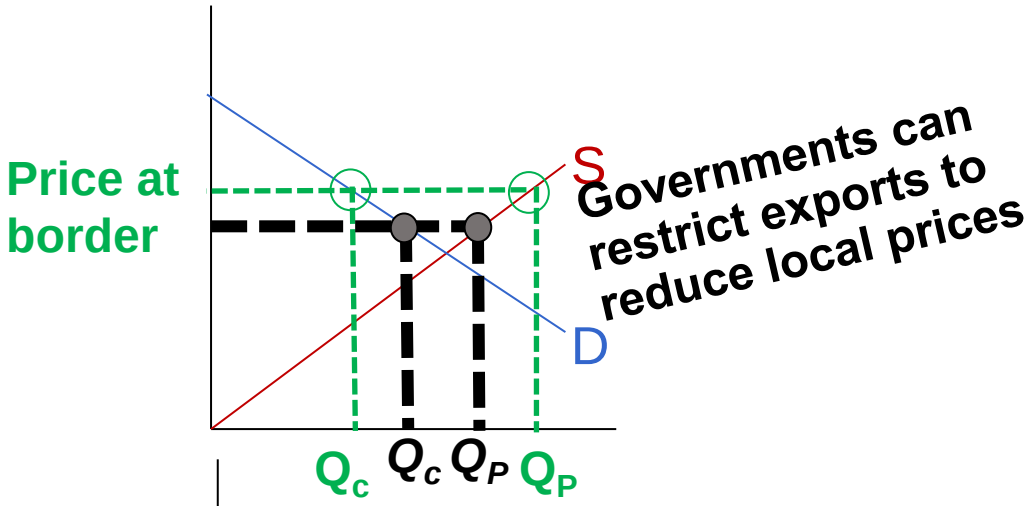
- Food prices in each place are generally set by opportunities to trade with neighbors, which determines price levels at which local people are willing to buy and sell.
- There are gains from trade in both directions:
  - exporting things for which foreigners will pay high prices,
  - importing things which foreigners will sell at low prices

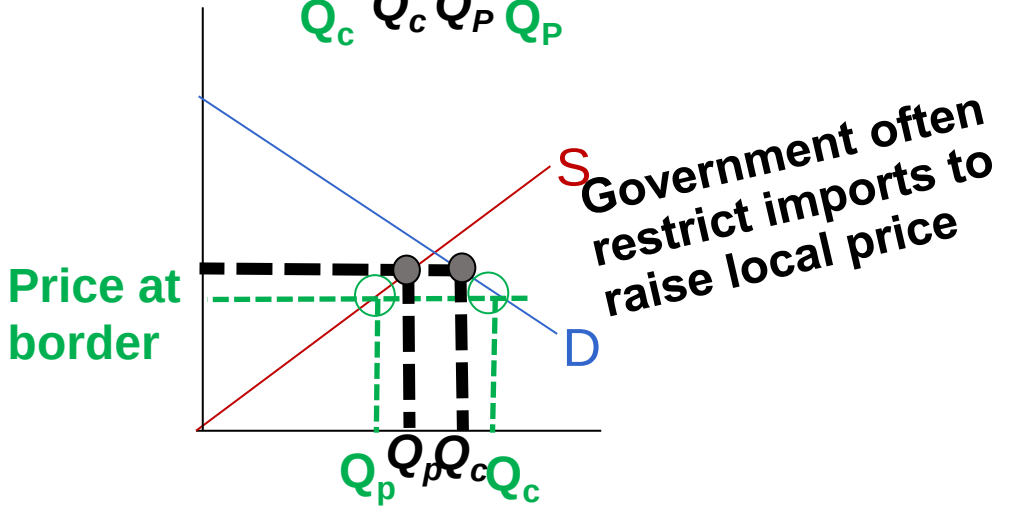


Economics aims to predict effects of policy choices

Almost all governments impose some restrictions on international trade

- Governments that control ports and border crossings can readily use trade taxes or other restrictions to lower local prices of goods that would otherwise be exported, and raise local prices of goods that would be imported;
- Governments can also use taxpayer funds to subsidize production, consumption or trade.

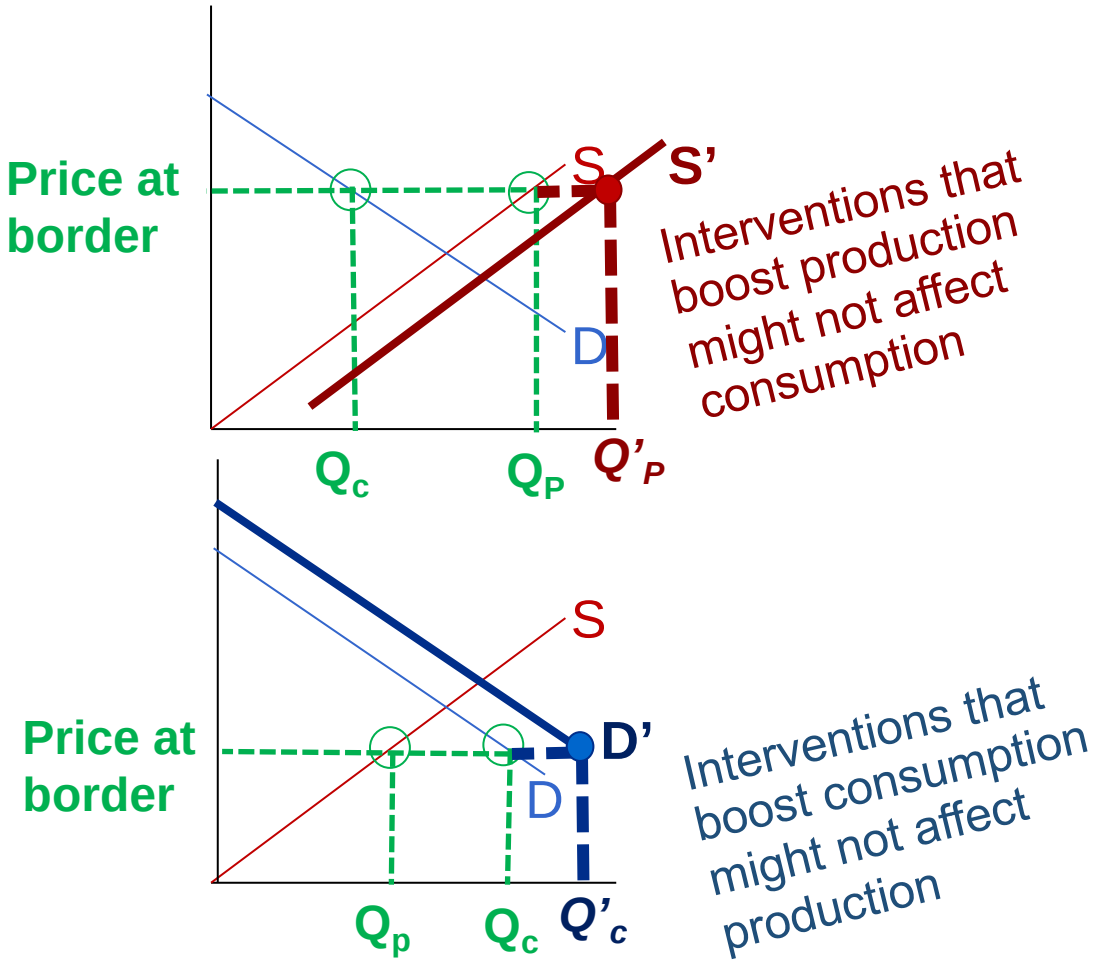




Economics offers surprising predictions about policy

When prices come from trade, production and consumption interventions don't affect price!

- Trade separates the quantities produced and consumed, so each side of the market varies independently
- But remote households or communities often *cannot* trade some foods at some times of year
  - This also applies to *services,* like child care and other non-tradables
  - In those settings, supply=demand so production and consumption are "non-separable"



“Separability” between production & consumption holds for *any* direction of trade

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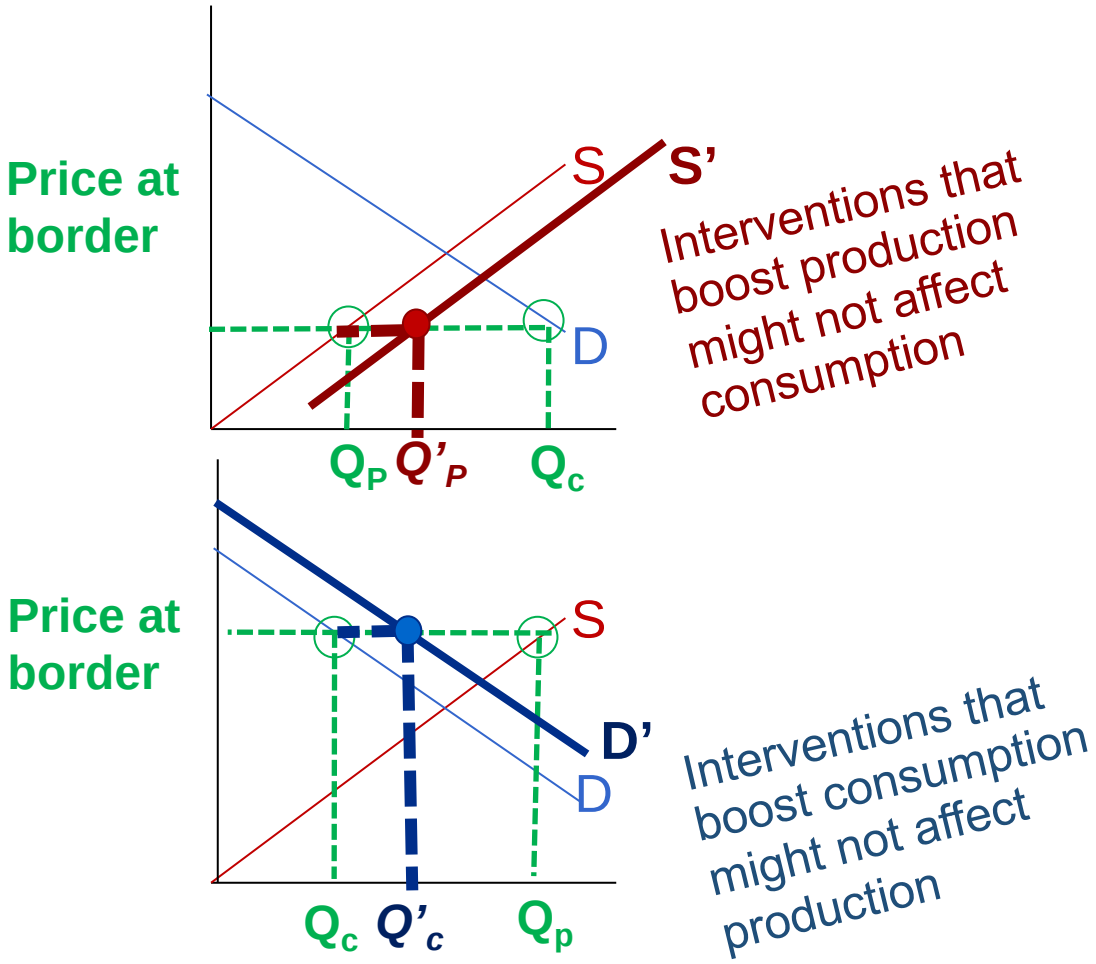
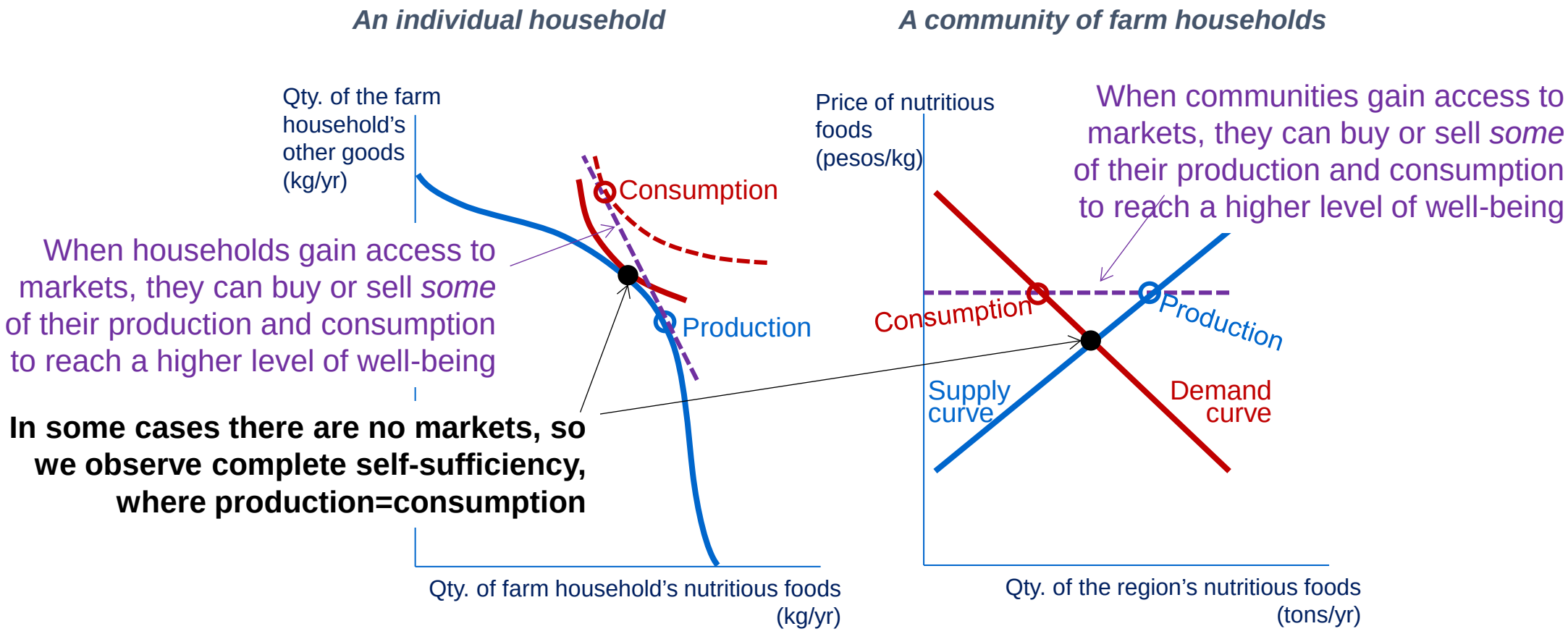


Economics reveals how agriculture-nutrition linkages depend on access to markets

Some items are never traded, and some are traded only in specific times and places



