LDC AGRICULTURE BASICS

I. TRENDS IN LDC FOOD PRODUCTION IN THE 1980S

A. Total Cereals Availability

$\hat{Q}$ = 39% (= 3.35% per year)
$\hat{N}$ = 26% (= 2.35% per year)

$\hat{q} = \hat{Q} - \hat{N}$ = 13% (= 1.25% per year)

Distribution of production uneven

In 75 countries, per capita food production fell during the 1980s including:

- ¾ of all African countries
- 2/3 of all Latin American countries
- ½ of all Asian countries

Pinstrup-Andersen: In next 20-30 years food production must grow to accommodate 100 million more people per year.

Demand for Food

$Q^D = N\,f(P,Y) \Rightarrow \hat{Q}^D = \hat{N} + \varepsilon_P \cdot \hat{P} + \eta \cdot \hat{Y} \geq \hat{Q}^S$???

Note: We're ignoring the distribution of food prod/cons. here

B. Yield Gains vs. Area Gains

Q = A*Y $\Rightarrow$ $\hat{Q} = \hat{A} + \hat{Y}$

- $\hat{A}$ is constrained by availability of land
- In most parts of the world, good ag. land is already under cultivation
- Negative correlation (covariance) exists between $\hat{A}$ and $\hat{Y}$ $\Leftrightarrow$ expansion occurs onto **marginal lands**.
- $\hat{Y}$ is achieved by:
  - Technological change (e.g., improved varieties)
  - Increased use of inputs (fertilizers, water, pesticides/herbicides) that limit crop losses

C. Trends in Yield Growth

- Yields grew tremendously in past 30 years, beginning with the Green Revolution
  - Rice yields doubled 1961-1993
  - Wheat yields tripled 1961-1993
- But $\hat{Y}$ has slowed (or stopped in some areas) in the past decade, in some cases due to the negative correlation between $\hat{Y}$ and $\hat{A}$
- **Sustainability of continued yield increases** due to seed-fertilizer based technological change called into question (e.g., rice-wheat system, Prabhu's work on declining experimental rice yields).

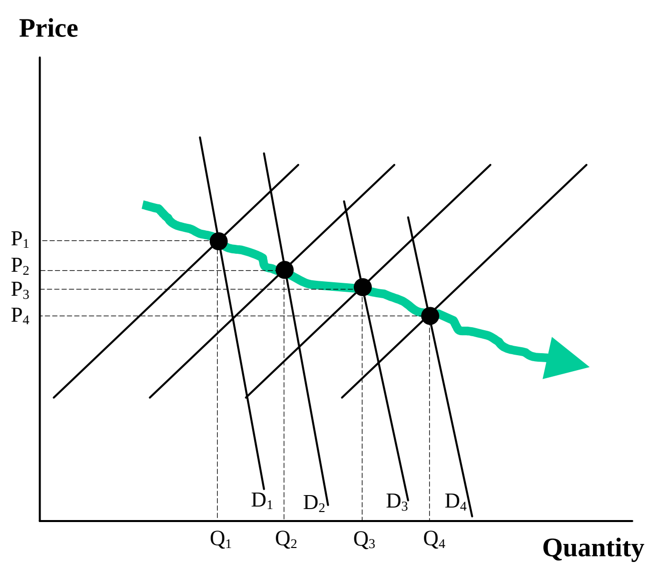
Biotech revolution on the horizon???

D. Trends in Area Growth

- Area increase has played only a small part in total food production increases since 1980
- **Exception:** Africa (no green revolution there for the most part).

E. Price Trends

- Prices have been falling since 1976



- If demand shifts out more slowly than supply, then equilibrium price (P*) will fall
- Developed country food production enters picture here too!!
    - Trade in cereals means that tech. changes and other forces pushing out DC food supply will mean lower prices for LDC importers.

