

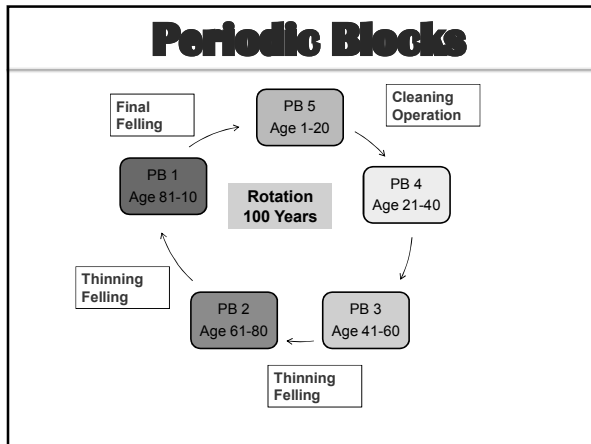
- ### Area and Volume Methods
- Permanent PB Method
    - Cotta Method
  - Revocable PB Method
  - Single PB Method
  - Floating PB Method
  - Evolution of Area and Volume Methods
  - Judeich's Stand selection method

- ### Yield Regulation
- #### Area and Volume Methods
- ❖ Estimation of final yield from areas to be regenerated
    - ❖ (Periodic Block I)
  - ❖ Area of PB I regulates the final yield to be cut in the period and yield is prescribed by volume
  - ❖ Thinning yields from younger crops are carried out over a fixed cycle meaning that thinnings can also be included in the yield

- ### Yield Regulation
- Yield Regulation in Regular Shelter wood Systems
  - Area Allotment by Period Block (PB) Method
    - Less rigid than area method
    - Coupe not demarcated on ground
    - Compartments allotted in various PBs
  - Final yield obtained from PB1 by:-
    - Area (gross or reduced)
    - Volume
    - Area and Volume

- ### Yield Regulation
- #### (A) Permanent PB method
- ❑ Annual coupes of high forest can not be regenerated annually
  - ❑ Regeneration is obtained by gradual reduction of canopy [ why]
  - ❑ Clean forest floor under a canopy is necessary to obtain natural regeneration.
  - ❑ Felling is carried out in stages
    - seeding, secondary and final [ why]

- ### Yield Regulation
- #### (A) Permanent PB method
- ✓ Permanent allocation of areas to all the PBs.
  - ✓ Adjustments and compromises to fit into a pre-conceived pattern.
  - ✓ Possible in forests where regeneration presents no difficulty.
  - ✓ Three Principles
    - One rotation for all species in Felling Series
    - Regeneration period a simple function of rotation
    - Periodic block:-
      - equal/equi-productive
      - Compact group of contiguous compartments



### Yield Regulation

(A) Permanent PB method

- ✓ No of PBs = Rotation/ Regen period  
= 120/30 (for Example)  
= 4
- ✓ Area of PB = Area of FS/No of PBs  
= 1000/4 (for Example)  
= 250
- ✓ This may be gross or reduced area

**Note: All PBs are equal in size or equi productive**

### Yield Regulation

(A) Permanent PB method

- ❖ Determining Final yield
- ❖ Cotta Method
  - > Determine standing volume of PB I = V
  - > Average annual increment (i) of the PBI growing stock for half the regeneration period (Pxi/2) also added to standing volume of PB I

### Yield Regulation

(A) Permanent PB method - Determining yield  
Volume and Increment Method

> COTTA'S FORMULA

Annual Yield = (GS at the beginning + Average increment during the period)/ period

$$Y_a = \frac{V + Pi/2}{P} \quad \text{OR} \quad Y_a = \frac{V}{P} + \frac{i}{2}$$

Where  $Y_a$  is the annual yield,  $P$  the period,  $V$  the standing volume in PB I,  $i$  the annual increment of the P.B.I

### Cotta's Method of yield Calculation

- If 35000 CMT is the standing volume in PB1, Period is 35 years, and 300 CMT is the annual increment in PB1 then according to Cotta's formula what is the annual yield?

$$\begin{aligned}
 Y_a &= \frac{V}{P} + \frac{i}{2} \\
 &= \frac{35,000}{35} + \frac{300}{2} \\
 &= 1000 + 150 \\
 &= 1150 \text{ cmt}
 \end{aligned}$$

### Yield Regulation

2. Yield Calculation

Calculate the annual yield for PBI of a stand for 1000 hectare. The volume of the stand in PBI is 15,000 CMT. Rotation is 120 years and period of regeneration is 30 years. The PBI of the stand is putting annual increment of 100 CMT

$$\begin{aligned}
 Y_a &= \frac{V + Pi/2}{P} \quad \text{Or} \quad Y_a = \frac{V}{P} + \frac{i}{2} \\
 Y_a &= \frac{15000}{30} + \frac{100}{2} \\
 &= 500 + 50 \\
 &= 550 \text{ CMT/Yr}
 \end{aligned}$$

