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(i) PRODUCTIVITY

Productivity

Productivity [Producers = To produce] \rightarrow
"Productivity is the amount of energy contained in organic matter fixed by an ecosystem or its component per unit time per unit area."

Productivity is measured in terms of dry matter formed or energy captured per unit area per unit time, e.g., $\text{g m}^{-2} \text{yr}^{-1}$, $\text{Kcal m}^{-2} \text{yr}^{-1}$. The values are used in comparing productivity of different ecosystems. The branch of ecology that deals with the study of various factors and the amount of production of organic matter in different ecosystems as well as different components of each ecosystem is called production ecology.

Types of Productivity

Productivity is of two types, primary and secondary.

① Primary Productivity \rightarrow It is the rate at which energy is trapped

or biomass synthesized by producers per unit time per unit area through the process of photosynthesis. Primary productivity has two aspects -

(A) Gross Primary Productivity [GPP, P_g]

It is total amount of energy captured or the total organic matter/biomass manufactured by the producers in their photosynthesis per unit time per unit area.

(B) Net Primary Productivity [NPP, P_n]

It is the amount of energy or biomass stored by the producers per unit area per unit time. Net primary productivity is less than the gross primary productivity by the amount of energy or organic matter used up by the producers in their own respiration per unit area per unit time.

Net Primary Productivity [NPP] =

Gross Primary Productivity [GPP] -
Respiration [R].

Therefore, while GPP is the amount of energy captured or biomass formed in photosynthesis, NPP is the difference between the

amount of photosynthetic yield and the consumption of organic matter in respiration. Net Primary Productivity brings about accumulation of biomass in the producers. This biomass and its contained energy serves as food for herbivores and decomposers.

Difference between GPP and NPP

Gross Primary Productivity [GPP]	Net Primary Productivity NPP
i) It is the rate of total amount of energy captured or organic matter formed by producers	i) It is the rate of energy stored as biomass accumulated by producers
ii) It depends upon the amount of photosynthesis area and photosynthetic efficiency.	ii) It depends upon rate of photosynthesis as well as respiration
iii) It is gross gain of energy or biomass being equal to sum of net primary productivity and respiration rate.	iii) It is the net gain of energy or biomass being equal to primary productivity minus the rate of respiration.

Net Primary Productivity ^①
should not be confused with total biomass or standing crop of autotrophs. It is the rate at which biomass accumulates. Standing crop is the total biomass present in the ecosystem. Net primary productivity of the biomass is estimated as 170 billion tonnes on dry weight basis while the standing crop is 1855 billion tonnes. Out of 170 billion tonnes, terrestrial ecosystem accounts for 115 billion tonnes while ocean, which occupy more than 70% of earth's surface, manufacture only 55 billion tonnes of organic matter.

Magnitude of primary productivity depends upon

- The efficiency and photosynthetic capacity of producers.
- Solar radiations available.
- Temperature
- Nutrients
- Soil moisture

These components vary from ecosystem to ecosystem. Therefore, there is variations in the productivity of different ecosystems. The most suitable conditions for photosynthesis occur in tropics. Here the

photosynthetic activity can be sustained at optimum rate throughout the year. Variations occur with the availability of moisture. Mature tropical rain forests have a net primary productivity of more than 20 tonnes/ha/yr. In temperate areas the primary productivity is less than that of tropical areas due to cold climate during winter which often also receives snow. The lowest productivity is that of deserts. It is less than 1 tonnes/ha/yr. It is due to extreme aridity and poor nutrient supply along with unfavourable temperature regimes.

In aquatic ecosystems, primary productivity is limited by light which decreases by depth. In deep marine habitats, both light and nutrients become limiting. The most limiting nutrient of marine ecosystems is nitrogen. It is because of these limitations the total productivity of oceans is less than 50% of terrestrial productivity despite occupying three times more area. Where light and nutrients are available in good quantity the primary productivity is very

high. The highest primary productivity is that of coral reefs followed by ~~estuaries~~ estuaries and then tropical rain forests.

Area, Mean Plant Biomass and NPP of Major Ecosystems

Ecosystems	Area Million Km ²	Mean Plant Biomass tonnes/ha	Mean NPP Tonnes/ha/yr
1) Tropical Rain Forest	17	440	20
2) Tropical Deciduous Forest	8	360	15
3) Temperate Deciduous Forest	7	300	12
4) Temperate coniferous Forest	12	200	8
5) Savanna	15	40	9
6) Temperate Grass Land	9	20	5
7) Desert Shrub	18	10	0.7

∴ Tonne = metric Ton = 1000 kg

∴ Hectare (ha) = 10,000 m²

(2) Secondary Productivity [SP] →

It is the rate at which organic matter is built up by consumers especially

the primary consumers or herbivores. ⑦
Consumers are heterotrophic. They obtain ready made organic matter. A part of organic matter is wasted in this consumption. A part comes out as undigestible faecal matter. Out of the remaining matter which has been digested and absorbed by the body, a part is consumed for obtaining energy in respiration. The rest is assimilated and used in growth and body building of consumers. Herbivores pick up a fraction of plant matter for their feeding so that the producers are not destroyed. A good part of ingested matter is passed out as faeces. However the latter is not lost from ecosystem as it becomes available to decomposers. Herbivores consume about 30% of the total food energy in respiration. The rest is used in body building. Carnivores spoil a lot of organic matter during preying. They are, of course, more efficient in converting food into biomass because of easy digestion of meat. However they consume more organic matter in respiration upto 60%. It should,

however be clear that in secondary productivity no new organic matter is formed. It is only utilization of part of food manufactured by primary producers in building of consumer biomass -

Differences between Primary Productivity [PP] and Secondary Productivity [SP]

Primary Productivity [PP]	Secondary Productivity [SP]
1) It is rate at which organic matter is built up by producers	1) It is rate at which organic matter is built up by consumers
2) It is due to photosynthesis	2) It is due to herbivory and predation
3) There is net gain of energy in the biosphere.	3) There is no such activity.

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