Pinstrup-Andersen's Laundry List

- Economic/Ag growth to ease distrib. problems (esp. in Africa)
- Reduce population growth, rural to urban migration
- Resources to int'l ag. research, infrastructure, credit
- Liberalization (reduce distortions)
- Manage environmental degradation (Sustainability)

II. CHARACTERIZING LDC AG (PEASANT) HOUSEHOLDS

Most LDC households live in rural settings (61% of LDC labor force, 73% in least developed countries).

Most of these households depend partly or wholly on agriculture for subsistence and income.

A. Transition state: Between pure subsistence agriculture and commercialized agriculture – i.e., **semi-subsistence**

B. Dominated by farming: Households produce part of their food needs and supply part of the labor for agricultural activities.

- Owns some land (although tenure arrangm'ts may be complex)
- Uses own labor (at least in part)
- Consumes some of own output
- Capital used both for prod. and cons. (e.g., oxen)

C. Markets: Varying degrees of completeness, tend to be thinner in harsh or isolated areas

- Output – infrastructure issues, price policies
- Labor – varied arrangements (PHL, exchange, sharecropping)
- Other Physical Inputs – infrastructure issues, price policies
- Credit (inter-temporal mkts.) – poorly formed, often **linked**
- Land – varying, complex tenurial, exchange relationships
- Insurance – not usually present ⇒ **risk** assumes greater role in determining aggregate supply, other behavior than in DC's)

D. <u>Income Sources</u>:

- Marketed surpluses of food
- Cash crops (e.g., cotton, cocoa, coffee, tea)
- Off-farm Labor (both ag and non-ag)
- Remittances

E. <u>Varied Land Tenure Arrangements</u>:

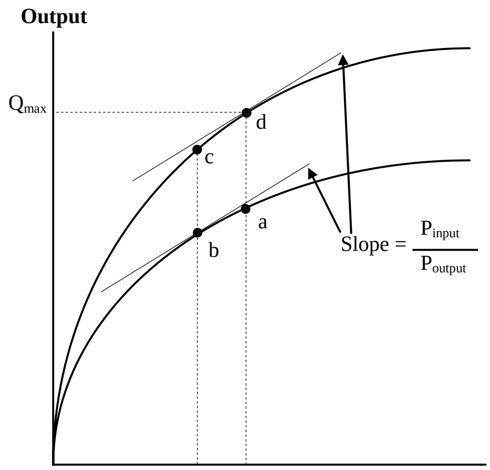
- Owner-operator
- Sharecropper
- Cash Rents
- Landless
- Smallholder vs. large land(lord) holder

Land tenure $\Rightarrow$ investment in productivity enhanceing activities.

- e.g., soil erosion protection
- e.g., slash and burn where property rights are usufruct

III. PROFIT MAXIMIZATION AND EFFICIENCY

- Note difference between allocative and technical efficiency.



a = technically inefficient, allocatively inefficient

b = technically inefficient, allocatively efficient

c = technically efficient, allocatively inefficient

d = technically efficient, allocatively efficient

- **Unconstrained profit maximization requires both types of efficiency.**

- **Profit Maximization may be constrained by:**
  - **Risk & Uncertainty**
  - Tradeoffs with other arguments of the Utility function (especially **labor/leisure** tradeoffs).
  - **Unequal power relationships** due to constraints imposed by cultural and other features of agrarian society.
  - Distortions or market failures that prohibit achieving technical efficiency.

Policy Implications

- If **pure, unconstrained profit maximization** characterizes the agricultural economy, then the only way to significantly alter output is to shift out the production possibilities frontier (e.g., via **technological change**)

- Belief in allocative efficiency of farmers is the "philosophical" underpinning of price policy:
  - Farmers respond optimally to price incentives ⇒ changing price incentives will change output mix. **But what about the distortions involved in altering market price signals?**

If profit maximization is constrained, then you can operate on those constraints

- If allocative efficiency holds, but technical efficiency doesn't, then extension/farmer education may be the least-cost method of increasing output/productivity.

