Topic 3
Production Theory as Applied to Forestry

Dr. B. Sundar

Flow

1. The Production Decision of a Firm
2. Total Product, Average Product, and Marginal Product – Example
3. The Law of Diminishing Marginal Returns
4. Isoquants – Example
5. Returns to Scale
6. Marginal Products in Forestry – special issues

1. Production decision of a firm

- The production decision of a firm can be studied in three steps:
  1. Production technology – describing how inputs (labor, capital) can be transformed to outputs like lumber, car, and TV
  2. Cost of production – Cost of inputs have to be minimized
  3. Input choices – Given a production technology and cost constraints, the firm must choose the input ratio (low wage rates may force a firm to employ more labor)

- The production function: $q = F(K, L)$, where K = capital, L = labor
  - K, L, or both may vary, and applies to a given technology
  - Short run – the time period in which the factors of production cannot be changed
  - Long run – the amount of time required to make all inputs variable

2. Example- Total, Average, and Marginal Products

- Assumptions
  - K is fixed, L is variable
  - The firm can produce more only by increasing L
- Average product = q/L
- Marginal product = change in q / change in L

2. Example…

Amount of Labor (L)	Amount of Capital (K)	Total Output (q)	Average Product (q/L)	Marginal Product (Δq/ΔL)
0	10	0	—	—
1	10	10	10	10
2	10	30	15	20
3	10	60	20	30
4	10	80	20	20
5	10	95	19	15
6	10	108	18	13
7	10	112	16	4
8	10	112	14	0
9	10	108	12	–4
10	10	100	10	–8

2. Example…

- We can graph the information in the Table to show
  - How output varies with changes in labor
    - Output is maximized at 112 units
  - Average and Marginal Products
    - Marginal product is positive as long as total output is increasing
    - Marginal Product crosses Average Product at its maximum

2. Example …

- When marginal product is greater than the average product, the average product is increasing
- When marginal product is less than the average product, the average product is decreasing
- When marginal product is zero, total product (output) is at its maximum
- Marginal product crosses average product at its maximum

