

Yield Regulation

- Definition and types of Yield
- General Principles of Yield Regulation
- Silvicultural systems and yield regulation
- Basis of Yield Regulation
 - Area, Volume, Increment, Size Class
- Methods of Yield Regulation by Area:-
 - Equi-extensive Area
 - Equi Productive Area
- Summary

Yield Regulation

Definitions

- Yield

The volume or number of stems that can be removed annually or periodically, or the area over which fellings may pass annually or periodically, consistent with the attainment of objects of management.
- Yield Regulation

Determination of yield and the prescribed means of realizing it.

Yield Regulation

Types of Yield

- **Final Yield**
 - ✓ All the material derived from the main felling in a regular forest.
 - ✓ Controls the proportional distribution of age-classes.
- **Intermediate Yield**
 - ✓ All material from thinning or operations preceding the main felling in a regular forest.
 - ✓ Controls the economy by providing early returns, influences the length of rotation and controls the quality of timber.
- **Total Yield**
 - ✓ The sum of final and intermediate yields

Yield Regulation

➤ Objectives

- ✓ To know the total volume of timber that can be felled
- ✓ To fell each stand or tree at maturity
- ✓ To obtain maximum yield of the desired produce.
- ✓ To fell, approximately, the same quantity of material annually or periodically
- ✓ To limit the area to be felled so that it can be regenerated
- ✓ **Sustained yield is key objective**

Yield Regulation: General Consideration

➤ Why Cutting ?

- To obtain regeneration
 - open canopy
- To tend the crop
 - control crop composition by removing inferior crop, provide spacing for growth
- To adjust the Growing Stock
 - Overstocked
 - Understocked
- To meet the bonafide demands of the people
 - Suitable species, size, quality and quantity of wood in time and space
- To obtain income

Yield Regulation: Process

- ✓ Determine the allowable cut.
 - ✓ Yield calculation
- ✓ Allocate the cut to the entire forest.
 - ✓ Felling series
- ✓ Prepare chronological sequence of cutting operations.
 - ✓ Coupe laying (Thinning, Main Felling)
- ✓ Regulate the cut through checks.
- ✓ Evaluate the process of felling.

Silvicultural Systems in Relation to Yield Regulation

- Some methods of yield regulation imply a certain method of yield calculation.
- These methods of yield calculation are particularly applicable to certain types of silvicultural systems.
- However, yield calculation is based on certain principles.
- These principles can be applied to various silvicultural systems based on their suitability.

Silvicultural Systems in Relation to Yield Regulation

Sr.No.	System	Feature	Yield Regulation By
1	Clear Felling	Age Gradation	Area
2	Regular Shelter wood	Age Class	Area and Volume
3	Irregular Shelter wood	Age class or gradation not discernible	Volume
4	Selection	Age class	Size class

Methods of Yield Regulation

Key Objective is sustained yield

Methods of yield regulation

1. **By Area**
 - Annual coupes (Gross Area, reduced area)
2. **By Volume**
 - Von Mantel and its modifications
3. **By Area and Volume**
 - Permanent PB method
4. **By Volume and Increment**
 - Formula methods
 - **Regulate the cut through checks**
 - ✓ Actual present volume only
 - ✓ Comparison of actual and normal GS
 - ✓ Comparison of successive enumerations
5. **By Size Classes**
 - Brandis Dia Class method
 - Symthies Safe-guarding Formula

Yield Regulation: Methods

Area Method

Two ways:

- A. Equi-extensive area**
 - ❖ Annual coupes by gross area
- B. Equi-productive area**
 - ❖ Annual coupes by reduced area

Yield Regulation

By Area Method

➤ **A. Equi-extensive area:**

Area of forest/felling series is divided into annual coupes equal to No. of years in rotation and one coupe felled every year.

$$\text{Area Annual Coupe} = \frac{\text{Total Area (A)}}{\text{Rotation (R)}} = \frac{1000}{100} = 10 \text{ ha}$$

Area Method in Regular Forest

- In a regular forest, the oldest age class is harvested each year, the age-class distribution is maintained

Yield Regulation

A. Equi-extensive area:

➤ Advantages

- Simple and easy to apply
- Leads to regularity of age gradation

➤ Disadvantages

- Change in rotation will necessitate change in coupe size
- Presupposes uniformity of crop in terms of quality and density
- Felling is prescribed irrespective of crop condition

Yield Regulation

By Area Method

➤ B. Equi-productive area:

- ❖ Density and site quality vary from coupe to coupe.
- ❖ Basic aim is to work in equi-productive areas.
- ❖ Need to apply reduction factors to equalise annual yield.
- ❖ Reduction factors applied for density & quality and areas allotted to each coupe made equi-productive.
- ❖ An average site is assumed as the base or standard of comparison and all other sites then related to it.

