

Assessment of Volume Renewal of Beech Species by the Method of 3p

M.M. E-Fallahchai, S. Armin Hashemi and Reza Rashidi

Department of Forestry, Lahijan Branch, Islamic Azad University, Lahijan, Iran

Abstract: The purpose of this study is comparison of volume renewal, way a hundred percent with sampling way by 3p. In order to reduce the field work and to accelerate the outputs of forest products the one hundred percent volume renewal in north forests were replaced by the volume renewal that used 3p sampling method during 2001-2002, which its field operations are accomplished by industrial and fire wood trunks volume measurement and the obtained results are generalized to all trees of the same annual cutting license. In order to assess and to compare the, method of 3P with one Hundred percent volume renewal as many as 248 trees with a volume of 930.9 m³ of the marked trees of beech species of series 9 from Galandroud project were carried out for one hundred percent volume renewal, which its industrial trunks with diameter above 20 cm were equal to 749.28 m³. The obtained results from various sampling by method of 3P among these trees indicates tat its difference in relation to the one hundred percent volume renewal was variable from at least 0.02% up to maximum 7.32%, which in 11.11% of the cases the difference was less than 1% , and in 88.89% of the cases, the difference was less than 4%. In the method of one hundred percent volume renewal in relation to the method of 3P, in terms of the numbers of working days, there was about 30% savings, and in terms of the expenses of the execution there was about 154% savings. With observing the technical points and necessary care in measuring the trees while marking them and also observing the proper principles of cutting sample trees and other marked trees and care in measuring of sample trees, there will be much effect in increasing or reducing of volume in relation to the coefficient designated.

Key words: Assessment, beech, 3P, forest, volume renewal, stand

INTRODUCTION

After the ratification of forests and pastures in nationalization in 1961, the forests of the country with possession of the forest land as production element in forest was taken under state ownership, and economic favor resulting from the share of landing gross income obtained from all kinds of productions of marked trees sales called the land lord's share belonged to the government (Mohajer, 2005; Zobiri, 2000). The Before for calculation of rial (monetary unit of Iran) value of landlord's share of the forest management planning to the coefficients of landlord' share of industrial trunks in percent T and firewood in aster (rials), and to the a verge price of the industrial tree trunks and the volume of industrial trunks and firewood, three would be a need for each cutting License. By considering the fact that different parts of stems do not have equally economic and commercial values, according to the amendment 10 of articles 15 and 16 of the conservation and exploitation law, the marked trees after cutting are measured again by experts and observers, and after species separation the volume of the industrial trunks and the whole volume of fire wood of each cutting license is assessed (Bickford *et al.*, 1963; Beers, 1977).

Three fore, for calculation of the rate of the landlord's share , volume renewal of the marked trees is

necessary , and from the beginning of the execution of forest management planning up to the year 2000, the volume renewal of the cutting permits is surd by the experts and observers with field operations and by hundred percent inventory was carried out , and by expansion of the level of forests under the coverage of forest management planning and the increasing of the timber harvesting rate , the number of the trees under volume renewal was increased (Scott and Kohl, 1994). So, for prevention of increase - sing of the expenses and waste of time and in the year of the industrial timber in relation 1982, in which the volume of the industrial timber in relation with the standing timber was calculated (Kangas, 1994). But because of the lack of adjustment of the volume of the timbers produced with the assessed volume, this method was canceled after five years. Until in the year 2000, the organization of forests after all-out investigations in order to reduce the time of volume renewal and acceleration of the exploitation operations and for the preservation of the benefits of the government , precision , safety of work, the 3p sampling replaced by the hundred percent inventory (Van Deusen, 1989)

This method which is a statistic cal method is presently carried out in the series that the numbers of marked trees in them are over 450 trees .sampling by the method of (three - p sampling) which is taken from the first letters of three words starting with p, that is,

probability, Proportional and prediction, is a statistical method which proposed by grosenbaugh in America in the year of 1950. The 3p sampling of trees with the probability of their selection in relation to or proportional with the predicted a mount char acrostic of the statistical case of using this method, which at first the trees are marked for sales, and in order to assess precisely the standing timber, which also can be aided by the table of the local volume, some of the trees are chosen and their volumes are measured precisely, and from the relation of precise volume to assessed volume or from relation between the assessed volume and the precise volume of the trees chosen, the volume of the other trees are assessed more precisely (Gregoire, 1998; Schreuder and Wood, 1986). In this method, the selection of the trees is in relation to their importance, that is the trees which their diameter at breast height or their volume are over assessed, or on the basis of volume table, having more volume, will have more chance for selection.

