ToppersNotes

IES/GATE
CIVIL ENGINEERING

IRRIGATION & HYDROLOGY

VOLUME-III

Sierra Innovations Pvt. Ltd.

Contents

WATER-RESOURCE & ENG.-II

(IRRIGATION ENG.)

→ Global Distribution of water

→ Multi-purpose use of water

→ Irrigation Eng. ⊕ Imp. for GATE

→ Design of CANALS ⊛ " " "

→ Analysis of Gravity Dams. ⊕ Imp. for ESE

→ water Logging & Drainage Design.

→ Miscellaneous Topics { Gross Drainage work, River Training, Spillways, etc.

Ref. Books :

(1) Irrigation Engg & Hydraulic structures — by S.K Garg.

Marks Distribution

(1) Gate : 3-4 marks

ESE (o) : 8-10 que

ESE (c) : 25-30 marks

1. GLOBAL ESTIMATES of WATER

S.No.	SEGMENT	Vol. of water ($\times 10^6$ B m^3)	% of total water
(1)	OCEANs.	1348	97.3
(2)	Fresh water	37.5 *	2.7 *
	Distribution of F.W among Various sources		
	(i) Polar Ice	28.2	2.03
	(ii) Ground water	8.45	0.61
	(iii) Lakes & Rivers	0.127 *	0.01 *
	(iv) other Sources	0.723	0.05
		1385.5	100%

Multipurpose Use of water :-

The multipurpose use of water is best given by the water allocation priority of NWP (national water Policy) 2002, which are as following. (↓ 1st NWP is developed in 1988, & IIIrd → 2012 ↓ 1st)

(1) Driking water
(2) Irrigation
(3) Hydropower
(4) Ecology
(5) Agro & Non agro Industries. (Agriculture & Non Agriculture
(6) Navigation and other uses.

IRRIGATION

Introduction :-

(1) Every Crop requires a certain quantity of water after a certain fixed interval, throughout its period of growth. ..... If the natural rain is sufficient and timely so as to satisfy both of the above requirement, no irrigation water will be required for producing that crop.

(2) In a tropical country like India, the natural rainfall is neither sufficient nor does the water fall regularly as required by the crops. Therefore, Irrigation is significantly needed.

Note :- Different crops will have different water requirement, and the same crop may have different water requirements at different places of the same country, Depending upon the variations in climate, types of soil, Methods of cultivation & useful Rainfall etc.

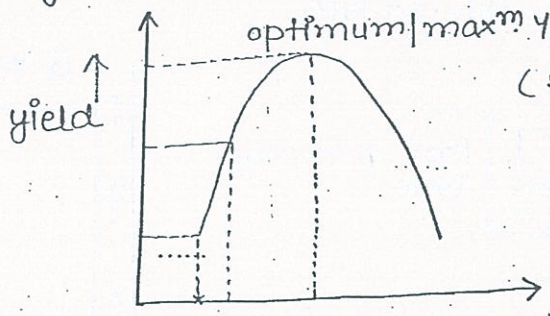
Definition of Irrigation :

Irrigation may be defined as science of artificial application of water to the land/fields, in accordance with the crop requirements throughout the crop period for full development of the crops.

Advantages of Irrigation :-

(1) Increase in food Production. (irr. helps in rising crop yield, & hence to attain self sufficiency in food)

(2) Ensuring optimum growth (or) yield.



(yield will be smaller for any quantity lesser than or excess of the optm qunty.)

(3) Elimination of mixed croping. (when irr. is not assured)
(sowing together of 2 or more crops in the same field) { which weather condn is not good for one of crop it may be good for other

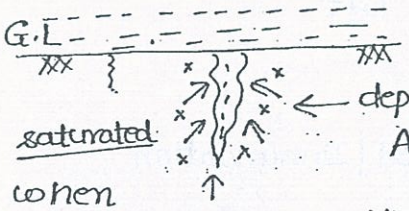
(4) Generation of Hydro electric power. (cheaper power generation)

(5) Improving Domestic water supply.

(6) In land navigation. (very useful) - for w.s.