Yield Regulation

Equi-productive area:

- ❖ **RF for quality** = MAI of QLTY to be reduced/ MAI of STD QLTY
- ❖ **RF for density** = Actual BA of forest to be reduced/ BA from yield table
- ❖ **Reduced area** = (Gross area) X (RF for quality) X (RF for Density)

Yield Regulation

B. Equi-productive area:

➤ Advantages

- Takes care of site quality and site density
- Ensures supply of desired quantity of timber

➤ Disadvantages

- Cumbersome
- Incorporation of site quality and density is tedious
- Fixation of coupe boundaries difficult

Yield Regulation

❖ Advantages of Area Method

- Simple and easy
- It is direct
- Leads to regularity of age gradations
- A regular forest can be achieved in a rotation

Yield Regulation

❖ Disadvantages of Area Method

- Rigid every change in rotation will necessitate re-division of coupes.
- Prescribes felling without consideration of the crop condition.
- Irregular volume flow if coupes equi-extensive.
- Difficult to lay out coupes of equi-productive area in unmanaged forest.

Yield Regulation			
Examples			
Find the area of the annual coupe by reduced area for site quality II, if the rotation is 20 years			
Sl No	Quality Class	Area (ha)	MAI (cum/ha)
1	I	300	9.38
2	II	500	6.79
3	III	200	4.2

Yield Regulation							
Examples							
Area of the annual coupe by red. area and actual size of coupe (quality), if the rotation is 20 years							
Quality Class	Area (ha)	MAI (cum/ha)	RF	Red Area (2x4)	Annual Coupe by reduced area (ha)	Actual size of annual coupe (ha) (6/4)	Year of felling (2/7)
1	2	3	4	5	6	7	8
I	300	9.38					
II	500	6.79					
III	200	4.2					
Total	1000						

Yield Regulation							
Examples							
Area of the annual coupe by red area and actual size of coupe (quality), if the rotation is 20 years							
Quality Class	Area (ha)	MAI (cum/ha)	RF	Red Area (2x4)	Annual Coupe by reduced area (ha)	Actual size of annual coupe (ha) (6/4)	Year of felling (2/7)
1	2	3	4	5	6	7	8
I	300	9.38	1.38				
II	500	6.79	1				
III	200	4.2	0.62				
TOTAL	1000						

Yield Regulation							
Examples							
Area of the annual coupe by red area and actual size of coupe (quality), if the rotation is 20 years							
Quality Class	Area (ha)	MAI (cum/ha)	RF	Red Area (2x4)	Annual Coupe by reduced area (ha)	Actual size of annual coupe (ha) (6/4)	Year of felling (2/7)
1	2	3	4	5	6	7	8
I	300	9.38	1.38	414			
II	500	6.79	1	500			
III	200	4.2	0.62	124			
TOTAL	1000			1038			

Yield Regulation							
Examples							
Area of the annual coupe by red area and actual size of coupe (quality), if the rotation is 20 years							
Quality Class	Area (ha)	MAI (cum/ha)	RF	Red Area (2x4)	Annual Coupe by reduced area (ha)	Actual size of annual coupe (ha) (6/4)	Year of felling (2/7)
1	2	3	4	5	6	7	8
I	300	9.38	1.38	414			
II	500	6.79	1	500	51.9 Or 52		
III	200	4.2	0.62	124			
TOTAL	1000			1038			

Yield Regulation							
Examples							
Area of the annual coupe by red area and actual size of coupe (quality), if the rotation is 20 years							
Quality Class	Area (ha)	MAI (cum/ha)	RF	Red Area (2x4)	Annual Coupe by reduced area (ha) RA/r	Actual size of annual coupe (ha) (6/4)	Year of felling (2/7)
1	2	3	4	5	6	7	8
I	300	9.38	1.38	414			
II	500	6.79	1	500	51.9 Or 52	37.6 (8)	
III	200	4.2	0.62	124		52 (10)	
TOTAL	1000			1038		83.8 (2)	
						988.4	

Yield Regulation							
Examples							
Area of the annual coupe by red area and actual size of coupe (quality), if the rotation is 20 years							
Quality Class	Area (ha)	MAI (cum/ha)	RF	Red Area (2x4)	Annual Coupe by reduced area (ha)	Actual size of annual coupe (ha) (6/4)	Year of felling (2/7)
1	2	3	4	5	6	7	8
I	300	9.38	1.38	414	51.9 Or 52	37.6 (8)	1-8 yrs
II	500	6.79	1	500		52 (10)	9-18 yrs
III	200	4.2	0.62	124		83.8 (2)	19-20 yrs
TOTAL	1000			1038		988.4	20

Yield Regulation		
Examples		
Find the area of the annual coupe by reduced area & actual size of coupe for 0.5 density, if the rotation is 25 years		
Sl. No.	Crop Density	Area (ha)
1	1	300
2	0.75	200
3	0.50	400
4	0.25	100

