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LECTURE SERIES
IN
FOREST ECONOMICS AND FOREST MANAGEMENT

LECTURE OUTLINES AND VISUAL AIDS

prepared for

M.Sc. Forestry Classes

PAKISTAN FOREST INSTITUTE

Peshawar

by

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Forest Economist

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PAKISTAN FOREST INSTITUTE
VISITING PROFESSOR LECTURE SERIES

DERIVED DEMAND FOR FUELWOOD

Outline of Lectures Presented by
Dr. Charles W. McKetta, Forest Economist

in PRINCIPLES OF ECONOMICS M.Sc.-I
29 & 30 November 1992

A. The Instructional Context

1. Reasons for learning market behavior
   a. understand place of resources in society
   b. maximum benefit resource transactions
   c. efficient resource decisions
      1. optimal land allocation
      2. optimal timber management
      3. resource conservation
   d. understand and form forest policies

2. Learn techniques and applications later in M.Sc. III Natural Resources Economics

B. Necessary Background to This Point:

1. Aggregate consumer demand
   a. horizontal aggregation for commodities
   b. vertial aggregation for inseparables

2. The concept of supply
   a. marginal cost concept
   b. shape of natural resource supply
   c. integrating to costs of goods

3. Competitive market solution
   a. market clearing quantity
   b. equality of production and consumption levels
   c. market price formation
   d. net social benefits formation

C. Pakistani Fuelwood Market Function:

1. Market characteristics--competitive?
   a. uniform definable good?
   b. entry and exit? collusion?
   c. information and contracts?
   d. dependability of availability?

2. Demand effects and recent dynamics
   a. population/ Afghani refugees
   b. alternative energy prices
   c. collected non-market fuels
   d. non-financial energy preferences

3. Economic supply
   a. source of fuelwood
   b. growth magnitude and velocity
   c. production distribution
   d. upward sloping?

4. Equilibrium condition
   a. price setting
   b. optimal quantity
   c. empirical measures of price not quantity

5. Alternative futures
   a. gap studies--bio-physical extrapolation
   b. market studies--behavioral prediction

D. Where do Logs, Stumpage and Land get valued?

1. Vertically structured resource market layers
   a. retail commodity markets--fuelwood
   b. intermediate raw materials--logs or stumpage
   c. basic productive resource--land

2. One man's supply is another man's demand

3. Capitalist and Marxian Value Theorys:
   a. Bottom up--labor theory of value
   b. Top down--theory of value in use

E. Derived Demand for Forest Factors of Production:

1. Normalizing the x-axis
   a. assumed technical conversion
   b. consistent measurement equivalents

2. Simplifying supply assumptions
   a. scale affects production
   b. also primary and derived supply
   c. fixed supply is simpler

3. Rationalizing the conversion margin
   a. the difference is other known costs
   b. attribute all residual value to raw material
   c. this varies by scale of industry
   d. additive costs? marginal or average?

4. Response behavior of derived demand
   a. price, factor cost
   b. technology

F. Methods of Estimating Forest Products Values

1. Estimate production costs

2. Make market comparisons

3. Estimate potential income from production

4. RVA, TEA, NPV: all these in semester III

G. An example of Different Values of Standing Trees:

1. Demand for harvest stumpage (immediate product value)

2. Demand for future wood products (value from continuing growth)

H. Potential Income Valuation of Land:

1. Eventually we estimate land values

2. The rent optimization rule

3. Guiding decisions.
   a. purchase or sale
   b. what crop?
   c. what management intensity?
   d. what harvest cycle?

I. What if markets fail?

PAKISTAN FOREST INSTITUTE
VISITING PROFESSOR LECTURE SERIES

ECONOMIC ANALYSIS OF FOREST JOINT PRODUCTION

Outline of Lectures Presented by
Dr. Charles W. McKetta, Forest Economist

in NATURAL RESOURCE ECONOMICS M.Sc.-III
1, 2, & 3 December 1992

A. Jointness defined

1. Beef and leather example

2. Relevance to natural resource management
   a. basic resource undivided rural land
   b. large variablity in land product options
   c. unable to separate some private and social products
   d. many symbiotic advantages to mixed outputs
      i. service multiple markets/client groups
      ii. complementarity in production
      iii. economies of scale in management

3. Necessary to understand the economics of production

B. Single input--single output production background
(handout #1--graphics of production attached)

1. Approach to analysis
   a. aggregated relationships
   b. marginal relationships

2. Production functions
   a. outputs come from inputs
   b. concept of technical efficiency
   c. marginal and average indicators

3. Financial input decisions
   a. optimal input levels VMP=MFC
   b. the concept of derived demand for inputs

4. Financial output decisions
   a. optimal production levels MR=MC
   b. concepts of supply
   c. concept of Ricardian rents
   d. fixed costs and shutdown points

C. Single input--multiple output production
(blackboard: production possibilities frontier)

1. Representing joint production possibilities
   a. fixed proportions
   b. variable proportions

2. Possible single period interactions
   a. complementarity
   b. supplementarity
   c. competition

3. Tecnical joint optimization
   a. bio-physical ignores relative value
   b. bio-physical ignores cost (except fixed asset)

D. Jointness in Natural Resources and Forestry

1. Operational joint management synonyms and examples (these tend to be output mix defined)
   a. Multiple-use--trees/recreation
   b. Integrated resource management--trees/intangibles
   c. Agroforestry--trees/crops
   d. Silvopastoral systems--trees/livestock
   e. Ecosystem management--trees/all biota

2. Types of natural resource jointness (defined by nature of interaction)
   a. simultaneous intermixed--coffee/banana
   b. simultaneous adjacent--linear poplar/wheat
   c. intertemporal--plantation grazing
   d. sequential--gmelina drying of waterlogged barani
   e. wholism--minimal disturbance use of natural systems

E. Financial single-period joint optimization (handout #2 Gregory Timber--Grazing example attached)

1. Relative values drive solution
   a. concept of relative value
   b. graphics of relative values
   c. relative values between societies

2. Possible solutions at one budget level
   a. physical solution in complementarity
   b. financial solution in competition
   c. rationalizing the difference