Disadvantages of Irrigation :

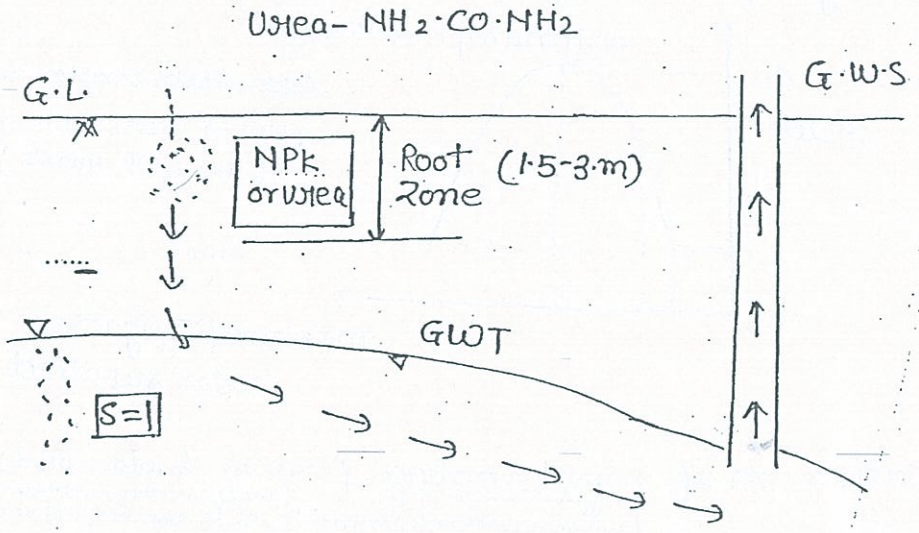
(1) Over Irrigation may cause water logging which reduces crop yield.



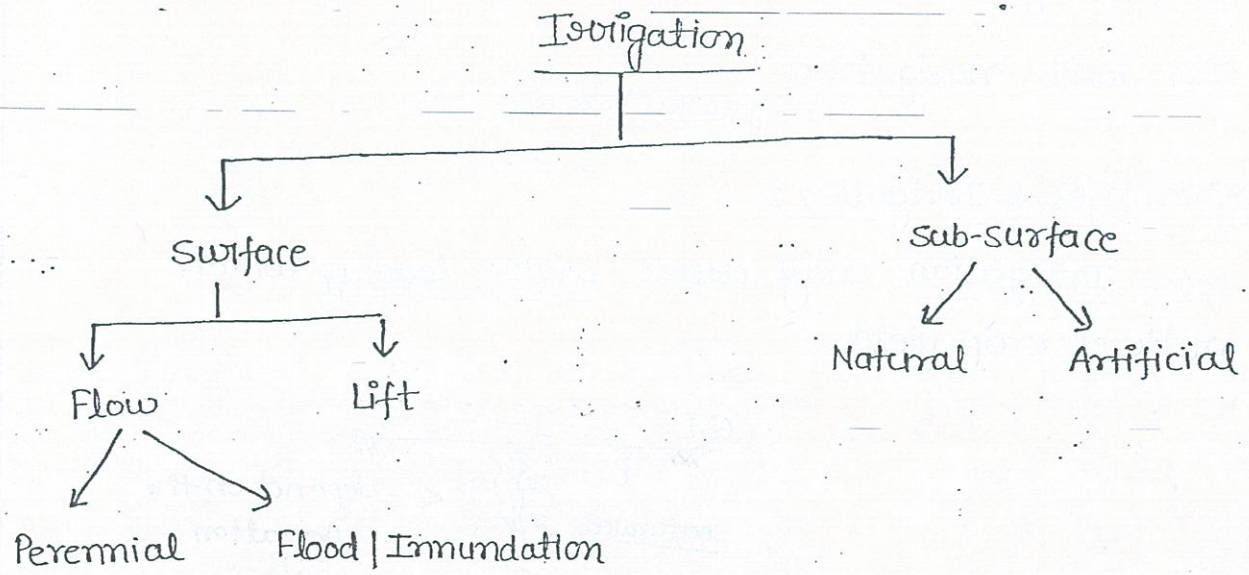
no air exist (no exist aeration) (Trees will be dia.)

(2) Irrigation may lead to creation of climatic condition, which is favourable for the spread of diseas like Dengue & Malaria.

(3) Irrigation may lead to seepage of Nitrates into the ground water table.



Types of Irrigation :-



1. Surface Irrigation

Definition –

" In this method of Irrigation, the water directly wets the soil surface." It can be further classified as —

(i) Flow Irrigation →

when water is available at such a height that it can be directly applied to the agricultural field by only the action of gravity, this method of Irrigation is called Flow Irrigation.