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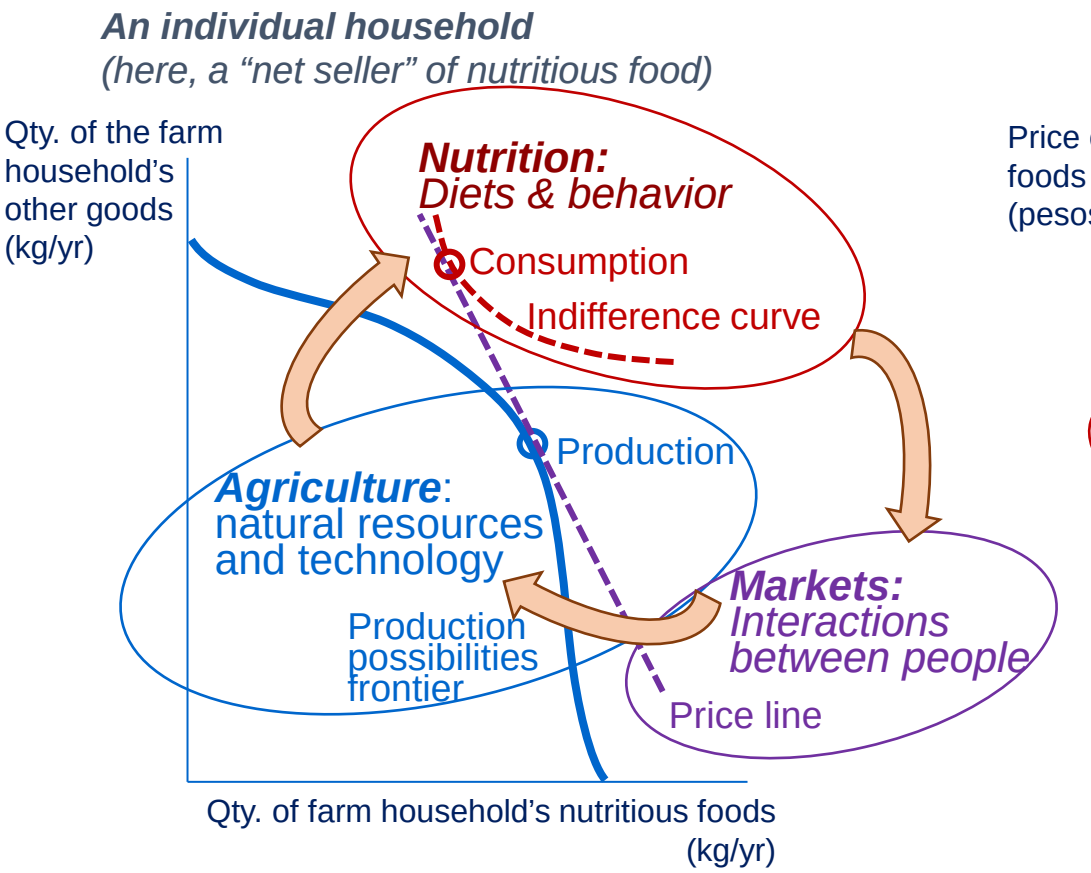
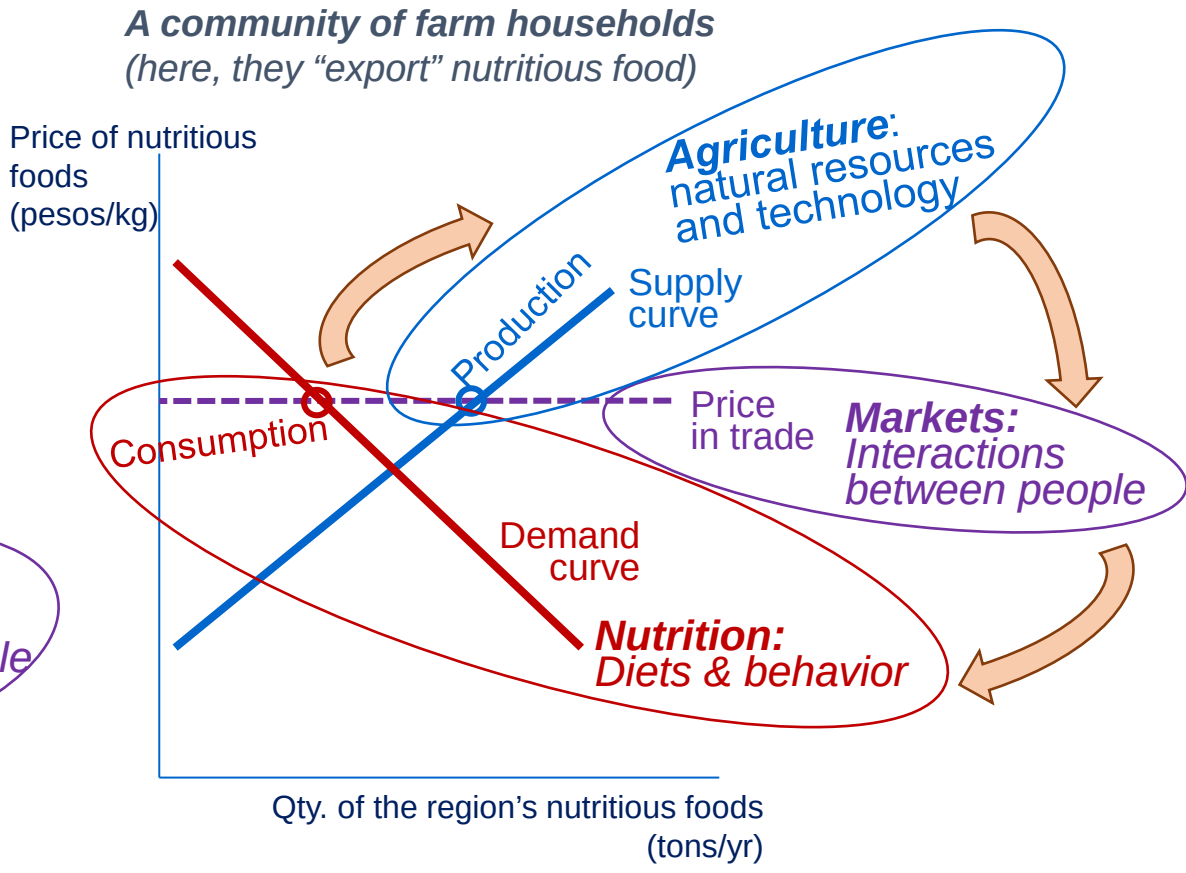
We'll use this basic economics model of ag-nut linkages to guide our understanding and frame research and improve analysis of policies and programs





In economics, causality runs in all directions–need natural experiments to identify effect sizes

The economics approach evolved for the purpose of guiding ag-nut policies and programs

- Economics arose in part from food policy debates in the 18th and 19th centuries

- *Agricultural* and *development* economics emerged in the 20th century as a specialized field to serve farmers, agribusinesses and governments, regarding ag-nutrition linkages

Economics helps explain otherwise puzzling facts, such as why (almost all) farming remains family farming

- Over 95% of farms are still run by self-employed family members
- Most farm investment is from family savings with limited bank loans or other capital
- In poor countries, farmers are even poorer than non-farmers
- As countries get richer, most farmers leave for salaried work; remaining farms become very valuable but are still family enterprises
- For most crops, farm sizes adjust to that which can employ and retain family workers

Economics aims to explain general patterns, and exceptions to each rule such as *non*-family farming

- Throughout history, many societies have tried corporate farms, collective agriculture and plantations with outside investors and hired workers
- Plantations have mostly given way to independently run family farms, except in production systems reliant on immediate processing such as tea or sugar, or highly controlled livestock and horticultural systems.

A bankrupt coffee plantation in Sao Tome (WA Masters, 2003)

Farm families everywhere also do other work

- Farming families almost all have some **nonfarm activity**, partly because crop production is so risky and partly because each family's access to additional land and water is so limited.

Right: Basket weaving in the Philippines
Top right: How houses are built in Ethiopia
Bottom right: How bricks are made in Zimbabwe

Photos: GE Shively 1996; WA Masters 2011, 2010

Farm families depend on natural resources

- The poorest farmers have no choice but to remain dispersed in remote rural areas to access the land, water and other resources they need to survive.

Ethiopia. WA Masters, 2011

Helambu, Nepal. GE Shively, 1985

Farm families depend on larger agribusinesses

- Farm families often play a central role in the development and management of successful **agribusinesses**, as individual entrepreneurs or members of cooperatives and stakeholders bringing nonfarm resources to farm households and food consumers, but those businesses often have scale economies so a single input supplier or food marketer will serve dozens, hundreds or even many thousands of farmers.

Zambia. WA Masters, 2010

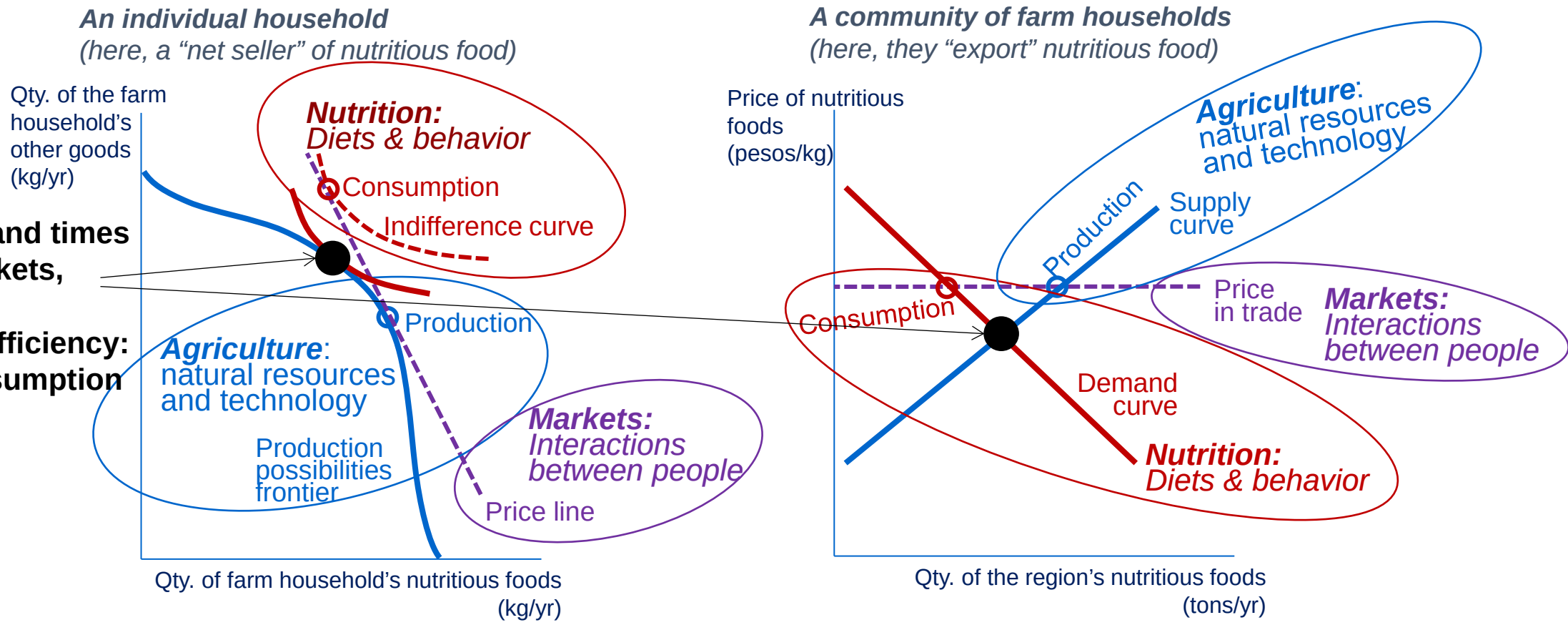
Farm families depend on rural-urban linkages

- Improving local agriculture through **market access and locally-adapted techniques** can make remote places less poor, improving rural work and raising the floor of rural living standards.
- Because farming is dispersed while nonfarm activity is geographically concentrated, growing **towns and cities create opportunities for employment, schooling and health** with both temporary and permanent migration and resource flows.

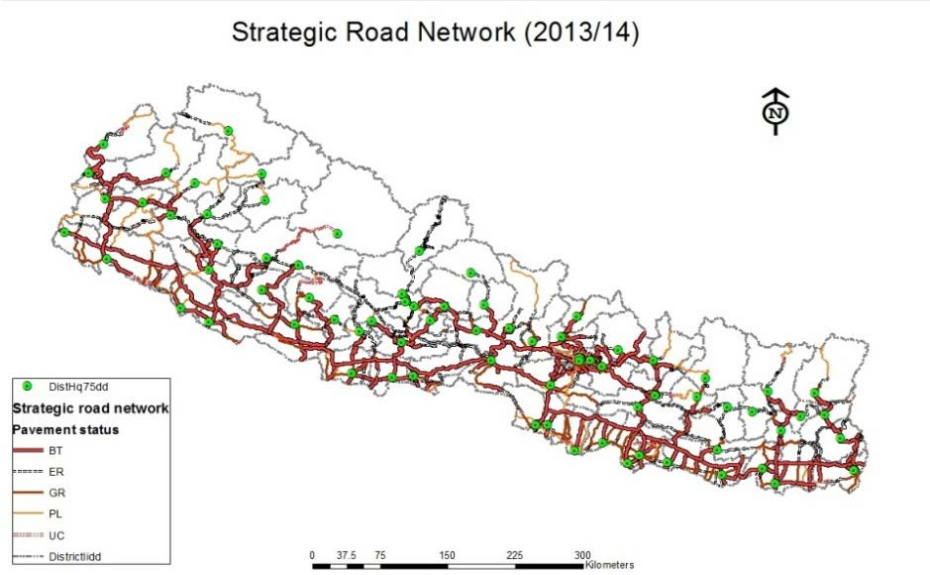
Farm-to-market transport options in China. WA Masters, 2006

Keeping our basic economics model in mind helps guide understanding and frame research

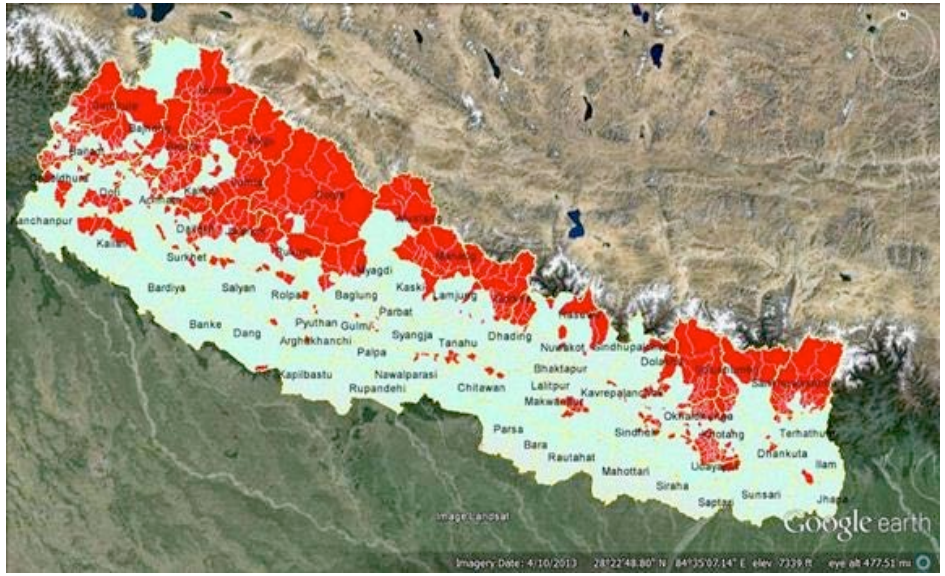
At some places and times there are no markets, so we observe complete self-sufficiency: production=consumption



Road infrastructure in Nepal



Road network

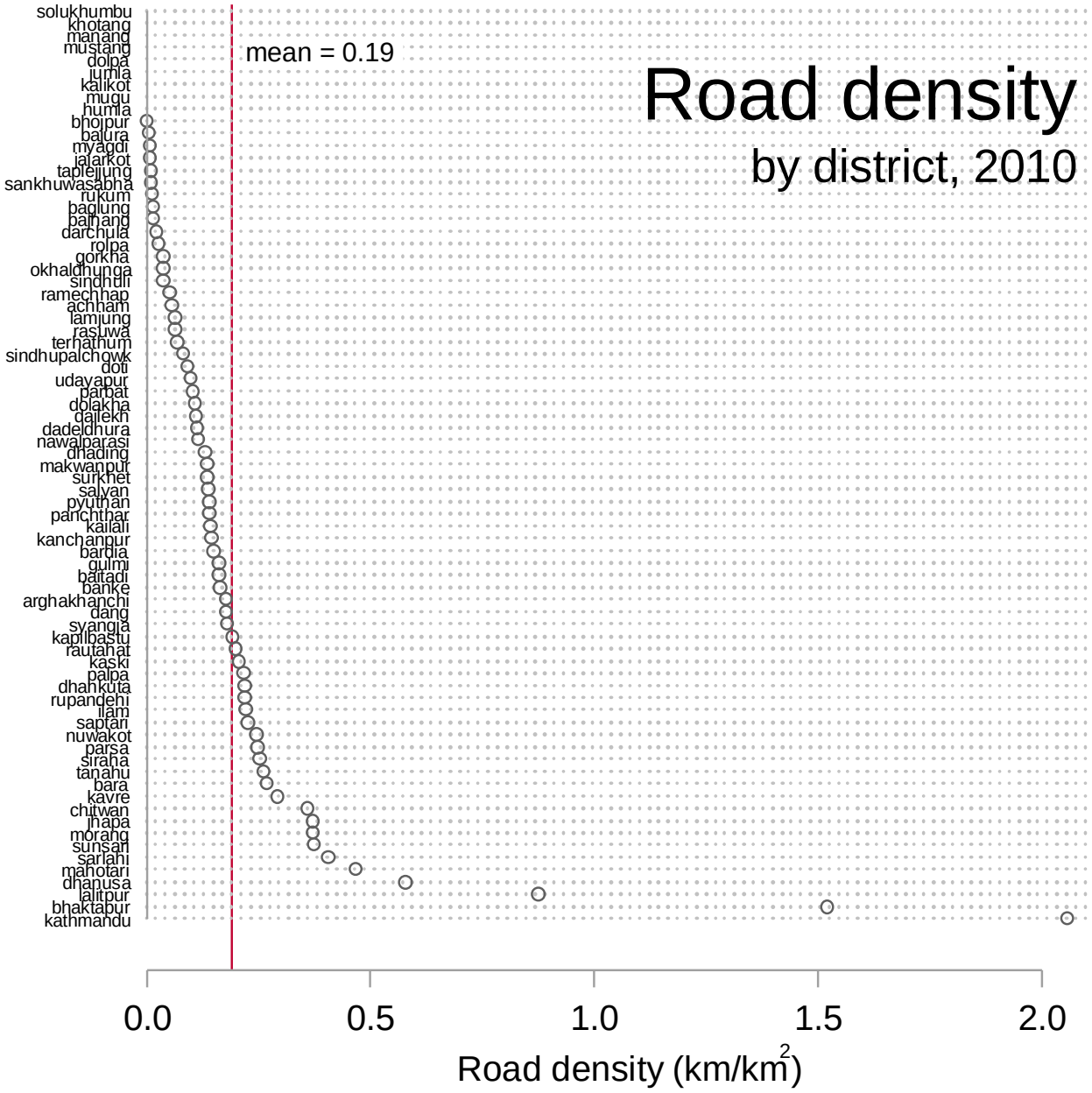


Isolated VDCs

Road density (km/100 km^2):