3. Multiple products, multiple scales
   a. increasing budget/ fixed land base
   b. expansion path of production
   c. optimal scale and optimal profits
   d. economies of scale and monocultures

5. Common solution at multiple budget levels

F. Multiple-input, multiple period joint production (handout #3 Thailand Eucalyptus/Mung Bean problem attached)

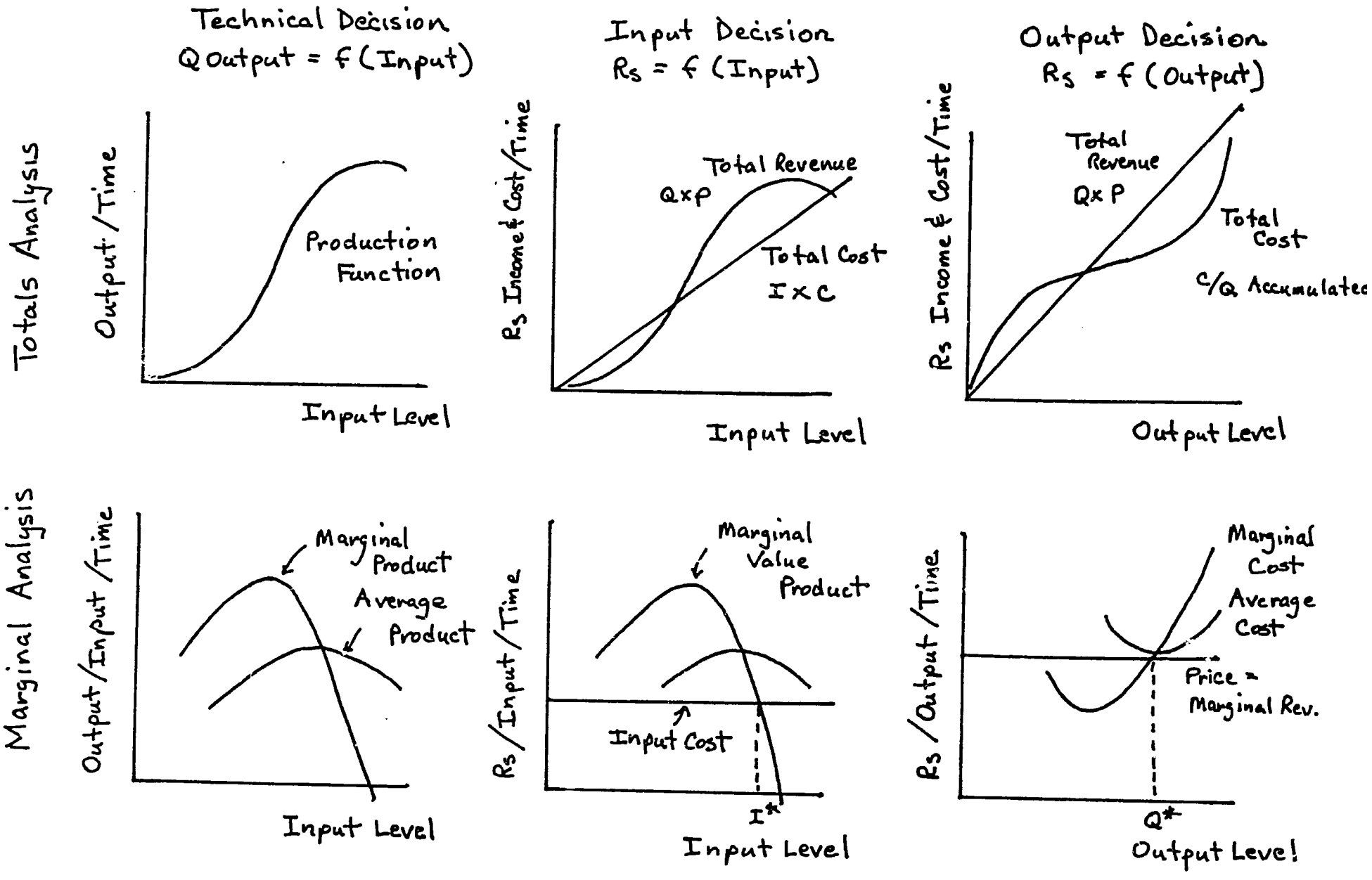
1. Intertemporal joint production functions
   a. mixing species
   b. mixing products
   c. mixing production regimes
   d. space complementarity and competition
   e. time complementarity and competition

2. Formulating joint product cost-benefit analysis (LOTUS 123 simulator--see instructor for disk)
   a. technical production functions
   b. valuing intertemporal costs and benefits

3. Other automated evaluation systems
   a. MULBUD variable case cost-benefit
   b. Linear Programming (LP) formulations
   c. Goal Programming (GP) formulations

G. Jointness in other integrated decisions
1. Interspatial, intertemporal, and organizational
2. A timber/grazing example