## Yield Regulation

### 2. Yield Calculation

Calculate the annual yield for PBI of a stand for 400 hectare. The volume of the stand in PBI is 18,000 CMT. Rotation is 80 years and period of regeneration is 20 years. The PBI of the stand is putting annual increment @ 1% /year

$$Y_a = \frac{V}{P} + \frac{(V \times 0.01)}{2}$$

$$Y_a = \frac{18000}{20} + \frac{(18000 \times 0.01)}{2}$$

$$= 900 + 90$$

$$= 990 \text{ CMT/Yr}$$

## Yield Regulation

### (A) Limitation of Permanent PB Method

- Very Rigid
- Forest Crops do not respond to a pre-determined plan
- Regen does not always appear as expected
- Final feelings have to be postponed in certain areas due to poor regeneration
- Fire, insect and wind often cause unforeseen complication
- Can be used where conditions are suitable for NR

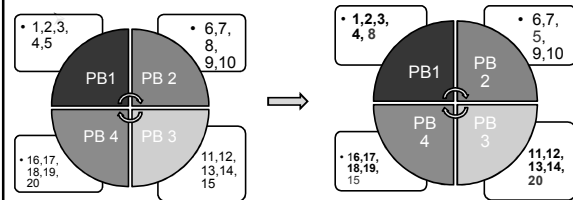
## Yield Regulation

### (B) Revocable PB Method

- Reallocation of areas to the PBs at the time of revision of working plan.
- Compartments allotted, as per average age to all PBs. May lead to fragmentation and dispersion. Compartment becomes unit of management
- PBs no longer self contained
- Only regeneration PBs are definitely allotted
- Other PBs are re-allotted at each revision as per crop conditions at that time.

## Yield Regulation

### (B) Revocable PB Method



Compartments re allotted to different PBs after WP Revision  
 Compartment is the unit of management  
 PBs not compact, may be scattered

## Yield Regulation

### (B) – Revocable PB Method

#### ❖ Allotment to Regeneration PB

- Areas where regeneration fellings have started, but not completed during the previous period.
- Areas which need to be taken up due to severe damage due to fire, storms, epidemics etc.
- Areas where the crop is mature and advance growth is already present.

## Yield Regulation

### (B) – Revocable PB Method

#### ❖ Allotment to Regeneration PB

- Areas where the crop is mature, but no advance growth present.
- Sometimes PB II areas also allotted so that some specific silvicultural operations could be carried out for preparing these for regeneration during the next period.
- PBs are not necessarily self contained.

## Yield Regulation

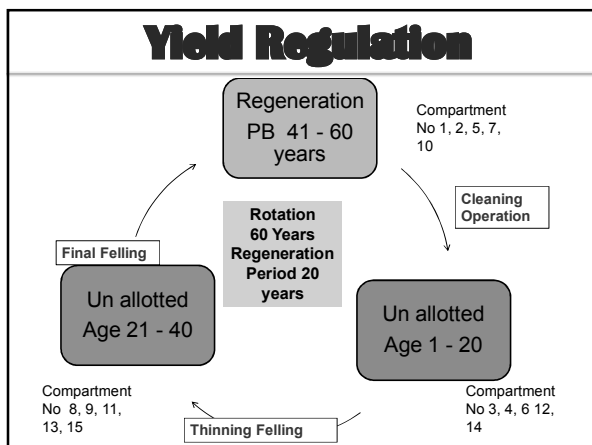
**(B) Advantages of Revocable PB Method**

- Less Rigid.
- A realistic and flexible system.
- Scattered PBs are advantageous with the view of protection where concentrated regen. is undesirable.
- Allotment to periodic blocks made in one period may be completely changed in the next period.

## Yield Regulation

**(C) – Single allotment/ PB Method**

- ❖ **Only one PB constituted**
- ❖ Areas allotted to the regeneration PB only
- ❖ Area of the regeneration PB should not be too large or small
- ❖ Regeneration period is fixed, which is equivalent to plan revision period
- ❖ Compartments in PB need not be contiguous
- ❖ Compartments re allotted to regeneration PB at revision based on crop condition
- ❖ **Final yield is calculated using Cotta's Formula**
- ❖ Intermediate yield calculated using yield table



## Yield Regulation

**II (D) Floating PB Method**

- Allotment of areas ready for regeneration in one PB.
- No Pre-Determined limit to the size of PB nor the length of the period.
- All crops which are over mature, mature or nearly so, and ready for generation or areas already under regeneration included in the PB.
- Yield is calculated by Cotta's Formula.
- Evolved in France under the name Quartier Bleu Method since FPB was coloured blue on maps. Rest of the area left uncoloured and called Quartier Blanc.