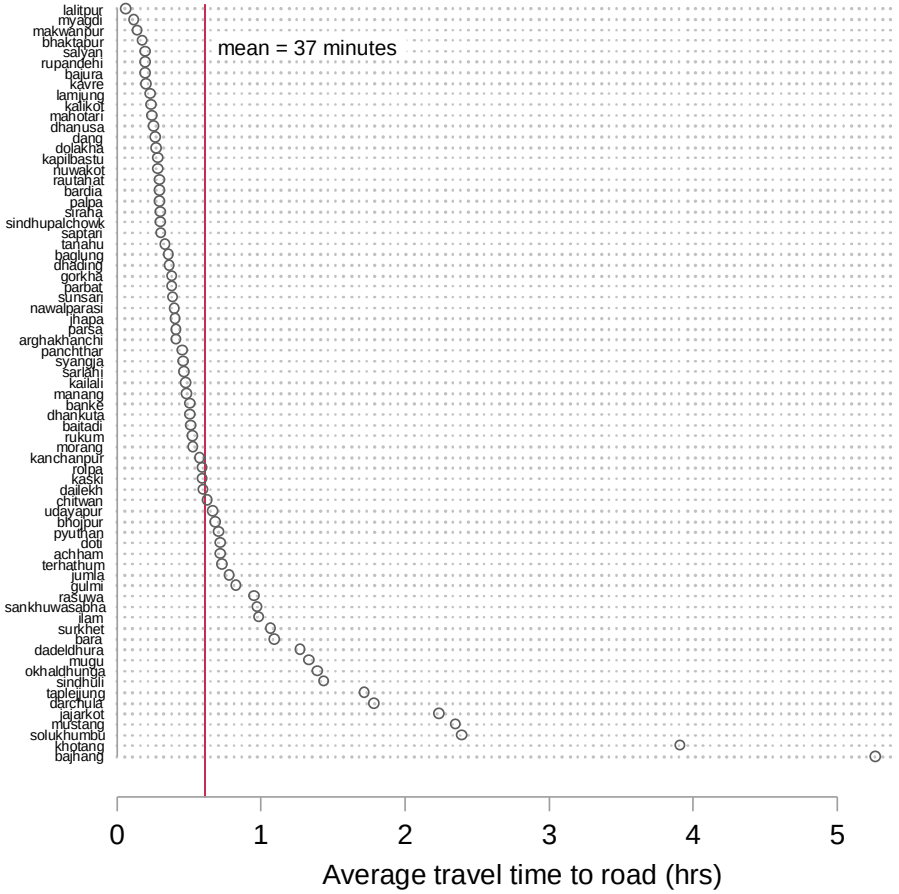
Nepal :	14
Switzerland:	173
India:	125
China:	42

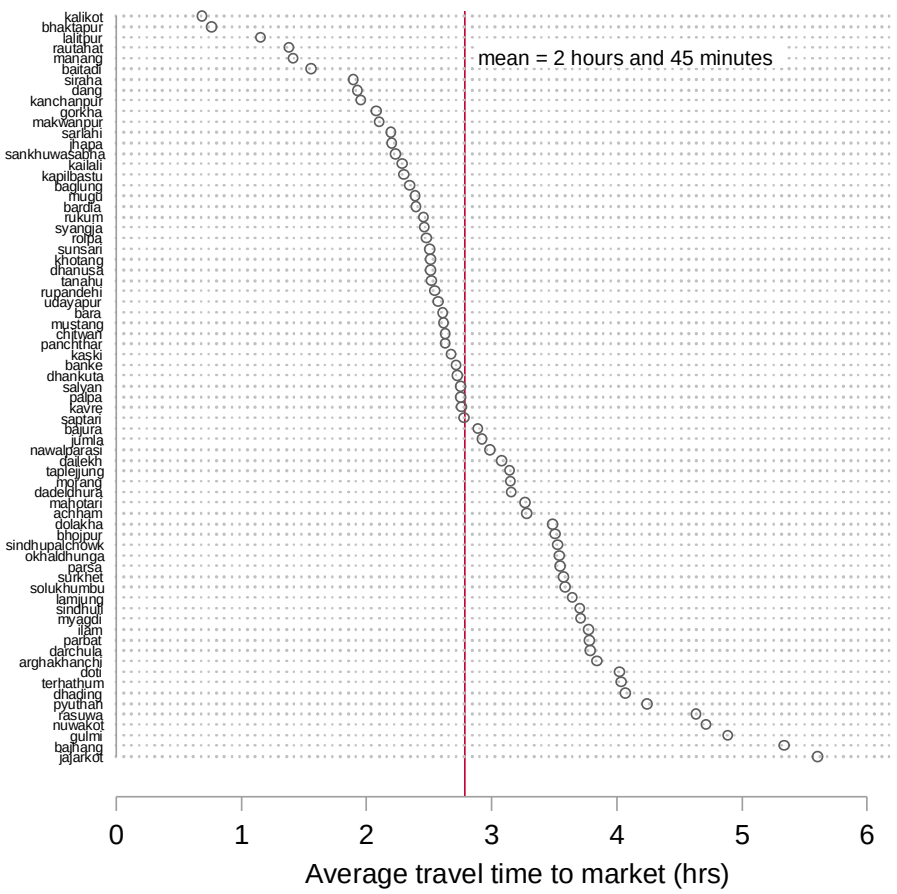
57% of Nepal's population does not have access to all-weather roads (CBS 2011)



Source: Nepal Bureau of Census, 2010

Travel times to paved roads and market centers

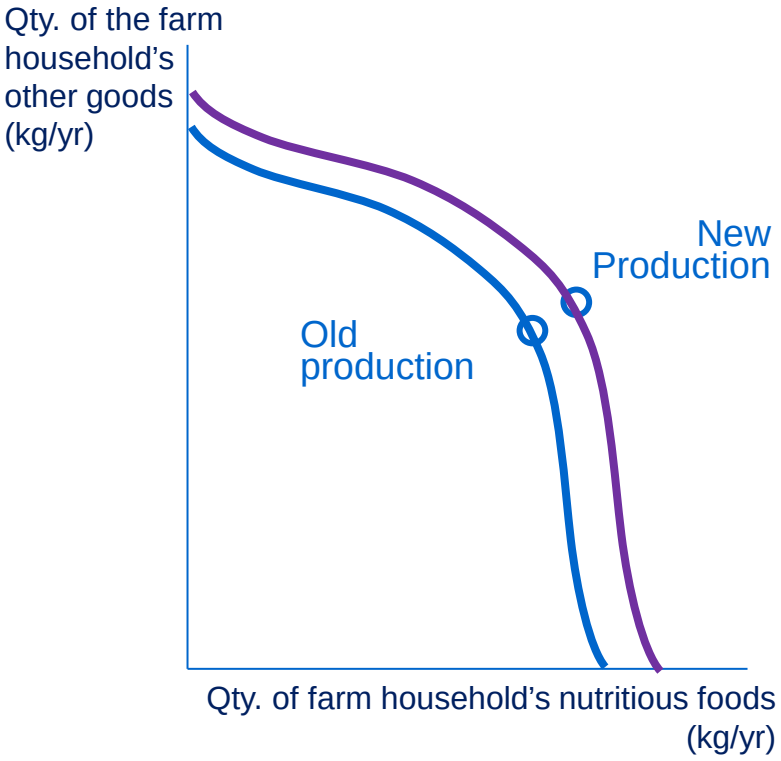




Average travel times for NLSS (2011) respondents, by district

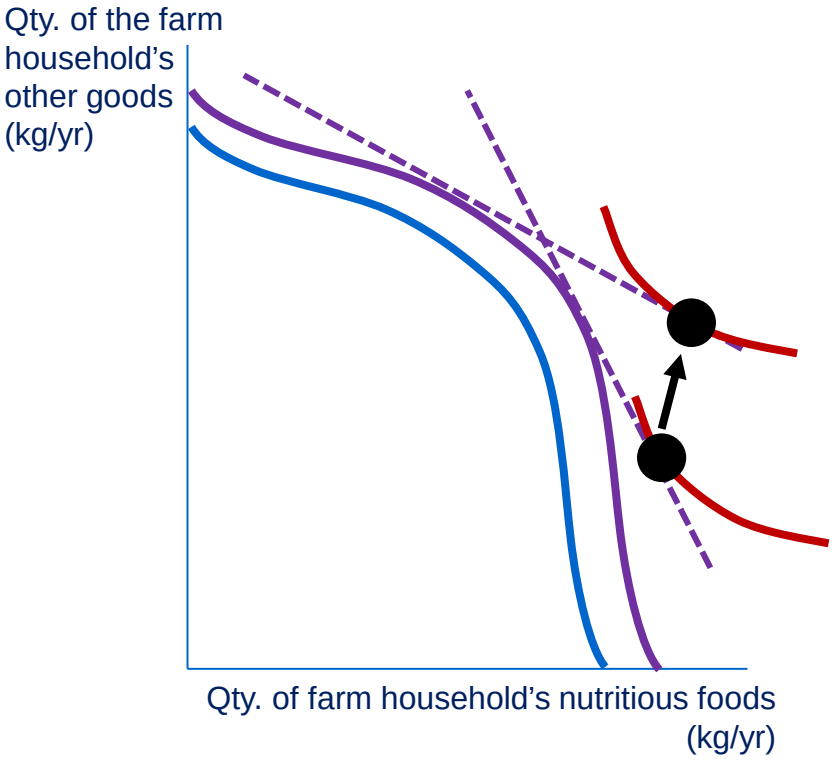
Basic economics tells us what better access does to…

production



Better access can shift the production possibilities frontier outward, due to improved access to agricultural inputs, knowledge and technology

Basic economics tells us what better access does to…

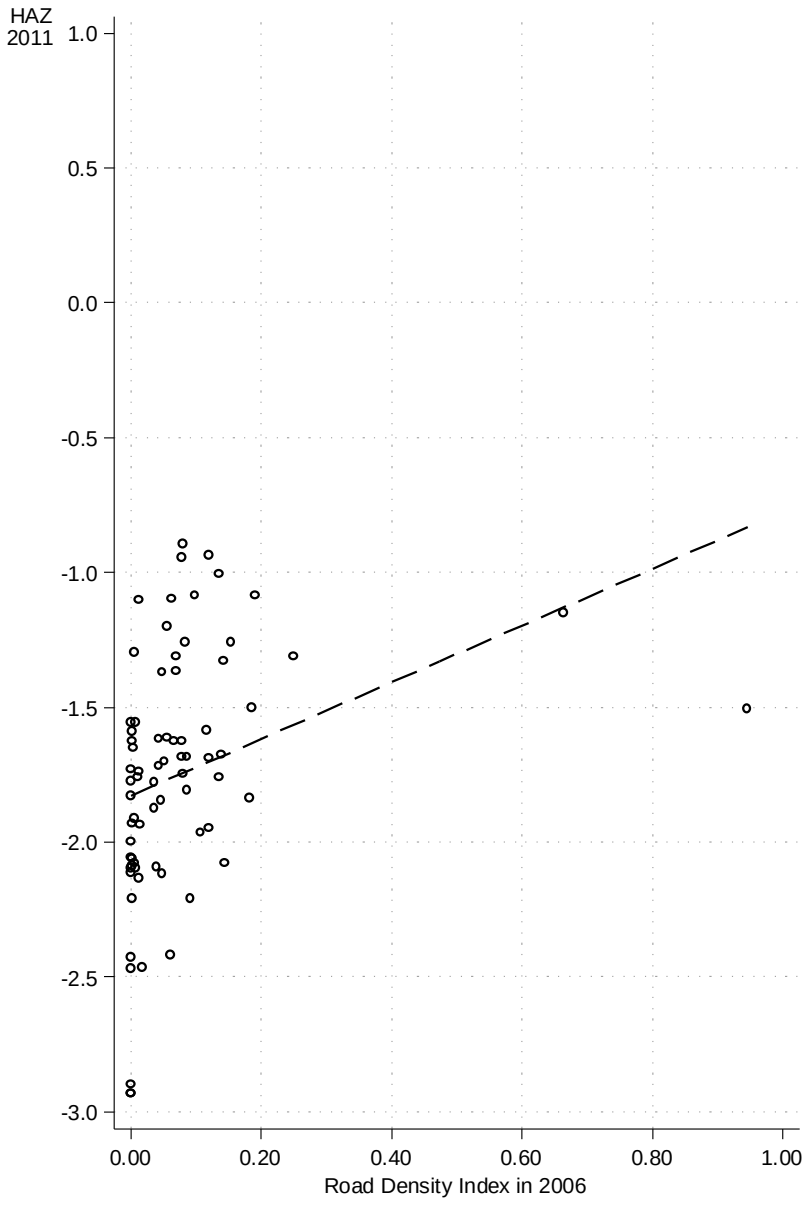


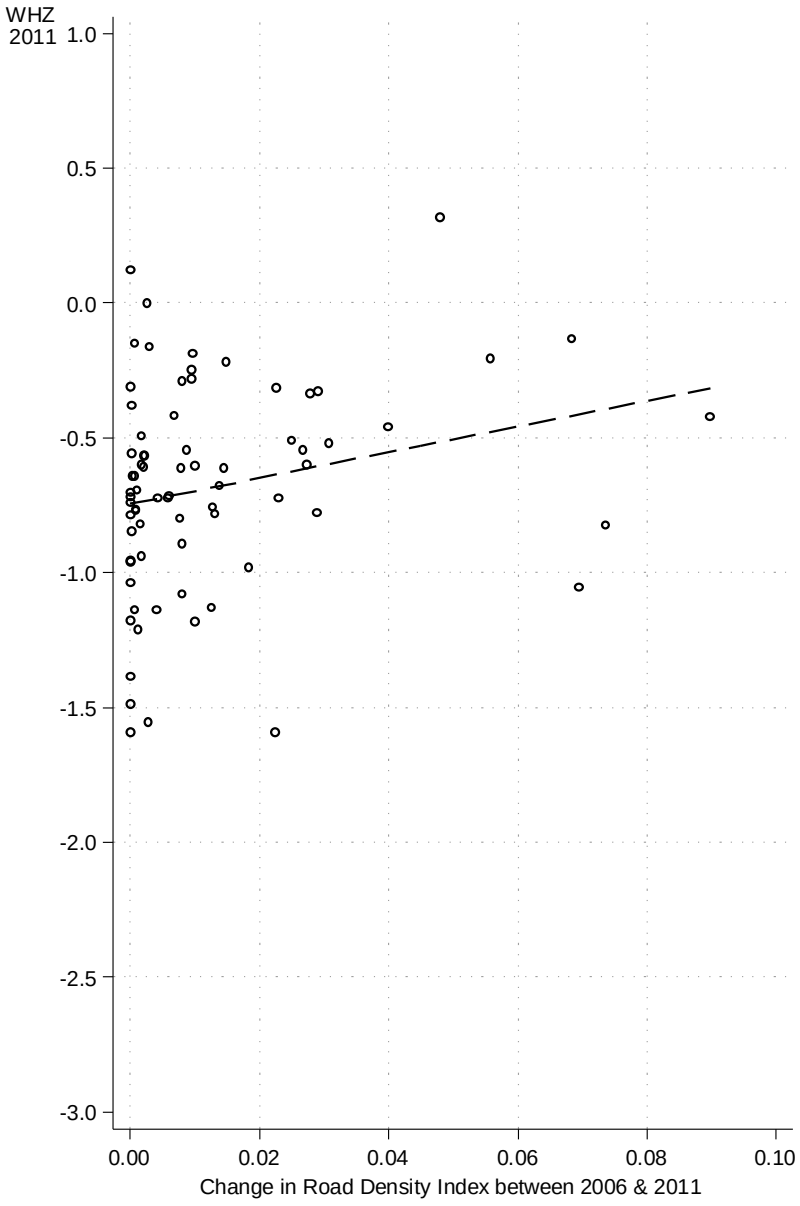
consumption

Better access can also shift the price ratio in favor of things the household either buys or sells.