Single - Input Single Output Production



McKetta 1992

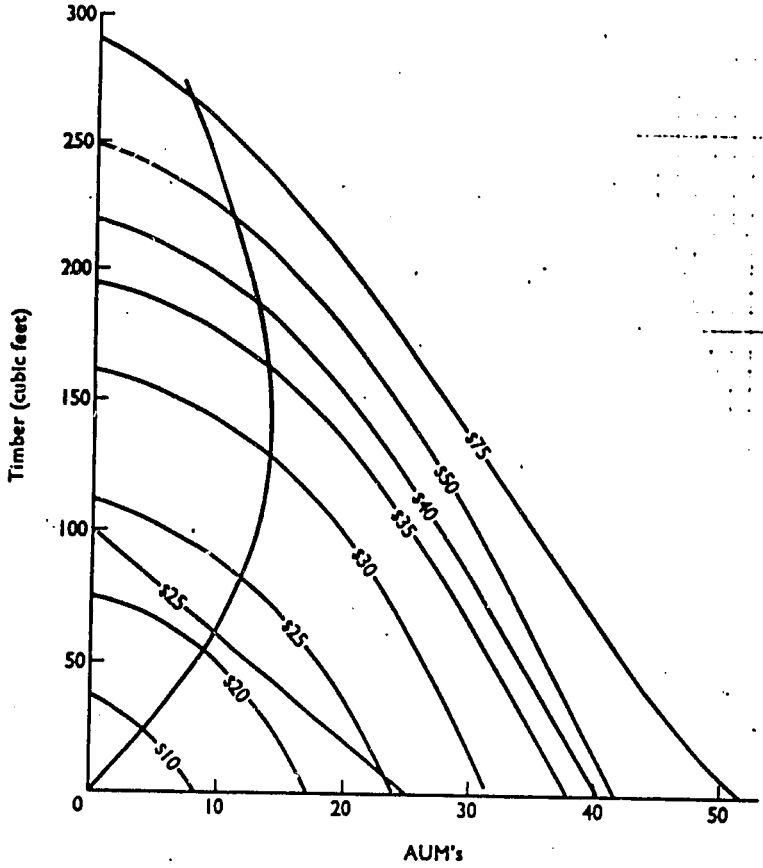


Fig. 18.1 Production possibility curves (isocosts) and isorevenues for joint production of timber and forage.

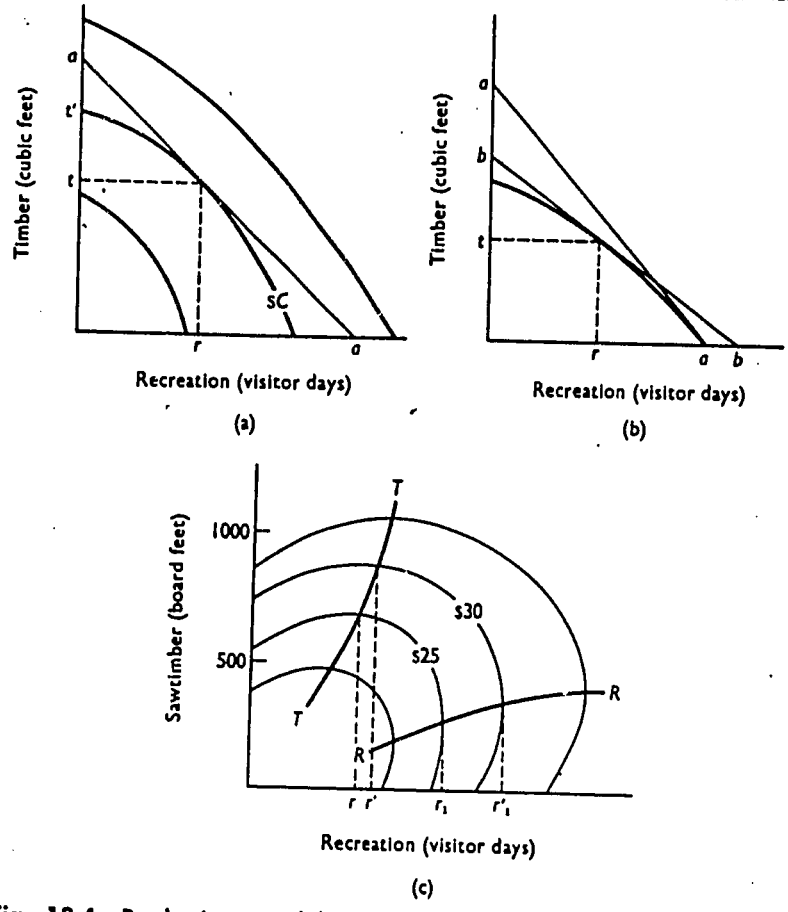


Fig. 18.4 Production possibility curves for three different kinds of forest areas.