- Likewise, if allocative efficiency is prevented by certain market failures, then work on those (e.g., **market information or market integration**)

HOUSEHOLD BEHAVIOR UNDER RISK & UNCERTAINTY

- Uncertainty and the risks associated with it have important effects on rural LDC households.

- Risk generally **shifts supply in, reduces welfare** relative to what it would be in the absence of risk.

- **Price risk and output risk** are intimately related at the market level.

TYPES/SOURCES OF UNCERTAINTY

- **Natural hazards –** yield/output uncertainty

- **Market fluctuations –** price uncertainty

  Due to communications, time lags in ag, mkt imperfections

- **Access to land –** "social uncertainty"

- **State actions (e.g. wars)**

SOME HYPOTHESIZED IMPACTS OF UNCERTAINTY (ELLIS)

1. Sub-optimal economic decisions (relative to certainty)

2. Slower adoption

3. Mixed cropping and other farming practices

4. Greater impact on the poor

5. Reduced by mkt integration due to better info flow, communication

6. Increased by mkt integration due to greater dependence on mkt (?)

MODELING BEHAVIOR UNDER UNCERTAINTY

NO UNCERTAINTY: **MAX U OR MAX π**

RISK NEUTRALITY: **MAX $E\pi$**

RISK AVERSION: **MAX $EU(\pi)$**

I. COST OF RISK

- Under certainty or risk neutrality, welfare function is π
- Under risk aversion, there are two general approaches:
    1. Safety first
    2. Expected utility

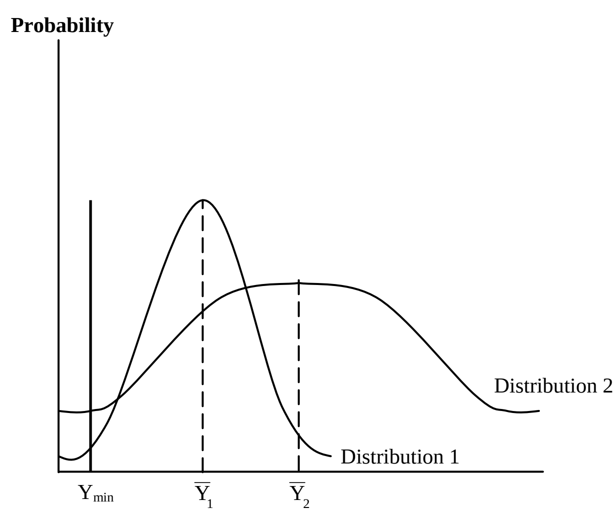
A. Safety First

Minimize the probability that income will fall below some minimum ("disaster") level.

e.g., Min $E\pi$ s.t. Prob $(Y < Y_{MIN}) < \bar{P}$ **Telser**

or

e.g., Min Prob $(Y < Y_{MIN})$ **Safety first**



- Applies more to places where there is a <u>real</u> serious disaster at $Y < Y_{MIN}$ like **starvation**
- More likely in **isolated areas** where markets are poorly developed (esp. credit markets)

B. Expected Utility Models

Assume U = U(Y), where $Y = \begin{cases} \bar{Y} - \delta \text{ with prob } .5 \\ \bar{Y} + \delta \text{ with prob } .5 \end{cases}$

$\Rightarrow$ EU(Y) = ½ $U(\bar{Y} + \delta)$ + ½ $U(\bar{Y} - \delta)$

Handout 9: Effect of an Increase in Risk

- Note that risk neutrality means that U(Y) is a straight line passing from the origin through "x". For that case, $EU(\bar{Y}) = U(\bar{Y})$.

- Note that $U(\bar{Y}) > EU$

  $\Rightarrow U(\bar{Y}) - E(U)$ = welfare cost of risk **(in utility terms)**

  $\Rightarrow \bar{Y} - \tilde{Y} = \rho$ = the amount of **income** that the producer would give up to exchange random income for sure income. (Note: both $\bar{Y}$ and $\tilde{Y}$ are non-random).