3P sampling can be used out of the list prelate to the wood, for example timber used this method in assessing of the logs of the trees, investigated the use of it in wildlife and also its management (Gregoire and Valentine, 1999). A lot of tests of 3p sampling have been offered, which some of them have used of the scientific background and also some of them have used of the computer simulation. The investigation of these reports explained this fact that the emergence of 3p sampling will result in significant differences in the opinions which in itself has caused a negative effect on acceptance of this method on the other people (Grosenbaugh, 1952). Although in the last eight years, the volume renewal by 3p sampling has replaced by the hundred percent volume renewal in the north forests of the country, but in this respect, with attention to the conditions of the forests in Iran (being mountainous of the natural stand and the kind of species), and also being new of the issue, the first research has been about issue of the assessment of volume renewal by the method of 3p sampling (case study of the species of beech in the production series of district 4 of neka zalemrood). The subject of this study is aimed at accelerating in exploitation activities and going out forest products, saving in time and decreasing expenses and increasing incomes in forest areas.

MATERIALS AND MTHEODS

The study was carried out at autumn 2009 in Mazandaran Proviance, of north of Iran.

Study area: This region is covered by deciduous broadleaf forests, grasslands, shrubs, cultivation. The mean annual precipitation in deciduous broadleaf forests is 1139 mm/year.

Material: In order to do this research as many as 117 trees with attention to the 3p sampling out of 487 trees in plot 10 of the forest management planning of galandrood district located in the west of Mazandaran province with an area of over 75 ha were chosen and cut. The maximum altitude of this area is about 1900 m above sea level and the minimum altitude is about 1981 m above sea level, with an average slope of 30-60% and general direction in northeast and southeast, and the kind of bedrock is sand stone in northeast and southeast, and the of bedrock is sandstone in northeast and southeast, and the kind of bedrock is sand stone and of humus is moul, and the rooting depth of the average to good trees is about 75-90 cm. The above mentioned forest community was rather thick, (diameter levels of 35-100 cm) which was covered by beech and horn beam, and among them the species of *acer cappadocicum*, alder, ash tree, basswood and oak were notable.

Therefore after cutting of the marked trees and on the basis of the guideline of 3p sampling, the volume of trunks and branches having diameter more 20 cm which were suitable to be changed into catin in and mine timber were measured precisely, so that the measuring of mid diameter of each log (maximum 4 m) up to diameter 20 cm in terms of centimeter in diameter level of two centimeters with a calipers and the length of the industrial log in terms of decimeter with meter were measured. The length of each log and its mid diameter were marked with color in order not to interfere with the measuring of the other logs. So in the volume renewal of the industrial trunks, the mid diameter less than 20 cm was also separated. Therefore for measuring of the precise volume, the industrial trunks with diameter of 12 to 18 cm were also measured.

Then in the second phase of the cutting after analysis of data with the use of the statistical axle software and the determine nation of the industrial coefficient in separation of species and generalizing it to the whole of the trees for obtaining a real volume and the assessment of the performance (sampling by the method of 3p), the whole of the beech trees which were cut, were again measured precisely by the above mentioned method, so that from 284 existing beech trees out of 487 trees from all kinds of species which were cut in the 3p sampling, only beech trees were chosen as exemplary trees: for more assurance in the use of this method, the sampling was repeated by the use of random numbers tables g in times (the reason for the repeating 9 times is that after repeating 9 times, the samples were chosen repeatedly), and each I me, random numbers were calculate the by the method of 3p sampling and the samples were chosen and the difference between the total of the industrial timber was calculated by the method of the industrial timer was calculated by the method of hundred percent inventory and 3p sampling.