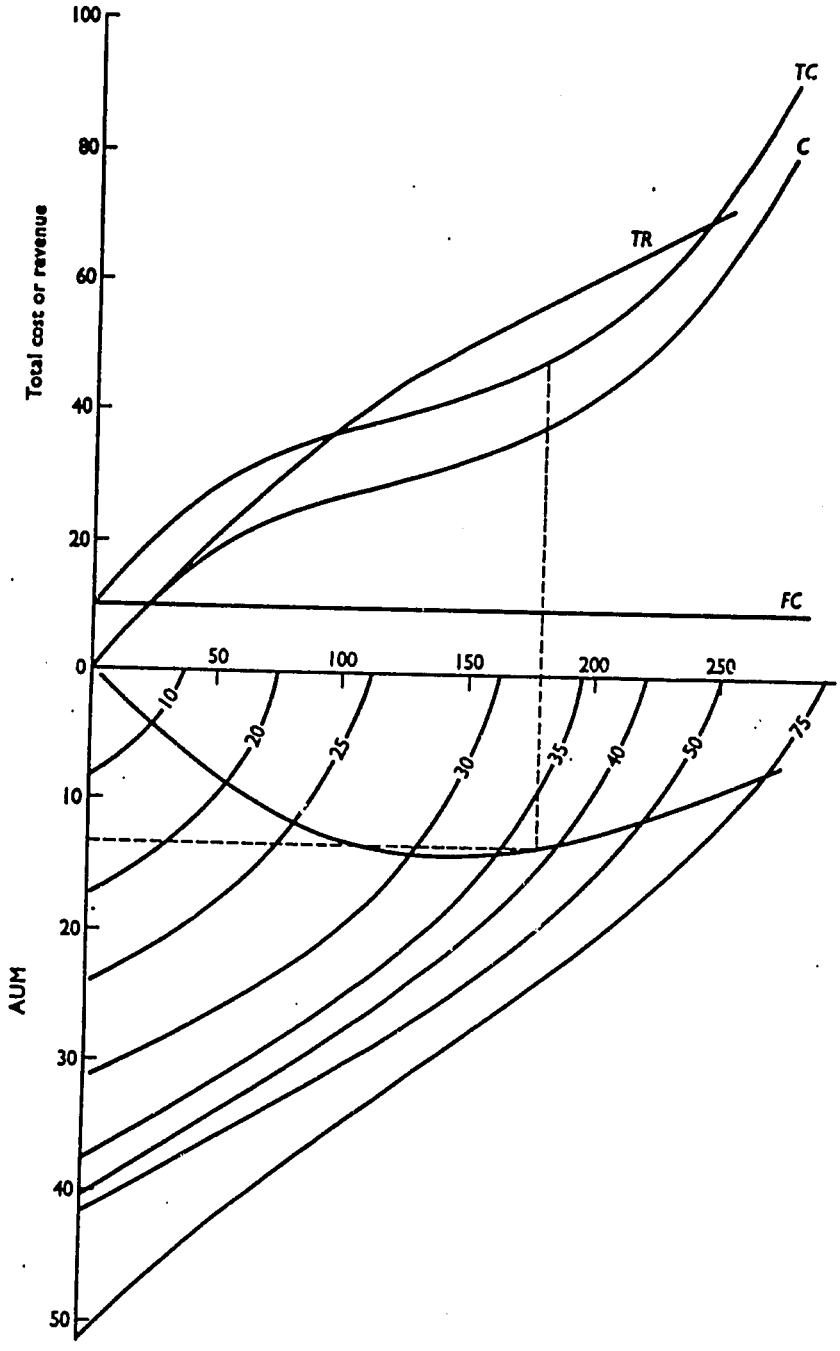


Fig. 18.2 The expansion path and the point of maximum net revenue, indicating the optimum combination of timber and forage under the assumed conditions.

PAKISTAN FOREST INSTITUTE
M.Sc. NATURAL RESOURCE ECONOMICS
Joint Production Alternatives Exercise

Because of PFI experience in agroforestry, a forester in Thailand has asked for advice to find an agroforestry option that gives peasants highest return on their one rai plots so they will stop shifting agriculture on nearby Phu Wiang watershed.

Outputs are in kilograms (Kg), areas in rai (r which is about 1/12 hectare), and values in baht (b). You have a choice between annual monocrops of vegetables: mungbean (MB), cassava (CV), or 3-year crop cycles of trees which resprout as coppice crops once established: eucalyptus (EC) or leucaena (LL), or 3-year agroforestry cycles of mixes of one crop and one tree. In all there are 8 options. Program this problem in LOTUS 123 so that you can make repetitive calculations to evaluate the sensitivity of your solution to changes in assumptions.

Monocrop cyclic yields:
Kg/rai/year of product by species

Year	MB	CV	EC	LL
1	80	2000	0	0
2	80	2000	0	0
3	80	2000	650	500

Agroforestry Cyclic Yields:
Kg/rai/year of tree product x vegetable product

Year	ECxMB	ECxCV	LLxMB	LLxCV
1	0x150	0x3600	0x150	0x3000
2	0x110	0x3300	0x70	0x2800
3	240x50	130x1400	470x30	340x900

Costs of Management by Species:	Plant	Harvest
EC & LL tree	600 b/r	0 b/r
MB annually in monocrop	400 b/r	250 b/r
annually in agroforestry	550 b/r	250 b/r
CV annually in monocrop	250 b/r	150 b/r
annually in agroforestry	350 b/r	150 b/r
Thailand's real discount rate	8%	

Crop Income by Species:	
EC & LL charcoal stumpage	2 b/Kg of charcoal equivalent
MB at market	10 b/Kg of bulk vegetable
CV at market	1 b/Kg of bulk vegetable

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Joint Production Analysis Questions:

1. Identify any zones of complementarity, supplementarity, or product competition that exist in this production function. Notice that all eight options are feasible sets within the same production function.

2. Identify the optimal production regime biologically, looking for the option that produces the most mean annual increment (MAI) of vegetables, of charcoal, of both (does this make any sense?), in Kg/rai/year. Do I operate in the zone of biological complementarity?

3. Rank the options financially and identify the optimal production regime financially in net present value (NPV) b/rai for six years. Do I operate in the zone of biological complementarity?

4. If charcoal is such a low valued product and relatively low volumes are produced, consider separately:

   a. How could a charcoal based option ever be financially optimal?

   b. What would happen if the market value of charcoal tripled, or wood had a construction value for poles that was three times charcoal value at the same rotation age?

   c. What would happen if wood product harvests had significantly higher values, e.g. factor of ten if allowed to grow for 6 years and sold as solid wood products?

4. Qualitatively describe how the optimal product mix answer to #3 would change, considered separately, if:

   a. We considered the advantage of leucaena's nitrogen fixing trait in system production. (Warning! trick question).

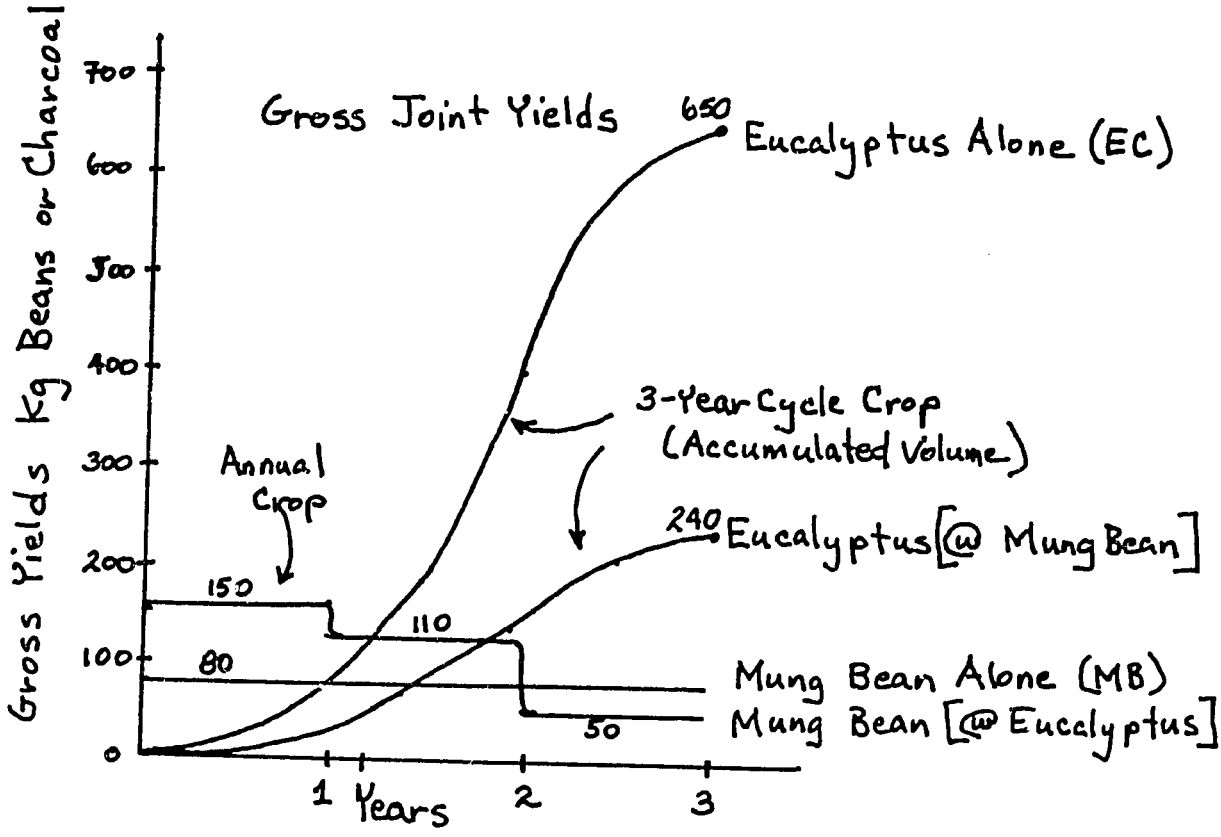
   b. We learned that leucaena leaves could be harvested as fodder worth 100 b/r/year in cycle years 1 & 2.