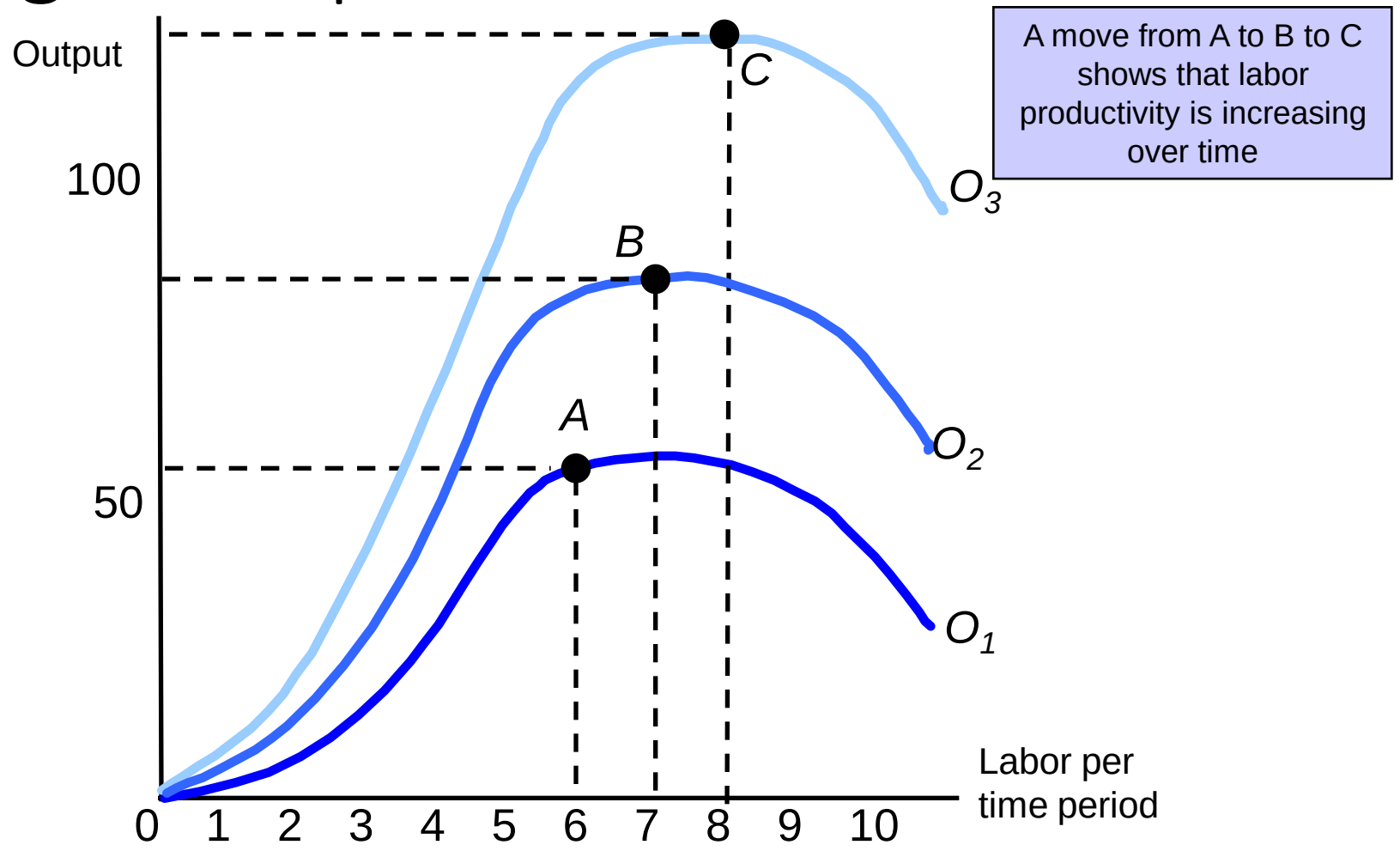
2. Example…

- From the previous example, we can see that as we increase labor the additional output produced declines
- Law of Diminishing Marginal Returns: As the use of an input increases with other inputs fixed, the resulting additions to output will eventually decrease.

3. Law of Diminishing Marginal Returns

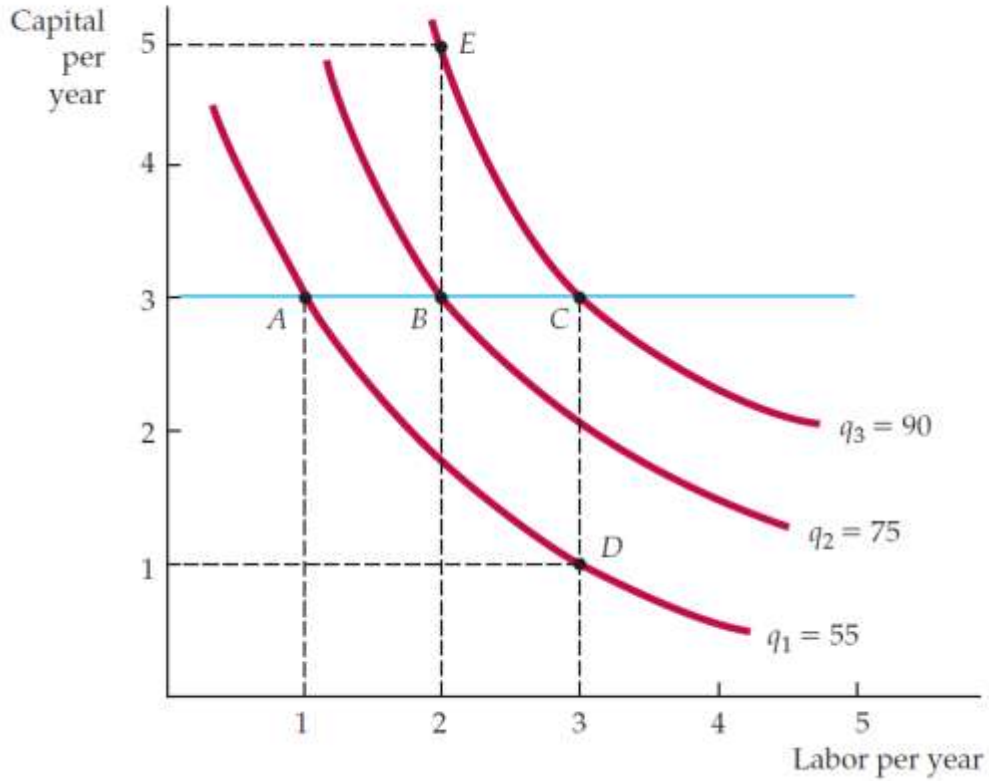
- Assumes a constant technology
  - Changes in technology will cause shifts in the total product curve
  - More output can be produced with same inputs
  - Labor productivity can increase if there are improvements in technology, even though any given production process exhibits diminishing returns to labor.