(ii) Lift Irrigation :-

If the water is lifted up by some mechanical or mannual action ex- pump etc. and then supplied for Irrigation then it is called lift Irrigation. Ex. Tubewell.

Flow Irrigation can be further classified into –

(a) Perennial Irrigation :- In this system of Irrigation, constant & continuous water supply is supplied to the crops in accordance with the requirements, throughout the crop period.

(b) Flood Irrigation :- In this method of Irrigation, soil is kept submmerged & flooded with water, so as to cause thorough saturation of the field.

This system of Irrigation is also called un-controlled Irrigation.

2. Sub-Surface Irrigation

In this method, water does not wet the surfaced and is directly applied to the root zone by action of capillarity.

It can be divided into following 2 types —

(i) Natural Sub-Surface Irrigation :-

Leakage water from channels etc. goes underground and during passing through root zone, it may Irrigate. when under ground irrigation is achieved simply by natural process, without any additional extra efforts, it is called natural sub-surface Irrigation.

(ii) Artificial Sub-Surface Irrigation :-

when a system of open jointed Drains is artificially laid below the soil, so as to supply water to the crops by capillarity, then it is known as Artificial sub-surface Irrigation.

TECHNIQUES OF WATER DISTRIBUTION

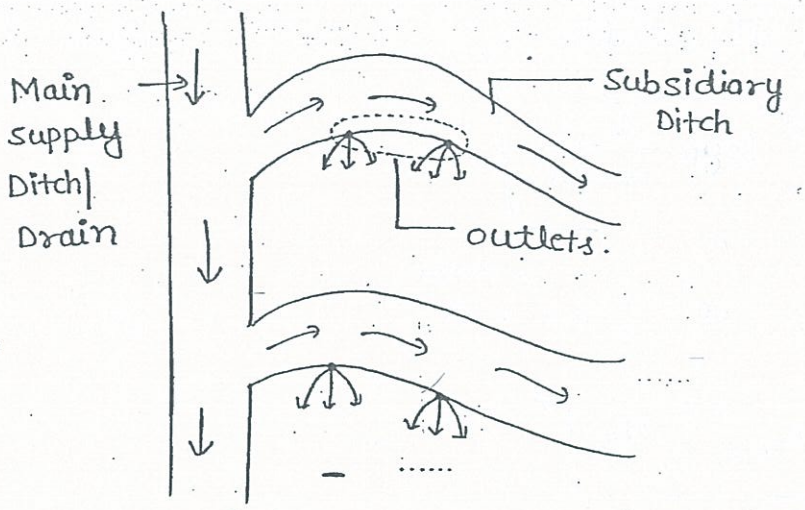
(1) Free Flooding (or) Ordinary Flooding :- (wild flooding)

⇒ In this method, the flow of water is not controlled.

⇒ This method is suitable for close growing crops.

⇓

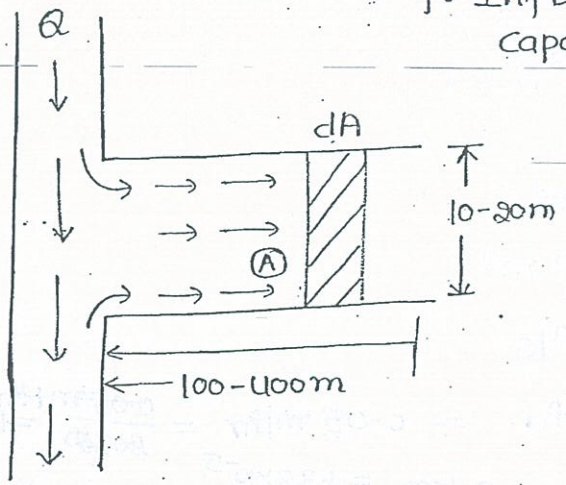
Rice (used on Rolling land)
(Topography irregular).



(2) Border Flooding :⇒ In this method, the land is divided into a no. of strips seperated by low leeves, which are called Border.

⇒ The land/field area is confined b/w 10 to 20m width and 100-400 m of length.

f: Infiltration (cm/hr) capacity.



Derivation :- Time 't' required for irrigation (irg) an area 'A', for given discharge (Q).