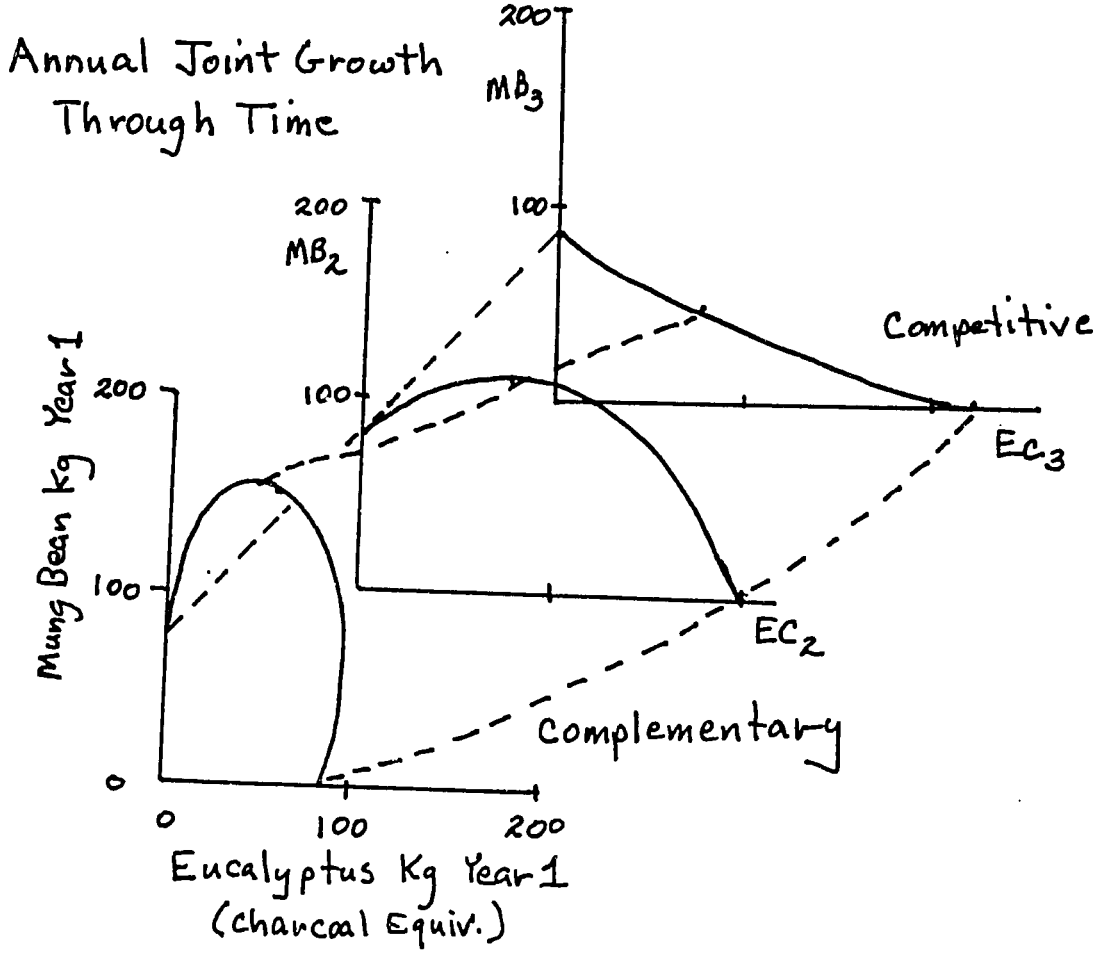
   c. If Thai peasants hated the smell of growing eucalyptus and preferred to work with leucaena 2 to 1?

   d. Average wet-season Thai family farm size were 100 hectares instead of 3.2 ha?

5. If we were given a rai of land with the EC tree root stock just cut-over, but alive and intact how could we incrementally value just that root stock alone?

Intertemporal Joint Production





An Example From Thailand

Wannawong, Belt, Mcketta
1990

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Joint Production Alternatives
Thai Agroforestry Problem Solution

We are choosing from eight farming options in the Thailand watershed problem. Our production alternatives exhibit some distinct product interactions, some positive and some negative, so a complete net analysis is necessary to select one.

Remember physical outputs are in kilograms (Kg), areas in rai (r which is about 0.16 hectare), and values in baht (b). Your options were:

Monocultures:
1) mungbean (MB) annual
2) cassava (CV) annual
3) eucalyptus (EC) 3-year cycle
4) leucaena (LL), 3-year cycle

Agroforestry mixes: (all 3-year cycles)
5) ECxMB
6) ECxCV
7) LLxMB
8) LLxCV

1. There are clear zones of complementarity and competition in options 5-8. Notice that having interplanted trees of either kind increases initial vegetable crop yields, but there is no noticeable initial benefit for trees. This could be either complementarity or supplementarity. These tables are written as harvest yields only, so we can't see the effect on tree inventory accumulation in years 1 & 2.