3. The Effect of Technological Improvement



4. Isoquants - Example

	LABOR INPUT				
CAPITAL INPUT	1	2	3	4	5
1	20	40	55	65	(75)
2	40	60	(75)	85	90
3	55	(75)	90	100	105
4	65	85	100	110	115
5	(75)	90	105	115	120



5. Returns to Scale

- In addition to discussing the tradeoff between inputs to keep production the same
- How does a firm decide, in the long run, the best way to increase output
  - Can change the scale of production by increasing all inputs in proportion
  - If double inputs, output will most likely increase but by how much?

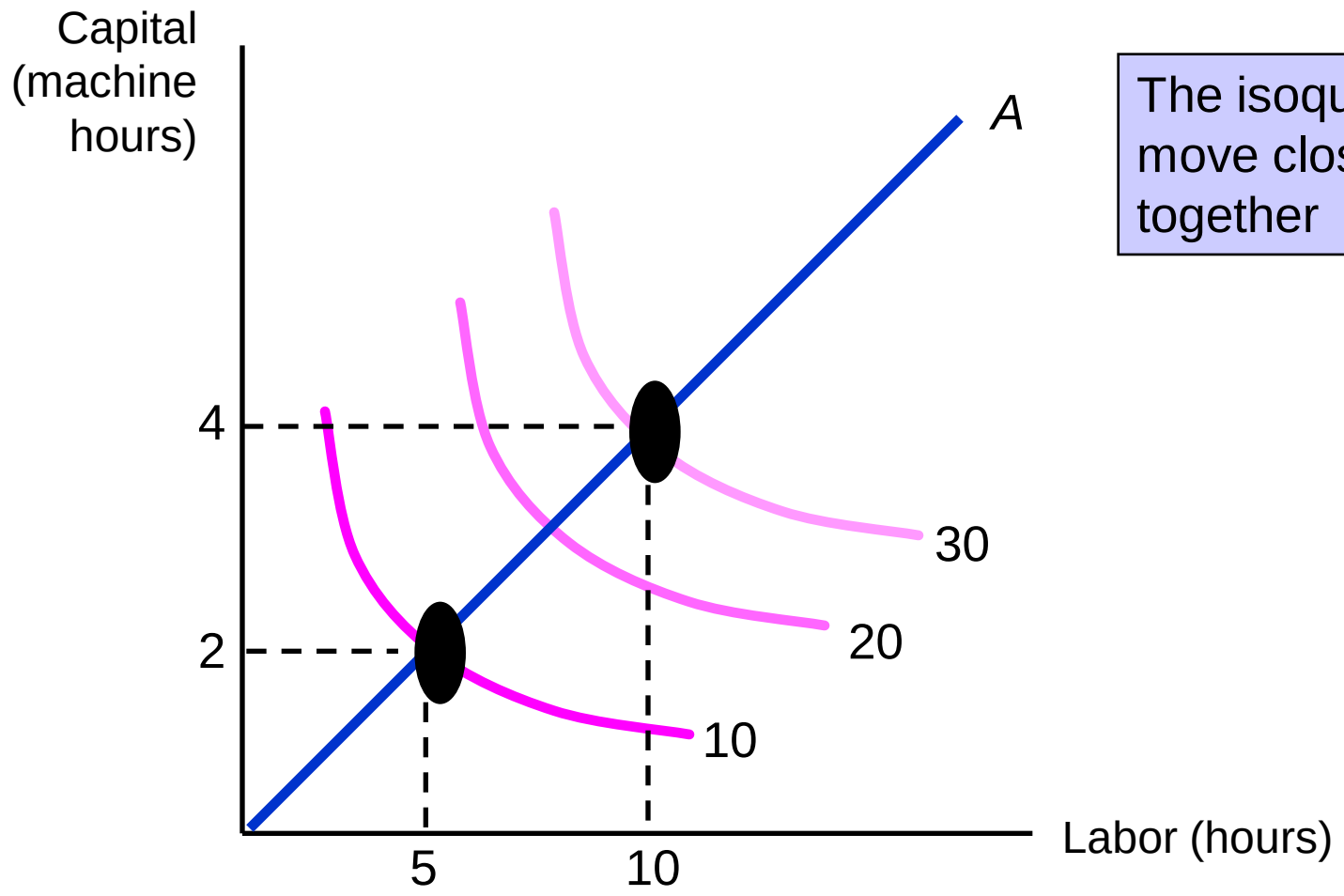
5. Returns to Scale

- Rate at which output increases as inputs are increased proportionately
  - Increasing returns to scale
  - Constant returns to scale
  - Decreasing returns to scale