- $\tilde{Y}$ is **certainty equivalent income:** The sure income that would give the producer the same utility as random income

  $\Rightarrow U(\tilde{Y}) = EU(\bar{Y})$.

C. <u>Magnitude of the Risk Premium (ρ) depends on two things</u>:

1. How curved the utility function is

- –U''/U' measures curvature
- As –U''/U' rises, ρ rises.
- **Risk neutrality:** $U''=0 \Rightarrow -U''/U'=0 \Rightarrow \tilde{Y} = \overline{Y} \Rightarrow \rho = 0$.

2. How variable income is

- That is, the size of δ in the graph
- More generally, income risk = $f\left[\text{var}(Y)\right]$

D. <u>Arrow-Pratt Measures of the Size of the Risk Premium (ρ)</u>

A = –(U''/U') : **Absolute Risk Aversion**

$R = -Y(U''/U') = \dfrac{\partial U'}{\partial Y} \cdot \dfrac{\overline{Y}}{U'}$ **Constant Risk Aversion**

(elasticity of U' w.r.t. Y)

After lots of math: $\boldsymbol{\rho = \tfrac{1}{2} A \times \text{var}(Y)}$

$$\frac{\rho}{\overline{Y}} = \tfrac{1}{2} R \times [CV(Y)]^2$$

E. <u>Interesting Points about the Cost of Risk (ρ)</u>

1. Risky Income is usually only <u>part</u> of Total Income

- The closer to "subsistence" ag HH's are, the more important risk is (especially if other income sources are relatively riskless)

2. ρ falls as risk aversion falls

- Transferring risk from more- to less-risk averse agents decreases the overall cost of risk

- This argument underlies attempts to understand **risk-sharing** or **risk-shifting** arrangements (like share tenancy)

F. <u>Empirical Evidence</u>

1. CV of Ag Income

a. **Filipino Rice Prod (Roumasset)**

Technique	Rainfed	Irrigated
Traditional	20%	25%
Modern	50%	33-42%

b. **Unirrigated South India:** CV = 5-32% (average = 17%)

2. Relative Risk Aversion (Binswanger)

- R ranged from 0.3 to 1.7

- Constant relative risk aversion a good approximation

- EU appears to fit data better than Safety First

II. SUPPLY UNDER UNCERTAINTY: RISK NEUTRAL FARMERS

$$\text{Let } Y = \pi = pq - wx$$

- **Both p and q are random because** at the time planting decisions are made (x is chosen) **p and q are unknown**

- **Producer's problem:** $\text{Max } E\pi = E(p)*E(q) + \text{cov}(p,q) - wx$

  $$= \bar{p}\bar{q} + \text{cov}(p,q) - wx$$

- **KEY POINT: $E\pi$ < (π under certainty)** because $\text{cov}(p,q) < 0$ (esp. in isolated markets).

- **If producer ignores the covariance between output and price, he would over-estimate the returns to his effort (x). But knowing cov(p,q), he chooses x accordingly.**

Define the "action certainty equivalent" price: $\hat{p} = \bar{p} + \dfrac{\text{cov}(p,q)}{\bar{q}}$

- This is the price which, if it prevailed on the market and there were no risk, would yield exactly the same output (supply) response as the random price "p"