   The later years demonstrate obvious crop competition. Increasing tree cover decreases yields of vegetables. By the year 2, vegetable yields are almost down to monocrop levels, by the third year they are minimal. We can presume that the trend would be accentuated in longer cycles.

2. Mean annual increment (MAI) can be determined for all options and all products, the question is whether it tells us anything.

		Veggie MAI	Charcoal MAI	Mixed Biomass MAI
Mono 1)	MB	80		80
Mono 2)	CV	2000		2000
Mono 3)	EC		217*	217
Mono 4)	LL		167	167
Agro 5)	ECxMB	103	80	183
Agro 6)	ECxCV	2767*	43	2810*
Agro 7)	LLxMB	83	157	240
Agro 8)	LLxCV	2233	113	2346

The difficulty is how can we compare an MAI of mung beans to an MAI of cassava? In mass cassava root certainly looks more productive, and we get more in the intercropped setting, but these crops have radically different forms, calorie contents and societal preferences.

It gets worse when we try to compare a food to a nonfood. Yes a monoculture of eucalyptus gives us more charcoal for energy, but how do we relate cooking and heating calories to digestion calories? Physical indicators tell us very little.

For pure energy we operate in a monocrop, the ultimate in competitive relationship, for consumable biomass we operate in an agroforestry mode, but over time the tree to cassava relationship is competitive. The joint biomass we can say the same. Notice that even though complementarity existed at some point in production, the optimal solution is at a competitive part of the curve.

3. The NPV in baht/rai takes into account relative social value and relative cost of production. The ECxCV agroforestry solution is driven by the fact that huge mass of a low valued veggie, augmented by early complementarity with eucalyptus offsets other considerations.

		6-year cash flow NPV's in baht/rai		
		Veggie	Charcoal	Mixed Biomass
Mono 1)	MB	272		
Mono 2)	CV	6617		
Mono 3)	EC		1159	
Mono 4)	LL		763	
Agro 5)	ECxMB			676
Agro 6)	ECxCV			9405*
Agro 7)	LLxMB			959
Agro 8)	LLxCV			7664

Again I operate in the zone of biological competition not complementarity.

4. Charcoal is a low valued product with relatively low volumes produced so several results are counter-intuitive.

   a. A charcoal based option becomes financially optimal because the early augmentation of cassava growth by tree presence leads to large early cash flows, and later cassava reductions are partially offset by the small charcoal yields and cassava loss is discounted over at least three years.

b. If wood value was tripled, it bumps up NPV's considerably, but the relative value shift still isn't quite enough to shift you to a new production option. The augmented cassava output still dominates, but notice that the higher leucaena wood yields would shift the preferred agroforestry mix at slightly higher wood prices.

		6-year cash flow NPV's in baht/rai		
		Veggie	Charcoal	Mixed Biomass
Mono 1)	MB	272		
Mono 2)	CV	6617		
Mono 3)	EC		4587	
Mono 4)	LL		3400	
Agro 5)	ECxMB			1942
Agro 6)	ECxCV			10090*
Agro 7)	LLxMB			3438
Agro 8)	LLxCV			9458

c. At six year cycles with large wood harvests, we can expect that veggie crops would gradually disappear under the developing overstory. We have no data on these yield functions, but if we assume that year 4-6 veggie yields were 0, increased wood contributions to NPV of the 6-year cycle occur at 3 years later than the first of two wood contributions in the 3-year cycles. We also lose the cycle 2-year 1 and cycle 2 year 2 veggie contributions to NPV. So the choice depends on the relative size of what you gain discounted 6 years, vs. the relative size of what you give up discounted 3,4, and 6 years.

4. Holding biology constant as well as costs, relative prices drive optimal output mixes and management regimes.

a. The advantage of leucaena's nitrogen fixing trait in system production already appears in the MB and CV yields. Remember the production function includes the complementarity effect on site.

b. When we learned that leucaena leaves could be harvested as fodder worth 100 b/r/year in cycle years 1 & 2, that just added value to the leucaena output. It is not enough to encourage pure monocrop, and even though ECxCV and LLxCV NPV's were already relatively close (9405 vs. 7664), an additional 319 baht of NPV isn't enough to shift farmers from one treexcrop mix to the other.

c. Even if Thai peasants didn't mind the smell of growing eucalyptus, many people hate to cook on it. It spits, burns fast and gives the food a funny flavor. A cultural preference for leucaena 2 to 1 would shift you rapidly into an LLxCV combination. LL values are not much lower than EC and the personal utility gain is significant.

d. As the land base changes, so do the optimal management treatments. There is an intimate linkage between economic farm size and technology. For example, what has happened in the Palouse as we shifted from horses to tractors and to bigger tractors. Family farm size has exploded. At higher investment levels, production functions tend to flatten out. Not always, but often the biological complementarities of agroforestry are overshadowed by the economies of scale in monocrops. In the Thai farm example we might see separations of fields and shifts into monocropping.

5. The calculations we have been doing are incomplete. At the end of two cycles, there is more than just land--there is land plus a living root system ready to sprout. The valuation of this is just like the mid-rotation valuation existing stands. Do a with and without comparison over the life of the root stock. Commonly root stock is replanted after three cycles because cyclic yields usually decline although I have assumed constant for simplicity.

If I had bare forest land at the end of two cycles:

$$NPV = -600 - \frac{600}{(1.08)^9 - 1} + \frac{650*2}{(1.08)^3 - 1}$$

$$= -600 - 601 + 5006 = 3805 \text{ baht}$$

If I had coppice ready land for one more cycle (i.e. replanting doesn't occur for three more years:

$$NPV = + \frac{(650*2)+3805}{(1.08)^3} = 4052$$

So ending root stock is worth 247 baht/rai in all tree options

PAKISTAN FOREST INSTITUTE
VISITING PROFESSOR LECTURE SERIES

ECONOMICS OF AMERICAN FOREST POLICY
Outline of Lectures Presented by
Dr. Charles W. McKetta, Forest Economist

in FOREST LAW AND POLICY M.Sc.-III
28 November 1992

A. What is forest policy?

1. policy as a standardized model for repetitive decisions.