In this example, the household produces more and consumes more from both groups

District-level road density and child growth





Source: Shively & Thapa (2017) A Dose-Response Model of Road Development and Child Nutrition in Nepal.

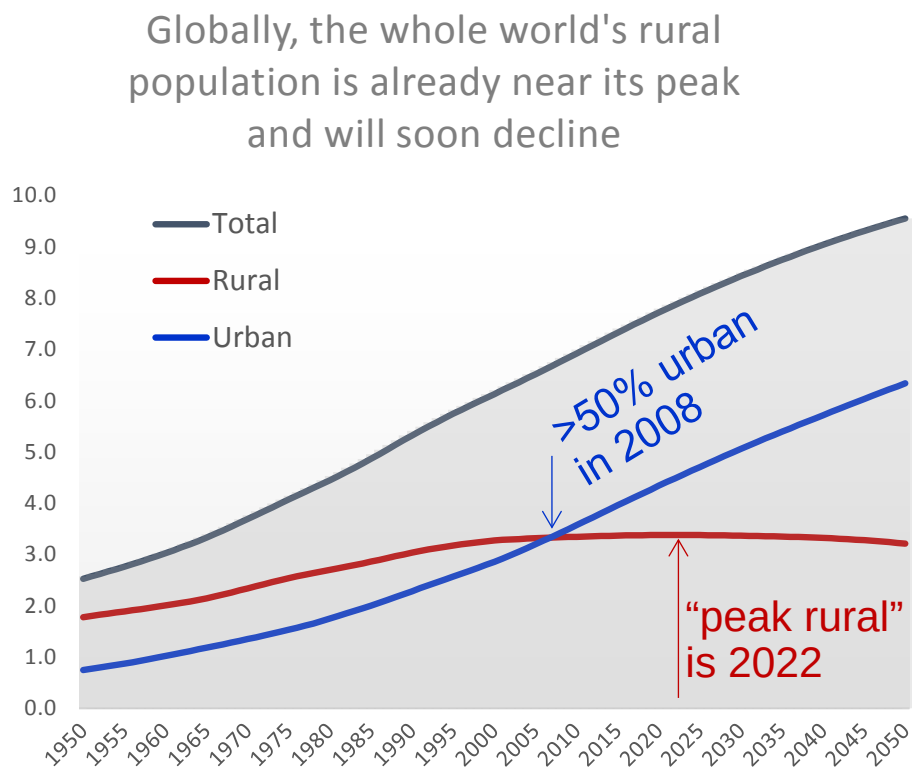
Low-income farming sets the floor for national living standards

- Living standards for agricultural households depends not only on new farming techniques, rural education and health care, but also the speed of rural population growth and hence the rate of decline in available land, water and other natural resources available per farm.

Nepal. GE Shively, 1985

Rural populations keep growing despite urbanization

- With economic development and urbanization, farming accounts for a falling share of employment and expenditure.
- Overall population growth leads to a rising number of farmers from year to year, until the nonfarm sector grows big enough to absorb all new jobseekers.



Source: Calculated from UN World Urbanization Prospects, 2014 Revision. Released July 2014 at http://esa.un.org/unpd/wup.

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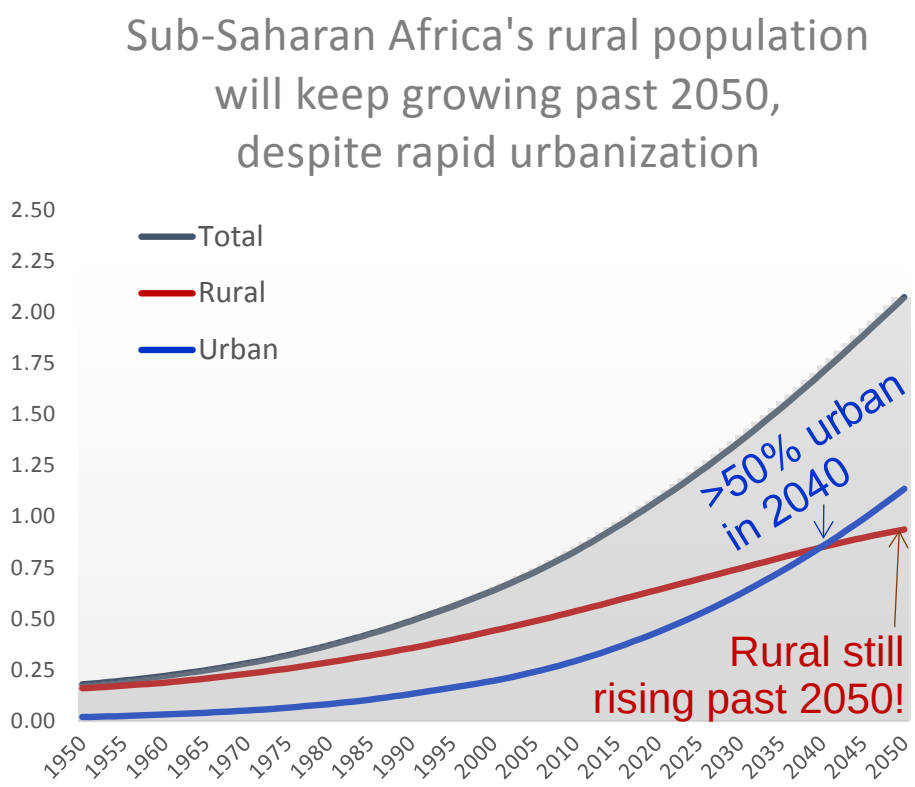

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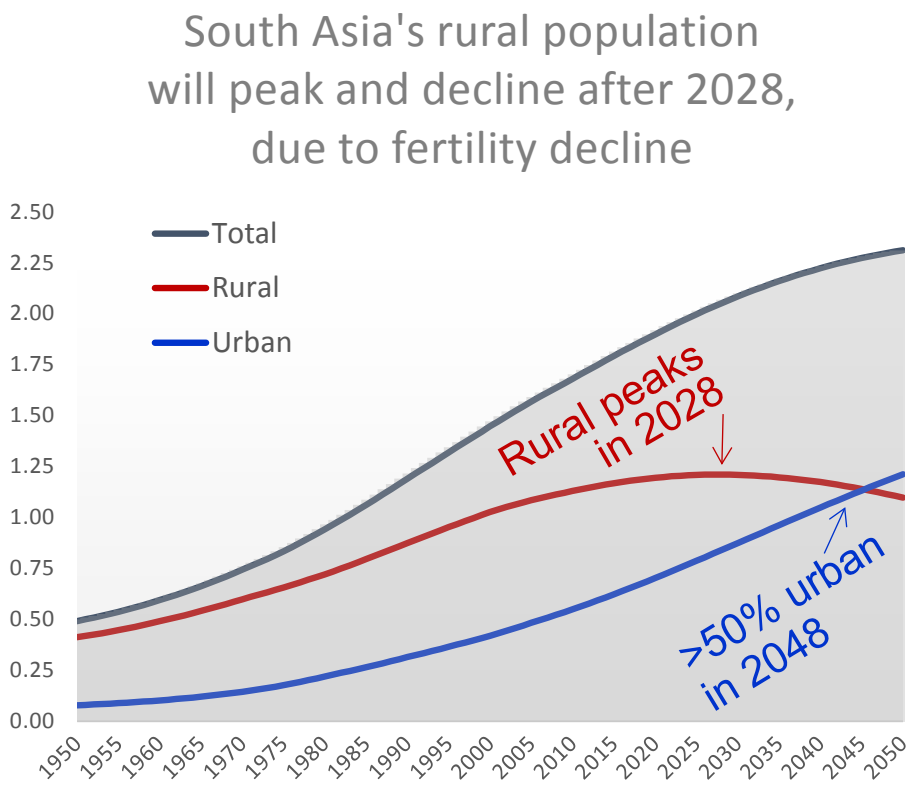

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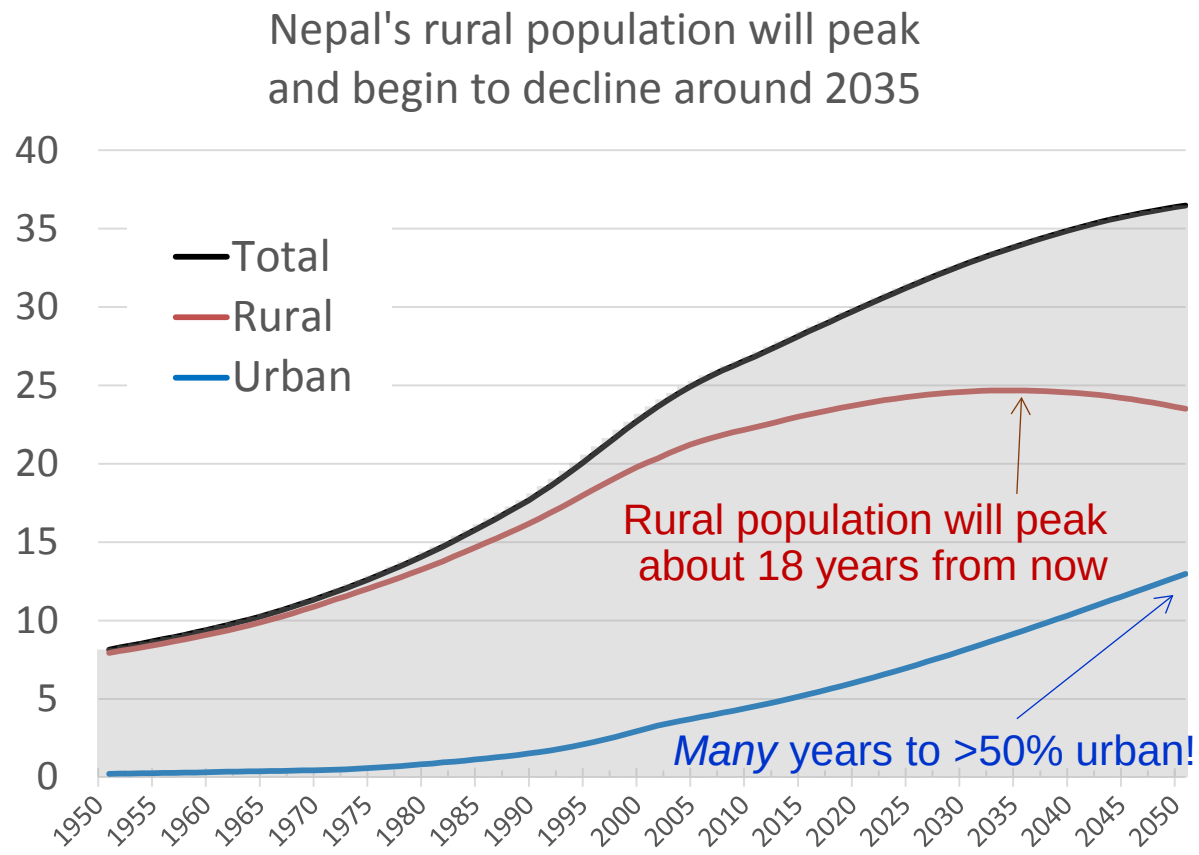
Rural populations keep growing despite urbanization

- With economic development and urbanization, farming accounts for a falling share of employment and expenditure,
- But overall population growth leads to a rising number of farmers from year to year, until the nonfarm sector grows big enough to absorb all new jobseekers.
- Nepal has unusually high migration from rural to international; over half of all agricultural households (NLSS 2011)



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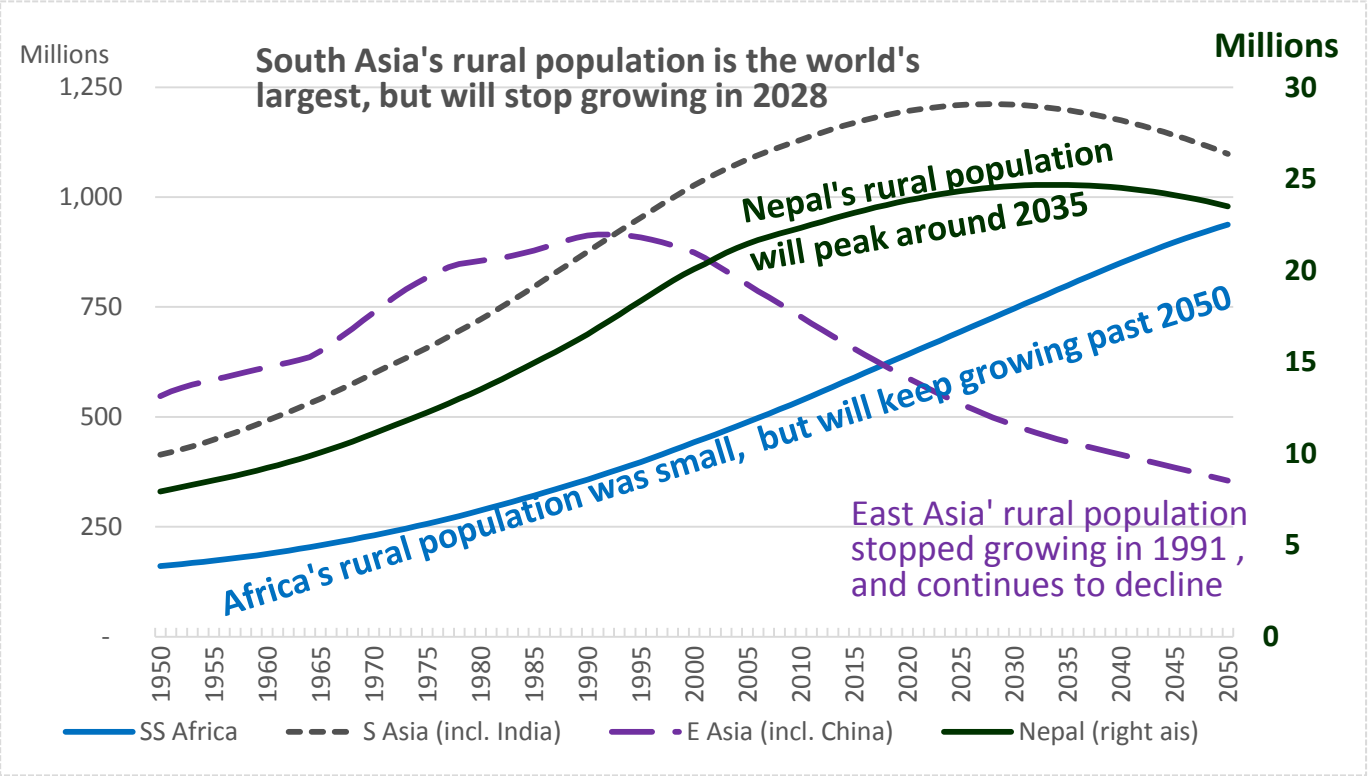
Rural population growth rates vary widely

- There have been big shifts in the speed of rural population growth and then decline
- First E Asia and then SE&S Asia had rapid rural population growth in the 1950s and 1960s, peaking & declining since 1990s
- Sub-Saharan Africa is now the only large region with rapid rural population growth through the 2050s

Rural populations of major world regions, plus Nepal (right axis)



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Once rural populations begin to fall, farms can mechanize and expand

- After the structural transformation turning point, new nonfarm jobs can employ all new workers, so the remaining farmers take over neighboring families' land using mechanization to expand cropped area; this allows them to eventually catch up with non-farmers' incomes, but that did not happen in the US until the 1990s and in the developing world will occur gradually over the 21st century.

