Economic of Natural Resources Management: Concepts and Principles

Training Course

Impact Assessment and Livelihood Analysis in Systems Research

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Points to be Pondered

- Economics of NRM: An Overview
- Economics of NRM: Areas of Discussion
- Impact Assessment Challenges of NRM
- An Analytical Framework for NRM Impact Assessment
- Economics of NRM Methods for Assessing Economic and Environmental Impacts
- Assessing the Impact of NRM: a Proposed Methodology
- Appendix: Proposed Development Indicators

Economics of NRM: An Overview

- Natural Resource Management deals with:
  - Supply, demand and allocation of the Earth's natural resources
  - Better understanding the role of NR in the economy
  - Development for more sustainable methods of managing those resources
  - Ensuring the availability of NR for future generations
- Resource Economists Studies:
  - Try to develop a sustainable and efficient economy
  - Is a trans-disciplinary field of academic research
  - Aims to address the connections, interactions and interdependences between human economies and natural ecosystems
  - Its focus is how to operate an economy within the ecological constraints of earth's NR

Economics of NRM: Areas of Discussion

- Basic economic concepts
  - Economic efficiency
  - Property rights, externalities and public goods
- Valuing environmental benefits
  - Estimating use value
  - Non-use value and contingent valuation
  - Practice and politics of valuing environmental benefits
- Economic of non-renewable resource management
  - Non-renewable resources – Optimal extraction
  - Non-renewable resources – Twists on the basic model
  - Non-renewable resources – Empirical evidence of scarcity