2. policy as standards of operation in regulation or law.

3. general perspectives on differing philosophies, business is on forming organizational policy to stimulate optimal behavior, public forestry takes regulatory approach.

4. Public regulatory-stye policy stems from a belief that individual decisions would not achieve a socially optimum forestry without control. eg forest devastation.

5. in forestry how do we restrict forest resource allocation and use to fit a predetermined sectoral model?
   a. control land use and product mix
   b. control management practices
   c. control site standards of practices

6. sustained yield even flow example rigid dogmatic approach that may or may not be contemporary optimality.

B. Different approaches to forest policy analysis

1. Schools of policy study vary considerably by what they consider to be the most relevant paradigm.

2. Historical Macro-forestry looks at development of forestry in a societal or ecosystem process. Usually bio-technically based.

3. Legal/Regulatory is often a statutory continuity which considers the historical development of government regulation.

4. Analytical models attempt to explain the formation of contemporary policy and predict its development.
   a. Process analysis is a consideration of the political steps in which policy is formulated. Important here are issues, individuals, institutions.

b. Micro-economic analysis evaluates value implications of policy alternatives in measures of societal efficiency and distribution of social welfare.

C. United States Forest History

1. Map--distribution of Forest Resources and Population
   a. Northern hardwoods, southern pines, western conifers
   b. Distribution of people have gone from 90% rural to 95%+ urban in one century.

2. Changes in US Forest Area, Inventory and Use
   a. Reductions of original forest area and inventory significant. clearing for agriculture from 350 to 140 million ha to by 1909.
   b. economic reasons for inventory changes relate to value and optimal inventory theory.
   c. 20th century forest reinvestment, since 1909 increase forest area mostly in private regions by 70 million ha., conifer growth rate 6 times higher (Clawson 1976).
   d. product value shift includes massive reduction in percapita wood use (-75%), and interest in nontimber commodities and ammenities.

D. US Forest Regulatory Changes

1. Formation of national forests
   a. local timber and stone
   b. forest reserves
   c. organic act of the Forest Service

2. Objectives for national forest management
   a. 1880-1940 protection and local use
   b. since WWII industrial scale commodity production
   c. 1960's inc. outdoor recreation interest
   d. 1970's inc. environmental interests, standards based state forest practices acts
   e. 1980's inc. endangered species interests, state and federal tax revisions
   f. 1990's inc. ecosystem diversity protection, western states prescription based forestry proposals

E. Regional differences in forest ownership are as extreme as the resource difference. Differences are in industrial orientation, ownership type, timber as a management objective, management practices, forest efficiency, and regulatory structure.

1. North non-forestry industrial, hardwood forests mostly private, forest industry minor importance. Timber objectives secondary to other private interests in forests. Management is extensive, inventories variable (low Y/G). Forest regulation state level and not restrictive.

2. South forestry major industry, pine forests all private wide variation in parcel sizes, timber is primary objective, amenities marketed. Management intensive, inventories kept low with growth high (high Y/G). Forest regulation state level, standards and stimulus oriented.

3. West forests major land use, minor % of GDP except in Idaho & Montana. Public conifers high cost management but extensive for timber. Large inventories, low Y/G. Restrictive federal timber policy, states standards oriented.

F. Microeconomics of regional timber supply

1. Management reveals great difference in objectives and operating philosophies west to south
   a. Western forests sustained yield regulated to protect existing inventories. Allowable cut not responsive to changing values. Large reductions cause large adjustment costs.
   b. Southern forests unregulated AAC, totally marginal cost supply and price responsive caused significant timber response displacing agriculture as timber prices rose.

2. Regional interactions product substitution in market frontiers. Western federal monopoly driving prices up but not responding. South capturing market.

3. National modeling for strategic planning is econometric reactive programming simulator. Represents market zones, forest zones, transportation costs, import/export balances for all major product groups and four forest owner behavioral models. Predicts output, value and shift reactions to federal policy.

G. Comparisons to Pakistani Forestry (inferences could be due to inaccurate due to outsider ignorance)

1. Similarities include rapid economic development, decreased per capita wood consumption (not yet proven), destruction of native forests, shift to private sector wood supplies. Mix of national and provincial forestry authorities.

2. Dissimilarities include continued rural population density, smaller middle class decision influence, higher forest investment risk, higher capital costs relative to labor, less infrastructure, less public environmental interest. Single institutional view of forestry education and research.

PAKISTAN FOREST INSTITUTE
VISITING PROFESSOR LECTURE SERIES

MODELING FOREST MANAGEMENT DECISIONS

Outline of Lectures Presented by
Dr. Charles W. McKetta, Forest Economist

in FOREST MANAGEMENT M.Sc.-III
5 & 6 December 1992

I. FM lecture #1: Forest Management Planning

A. Introduction to resource planning and optimization

1. Management objectives and criteria

2. Efficiency and constrained optimization
   a. constrained silviculture
   b. constrained management

3. Economics of planning

4. Hierarchical planning
   a. Integrated versus independent plans
   b. Operational, tactical, and strategic plans
   c. Inevitability of suboptimization

B. Forest Regulation Philosophies for Timber Production

1. Classical timber regulation
   a. Biological sustained yield
   b. Normal forest constructs

2. Financial timber regulation
   a. The timber supply decision nodes
      1. existing inventories
      2. stand investments
         i. management intensity
         ii. reentry cycle
      3. land use or product mix allocation
   b. Timber supply behavior
      1. response to expected price
      2. response to capital costs

3. Changes for multiple-use
   a. joint production functions
   b. joint optimization procedures

C. Formal Forest Planning Models

1. Reasons for using models
   a. control of decisions
   b. experimentation with alternatives
   c. coordination of interrelated decisions

2. Whole Forest Decision Sets
   a. controllable variables:
      product, inventory, harvest, growth, area
   b. decision dimensions:
      space, time, intensity

3. Types of analytical models
   a. ad hoc methods
   b. formula approaches
   c. algorithmic approaches

D. Mathematical Programming for Forest Planning

1. simulation models
   a. recursive nature of simulation
      i. the logic of loops
      ii. forest growth and cut loops
   b. satisficing as decision process
   c. simulation advantages
      i. experimental
      ii. independent modules construction
      iii. handle stochastic relationships

2. optimization models
   a. binary search
   b. linear programming
      a. feasible region
      b. objective function
      c. solution logic

   c. optimization advantages
      i. single best solution for control
      ii. deterministic format
      iii. software readily available

3. Disadvantages of modeling
   a. ignores relevant factors, hides assumptions
   b. understates non quantifiables
   c. easy to overdo
   d. not perfect representation of system
   e. high technical capacity required
   f. used as decision instead of evaluate decision

PLANNING AND DECISIONS ARE INVESTMENTS TOO!