There has been a “great escape” from rural poverty: Huge improvements despite shrinking land area per household

- Although farmers are and will remain generally poorer than nonfarmers, recent decades have seen sharp improvements in rural health, education and living standards spreading across Latin America, Asia and most recently in Africa.
- The great escape from rural poverty involves new production techniques and market opportunities that can raise farm families’ income despite falling land area per household, but also depends on public education, health care and social safety nets.

Helping the rural poor promotes sustainable urbanization

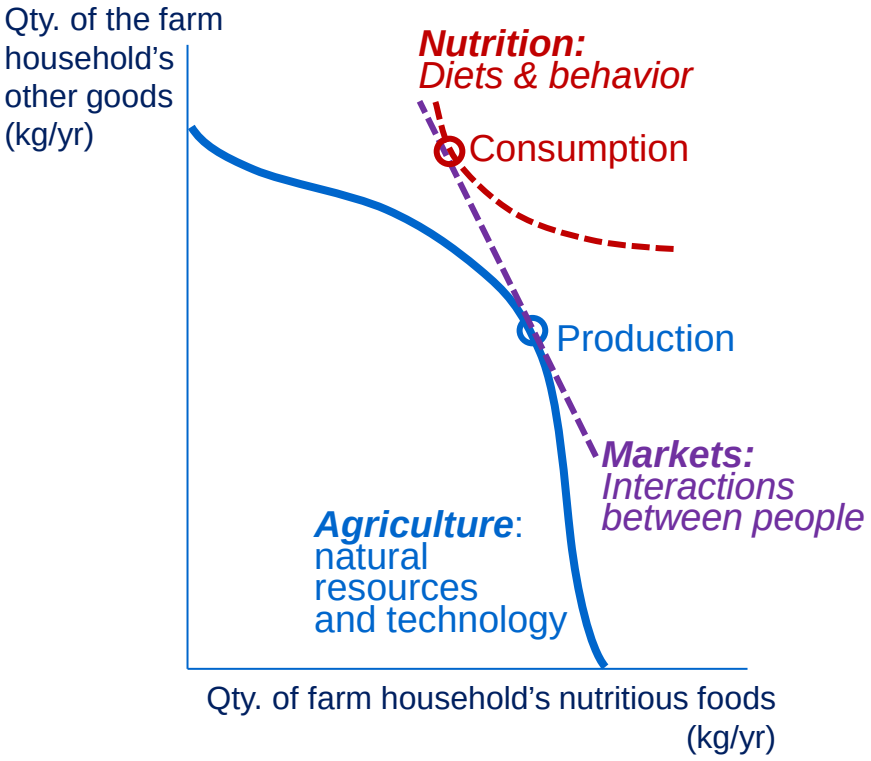
- Raising the floor of rural living standards improves conditions not only for those who remain in agriculture, but also for the urban poor including those who have recently migrated to towns and cities from rural areas.

What determines output, prices and consumption?

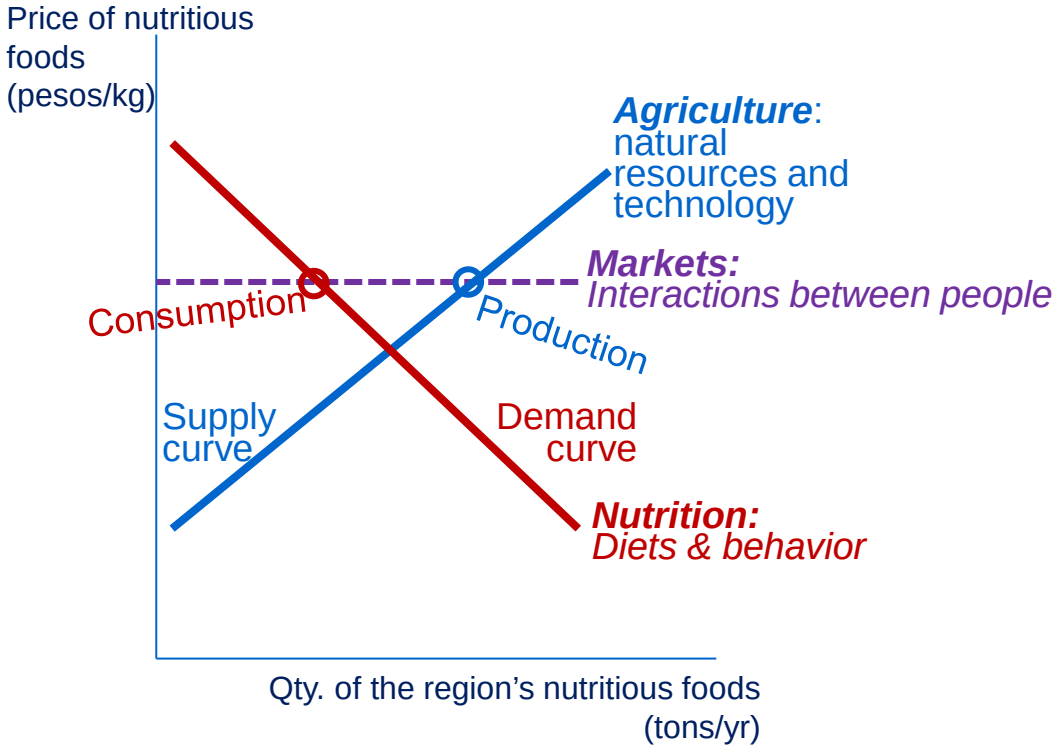
- We can look behind “supply” and “demand” to see how people and nature interact to determine outcomes

Again, keeping our basic economics model in mind helps guide understanding and frame research

An individual household
(here, a "net seller" of nutritious food)



A community of farm households
(here, they "export" nutritious food)



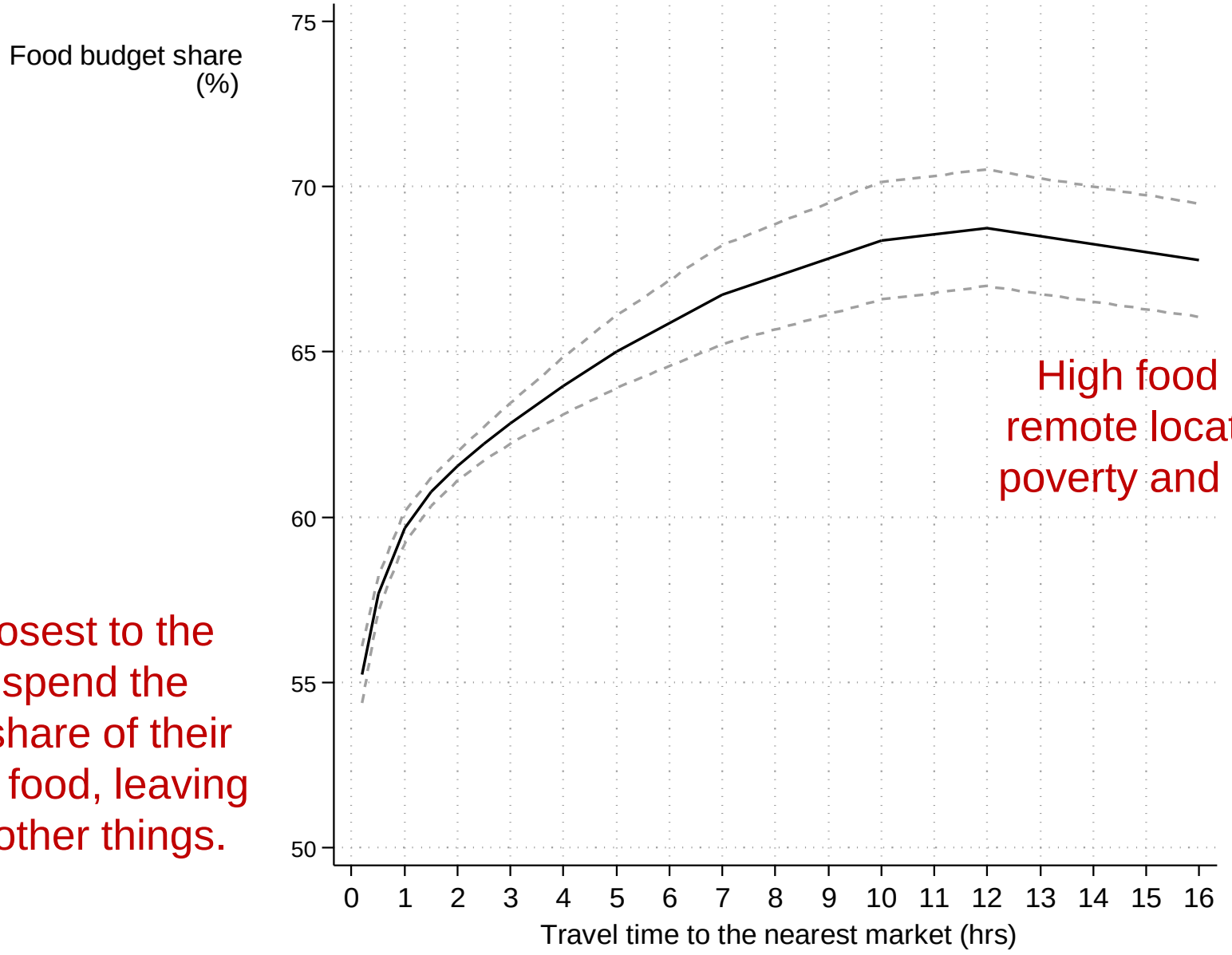
Spatial price differences reflect cost of transport

- Price levels at harvest vary with transport costs from farm to market, with lowest prices in the most remote selling regions, and highest prices in the most remote buying regions.
- Price differences across locations can be reduced primarily by reducing the cost of transport from place to place just like improvements in storage can reduce price variation over time.

Groundnut prices in Ghana, August 2013

Source: Masters, Ghosh and Sarpong (2013), from data reported through Esoko.com. Prices are in Ghana cedis per 82 kg bag of shelled peanuts (http://app.esoko.com).

Food budget shares in Nepal

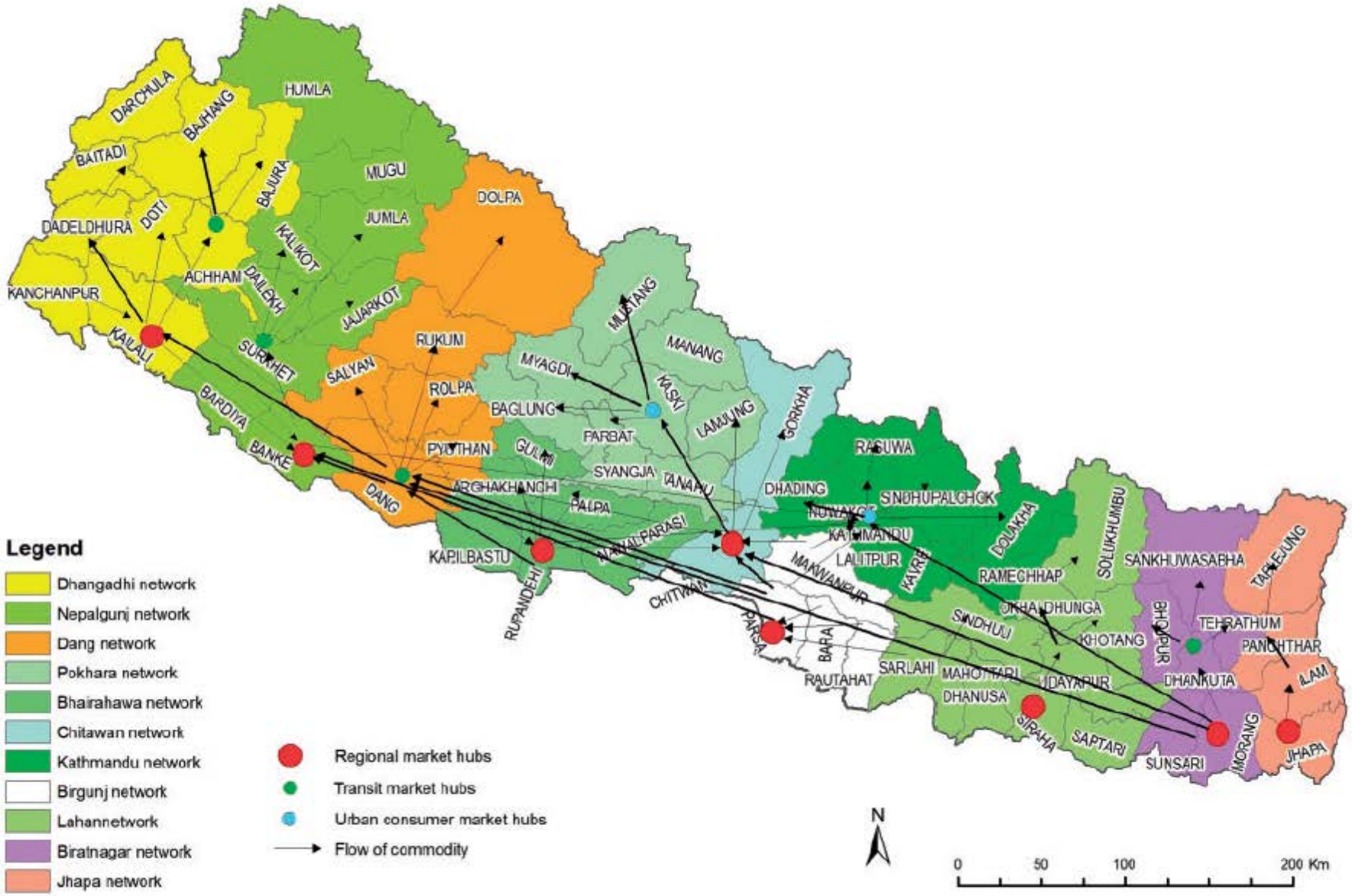


High food budget shares in remote locations are driven by poverty and higher food prices.

Those closest to the market spend the smallest share of their income on food, leaving more for other things.

