THE RELASCOPE AND ITS USE IN FOREST INVENTORY WORK

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Introduction

Growing stock of a particular forest which is expressed in cubic meter (m^3) or cubic feet (cft) on unit area basis is one of the most important parameters determined from forest inventories. In Europe the growing stock was estimated with the help of one of the following methods till 40 years back (6).

(i)   volume estimation with the help of yield tables.

(ii)   Full enumeration of stands (subcompartments).

(iii)   fixed plot sampling (full enumeration of circles with different areas and then making projections for the whole area).

About 40 years ago BITTERLICH develop technique known as Angle Count Sampling (ACS) for measuring the *basal area per hectare* of a forest with the following characteristics(3).

(i)   deliniation of sample plots is not necessary.

(ii)   basal area per hectare is determined through simple counting of those trees whose breast height diameters (cross section) exceed a critical angle.

(iii)   only one man is required for this counting work.

This technique is also known by different names like variable plot sampling, horizontal point sampling or plotless cruising (7).

This technique has been used for assessment of growing stock in Pakistan (1,2) in the past using prisms of different basal area factors.

Instruments can be used for this purpose e.g. blades, prisms and relascopes. Such an instrument has to project a horizontal angle of arbitrary size. All those trees visible from a sample point are counted whose diameters appear bigger than a certain projected angle. In this way each counted tree represents the same basal area per hectare regardless of its diameter. Blades and prisms give satisfactory results in plain area as these do not have self adjustment system for slopes. Correction for slope for selection of each tree is quite time consuming and prone to error using above instruments. The relascope was developed to overcome these difficulties.

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Uses of relascope

The instrument has multiple uses beside the self adjustment for slope. Measurements which are important for inventory work can all be taken by relascope and are described below:

(a)   *Basal area determination:*

Different scale arrangements (Metric standard, Wide scale, Metric CP or American scale) provide various basal area factors which are expressed either in square meter per hectare or in square feet per acre. According to a particular basal area factor used one is able to select the sample trees in a horizontal point sampling. Count such trees and determine immediately the basal area per hectare of the stand.

(b)   *Horizontal distance measurement:*

Under different degrees of inclination the direct measurement of horizontal distances is possible, because of the automatic slope correction. Alternatively a horizontal or vertical staff target can be used. This type of optical measurement is very helpful during inventory work, especially for measuring horizontal distances between sample plots or in determining horizontal distances for tree height measurements.

(c)   *Tree-height measurement:*

The height of trees can be measured directly in distances of 20, 25 and 30 m from the tree, using tangent scales of the relascope. Additionally with the help of a correction formula it is possible to use any desired distance from a tree to measure the height.

(d)   *Determination of upper stem diameters:*

Based on geometrical principles of optical relascope measurements the size of upper stem diameters can be determined using different scales (white and black strips). This is helpful in obtaining data about the stem form for accurate volume calculations (e.g. volume tables.)

(e)   *Use of relascope as clinometer:*

Though some of the relascopes have no separate slope percentage scale for measurements of inclination, one can use the tangent scales (20, 25, 30m) for this purpose.

For proper use of relascope and its correct application for taking measurements a guide-line is always provided by the manufacturers(4). A field instruction manual for the use of this instrument for the sampling inventory of the Institute Forest has been developed(5).

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The efficiency of horizontal point sampling using relascope

Before starting a forest sampling inventory, the question concerning the sampling technique has to be answered. Of different alternatives only that technique should be selected which gives a certain desired precision with less cost.

Application of the horizontal point sampling and use of relascope has the following advantages in comparison to fixed plot sampling (8, 9).

(a)   Demarcation of sample plot boundary is not necessary.

(b)   Sample trees are selected proportional to their basal area therefore large sized trees become more often sample trees.

(c)   Total basal area per hectare is obtained without diameter measurements of individual trees.

(d)   Using Bitterlich's relascope with its automatic slope-correction no time is wasted for correction procedures during layout of plots.

(e)   Beside the angle count method the relascope can be used for the measurements of height, upper stem diameter, horizontal distance and slope.

(f)   Without the check of border line trees a single person can carryout a rough horizontal point sampling in reconnaissance inventories.

In a larger scale efficiency test of the US Forest Service horizontal point (K=2.30 m^2/ha) and fixed plot (0.10 ha) sampling have been carried out on 655 sampling plots in Texas (8,9). The results show no significant differences in the total volume estimation. Coefficient of variation for ACS was 96% and for fixed plots it was 82%. To obtain the same standard error (volume) ACS sampling required 20% more plots. In spite of these additional plots the total data recording period was much shorter than for fixed plot sampling. Similarly experiences for Canada showing that 2.3–3.1 more ACS (K=10 square feet/acre) plots are required than fixed plots (area = 0.2 acre) to obtain the same standard error in basal area determination. However the time required for data collection with ACS sampling is only 30–50% as compared to the fixed plot sampling (8, 9).

A comparison of ACS and fixed plot sampling was carried out in the Chir pine region of the Institute Forest in Shinkiari in N.W.F.P. 10 plots with horizontal point sampling with K = 4 m^2/ha and K = 9 m^2/ha as well as 10 plots with a fixed area of 200 m^2 and 500 m^2 were measured with the same plot centre.

Table 1 below shows the mean values, standard deviations and coefficient of variations (CV%) of the basal area and volume as well as the number of sample trees measured per plot is given. Coefficient of variation for volume estimates are 56% for ACS with K = 4 m^2/ha and 57% for fixed plot of 500 m^2.

Table 1: Mean values, standard deviations and coefficient of variations for different ACS and fixed area plots.

Plots	ACS		Fixed area Plot circles	
	K = 4 m²/ha	K = 9 m²/ha	200 m²	500 m²
Number of plots	10	10	10	10

Basal area m²/hectare

Average $\overline{X}$	19.6	14.4	20.0	19.8
Standard deviation sd	12.3	10.8	14.8	12.2
Coefficient of variation CV%	63	74	74	62

Volume m³/ha

$\overline{X}$	176.3	126.2	178.5	174.0
sd	98.3	95.8	129.3	99.1
CV%	56	76	72	57

Number of trees/plots

$\overline{X}$	4.9	3.6	3.5	8.2
maximum	11	4	9	23
minimum	1	0		1

The study showed that time consumed on layout of one plot with ACS (4 m²/ha) was about 30 minutes for selection of sample trees and measurement of all diameters and heights. On the other hand time spent on layout of a fixed area plot of 500 m² was 1 hour and 5 minutes for the same measurements due to a higher number of trees in the plot.

Recommendation

Considering the advantages of ACS in combination with "Spiegel Relascope" the introduction of the instrument in combination with ACS for forest inventories of Pakistan can be recommended to reduce the field work and expenditure to a higher degree and to obtain accuracy of a desired standard.

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