PLANNING MUST BE FLEXIBLE TO BE PROFITABLE!

1. Knowledge is imperfect, tomorrow is discounted
2. If conditions change, decisions decay
3. Marginal planning costs rise, values decline
4. Planning expenditures related to asset values

IF INTERACTIONS EXIST, INDIVIDUAL DECISIONS MUST COMPROMISE!

1. ADMINISTRATIVE INTERACTIONS: Do individual decisions have to be coordinated with orgaizational decisions?
2. SPATIAL INTERACTIONS: Must local site decisions be coordinated with forest and regional decisions?
3. INTERTEMPORAL INTERACTIONS: Must today's actions be coordinated with tomorrow's actions?
4. JOINT PRODUCTION INTERACTIONS: Do decisions on one forest output affect decisions on others?

CATEGORIES OF FOREST PLANNING
DIFFERENTIATED BY FOCUS

SCOPE	HORIZON	RESOLUTION	PURPOSE	COST
STRATEGIC	Long > 10 yrs	Sketchy Regional	Resource Allocation	Very Low
TACTICAL	Mid-term < 10 yrs	General Local	Define Projects	Low
OPERATIONS	Short-run < 1 year	Detailed Site	Implement & Control	High

II. FM lecture #2: Demonstration of Forest Modeling Tools

A. A case forest for reference--Jerry Wilcox
(handout #1: data for Wilcox demo problem)

1. Resources and growth potential
   a. inventory and current growth
   b. area and potential growth

2. Objectives and constraints
   a. sustainable timber
      i. volume
      ii. flow pattern
      iii. stand organization
   b. financial returns
      i. net cash flow
      ii. wealth
   c. parks and such

B. Formula Approaches to Regulation
(blackboard exercises, computer demo #1 LOTUS 123)

1. Area regulation
   a. preprioritization stand order, rotation
   b. unstable flow
   c. stable distribution

2. Volume regulation--the Austrian formula
   a. inventory adjustment: Ga-Gr
   b. spread over R
   c. contribution of increment (Ia+Ir)/2

3. Insurmountable inconsistencies in specifications
   a. harvest flow pattern
   b. stand distribution

C. Algorithmic models to Simulators
(computer demo #2: LOTUS 123)

1. Spreadsheet for simple recursive calculations

2. Calculations for Volume/Area Check models
   a. age class calculation logic
   b. regulation indicators
   c. subsequent cycle interactions

3. Iterative solutions

D. Optimization Models

1. Binary search simulator
   (computer demo #3: HARVEST)
   a. area regulation
   b. even flow regulation
   c. value maximization
   d. compromise solutions

2. Linear programming optimization
   (computer demo #4: LINDO)

3. Goal programming adaptations
   a. nontimber targets--eg social indicators
   b. compromise algorithm

4. Applied Mathematical Forest Planning Models
   a. Forest scale linear program--FORPLAN
   b. Regional policy simulator--TAMM

E. Dynamic spatial simulators
   (computer demo #5: SNAP II+)

1. Area analysis problems
   a. ecological base
   b. spatial interactions GIS
   c. constrained treatment optimization
   d. simultaneous network optimization

2. Solution components
   a. ecological files
   b. network and product files
   c. value and network spatial display

FOREST MANAGEMENT MODEL COMPARISON
THE WILCOX FOREST

THE WILCOX FOREST IS A SMALL AMERICAN FOREST OF 250 ACRES. THE CONIFERS ON THIS FOREST ARE MANAGED USING EVEN-AGE SILVICULTURE AND ARE FOUND IN THREE STANDS:

STAND A:	OLD GROWTH	VOLUME DECLINING
STAND B:	POORLY STOCKED MATURE	GROWING SLOWLY
STAND C:	PLANTATION	GROWING RAPIDLY

CURRENT STAND DISTRIBUTION AND POTENTIAL GROWTH
HARVEST/ACRE AT ENTRY DECADE N

STAND	AREA	VOL-D1	VOL-D2	VOL-D3
A	50	51	48	45
B	100	20	23	30
C	100	10	30	60

ONCE A STAND IS HARVESTED IT WILL BE REPLACED BY A PLANTATION THAT PRODUCES YIELDS ACCORDING TO THE QUALITY OF THE SITE.

LAND SITE QUALITY AND FUTURE PLANTATION YIELDS
ACCUMULATED GROWTH/ACRE AT AGE N

STAND	SITE	VOL-10	VOL-20	VOL-30
A	POOR	0	10	35
B	POOR	0	10	35
C	GOOD	5	20	60

THE PROBLEM IS TO RE-REGULATE THIS FOREST TO ACHIEVE DIFFERENT GOALS USING DIFFERENT MANAGEMENT MODELS

CONSTRAINTS:
- MINIMUM HARVEST FLOW/PERIOD
- FLOW REGULARITY (2500/DECADE)
- RETAINED INVENTORY (3000 REMAINING)
- TARGET AGE 30 ROTATION
- RETAINING A 60 ACRE PARK

WE WILL USE:
- CLASSICAL REGULATION--ALGEBRA
- SIMPLE SIMULATION--LOTUS 123
- FOREST SIMULATOR--HARVEST
- LINEAR PROGRAMMING--LINDO
- GOAL PROGRAMMING--LINDO
- DYNAMIC SPATIAL SIMULATION--SNAP II+