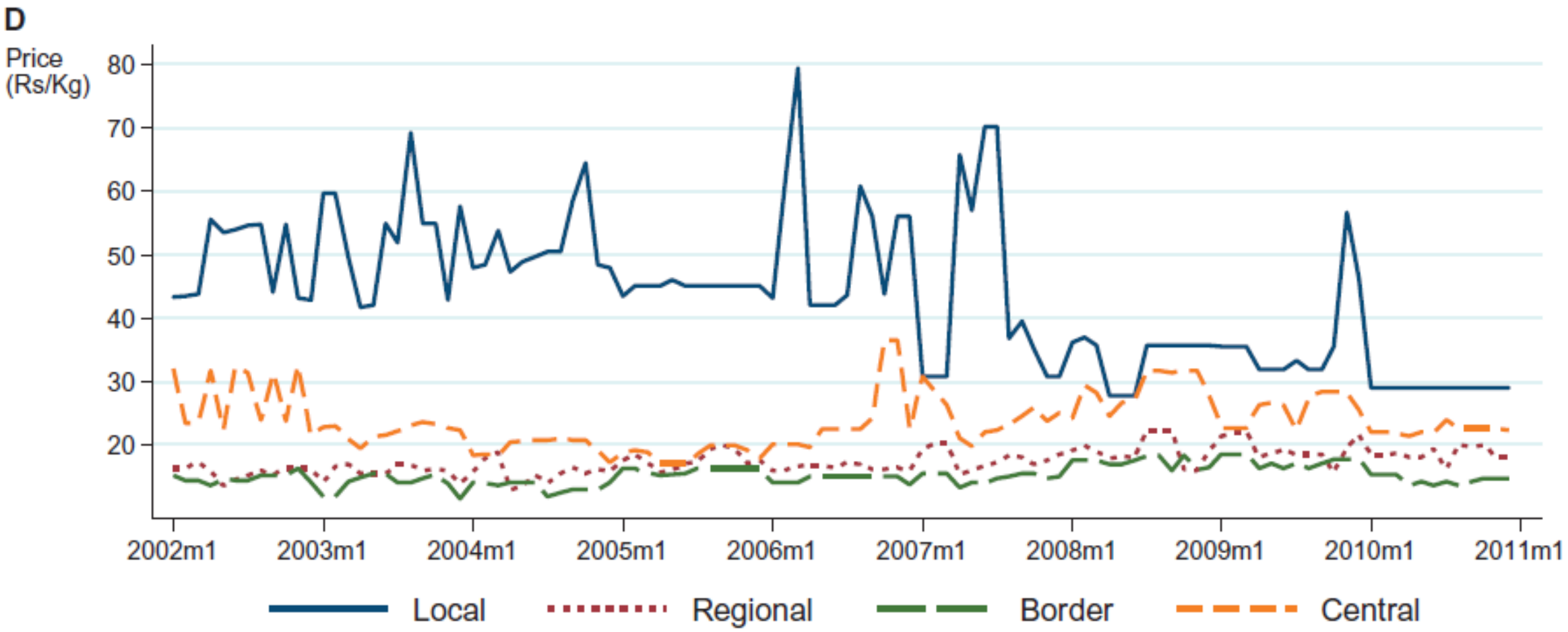
Source: NLSS 2011

Food grain markets and commodity flows in Nepal



Source: Shively and Thapa, AJAE (2016), adapted from WFP/FAO (2007)

Implications? Monthly real rice prices in Jumla and connected markets (2002-2010)



Source: Shively and Thapa, AJAE (2016)

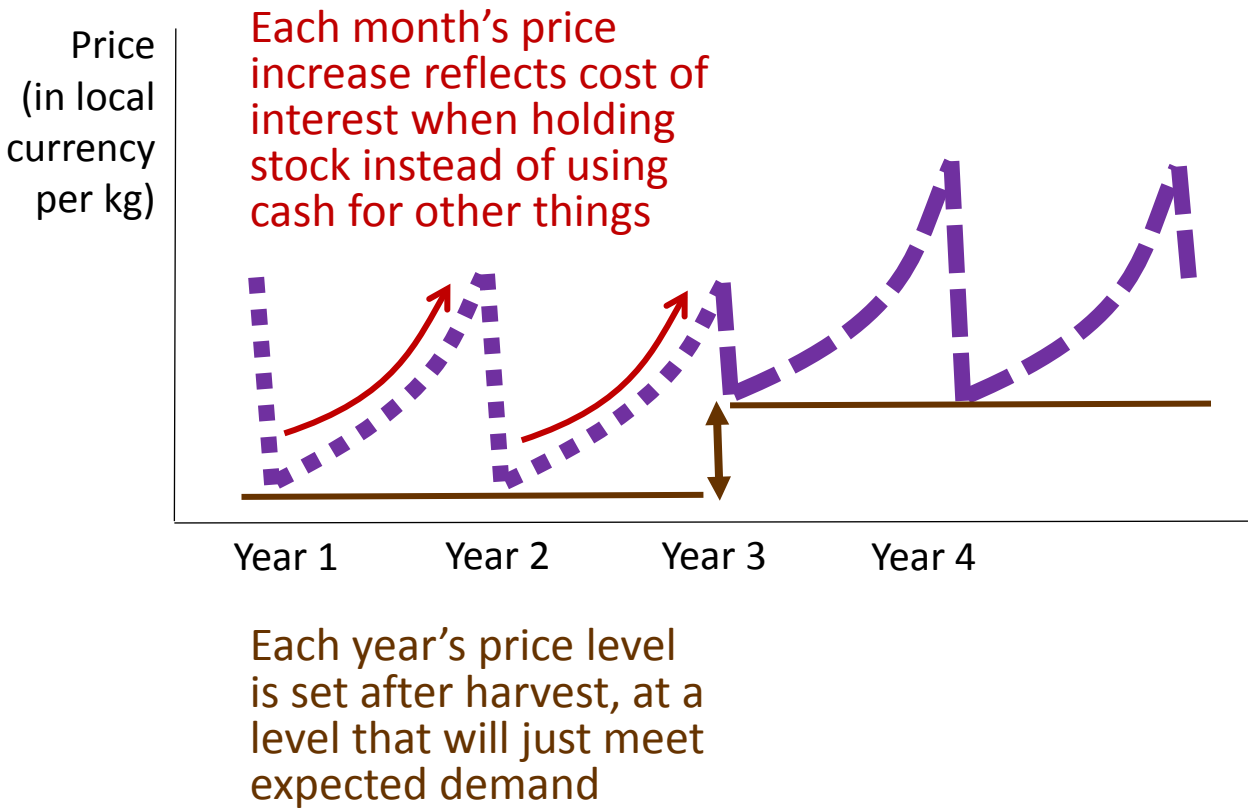
Seasonal price changes reflect cost of storage

- Crop production is usually seasonal, with simultaneous harvests across a large geographic region that must be stored or transported to the times and places where products are needed.
- Price rises after harvest are due to storage costs from month to month, which in poor places is primarily the value of capital that could be invested elsewhere plus the risk of loss.

A farmer's maize bin in Uganda
Photo: W.A. Masters, 2010

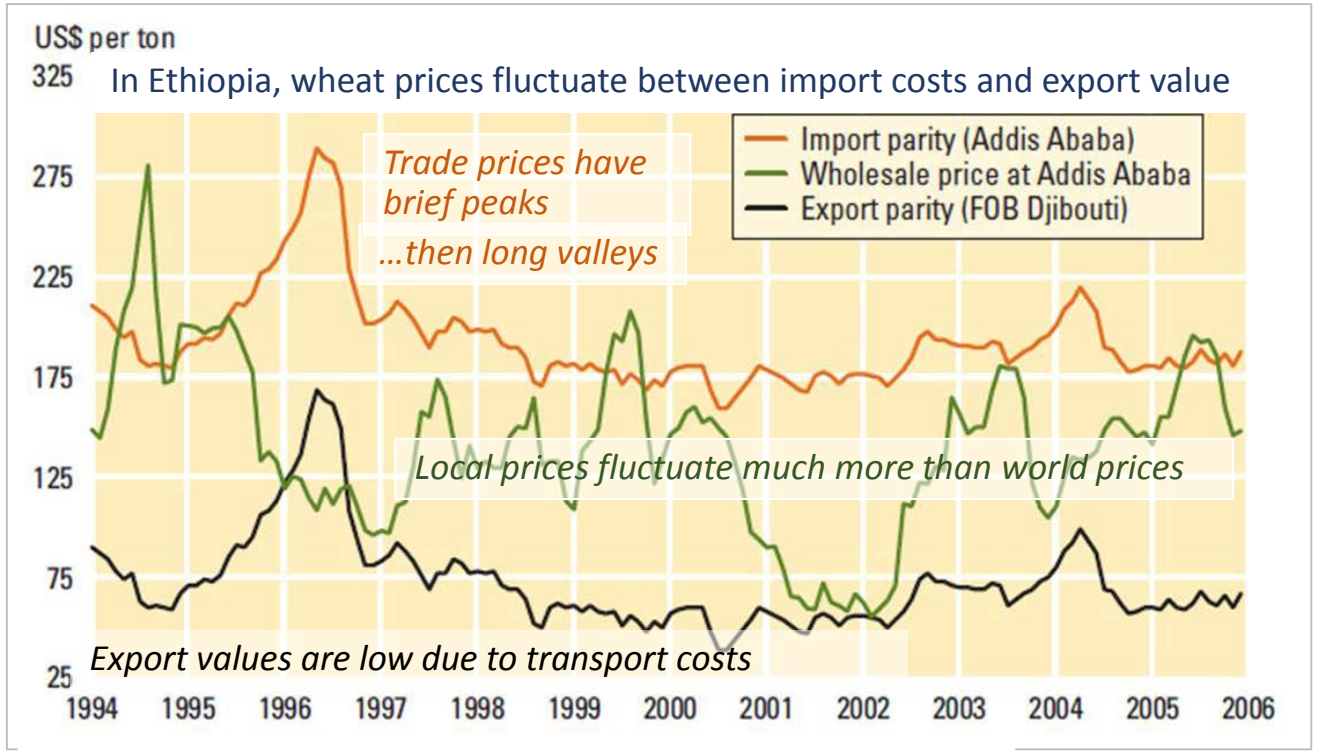
Seasonal price changes reflect cost of storage

- In a hypothetical, fully isolated rural area with one harvest/year, prices follow a sawtooth pattern
  - Seasonal price rises reflects cost of storage until the next harvest
    - Prices fall at harvest, so stocks are drawn down to zero just before that
  - Annual price level reflects total year's supply relative to demand
    - Any surprises during the year will be reflected in price jumps up or down



Global trade helps smooth prices

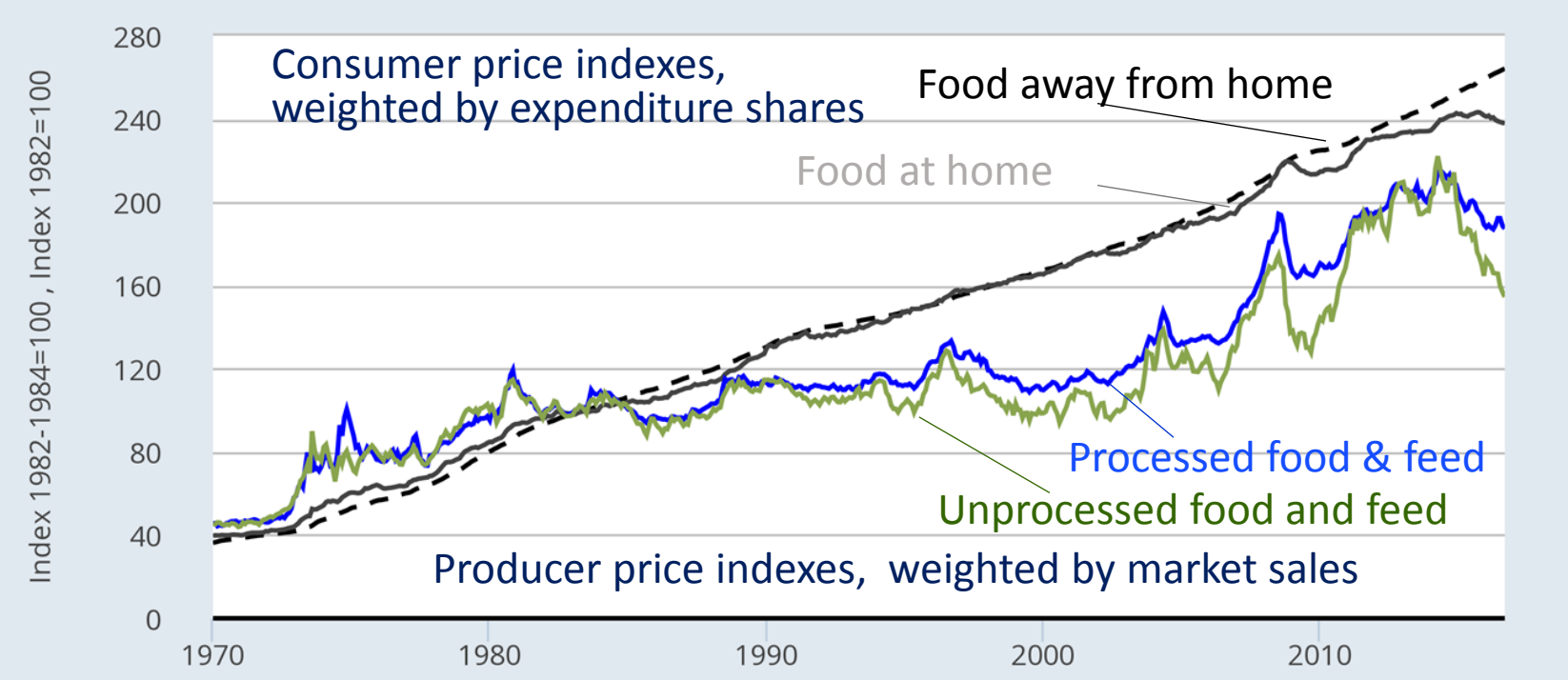
- Price changes from year to year reflect expected demand relative to supply in each location
- The main instrument for stabilization is trade among diverse regions, which smooths out local fluctuations due to weather or other production shocks in each place.



Source: Reprinted from World Bank, *World Development Report 2008*.

Retail food prices are *much* smoother than agricultural commodity prices

- Retail food, especially for food away from home, is mostly a service.
- Prices of processed foods are somewhat more stable than unprocessed foods, because they include more services



Source: US. Bureau of Labor Statistics, downloaded 12 November 2016.
Definitions and chart data are available at http://myf.re/g/aPV1

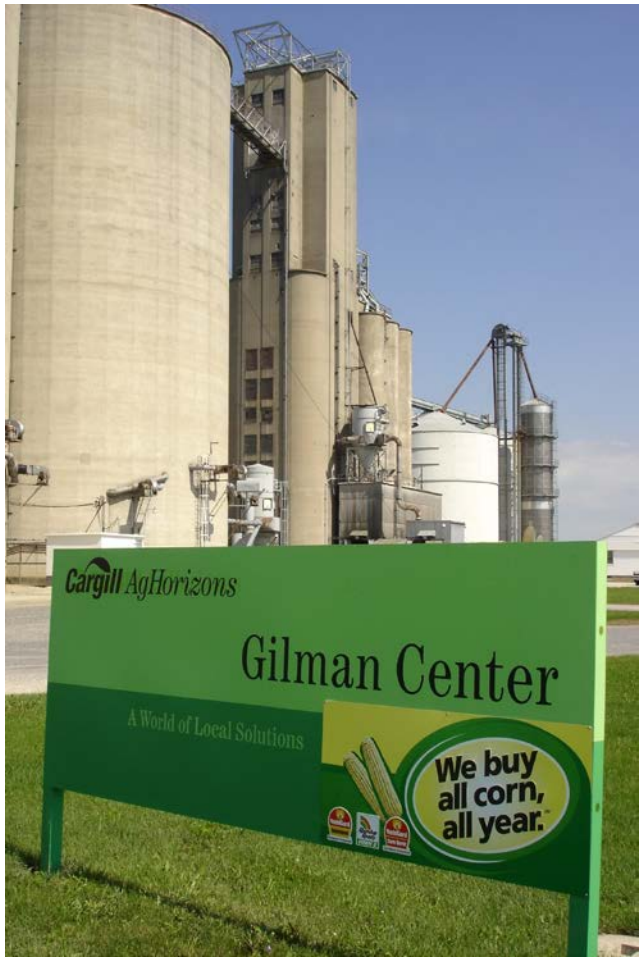
Postharvest storage + trade can add value

- Postharvest handling of crop and livestock products is important not only for storage and transport, but also to:
  - protect food against contamination,
  - improve nutritional value and
  - increase trust in the many quality and safety characteristics that cannot be observed before or sometimes even after food is actually eaten.

Fortified infant foods for sale in Kampala, Uganda
Photo: WA Masters, 2011

Postharvest handling involves scale economies and hence monopoly power

- Like farm input supply, postharvest handling is typically characterized by scale economies with large traders, transporters and processors buying from many farms and selling to many consumers, giving rise to market power for which the main remedy is use of farmer-owned or consumer-owned cooperatives, and enforcement of competition policy to prevent monopoly behavior.