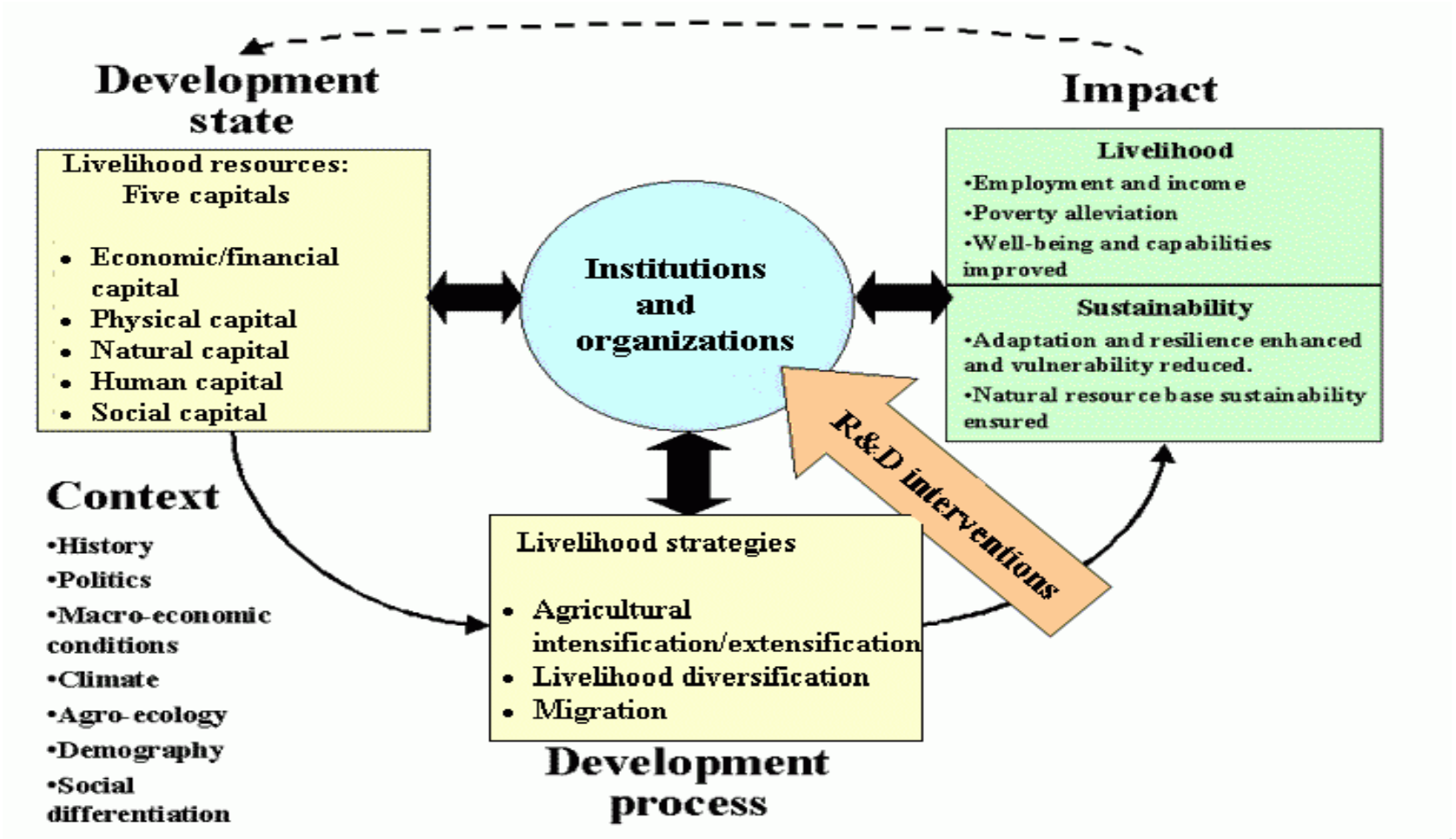
Economics of NRM: Areas of Discussion

- Land economics
  - Land economics – The basic model
  - Land economics – Applications to land use change
  - Land economics – Land use change and the environment
- Economics of renewable resource management
  - Introduction to renewable resources
  - Fisheries
  - Forests and the optimal rotation problem
  - Species preservation and biodiversity
  - Water resources
- Economic growth and sustainability
  - Green accounting / Green economy

Impact Assessment Challenges of NRM

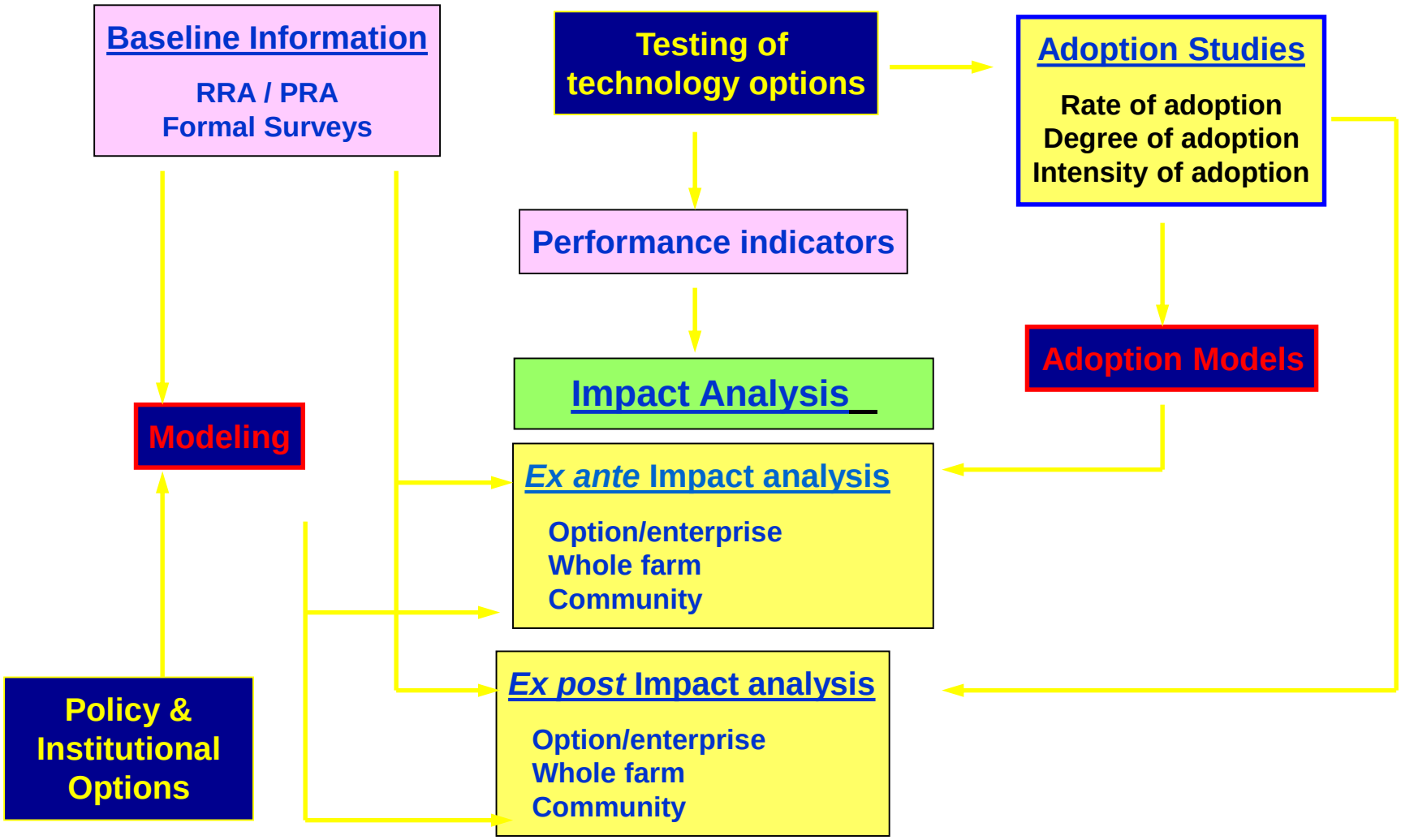
- Assessing the impact of NRM research poses a challenge to scientists
- The complexity of NRM interventions requires a more holistic approach to impact assessment
- IA for NRM combines the traditional factors of economic and environment priorities with newer aspects of social actors and institutions
- Increasing concerns about degradation of NR and the sustainability of agricultural production potentials in arid regions
- ICARDA have initiated research and development programs for NRM in CWANA region
- Efforts in this direction include the design and development of low-cost technological options for NRM and conservation of soil, water, agro-biodiversity and forestry resources