RESULTS AND DISCUSSION

In order to preserve the quantities and qualitative values of cut trees and transforming them into all sorts of wood productions in least possible time the easiness in departure the cut trees is very important thus finding a solution in order to reduce the phases of the exploitation (cutting, preparation, changing and transportation) in forest management planning has always been the center of attention for authorities Right now the most important matters are the execution of the exploitation operations, volume renewal of cut trees and obtaining all kinds of products, issuing transpiration License and inspection of firewood and charcoal stocks for calculation of landlord's share and charges, fulfillment of the order of quantities and qualities supervision, control of the protection issues and prevention of emergence of illegal trafficking of timber, all are important matters at the considering the harvest of one million cubic meter in one year in the forest management planning in the north of the country, and also considering the potential and capacity of the existing expertise in the quadruple general office of the natural resources in the north of country, volume renewal of such trees would last on more than usual , in that case the following negative effects such as remaining of the cut trees in the forest area for a long time, reduction of the quantitative and qualities values of the cuttings. due to the Cracks, fungus and insects attacks, failure and delay in harvesting and transportation of the wood products and timely execution of the other side obligations, wasting the time f the technical personnel and machinery and equipments, and finally increase of the execution expense and reduction of the incomes of the management planning, and lack of the timely supplying of wood needs of the related industrials will be their outcomes.

Therefore adoption of suitable technical and scientific working procedures for accelerating in volume renewal of trees in order to prevent from the negative outcomes at this juncture is an important order.

The obtained results from the 3p sampling in the forest under operation and comparison it with the hundred percent volume renewal of industrial trunks having diameter of above 20 cm in beech species (*Fagus Orientalis*) with a volume of 794.28 m³ implied that with the execution of 9 times sampling out of 248 marked beech trees, the percent of the error of the calculation ranged from at least 0.020% up to the maximum 7.32%, so that in 11.11% of the cases, the difference was less than 1% and in 88.89% of the cases , the difference was less than 4%. In the study, in the comparison of 3p sampling with hundred percent volume renewal, as many as ss1 trees with a volume of 2946.6 m³ of marked beech trees were carried out for the hundred percent volume renewal, which the results obtained from the various

Table 1: The difference between the total amounts of industrial timber measured by the method of hundred percent inventory and 3p sampling

Sampling rank	Marked volume (m ³)	Industrial volume (m ³)	Error (%)
1	442/07	369/79	-2/12
2	436/04	372/93	-2/62
3	396/5	339/35	-2/78
4	443/88	380/06	-2/21
5	447/08	375/16	-3/30
6	410/38	351/20	-0/02
7	456/11	319/65	-1/28
8	410/19	333/05	-2/18
9	415/56	340/35	-7/32

Table 2: Implies that in 11.11% OF cases, the difference is less than 1%, and in 88.89% of cases, the difference is also less than 4%

Absoluter error (%)	Replication	Frequency	Cumulative frequency (%)
0-1	1	11/11	11/11
1-2	1	11/11	22/22
2-3	5	55/56	77/78
3-4	1	11/11	88/89
4-5	0	0	88/89
5-6	0	0	88/89
6-7	0	0	88/89
7-8	1	11/11	100

The comparison of the frequency of the numbers and volume in marked trees qualitatively