(*) Let in time 'dt', Area irrigated further is = dA { for depth of water = y }

$$\Rightarrow Q \cdot dt = A \cdot f \cdot dt + y \cdot dA$$

$$\boxed{t = \frac{2.303\, y}{f} \cdot \log_{10} \frac{Q}{Q - fA}}$$

At, $t \to \infty \quad \Rightarrow \quad Q - fA = 0$ (A → Amax)

$$\boxed{A_{max} = Q/f}$$

Ques 8(1) Find the time required to irrigate a strip of land whose area is 0.04 hect. from a tubewell having a discharge of $0.02\ m^3/s$. Infilteration capacity of soil is f = 5cm/hr, & Avg. Depth of flow in the field is 10 cm.

$$\Rightarrow \quad t = \frac{2.303\, y}{f} \cdot \log_{10} \frac{Q}{Q - fA}$$

$A = 0.04$ hect.

$= 0.04 \times 10^4\ m^2$

$Q = 0.02\ m^3/s$

$f = 5$ cm/hr. $= 0.05$ m/hr $= \frac{0.05\ m/hr}{60 \times 60} = 1.38 \times 10^{-5} = 1.80$ m/sec.

$y = 10$ cm. $= 0.1$ m

$$t = \frac{2.303 \times 0.1}{1.80 \times 1.38 \times 10^{-5}} \log_{10} \frac{0.02}{0.02 - \left(\frac{1.80 \times 0.04 \times 10^4}{1.38 \times 10^{-5}}\right)}$$

$t = 2340.73$ Sec

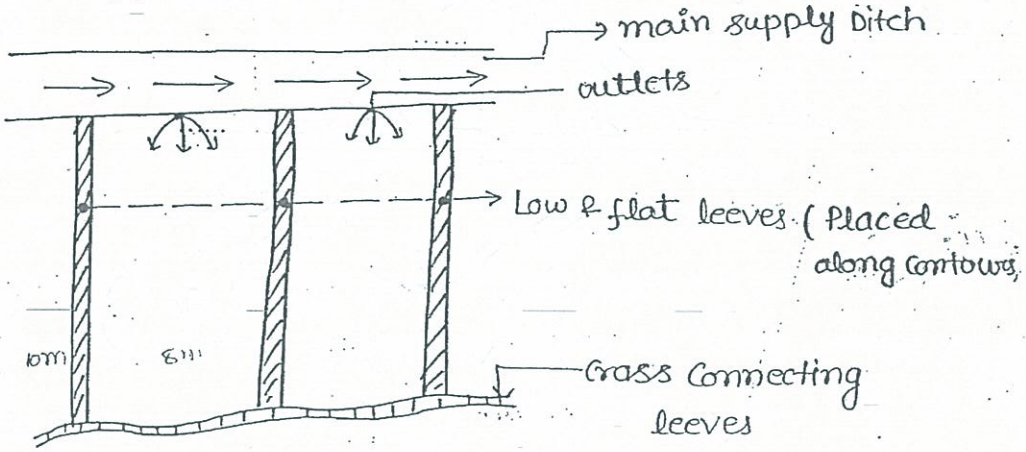
$\boxed{t = 39.05\ min}$

$$A_{max} = \frac{Q}{f} = \frac{0.02}{1.38 \times 10^{-5}}$$

$= 1449.275\ m^2 = 0.144$ hq.

(3) Check Flooding :

This is a modified form of ordinary flooding in which the water is controlled by surrounding the check area with cross connecting leeves. These leeves are generally constructed along the contours