An Analytical Framework for NRM Impact Assessment



Analytical framework for NRM impact assessment on sustainable rural livelihoods (adapted from Scoones, 1998)

Adoption and Impact Assessment



Economics of NRM
Methods for Assessing Economic and Environmental Impacts

- Indicators
- Cost benefit analysis
  - Economic surplus approach
- Econometric approach
- Bio-economic optimization modeling

Economics of Natural Resources Management

Economic Surplus Approach

Economic Surplus Approach

- Used to estimate the benefits and costs of agricultural research induced changes
- Provides a relatively simple, flexible approach to specifying the value of research by comparing situations with and without
- Uses the concepts of demand, supply, and equilibrium and economic welfare to producers and consumers
- Demand and supply may be defined at farm, retail or intermediate stage of marketing
- Measures the size and distribution of benefits in different market settings (Factor markets, Product markets, etc.)

The Basic Model

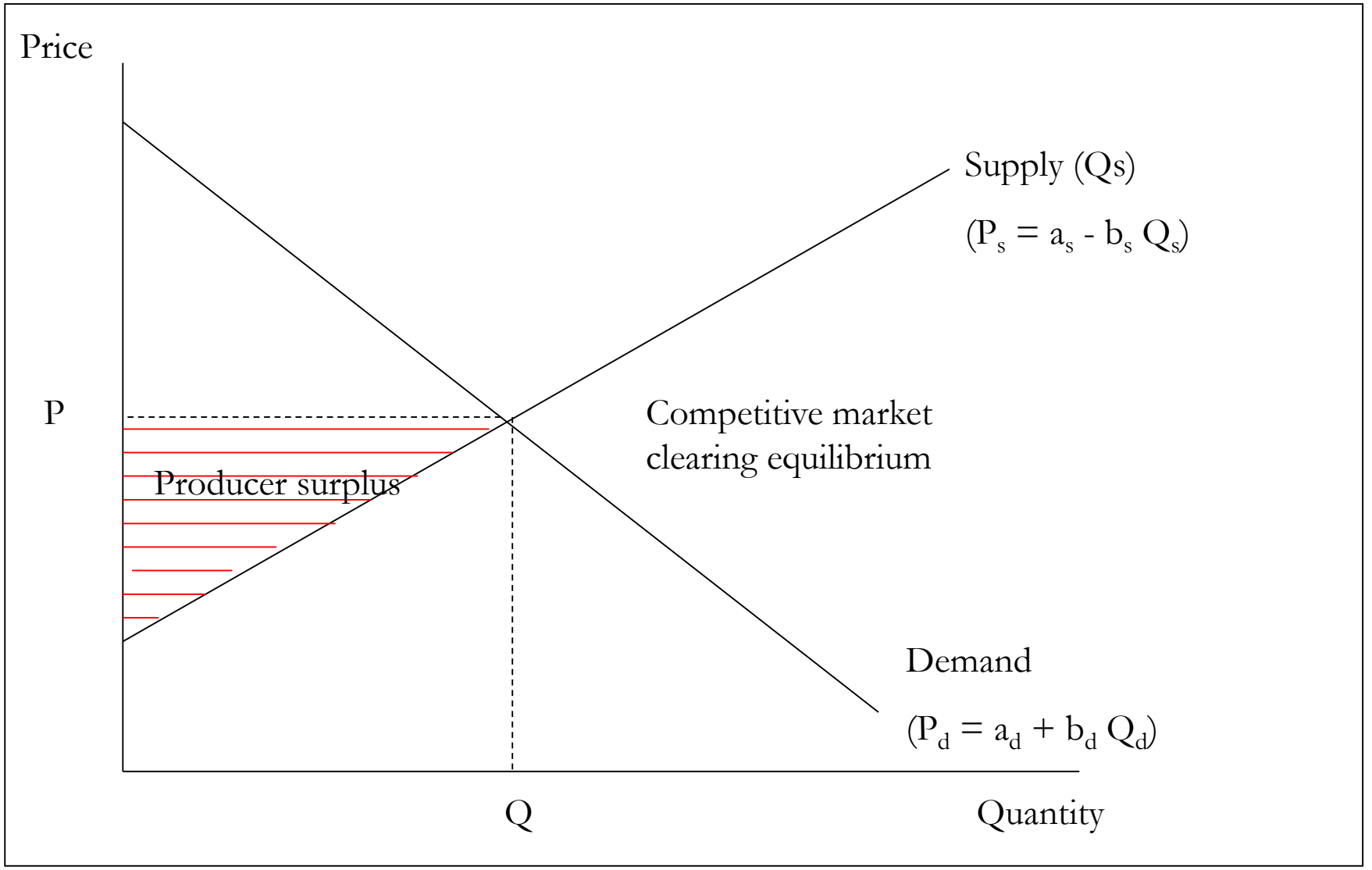
- Supply and Production costs
  - Production levels depend on the use of inputs
  - Higher product price will bring more inputs onto each hectare and more hectares under the crop
  - Mathematically, the influence of production costs on production level can be expressed as a function that can take different shapes