Cargill maize storage facility in USA
Photo: WA Masters, 2009

Postharvest systems can add value… and may improve or worsen food safety and nutrition

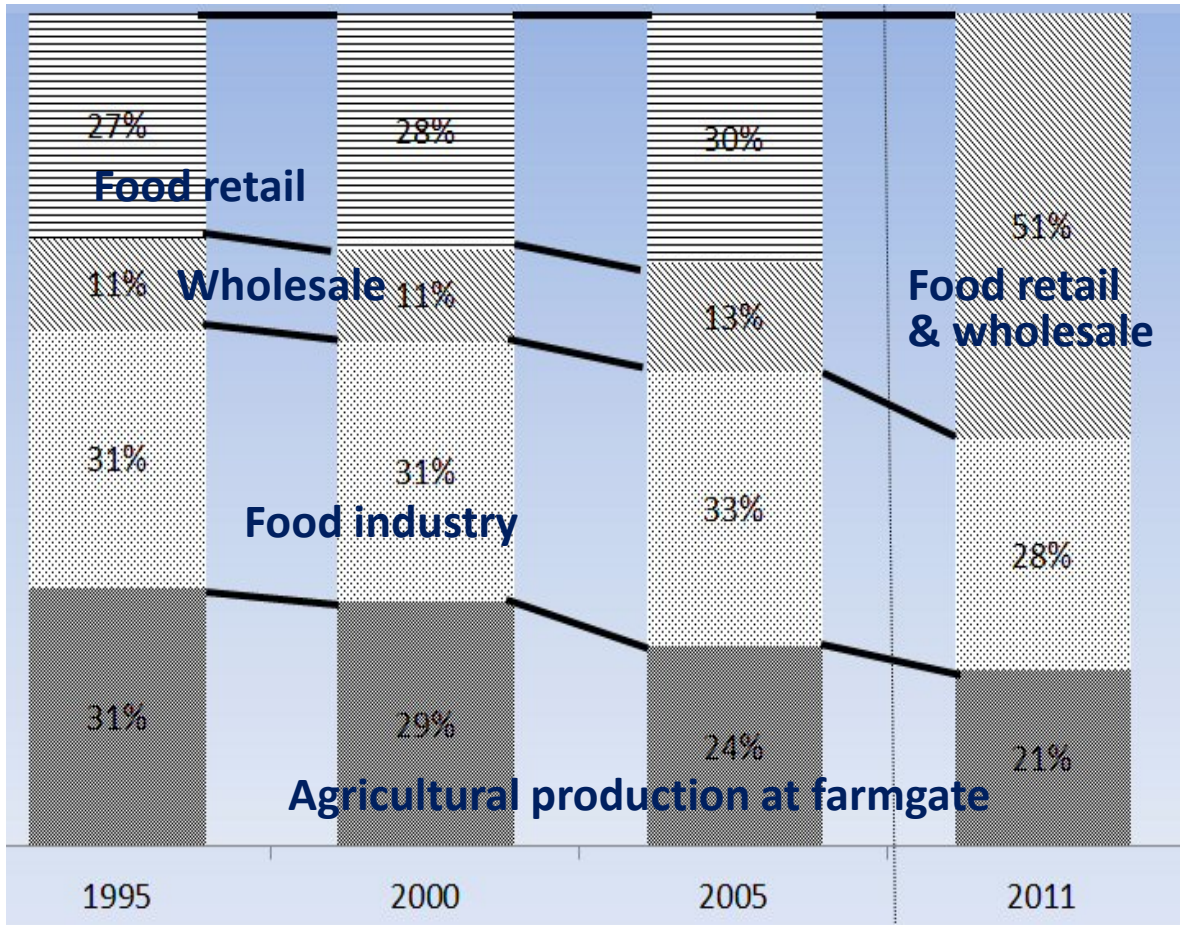
- While successful postharvest systems can greatly improve food safety and nutritional value, dysfunctional systems can lead to heavy burdens of contaminants such as salmonella and e. coli in vegetables, meat and milk, or aflatoxins from moldy grain or nuts; food processing can also sharply worsen diet quality by introducing unhealthy levels of sugar and other refined carbohydrates as well as salt, saturated fats and other ingredients that can lead to hypertension, diabetes and cardiovascular disease

Food safety testing laboratory in China
Photo: WA Masters, 2006

Food prices and markets are very different from agricultural commodity prices and markets

- Raw commodities that are traded internationally account for a small fraction of most foods' retail prices and consumer expenditure,
  - major exceptions are rice and maize among low-income consumers for which sudden price increases can cause extreme hardship.
- During world food price spikes governments can
  - protect vulnerable consumers using social safety nets, and
  - can stabilize prices to some degree by altering trade policies, but most commodity prices

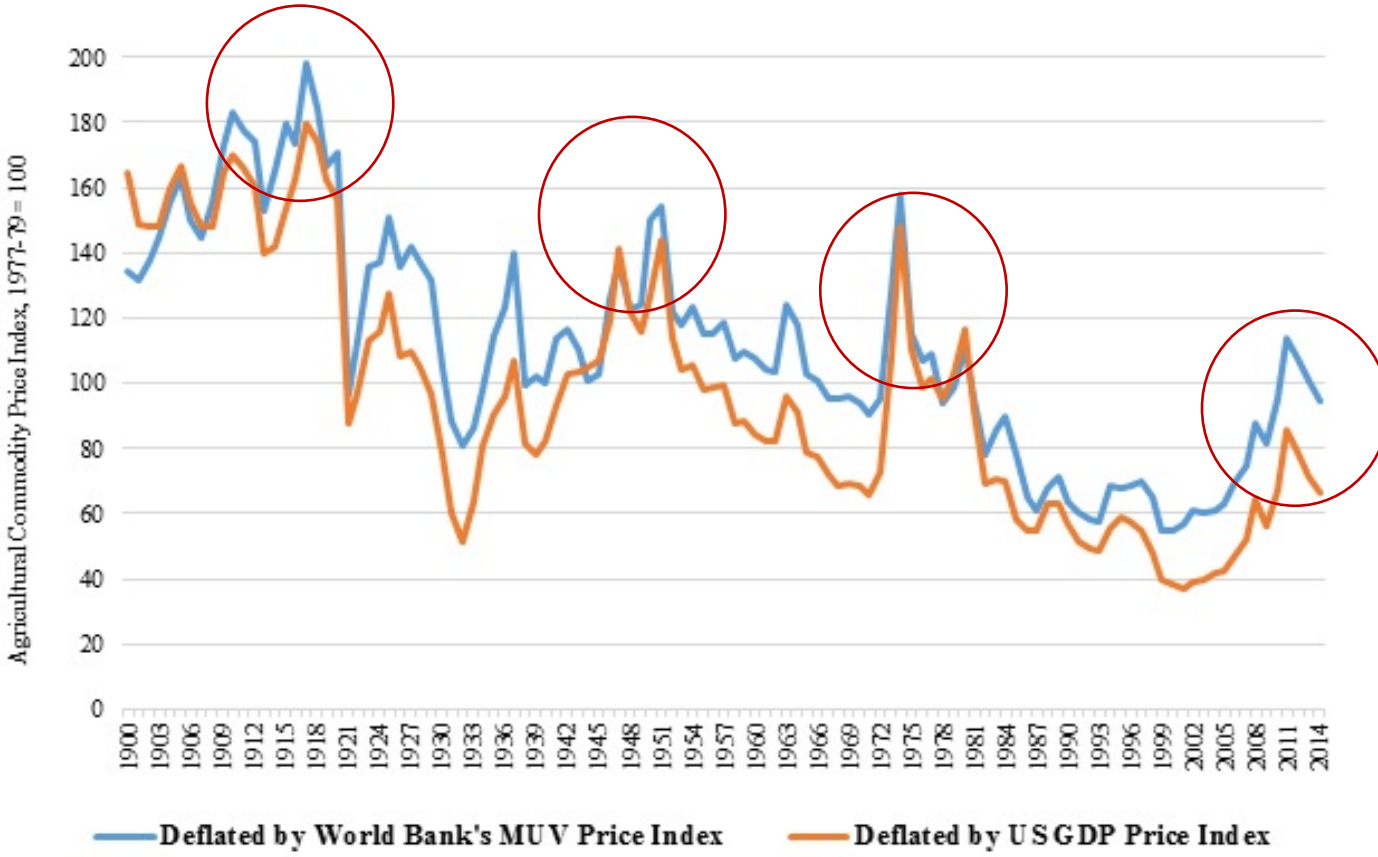
Shares of value added in EU food supply, 1995-2011



Source: Alan Matthews (2015), "Farmers' share of food chain value added", http://capreform.eu.

Global food markets have periodic crises

- Agricultural commodities generally follow U-shaped price patterns, as periods of low prices during which traders expect upcoming harvests to meet each year's demand are interrupted by years in which supply falls short, stocks are drawn down faster than expected so prices spike up.



Source: Uma Lele (2015), from Pfaffenzeller, S (2013). "Updating the Grilli and Yang Commodity Price Index – beyond 2003" with data updated by Keith Fuglie.

To improve agriculture, the most powerful investment is new knowledge about production

- The most important lever for broad-based, equitable and sustainable rural development is to change the technologies that are available for poor people to use, through agricultural innovations such as better seeds and soil amendments, crop protection and livestock systems.

Top: Agricultural research in Ethiopia
Bottom: Agricultural input dealer in Zambia
Photos: W.A. Masters, 2010 and 2011

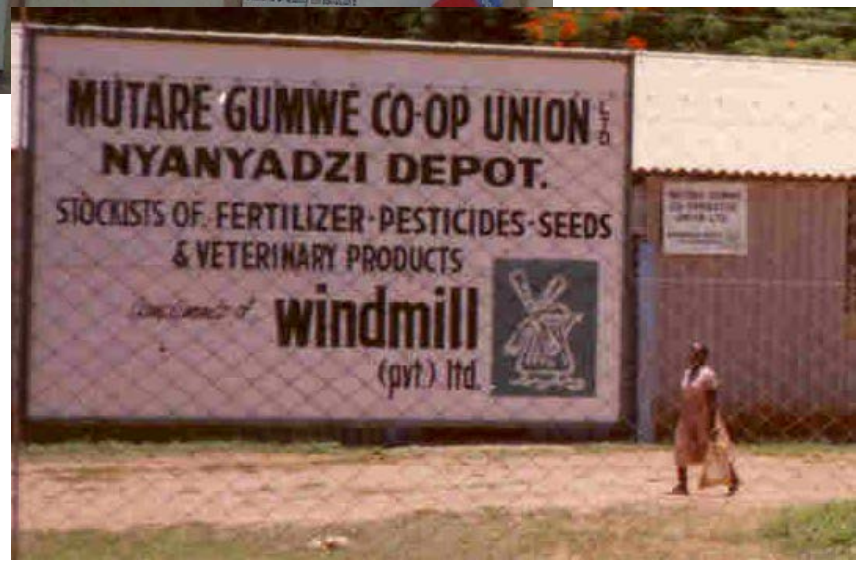
Agricultural innovations often embody public R&D in privately-sold farm inputs and products

- Even in countries where seed multiplication, input sales and product markets are dominated by agribusiness firms selling branded products, the value of discovering new techniques flows quickly to other people so most agricultural research is still conducted by the public sector.

Top: Hybrid maize bred for the USA
Bottom: Hybrid sorghum bred for India
Photos: W.A. Masters, 2009 and 2011

Innovation runs on institutions

- The speed and focus of agricultural innovation depends on public investment
- The role of private-sector agribusiness depends on definition and enforcement of intellectual property and regulations to protect others from potential harm.



Top: Government regulatory agency in Ghana
Bottom: A farmers' cooperative in Zimbabwe
Photos: W.A. Masters, 2011 and 1988

Innovation depends on infrastructure, too

- Improvements in rural infrastructure, including electrification and water supply, are central to poverty alleviation not just to help farmers buy agricultural inputs and sell agricultural products, but also to improve nutrition and raise living standards through the goods farmers buy.
- In regions with low population density and low incomes, rural infrastructure may be prohibitively costly, so careful targeting is needed to avoid wasteful and environmentally damaging construction.

A protected well in Ethiopia
Photo: W.A. Masters, 2011

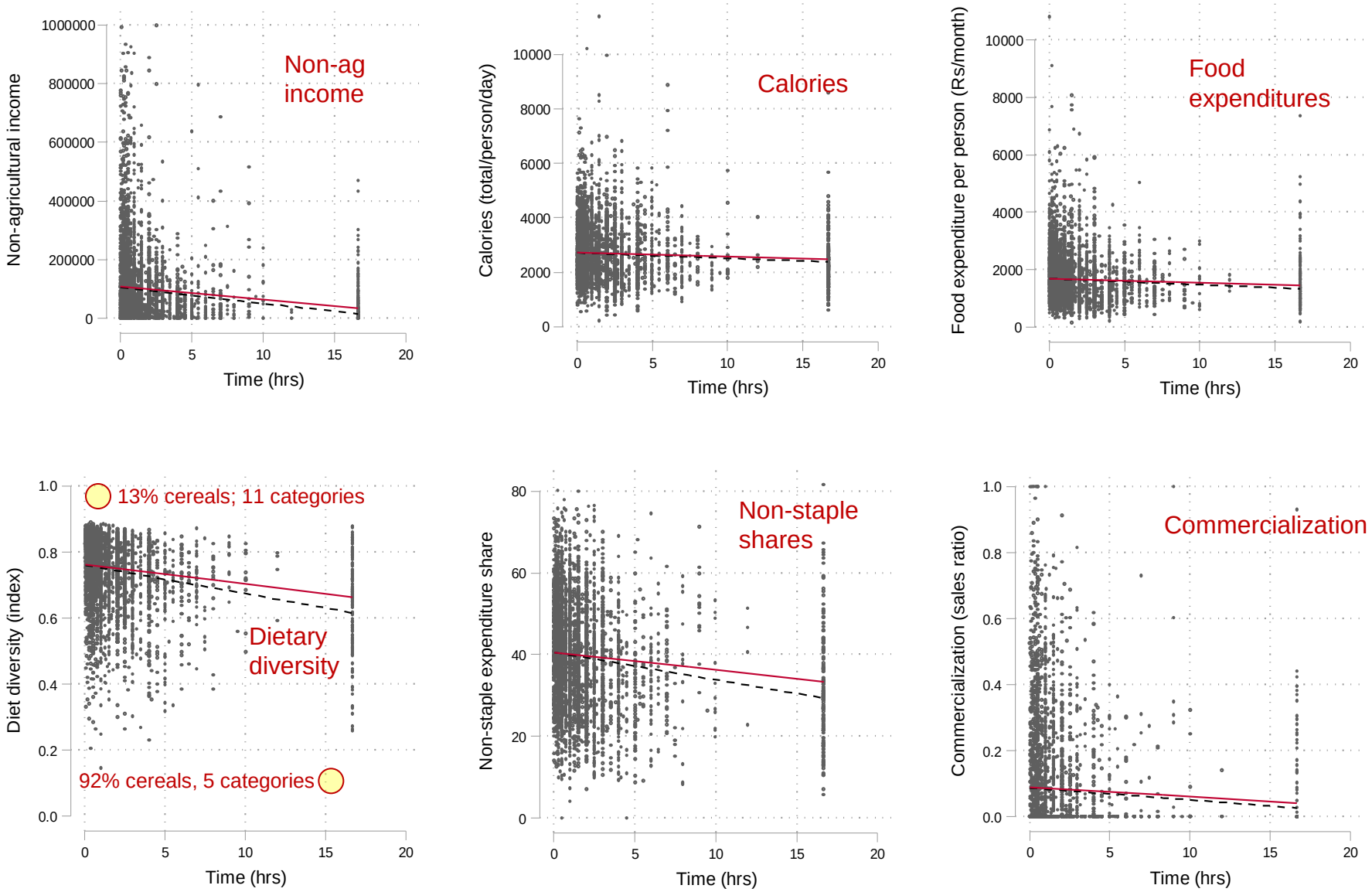
Innovation depends on infrastructure, too

- Improvements in rural infrastructure (e.g. water supply & electrification) are central to poverty alleviation. They help farmers buy/sell inputs and products, and improve nutrition and raise living standards through purchases.