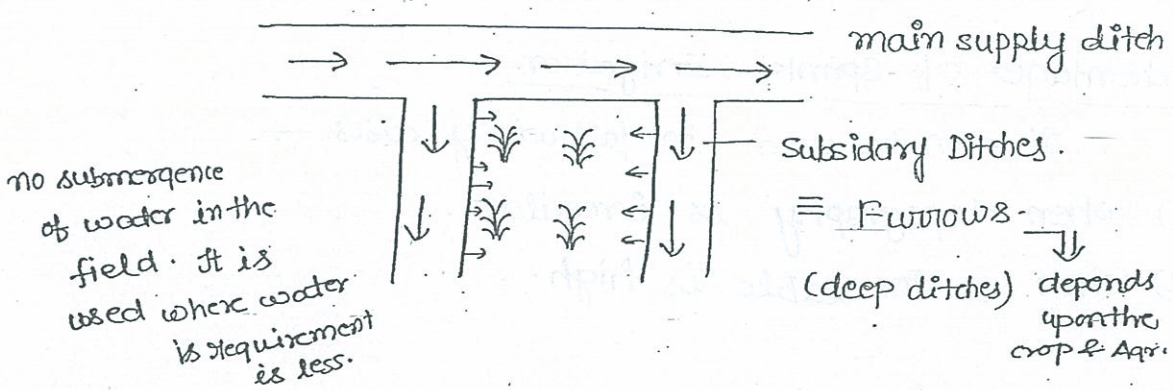


use in Hilly areas.

(4) Furrow Irrigation :-

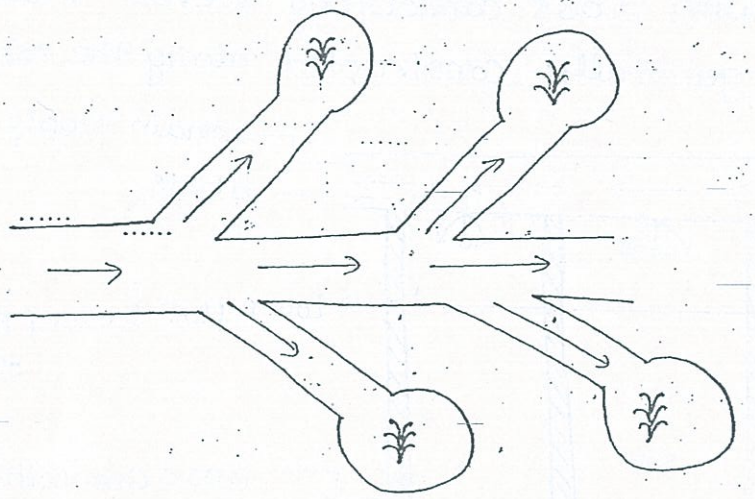
Furrows are narrow ditches which are excavated b/w rows of plants & carry irrigation water through it.

In this method of Irrigation only **20 to 50%** of the field area is **wetted** & therefore, evaporation losses are considerably reduced.



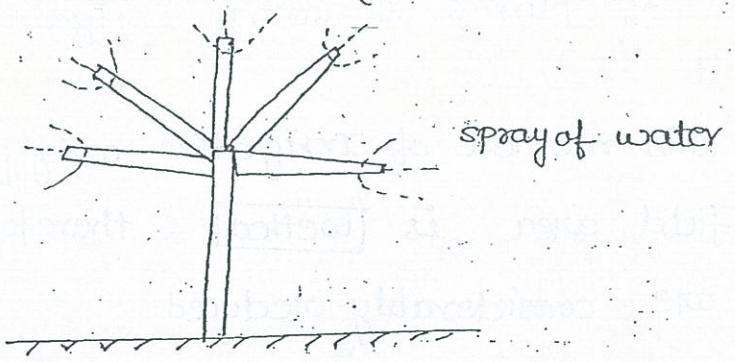
(5) Basin Flooding :-

This is a special type of flooding (check flooding) and is specifically adopted for orchid trees.



(6) Sprinkler Irrigation :-

In this method of Irrigation, water is applied through a network of pipes & pumps and water is made available in the form of spray.



Advantages of Spimkler Irrigation :

It can be used in following cases —

(1) when topography is irregular.

(2) when water table is high.

(3) when soil is permeable or less permeable.
(4) when water is not easily available.
(5) when seepage loss is more.
(6) when no. of labour have to be reduced.
(7) when fertilizers & Insecticides are to be mixed with Irrigational water.

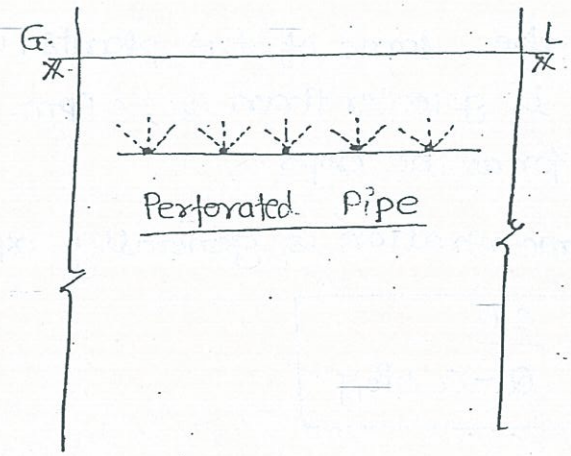
Disadvantages of Sprinkler Irrigation :-

(1) Evaporation loss is more.
(2) Initial Installation cost is high.
(3) Technical man power is required.