$$Ps = S\ (Qs)$$

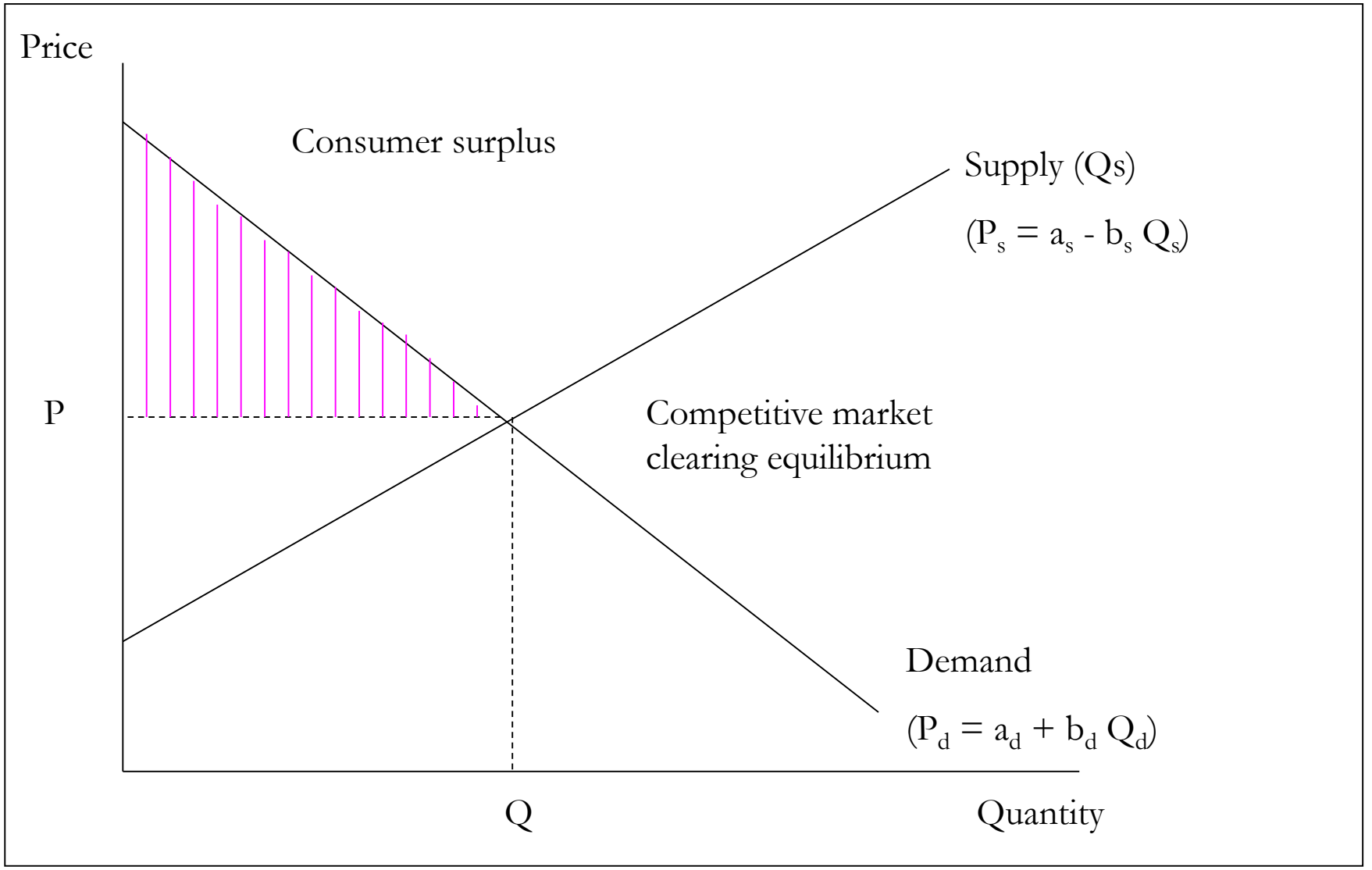
- Demand and consumption values
  - Quantities consumed depend on price paid
  - Mathematically, a demand curve can take different shapes