Community irrigation project in the Philippines; Photo: GE Shively, 1999

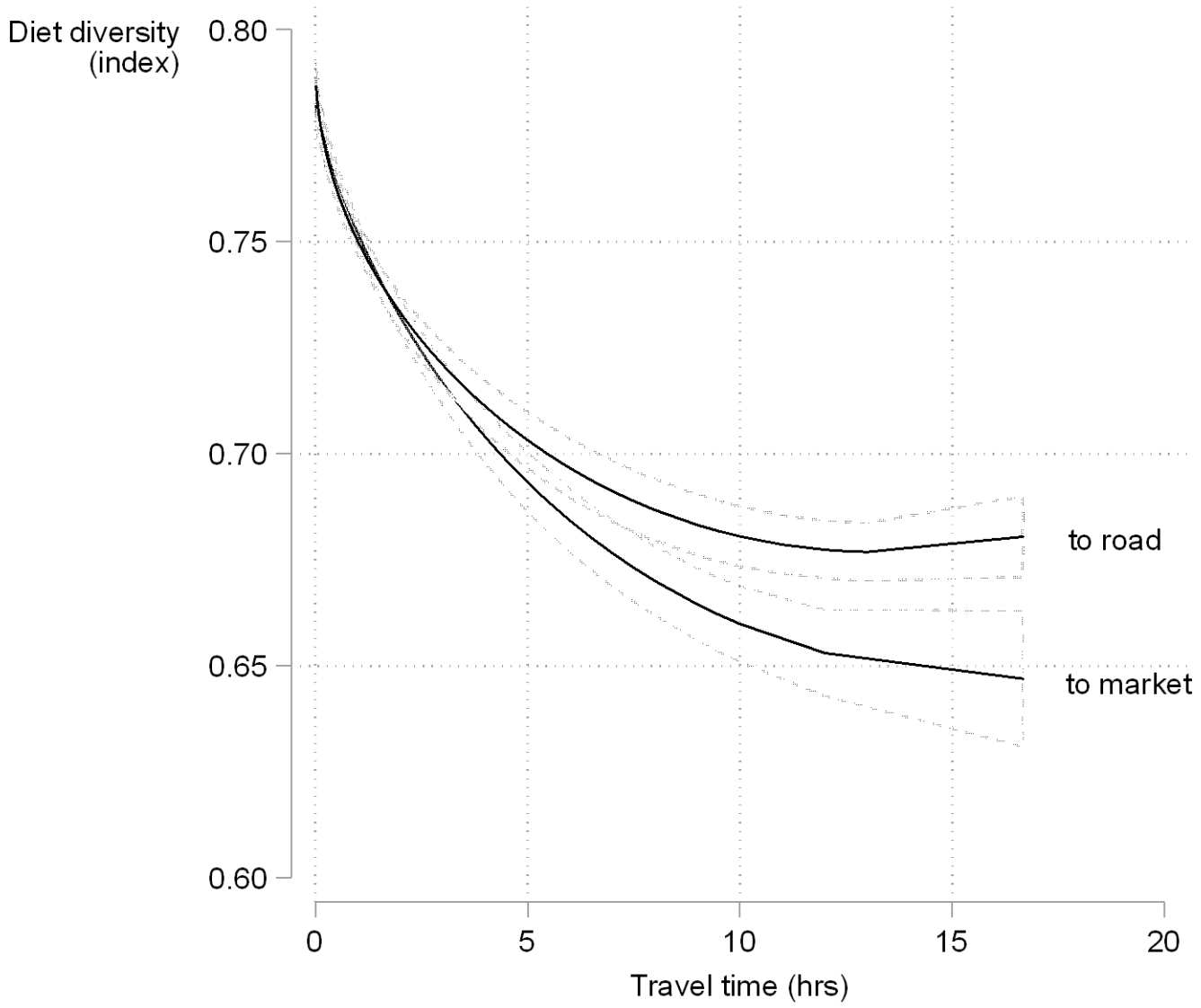
A protected well in Ethiopia; Photo: WA Masters, 2011

Travel time in Nepal and food security indicators



Source: NLSS 2011, agricultural households only, as reported in Shively and Thapa (2017)
Solid (red) line is regression plot against time to road and dashed (black) line is regression plot against time to market

Roads vs. markets in Nepal



Being far from a market is more detrimental than being far from a road!

Institutions determine what investments are made

- Equitable property rights and market access make it possible to have people-centered development
- Agriculture depends on natural resources such as farmland, ground and surface water, forests and fisheries which originate in the public domain, and are brought into private use as population grows and economic activity expands.

Fertile valley landscape in Ethiopia Photo: W.A. Masters, 2011

Institutions and property rights vary across countries and change over time

- Countries differ greatly in how they allocate property rights, but ensuring that farm families can divide the available agricultural land in efficient and equitable ways is a fundamental determinant of agricultural productivity and sustainable development.
- Water, forests and fisheries typically remain in the public domain well after land is parceled out for private use, but when they too become scarce, using them efficiently and equitably becomes an essential driver of food supply and sustainability.

Top: Hillside farming in Ethiopia; bottom: Pivot irrigation in Egypt using Nile water from Ethiopia (W.A. Masters, 2011 and 2016)

Sustainable agriculture can improve nutrition

- Governance systems that target improved nutrition can move agricultural practices towards increasingly efficient plant-based systems that also achieve environmental goals.
- Dietary patterns, like agricultural systems, respond to better governance that delivers both investments and incentives to change, including regulations such as mandatory disclosure of nutritional composition.

Beans and fortified flour for sale in Tanzania
W.A. Masters, 2016

Improvements require bringing together diverse views

- Better governance will not come from evidence alone; persistent direct engagement with the public, with business leaders and with government officials will be needed.

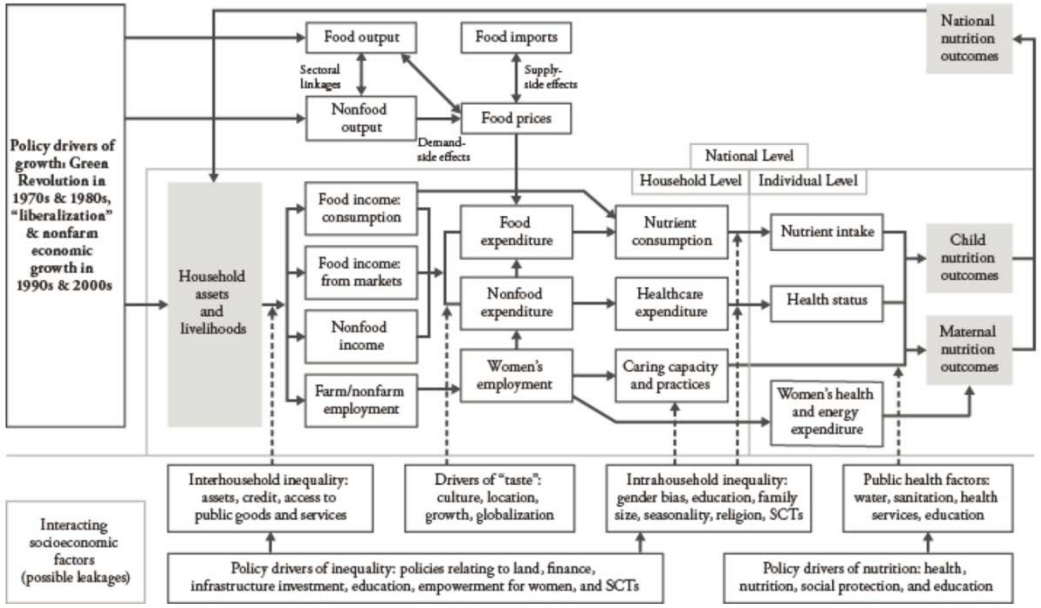
An agricultural policy workshop in Malawi; Photo GE Shively, 2009

An agricultural policy workshop in Ethiopia; Photo WA Masters, 2016

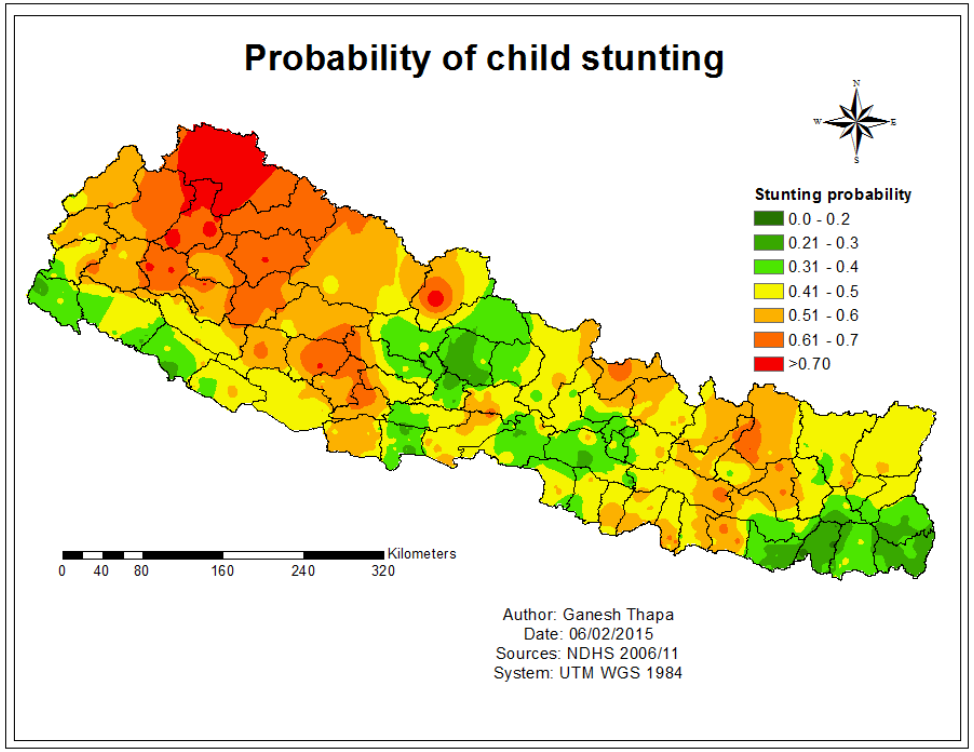
Introduction to Economics for Agri-Health Researchers

Conclusions and take-away messages

Key takeaway #1:
The same world can be understood in *many* different ways

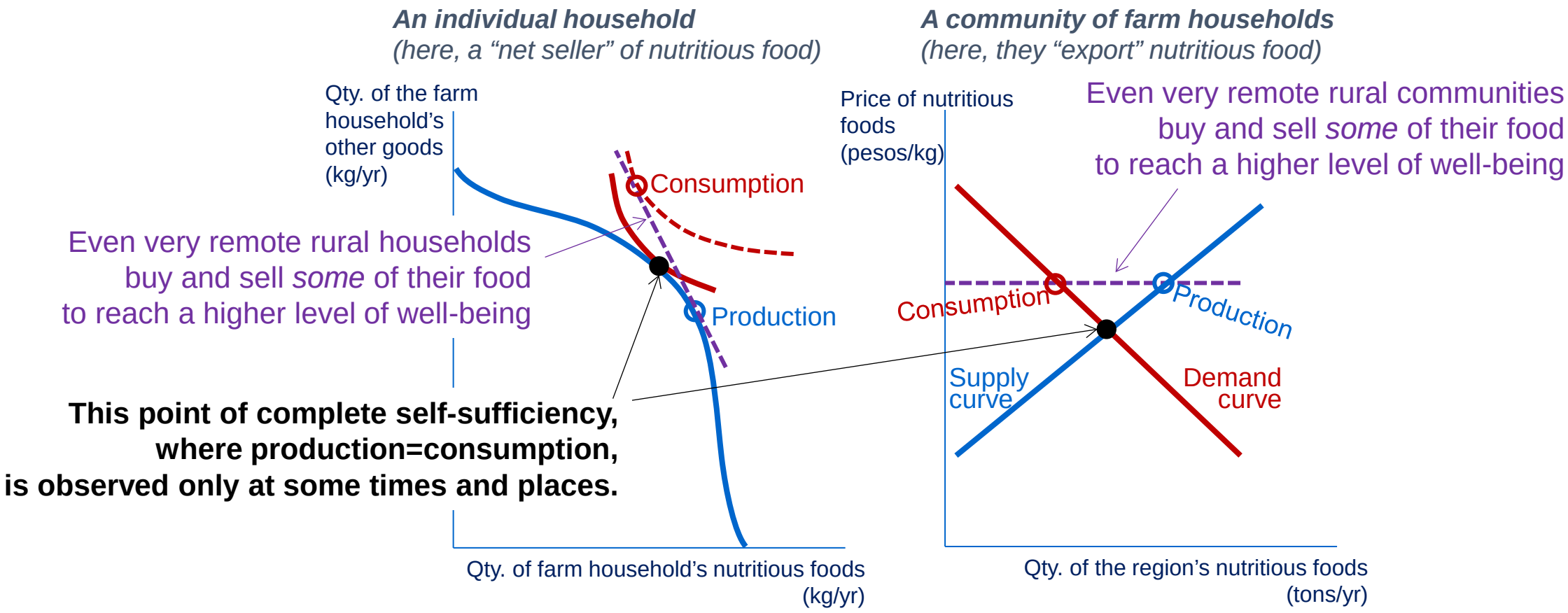


Causal pathways and flow charts

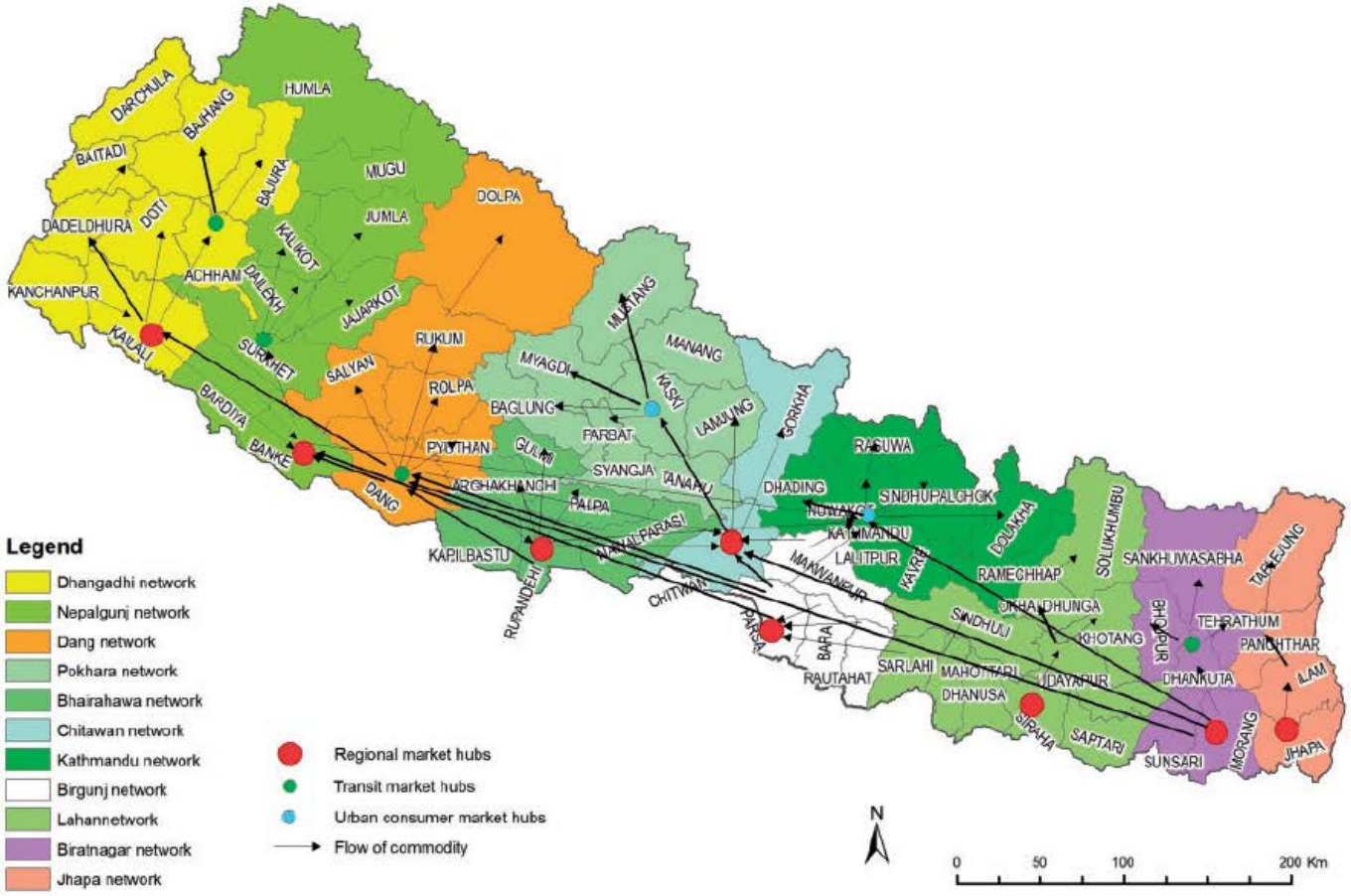


Data visualization and maps

Takeaway #2: Economics offers a useful causal model of individual choices and social outcomes



Takeaway #3: Economics can be very helpful for analysis of agriculture-nutrition linkages and to improve food policies and programs



Source: Shively and Thapa, AJAE (2016), adapted from WFP/FAO (2007)

Thank you!

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