Note : This method of Irrigation is not suitable for heavy Irrigation. Ex. Rice.

(7) Drip Irrigation :-

This is also called as trickle Irrigation. In this method, water is directly applied in the root zone of the plants using drip nozzels.



(water level is low).

Note :→ Evaporation & seepage losses are considerably reduced in this method of Irrigation.

→ This method can not be used when heavy irrigation is required.

→ Like the sprinkler system, this method also involves technical knowledge and therefore not adopted by ordinary farmers.

Quality of Irrigation Water :-

(1) Sediment Concentration :- (Young mountain - Himalays.)

when fine sediments from water is deposited on sandy soil, the fitility of the land is improved. whereas, if sediments are obtained from the eroded areas then fertility gets reduced.

(2) Concentration of saluble salts :-

If the salt concentration is greater than 700 ppm it is harmful to the some of the plants, whereas, if this concentration is greater than 2000 ppm. then this water is harmful for all the crops.

The salinity concentration is generally expressed as.

$$C_S = \frac{C \cdot Q}{Q - C_u + P_{eff}}$$

where,

Q is quantity of water applied.

C → Concentration of salts in Irrigation water

Cu → Consumptive use of water

Peff → Usefull rainfall.

Note :- Salt concentration is usually measured by finding the electrical conductivity of water. (μmho/cm).

Classification of Irrigation water Based upon electrical conductivity :-

E.C (μmho/cm)	Classification
100 - 250	C_1 → low — Irrigation
250 - 750	C_2 → medium — Note →
750 - 2250	C_3 → High
>2250	Cu → Very high — x can not be used as irrigation H_2O.

Note : C_2 & C_3 can be applied as irrigation water if required treatment is done according to crop requirement.

(3) Proportion of Na^+ ions :- It is often expressed in terms of SAR where SAR = (Sodium Absorption Ratio)

$$SAR = \frac{[Na^+]}{\sqrt{\frac{[Ca^{2+}] + [Mg^{2+}]}{2}}}$$

, in 'emp' equivalents per million).

Classification of Irrigation water Based upon SAR Values :-

SAR Values (epm)	classification
0 – 10	S_1 → low
10 – 18	S_2 → Medium
18 – 26	S_3 → High
> 26	S_4 → Very high

Note :

The SAR Values can be reduced by adding Gypsum ($CaSo_4$) in the soil or in the Irrigation water.

(4) **Boron Concentration :**

Traces of boron (B) are found to be useful for plants growth, However, if its concentration becomes more than 0.3ppm, it may prove to be toxic to some of the plants.

Note (*)

Sodic Soils :-

(1) Sodic soils are charcterised by high concentⁿ of Na^+ ions.

(2) They are defined as consisting and exchangable Na^+ %ge greater than 15%.

(3) These occure with in arid areas. & are unstable show poor physical & chemical property, delay water infilteration & availability, therefore finally effecting plants growth.

(#)

WATER REQUIREMENTS OF CROPS (*) Imp for GATE & ES.

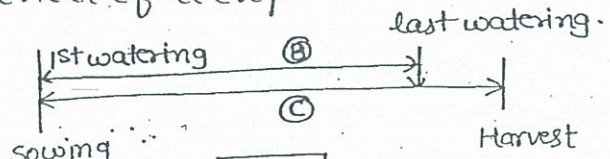
Introduction :-

The term 'water requirements of crops' means, the total quantity & the way in which a crop requires water from the time it is sown to the time it is harvested.

(1) CROP PERIOD :- The time period from the instant of sowing of a crop to the instant of its harvesting is called crop period.

(2) Base Period :-

It is the time period from the I^st watering of a crop to its last watering before Harvesting is called the base period of a crop.



C > B

C ≈ B

Note :(x) Although crop period is slightly more than the base period But for all practical purposes they are taken as equal time period, & generally expressed in 'days'.

(*) Therefore, the term like growth period, crop period, Base Period etc are one and the same thing representing base Period.