## Floating PB

			FPB
FPB			
		FPB	
FPB		FPB	

**Note:-**

1. Compartment Shown in Red are in Floating PB meant for regeneration with no fix Regeneration period.
2. Other Compartments are un allotted
3. Compartments shall be re allotted at the time of revision of PB

## Yield Regulation

**(D) Floating PB Method**

- In a normal/near normal forest areas fit for inclusion in FPB will be in correct proportion corresponding to regen. period.
- In abnormal forest a very large proportion may required to be included due to large extent of overture woods
- In abnormal forest limit the area of FPB on grounds of practical convenience

## Yield Regulation

### (D) Floating PB Method

- Advantages
  - Closely relates fellings to silvicultural needs.
  - No artificial time limit for completion of regeneration.
- Disadvantages
  - Works satisfactorily in forests having normal distribution of age classes.
  - In abnormal forests, leads to considerable diffusion of operations.

## Yield Regulation

### (D) Floating PB Method

□ Period of Regn (P):Rotation (R) :: Area of FPB: Area of FS

$$P \times FS = R \times FPB$$

□ 
$$P = R \times FPB / FS$$

□ Area of FPB = (Regn period) (Area of FS)/Rotation

□ Area of FPB ascertained by adding full (Reduced) area of compartments newly added to FPB and area of compartments already under regeneration

## Yield Regulation

### Evolution of area and volume methods

- ❖ 1. Permanent PB: Fixed self contained PBs with permanent boundaries. Fixed scattered PBs with permanent boundaries.
- ❖ 2. Revocable PB:- PB scattered or self contained with boundaries subject to revision at intervals.
- ❖ 3. Single PB:- scattered or self contained with fixed period.
- ❖ 4. Floating PB:- passing gradually over the whole forest

## Yield Regulation

### II (E) Judeich's Stand selection method

- Basis: No system of yield regulation could be accurate over a long period if not revised frequently.
- Same principal as in floating PB method.
- Treatment of crop as per its needs.
- Regulates yield for a short period, say 10 years.
- Involves careful selection and allotment of more or less proportionate area of mature stands for felling and regeneration during plan period.

## Yield Regulation

- ❖ Suitable rotation and working plan period are fixed
- ❖ Mature compartments selected for felling and regeneration for working plan period on following principals:
  - Priority for regeneration.
  - Stands which must be felled to meet the silvicultural necessities.
  - Mature and over mature stands.
  - Stands whose felling is desirable for convenience (Falls between two mature stands).

## Yield Regulation

### (E) Judeich's Stand Selection Method

- Area is calculated following Hufnagl's method
- Yield is calculated following Cotta's method

#### 1. Area Calculation

$$\text{Normal coupe for the period} = \frac{\text{Total area} \times \text{Regn period/rotation}}{FS \times P / R}$$

$$\text{Area of PB (actual coupe for the period)} = \left\{ \frac{FS \times P}{R} \right\} \times \{\text{modification factor}\}$$

$$\text{Modification factor} = \frac{\text{Actual Average age}}{\text{normal Average age}}$$

$$\text{Normal Average age} = \frac{1}{2} \text{Rotation}$$

$$\text{Actual Av. age} = \frac{\text{Summation of product of area of compt. and average age/sum of all compts.}}{\sum \text{Age class Area} \times \text{Av age of class} / \text{Total Area}}$$

### Judeich's Stand Selection Method

Calculate the area of PB if R = 80 and regen period is 20 Yrs

AGE CLASS	AREA (Ha)
1-20	400
21-40	300
41-60	700
61-80	600

### Judeich's Stand Selection Method

Calculate the area of PB if R = 80, regen period is 20 Yrs

AGE CLASS	Av Age	AREA (Ha)	Av Age X Area	Average Age
1	2	3	4= 2x3	5
1-20	10	400	4,000	$\frac{90,000}{2,000} = 45$
21-40	30	300	9,000	
41-60	50	700	35,000	
61-80	70	600	42,000	
<b>Total</b>		2,000	90,000	

### Judeich's Stand Selection Method

Actual average age =  $90,000/2000 = 45$

Area of PB =  $\{FS \times P / R\} \times \{\text{modification factor}\}$

Modification factor =  $\frac{\text{Actual Average age}}{\text{normal Average age}}$

Normal Average age =  $\frac{1}{2}$  Rotation

Area of PB =  $(2000 \times 20/80) (45/40) = 562 \text{ Ha}$

## Yield Regulation

### I (E) Judeich's Stand Selection Method

#### ❖ Advantages

- ✓ Elastic
- ✓ Working based on actual conditions of crop
- ✓ Easy to correct mistake

#### ❖ Disadvantages

- ✓ Crops may become mixed w.r.t. age class distribution
- ✓ Sustained yield may be affected if too much freedom exercised in selecting crops for felling

## Summary

1. Area and Volume Methods are used for calculating yield in forests normally under shelter wood systems
2. Various Forms of PB methods are used in ensuring regeneration and yield calculation starting from Fixed PB to Revocable PB to Single PB to Floating PB and Judeich stand selection method
3. The area for harvest varies depending upon selection of compartments under PB1
4. Yield in PB1 is calculated using Cotta's method
5. Cotta's method of yield calculation incorporates volume in Regeneration block (PB1) and increment put on the volume during regeneration periodt