$$P_d = D\ (Q_d)$$

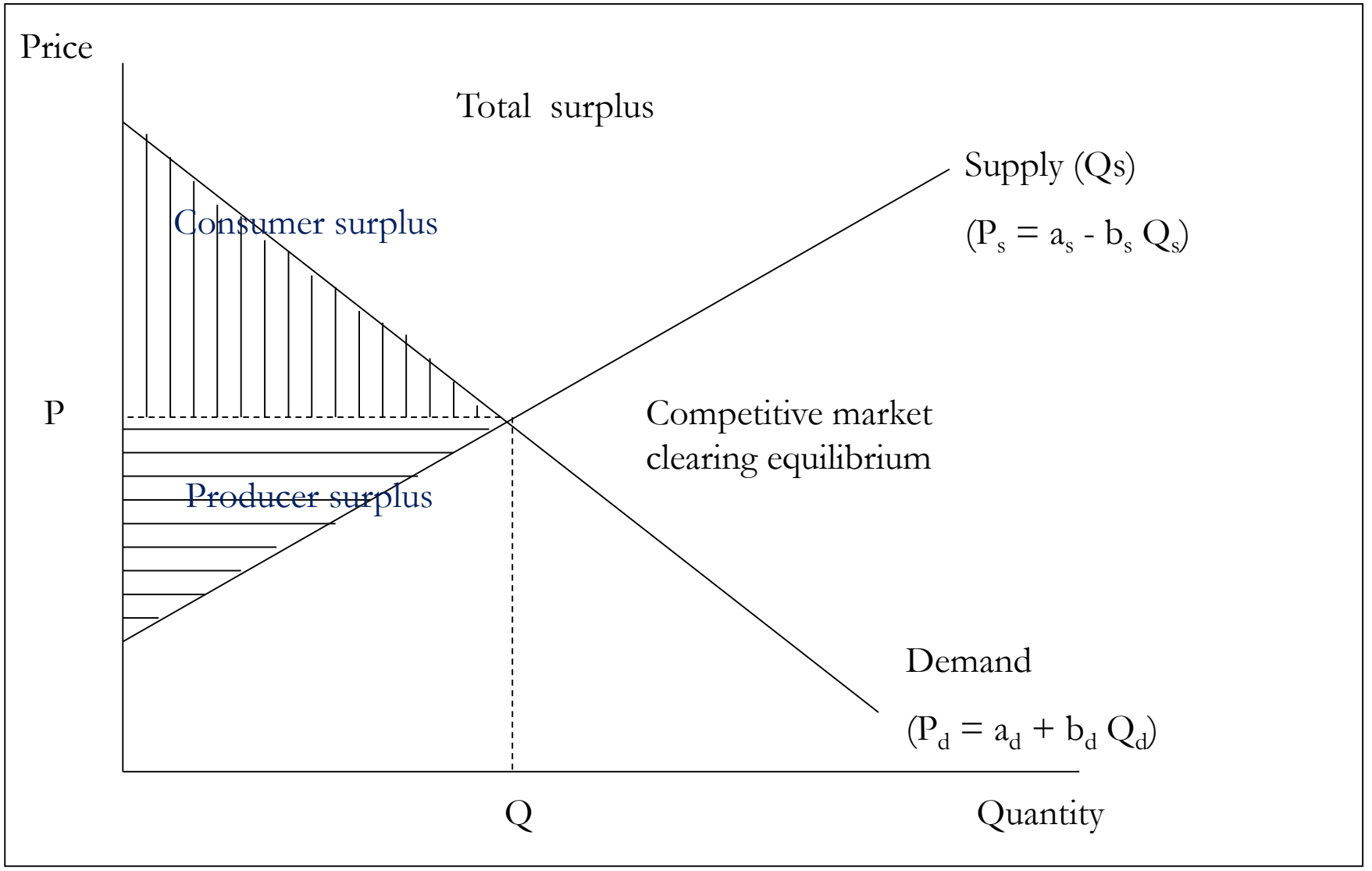
Equilibrium and Economic Surpluses



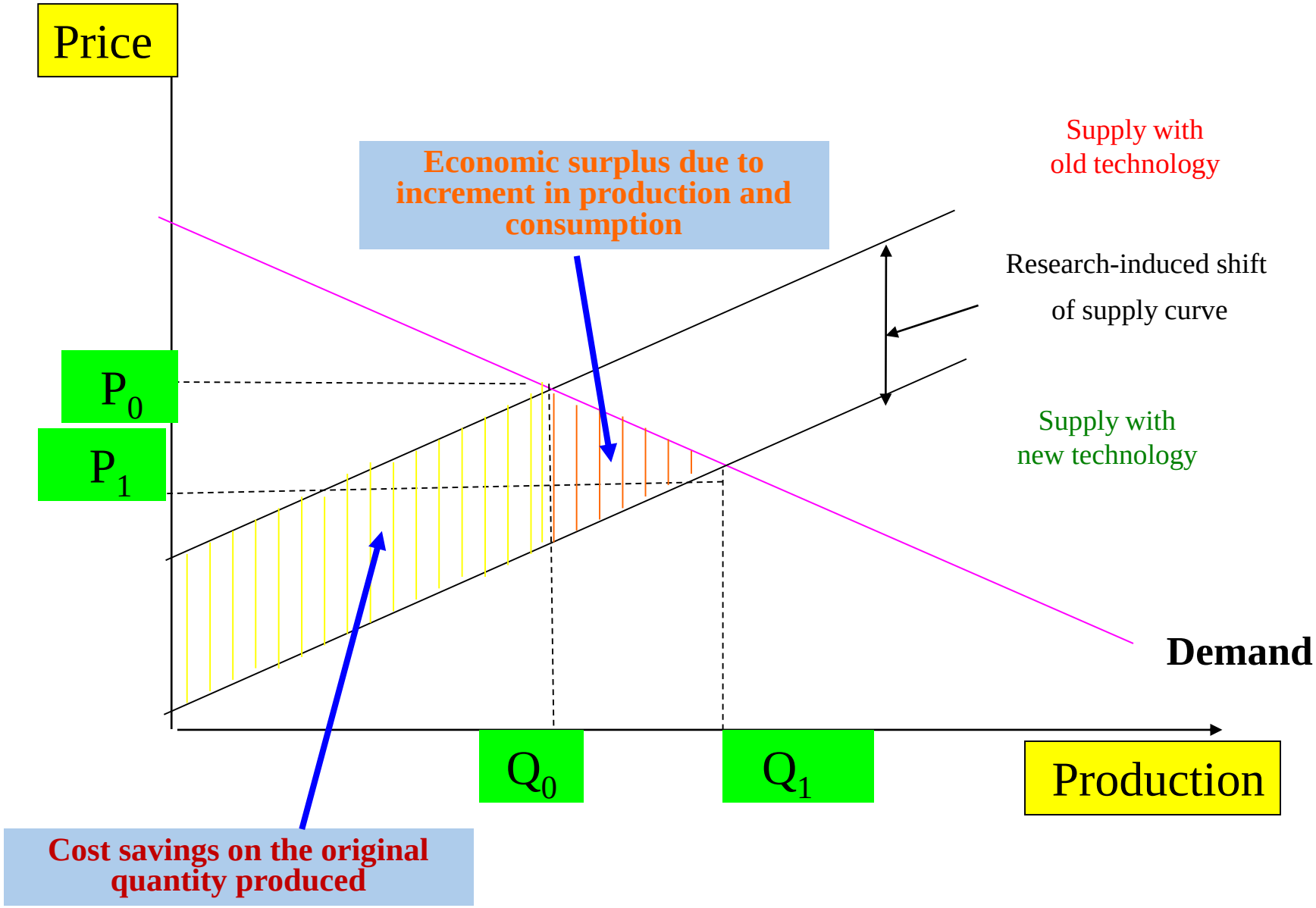
Equilibrium and Economic Surpluses



Equilibrium and Economic Surpluses



Impact of Research on Economic Surplus



Possible Outcomes

- Consumers gain because they consume more goods at a lower price

- The net welfare effect on producers may be positive or negative depending on elasticities and the nature of research-induced supply shift
    - Sell more goods but at lower (costs and revenues affected)
    - Revenue may fall when supply increase (inelastic demand)
    - Revenue falls faster than costs and producers loses (pivotal supply shift – inelastic demand)

- The sum measures the net welfare change: gainers could in principle compensate losers and still be better off (consumer taxes – producer subsidies)

Data and Estimation Formula

- Data and Parameters
  - Agronomic data on yields before and after technical change
  - Price before technology-induced technical change
  - Quantity before technology-induced technical change
  - Price elasticity of supply (ε) and demand (η)

  - J is the proportional change in yield
  - K is the vertical shift of supply function (proportion of initial price)

$$K = J / \varepsilon$$

- Reduction in price relative to its initial value, due to supply shift

$$Z = K\varepsilon / (\varepsilon + \eta)$$

- Consumer Surplus $\Delta CS = P_0 Q_0 Z (1 + 0.5 Z \eta)$
- Producer Surplus $\Delta PS = P_0 Q_0 (K - Z) (1 + 0.5 Z \eta)$

- Social Surplus $\Delta SS = \Delta PS + \Delta CS$

- Net Economic Benefits $NEB = \Delta SS - R - E$

Criticisms of The Methods

- Ignores transaction costs, externalities, and general equilibrium effects
- Policy irrelevance
- Measurement errors
  - Equivalent variation & Compensating variation as alternative measures for monetary measure of consumer welfare (Continued use because less information required in calculation, estimation of demand function not required but secondary sources of elasticities)