0.50 Standard Density

Yield Regulation						
Examples						
Area of the annual coupe by red area and actual size of coupe (density), if the rotation is 25 years						
Crop Density	Area (ha)	RF	Red Area (2x3)	Annual Coupe by Reduced Area (ha)	Actual size of annual coupe (ha) (5/3)	Year of felling
1	2	3	4	5	6	7
1	300	1/0.5=2.0				
0.75	200	0.75/0.50=1.5				
0.50	400	0.5/0.5=1				
0.25	100	0.25/0.50=0.5				
TOTAL	1000					

Yield Regulation						
Examples						
Area of the annual coupe by red area and actual size of coupe (density), if the rotation is 25 years						
Crop Density	Area (ha)	RF	Red Area (2x3)	Annual Coupe by Reduced Area (ha)	Actual size of annual coupe (ha) (5/3)	Year of felling
1	2	3	4	5	6	7
1	300	1/0.5=2.0	600			
0.75	200	0.75/0.50=1.5	300			
0.50	400	0.5/0.5=1	400			
0.25	100	0.25/0.50=0.5	50			
TOTAL	1000		1350			

Yield Regulation						
Examples						
Area of the annual coupe by red area and actual size of coupe (density), if the rotation is 25 years						
Crop Density	Area (ha)	RF	Red Area (2x3)	Annual Coupe by Reduced Area (ha)	Actual size of annual coupe (ha) (5/3)	Year of felling
1	2	3	4	5	6	7
1	300	1/0.5=2.0	600	1350/25=54		
0.75	200	0.75/0.50=1.5	300	54		
0.50	400	0.5/0.5=1	400	54		
0.25	100	0.25/0.50=0.5	50	54		
TOTAL	1000		1350			

Yield Regulation						
Examples						
Area of the annual coupe by red area and actual size of coupe (density), if the rotation is 25 years						
Crop Density	Area (ha)	RF	Red Area (2x3)	Annual Coupe by Reduced Area (ha)	Actual size of annual coupe (ha) (5/3)	Year of felling
1	2	3	4	5	6	7
1	300	1/0.5=2.0	600	1350/25=54	54/2=27	
0.75	200	0.75/0.50=1.5	300	54	54/1.5=36	
0.50	400	0.5/0.5=1	400	54	54/1=54	
0.25	100	0.25/0.50=0.5	50	54	54/0.5=108	
TOTAL	1000		1350		999	

Yield Regulation

Examples

Area of the annual coupe by red area and actual size of coupe (density), if the rotation is 25 years

Crop Density	Area (ha)	RF	Red Area (2x3)	Annual Coupe by Reduced Area (ha)	Actual size of annual coupe (ha) (5/3)	Year of felling = (2/6)
1	2	3	4	5	6	7
1	300	1/0.5=2.0	600	1350/25=54	54/2=27	1-11 yrs
0.75	200	0.75/0.50=1.5	300	54	54/1.5=36	12-17yrs
0.50	400	0.5/0.5=1	400	54	54/1=54	18-24yrs
0.25	100	0.25/0.50=0.5	50	54	54/0.5=108	25 th yr
TOTAL	1000		1350		999	

Yield Regulation

Hufnagl's Variation

➤ **Regulation by Area**

➤ Area of Each PB = $\frac{\text{Total Area} \times \text{Regn Period}}{\text{Rotation}}$

$= \frac{A \times P}{R}$

Hufnagl Modification = $\frac{A \times P}{R} \times \frac{\text{Average Age}}{\frac{1}{2} \text{ Rotation}}$

Yield Regulation

Find the Average Age of a 1000 ha stand, with 80 year Rotation, Regeneration Period is 20 years with following age classes

Age Class	Average Age	Area	Av Age x Area	Av Age
1-20	10	200	2000	45000/1000
21-40	30	150	4500	
41-60	50	350	17500	
61-80	70	300	21000	
		1000	45000	45

Normal Average Age = Rotation / 2 = 80/2 = 40 years

Yield Regulation

Hufnagl's Variation

➤ **Regulation by Area**

➤ Area of Each PB = $\frac{\text{Total Area} \times \text{Regn Period}}{\text{Rotation}}$

$= \frac{A \times P}{R}$

$\frac{1000 \times 20}{80} = 250 \text{ ha}$

Hufnagl Modification = $\frac{A \times P}{R} \times \frac{\text{Average Age}}{\frac{1}{2} \text{ Rotation}}$

$= 250 \times \frac{45}{40} = 281 \text{ ha}$

Yield Regulation

➤ **Advantage and use of Hufnagl Method**

- If there is excess of higher age class, average actual age shall be higher than normal average age and the size of coupe shall be larger than normal
- If there is excess of young age class, average actual age shall be lower than normal average age and the size of coupe shall be smaller than normal
- This modification is applied in area under shelter wood systems of longer rotation than shorter rotations

Area and volume methods...