sampling by 3p method implied that its deference in relation to the hundred percent volume renewal ranged from at least 0.8% up to the maximum 5.3%, which in the 89% of the cases , the difference was less than 5%. There was a sampling which was carried out by forest organization, which its difference in relation to the hundred percent volume renewal was 5.4%. Table 1 shows the results of these calculations, so that the minimum difference is 0.02% and the maximum difference is 7.32%. The Table 1 show that the difference between total amount of industrial wood estimated in hundred percent method and 3p method has been shown. The Table 2 and Fig. 2 shows that that the differences of both methods in 11.11% cases is lesser than one percent and 88.89%, this difference is lesser than four percent. The Table 3 and Fig. 3 shows that 16.72% volume of marked trees are qualitatively intact and remaining have results that the percentage of each is presented in Table 3. The Table 4 and Fig. 4 shows that according to the marked index of volume, marked Beech trees with diameter more than 20 cm is equal to 930.95 m³ and the volume of its unmarked trees is 2.3 m³. The Fig. 1 shows that the number of marked trees in diameter level less than 50 cm is relatively high and the number of selected trees sample of it, is less. Figure 5 also has been modeled at the basis of the data from forth column of Table 2, In other words the column of cumulative frequency. the comparison of volume frequency of marked and sample trees , so that is seen that the most marked volume was related to diameters more than 50 cm in it sample trees have been also selected with good proportion (Fig. 6).

Table 3: Number and volume of the marked trees on the basis of quality

Condition of the marked trees	Number	Number (%)	marked volume	Marked volume (%)
Healthy	27	10/89	155/62	16/72
Broken (Broken from the end , middle and bottom)	11	4/44	28/85	3/10
Uprooted	20	8/06	52/75	5/67
Two branched (above the height of 1.20 cm) and multi branched	49	19/76	139/21	14/95
Lobed including bottom lobed	68	27/42	365/7	39/28
Standing dried and top dried	9	3/63	15/16	1/63
Infested and having fungus	5	2/02	32/79	3/52
Deformed , having a shape like a fork	59	23/79	140/87	15/13
Total	248	100%	930/95	100%

Table 4: Number of the marked trees in the plot 10 in series 9 of galandrood forest management planning

Row	Name of species	Numbers trees		Unnumbered trees		Total number	Total volume
		Number	Volume	Number	Volume		
1	Beech	248	930/95	23	2/3	271	933/25
2	Hornbeam	116	261/97	71	2/76	187	264/73
3	Alder	39	146/05	-	-	39	146/05
4	Oak	51	357/26	18	1.8	69	359/06
5	Maple	25	150/57	-	-	25	150/57
6	Elm	1	1/52	-	-	1	1/52
7	Ash tree	1	5/33	-	-	1	5/33
8	Mountain ash	5	4/17	-	-	5	4/17
9	Wild cherries	1	1/42	1	0/12	2	1/54
	Total	487	1859/24	113	6/98	600	1866/22