  - Income effects associated with a change in factor or product price is often substantial – producer surplus is much less reliable measure of the corresponding CV or EV
  - Aggregation of individual supply and demand curves into market demand – supply curves assumes tastes, money income, and price of other goods are constant across individuals in the economy

Criticisms of The Methods

- Functional form of supply and demand
- Elasticity of supply and demand
- Nature of technical change and corresponding supply shift or demand
- Size of research induced productivity improvement
- The timing of the flows of benefits and costs

Assessing the Impact of NRM
A Proposed Methodology

An Economic Analysis of Salinity Problems

Research objectives, Hypothesis and Methodological Framework

An Economic Analysis of Salinity Problems

- General objectives
  - Identify the nature of soil salinity problem
  - Investigate its impact on crop production and on the environment
  - Assess the feasibility of reducing soil salinity for better water management and environment protection

- Basic hypotheses
  - Salinity has not been responsible for loss in crop production and environmental degradation
  - The soil salinity problem cannot be reduced by improvement in drainage and water management
  - There is no environmental degradation in the specified area

- Approaches used to estimate losses caused by salinity
  - Linear Programming Approach – LPA
  - Production Function Approach - PFA

Production Function Approach

An Empirical Guidelines Analysis

- Technical Framework Analysis
  - Socio, economic, agronomic and biophysical data collection at plot, farm and district levels
  - Classification of farms into low, medium, high and severe salinity affected areas (Based on Electric Conductivity measures)
  - Field investigation on landscape, groundwater hydrology, water quality and drainage conditions

- Economic Analysis: PF with salinity variable (EC)
  - The approach assumes that salinity directly influence the crop yields
  - Several explanatory variables are included to estimate the PF
  - Cobb-Douglas form of PF is employed

