Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Botany

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Unit: 8

Module Name: Production and Productivity in Ecosystems

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Production and Productivity in Ecosystems

Solar energy enters the ecosystem through photosynthesis and flows in the ecosystem as food through various trophic levels.

Production is the incorporation of energy and materials into the bodies of organisms (biomass). Biomass is the mass of organic material in organisms of ecosystems.

Production falls into two major categories:

- Primary production
- Secondary production

Primary production - Production by photosynthetic and chemosynthetic organisms which produce organic matter from solar energy and inorganic matter.

Secondary production – Production by organisms which convert the organic matter of the plants into the substance of their own bodies.

Productivity

The rate of biomass production is called **productivity.**

- Primary Productivity
- Secondary Productivity

Primary Productivity

Primary Productivity is the rate at which photosynthetic and chemosynthetic organisms produce organic compounds in an ecosystem. Most primary productivity occurs through photosynthesis. As this is the first and basic form of energy storage it is known as primary productivity.

There are two aspects of primary productivity:

Gross primary productivity (GPP) - The total solar energy trapped in the food material by photosynthesis is referred to as gross primary productivity.

Net primary productivity (NPP)-The organic materials that remain after photosynthetic organisms have used some of these compounds for their cellular energy needs (cellular respiration).

NPP = GPP - R (Respiration)

Methods of measurement of Primary Productivity

Primary productivity is expressed in terms of

- Energy per unit area per unit time
- Biomass added per unit area per unit time

The amount and rate of energy fixation (primary production) can be measured in a number of ways.

1. Harvest method - Measure biomass and express as biomass per unit area per unit time.

2. CO_2 assimilation - Measure CO_2 uptake in photosynthesis and release by respiration.

3. O_2 production - Measure O_2 production and consumption from aquatic ecosystem. Water samples are taken in 'light' and 'dark' bottles and are suspended in water at a depth from where the samples were taken. The difference in the amount of oxygen collected in the illuminated bottle is calculated to determine the amount and rate of net photosynthesis. The decrease in the amount of oxygen in the 'black bottle' indicates the respiratory consumption of oxygen.

4. Radioisotope method - Uses Carbon-14 tracer in photosynthesis. Water samples are taken in 'light' and 'dark' bottles and a known quantity of

Carbon-14 is added. The amount of radioactive carbohydrate synthesised is determined.

5. Chlorophyll measurement - Assumes a correlation between amount of chlorophyll and rate of photosynthesis. If the chlorophyll content is known and assuming the rate of photosynthesis per unit of chlorophyll, the production of a sampled area can be calculated.

6. pH estimation - In aquatic plants photosynthetic utilization of CO_2 as well as release of respiratory CO_2 alters the pH of water. pH measurement is therefore one of the indirect methods to measure the photosynthetic production.

Primary Productivity of different Ecosystems

The productivity is variable in different ecosystems.

- A tropical wet evergreen forest gets intense sunlight throughout the year - highly productive.
- Alpine tundra ecosystem which is photosynthetically active for only two months in a year – less productive.

Environmental factors affecting primary productivity

- Solar radiation
- Temperature
- Moisture
- Mineral nutrition
- Biotic activities

Secondary Productivity (SP)

The rate at which new biomass is produced per unit area by the animal community. The potential energy resulting from primary production furnishes the energy required by other trophic levels in an ecosystem. Some energy, in the form of food, is consumed by herbivores or omnivores who may be eaten by carnivores, which in turn may be eaten by other carnivores. Not all food eaten is assimilated into an animal's body. Unassimilated food = faeces or droppings.

Secondary Productivity = food eaten – faecal loss