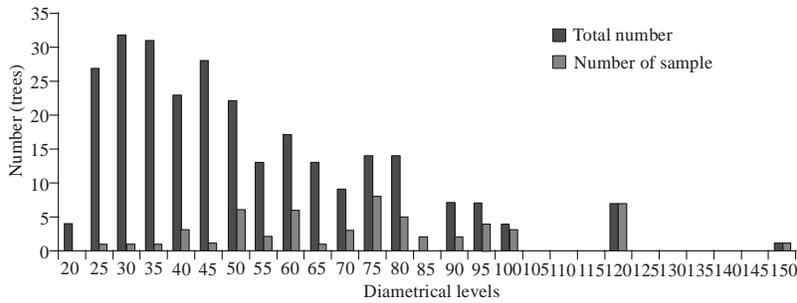


Fig. 1: The charting diametrical levels by the method of 3p

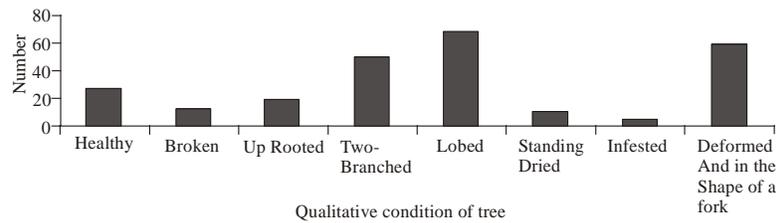


Fig. 2: The chart of the number of the marked trees on the basis of quality

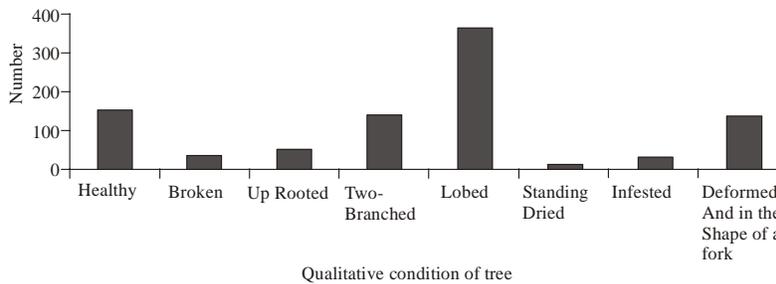


Fig. 3: The chart of the volume of the marked trees on the basis of quality

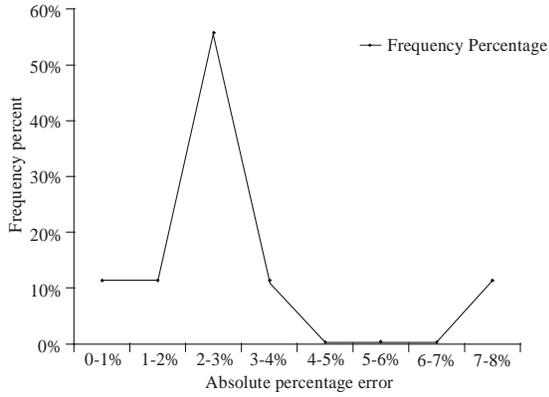


Fig. 4: The chart of the frequency percentage (the percentage of difference of the amount of industrial timber in both methods of hundred percentage inventory and 3p sampling)

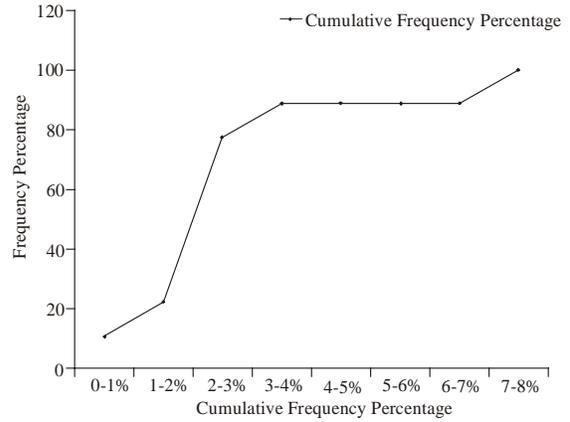


Fig. 5: The chart of the cumulative frequency percentage (the percentage of difference of the difference of the amount of the industrial timber in both methods of hundred percent inventory and 3p sampling)