5. Returns to Scale

- Increasing returns to scale: output more than doubles when all inputs are doubled
  - Larger output associated with lower cost (cars)
  - One firm is more efficient than many (utilities)
  - The isoquants get closer together

5. Increasing Returns to Scale…

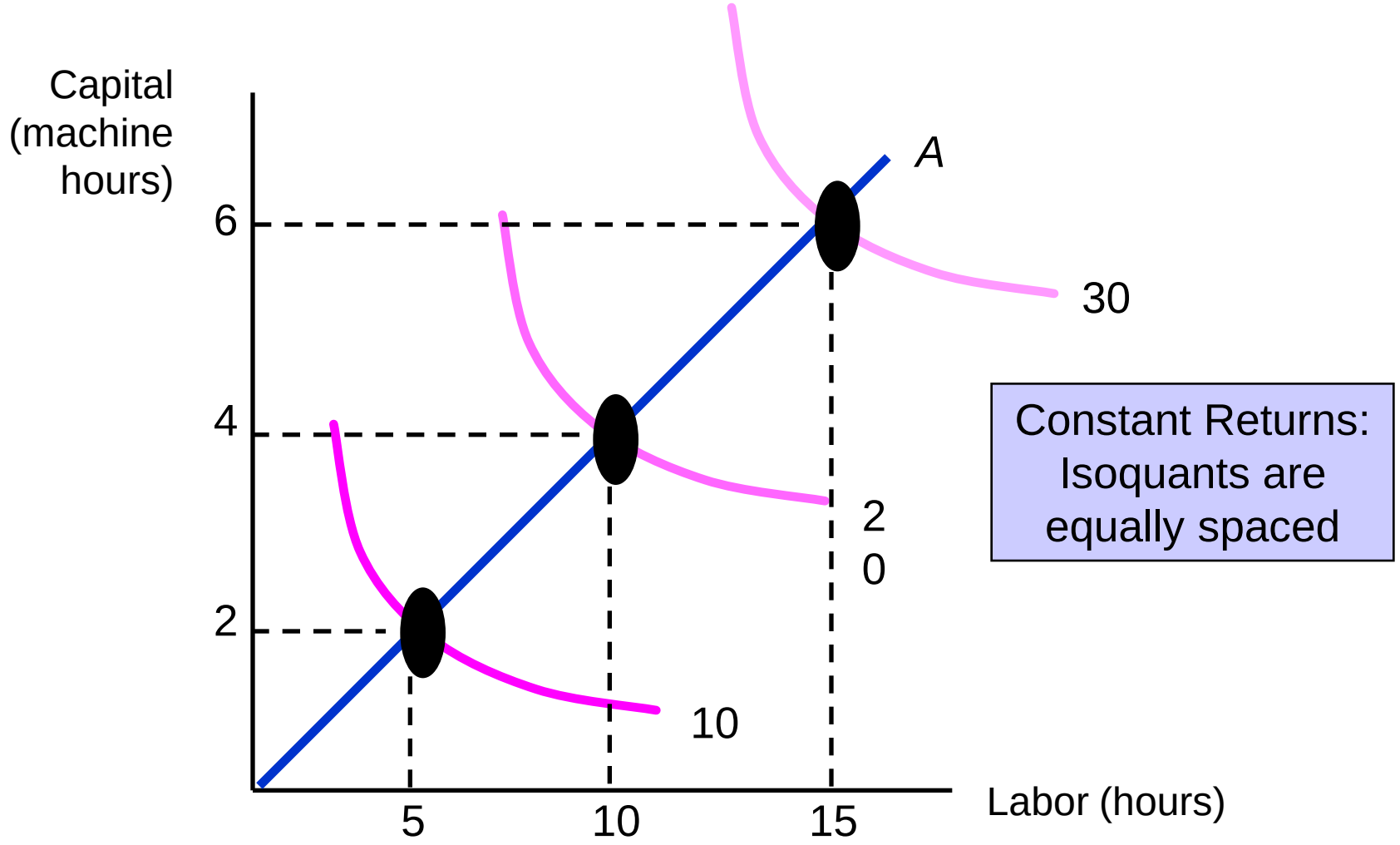


The isoquants move closer together

5. Returns to Scale…

- Constant returns to scale: output doubles when all inputs are doubled
  - Size does not affect productivity
  - May have a large number of producers
  - Isoquants are equidistant apart