Production Function Approach

An Empirical Guidelines Analysis

- Analytical Economic Model Form

$$Q = a\, L^{b} S^{c} F^{d} K^{g} EC^{h} e^{u} \quad (1)$$

Where;

- Q: Yield of the main crop;
- L: Cost of labor; S: cost of seed; F: cost of fertilizer; K: cost of capital
- EC: Electircal conductivity (dS/m)

- PF Decomposition Analysis: Gross income (Y) between salinity free soils and salinity affected soils

SFS $$\mathrm{Log}Y_n = \mathrm{Log}A_n + b_n \mathrm{Log}L_n + c_n \mathrm{Log}S_n + d_n \mathrm{Log}F_n + g_n \mathrm{Log}K_n \quad (2)$$

SAS $$\mathrm{Log}Y_s = \mathrm{Log}A_s + b_s \mathrm{Log}L_s + c_s \mathrm{Log}S_s + d_s \mathrm{Log}F_s + g_s \mathrm{Log}K_s \quad (3)$$

Production Function Approach

An Empirical Guidelines Analysis

- Taking the difference between (2) and (3) and rearranging:

$$\text{Log}(Y_s/Y_n) = \text{Log}(A_s/A_n)$$
$$+[(b_s - b_n)\text{Log}L_n + (c_s - c_n)\text{Log}L_n + (d_s - d_n)\text{Log}S_n + (g_s - g_n)\text{Log}F_n + (b_s - b_n)\text{Log}K_n]$$
$$+ [b_s\text{Log}(L_s/L_n) + c_s\text{Log}(S_s/S_n) + d_s\text{Log}(F_s/F_n) + g_s\text{Log}(K_s/K_n)] \quad (4)$$

Equation (4) apportions approximately the difference in gross income/ha between SFS and SAS into two components:

1. Measure land degradation effect

2. Measure the contribution of changes in input levels between the two situations

Production Function Approach

An Empirical Guidelines Analysis

- Factors influencing Salinity Control Effort
  - Personal Factors – PF (risk preference, education, age, experience)
  - Economic Factors – EF (income from farming, cost of control)
  - Physical Factors – PhF (topography, groundwater table, extent of affected area)

- The amount of salinity controls depends on the effectiveness and the number of practices such as:
  - Drainage improvement
  - Water management
  - Organic matter application

- Conceptual models for SCE
  - Model 1: Y (cost of control of salinity/ha) = F(PF, EF, PhF)
  - Model 1: Y (Salinity control score) = F(PF, EF, PhF)
  - Model 1: Y (Management time) = F(PF, EF, PhF)

Production Function Approach

An Empirical Guidelines Analysis

- Determining the Optimal Control of Salinity

  ❑ Preventive expenditure approach of salinity control

  - Depends upon the nature of physical environment, interaction between physical variables, price and technology
  - Collection and comparison of methods adopted by farmers (flushing, use of ameliorates, cultural methods, drainage practices, etc.) with technically appropriate methods to reduce soil salinity

- Salinity Effects on Environment
  - Interviews with farmers and key personnel
  - Assess the effects of the salinity problem on drinking water, human health and vegetation
  - Estimate cost of illness related to salinity problems

Proposed Development Indicators

- Economic and Poverty Indicators
  - Food security: Total and gender-differentiated available food in the household, Seasonal available food in the household
  - Income: Farm income, Household income/stability, Income sources (on/off farm, agricultural/nonagricultural), New products, Prices, etc
  - Equity: Farm and household income comparisons by well-being group and by gender, Distribution of economic surplus, Land tenure situation
  - Employment generation: Number of jobs, Percentage of active population employed (total, employees, self-employment, and gender-differentiated)

- Environmental Indicators
  - Production systems: Land use intensification and diversification
  - Forest: Area and map of forest area
  - Soils: Land productivity, water balance
  - Water: Water pollution, water quality, water availability
  - Others indicators: Agro-chemical use, air pollution

Proposed Development Indicators

- Human / Social Indicators
  - Community empowerment and equity in decision making
  - Participation in local policy decision making
  - Human capital: Education and experience, Individual capacities and Access to opportunities
  - Social Capital: Structural social capital (organizational density, networks), Cognitive social capital (conflict resolution, solidarity, cooperation, trust)
- Quality of Life Indicators
  - Nutritional levels
  - Access to health services
  - Access to consumer goods
  - Migration
  - Local well-being indicators

Thank you for your attention

Questions?