********* NOTE:** $\hat{p} < \bar{p}$ ***********

Objective function: $\text{Max } E\pi = \hat{p}\bar{q} - wx$

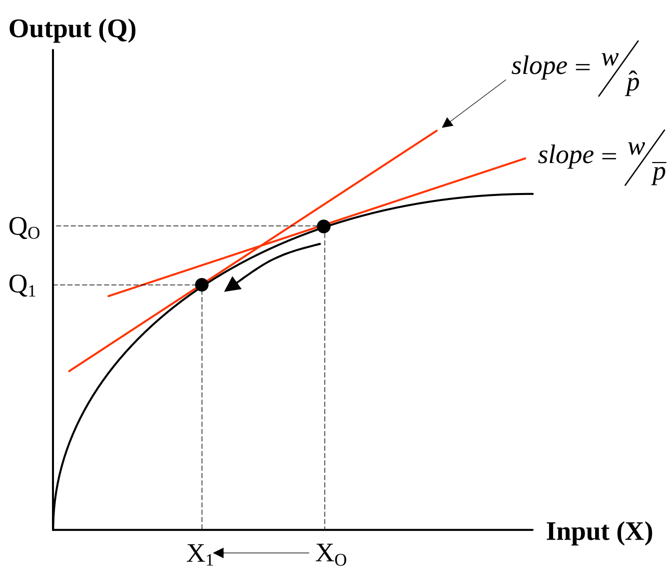
Optimizing condition: $\hat{p}\dfrac{\partial \bar{q}}{\partial x} = w$

By comparison, the no uncertainty optimizing condition is given by

$$p\frac{\partial \bar{q}}{\partial x} = \bar{p}\frac{\partial \bar{q}}{\partial x} = w$$

- Since $\hat{p} < \bar{p}$, production under uncertainty must occur earlier on the production schedule **(where** $\dfrac{\partial \bar{q}}{\partial x}$ **is greater).**

  $\Rightarrow$ **Supply (output) is lower under uncertainty**



III. <u>SUPPLY UNDER UNCERTAINTY: RISK AVERSE FARMERS</u>

Risk averse farmers maximize the expected utility of π:

$$\begin{aligned} \text{Max } EU(\pi) &= E[U(\overline{p}\overline{q} + \text{cov}(p,q) - wx)] \\ &= E[U(\hat{p}\overline{q} - wx)] \\ &= E[U(\hat{p}\overline{q})] - wx \quad \text{(assumes revenue and cost are additive)} \end{aligned}$$

Solution under uncertainty: $w = EU'(y) \cdot \hat{p} \frac{\partial q}{\partial x}$

Solution under <u>certainty</u>: $w = \overline{p} \frac{\partial q}{\partial x}$

- $\hat{p} < \overline{p} \Rightarrow$ ceteris paribis, q and x will tend to be smaller under uncertainty (as in risk neutral case)
- However, if EU'(Y) is very large then $EU'(y) \cdot \hat{p} > \overline{p}$: **a very high degree of risk aversion (EU' large) may dominate the smaller size of the certainty equivalent price** ($\hat{p}$)

KEY QUESTION: IS $EU'(y) \times \hat{p}$ GREATER THAN OR LESS THAN 1?

<u>Stiglitz & Newberry Intuition</u>

- Individuals who are **very risk averse increase their effort** when risk is increased because they are worried about **worst cases** and hence work hard to avoid them.
- Individuals who are **less risk averse** focus on the **lower effective returns** to farming ($\hat{p} < \overline{p}$) $\Rightarrow$ risk makes farming less attractive and hence lessens effort.

IV. <u>HOUSEHOLD RESPONSE TO RISK</u>

- Remember the **households produce <u>AND</u> consume**

- While low price is "bad" for producers, it's good for consumers
  ⇒ some sort of compensation takes place

<u>Implications</u>

- **Net selling** households produce more than **pure producers** under risk because consumption offers some "insurance" against price risk.

- **Net buying** households produce more for the opposite reason: **production helps buffer** potentially high cost of food when price rises

- **Fafchamps:** These two things imply a **predisposition toward food crops over cash crops.**

V. <u>SUMMARY: IMPLICATIONS OF RISK FOR AG HOUSEHOLDS</u>

1. Risk **reduces output**
2. Risk **alters mix of production activities** (food crops over cash crops, mixed cropping over mono-cropping).

3. Risk **alters the rate of technology adoption** (less risk averse adopt more rapidly)

Reducing the covariance between price and quantity can increase market supply. This can be facilitated by making markets more integrated (fertile ground for policy intervention).