5. Returns to Scale…



5. Returns to Scale…

- Decreasing returns to scale: output less than doubles when all inputs are doubled
  - Decreasing efficiency with large size
  - Reduction of entrepreneurial abilities
  - Isoquants become farther apart

6. Marginal Products In Forestry – Some Issues

- Marginal Revenue (MR) is the change in revenues resulting from a one-unit increase in output
  - Revenue = Price per unit * Quantity of units sold
- Marginal Revenue Product (labor), denoted as [MRP (labor)] is the additional revenue obtained by increasing labor by one unit
  - It is profitable for the firm to hire one more unit of labor if MRP(labor) >= wage rate, w
  - Similarly, firm will employ additional units of capital as long as MRP(capital)>= interest, I
  - This is the case with perfectly competitive markets guided by profit maximization

1. Forest goods production and use fails to be guided by profit maximization. Why?
   a. Government forests are guided by welfare objectives, and constrained by regulation
   b. Forest goods like recreation, water tables, and aesthetic value are not marketed, and hence their values cannot be realized by private sector
   c. Forest markets (barring lumber) are rarely perfectly competitive
      - Regional newsprint, pulp, and plywood markets have a few sellers who create a monopoly
      - There are barriers to entry (capital for paper and pulp, land requirements for growing trees)

6. Marginal Products In Forestry – Some Issues …

2. Time, a variable input, plays an important role in the trade of forest products

- Trees require years to grow and mature
- Forest owners need to decide on when to harvest, invest in roads, and in silvicultural interventions
- Wood quality and volume is higher, greater the time allowed for growth
- Time has an opportunity cost, and has a substitutability with other factors of production

3. Externalities in forestry

- Forestry generates positive and negative externalities simultaneously
  - For example, timber harvesting may enhance habitat for some species, but cause pollution and impair aesthetics
  - Here, the timber firm is not paid for generating benefits, nor charged for the damage
  - These externalities are market imperfections, and not compensated through markets
  - Since these costs and benefits are not registered, there is no economic incentive for agents in production decisions resulting in misallocation of resources
- Thus, too much of negative externalities (pollution), and too less of positive externalities (aesthetics) are generated

6. Marginal Products In Forestry – Some Issues …

4. Imperfect knowledge clouds decision making in forestry

- In perfectly competitive markets, across time periods
  - Buyers know fully about the goods, price, and utility
  - Sellers have full information on factor markets, and technology
- Forest business decisions abound with uncertainty about growth rates, natural losses, and species attrition

5. Special market forms

- Monopsonies in local land and timber markets, bilateral monopoly in certain forest labor markets, and restricted access to capital markets for small forest owners are impediments to market processes in forestry

Special market forms

- Monopsony
  - Market with only one buyer
  - The classic example of a monopsony is a company coal town, where the coal company acts the sole employer and therefore the sole purchaser of labor in the town.
- Bilateral monopoly
  - Seller is a monopoly
  - Buyer is a monopsony
  - The one supplier will tend to act as a monopoly power and look to charge high prices to the one buyer. The lone buyer will look towards paying a price that is as low as possible. Since both parties have conflicting goals, the two sides must negotiate based on the relative bargaining power of each, with a final price settling in between the two sides' points of maximum profit.
  - An example of bilateral monopoly is a lignite (brown coal) mine and a lignite based power station. Since transport of lignite is not economical, the power station is located close to the mine. The mine is monopolistic in producing lignite, and as the only buyer the power station acts as a monopsony.

6. Marginal Products In Forestry – Some Issues …

6. Indivisibility of inputs in forestry

- While the theory of market economies requires discrete, divisible, homogenous, and mobile inputs, input resources in forestry are heterogeneous, immobile, and indivisible restricting flexibility (ex: water basins, wilderness areas, and national parks)

7. No full control of inputs

- Forest enterprises often do not have full control of inputs, as with common property resources, which kill the incentives to conserve due to the ***free rider*** problem
- Leases, licenses, royalty payments to governments, and taxes create market failures

- In summary, when a variety of goods can be produced from forests, or inputs like land, labor, and capital can be employed in forestry or other activities, **we must focus on MC and MR for each form of production**

End of session

Thanks