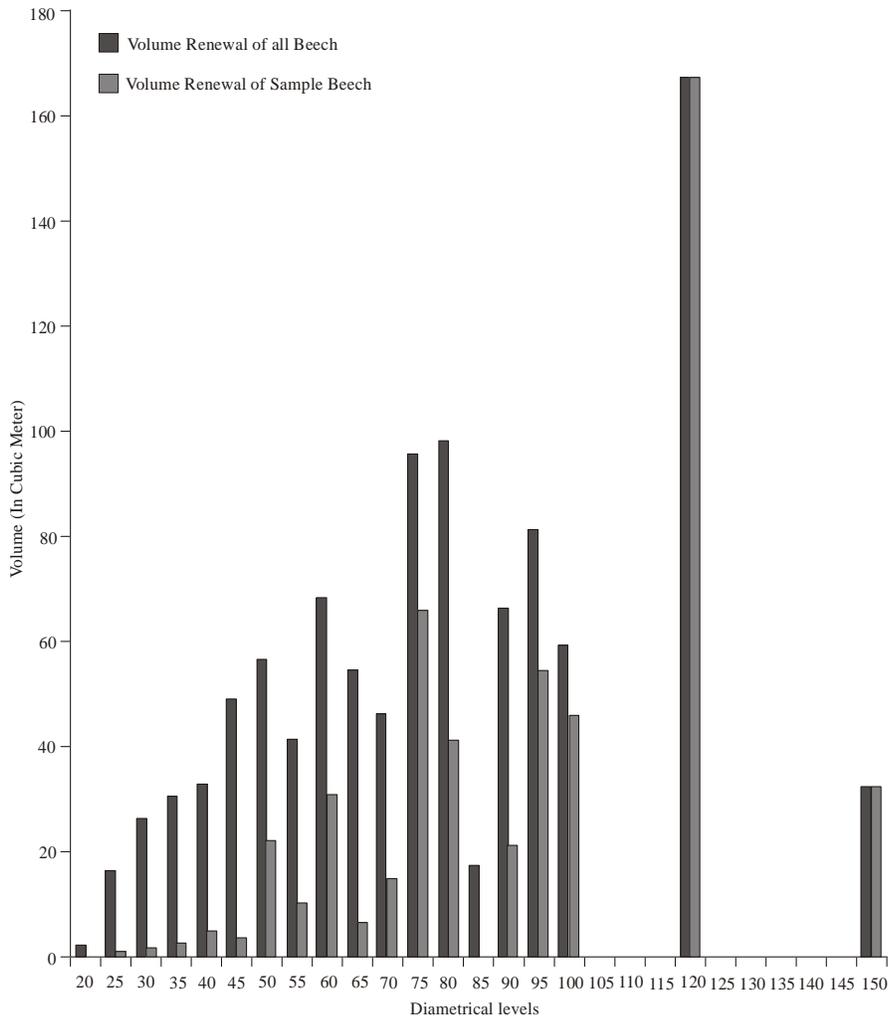


Fig. 6: The chart of the volume renewal of all market beech trees with selective samples

CONCLUSION

Perhaps these obtained results in this present study in the Galanrood district were because of this fact that there was a diametrical difference between trees and the slope of the district. The selection of the trees by the 3p sampling is in relation to their importance, that is, the trees which are thicker or having more volume, will have more chance for being selected, so that the number of the selective sample of the beech trees by the general office were 117 trees which were selected mostly from the diametrical class of above 5 cm, though a lot of marked trees in the diametrical class were below 50 centimeters, but these number of trees contained a little volume, and the main volume of the diametrical class above 50 centimeters so that trees with diameter above 100 cm as many as the existing numbers in the sampling were totally selected with the changing of the method of the silviculture from the shelter wood system to mono selection and the expansion of the area of the harvest site besides with reduction of the harvest volume those trees with no results in the future should have to be cut and even though in the plot under study, there were prediction for mono selection and corrective cutting, the healthy trees which were harvested on the basis of forest logy in terms of the number and volume were 10.89 and 16.72%, respectively, and the others were deformed, dried, hollow, which should have to be harvested, and on the basis of the industrial coefficient which was determined 89%, we obtained the industrial volume equivalent to 825.55 m³, which after the measuring of hundred percent inventory, the rest of the existing beech trees (193 trees) of industrial volume calculation was assessed equal to 402.74 m³, which by calculation of industrial volume by the method of 3p sampling was determined equal to 749.28 m³, and from the total of 487 marked trees, as many as 9 trees were not suitable for industrial timber (above diameter 20 cm). With this present question to the effect that whether this 3p sampling after eight years of execution in the north forest of the country faced mostly with reduction or increase of volume in relation to the determined coefficient or not, and also was protested by some of the executives of the plans, and some of the experts which were observing the forest management planning (Newton *et al.*, 1974). the question is that can we use this method in north forest of the country in spite of various natural sites and variety of species in the producing and renewing forest, and the answer is that with attention to the present study and with carried out investigations and executions and clearing up the site under the study from the cut wood (beech species), we have had a deficit as much as 79.26 m³ of industrial timber above 20 cm. Of course since the conditions of natural sites and location of the area have been suitable, we can admit that this method with little calculation error is answerable, and meanwhile

it is suggested that after a period of re-exploitation, this 3p sampling will be very highly answerable, of course some studies must be carried out for the districts of the lower and median strips. so in the site that there is a prediction for hygienic and corrective cuttings and mostly the deformed trees should be harvested, there will be naturally a great effect on the calculating error, volume renewal by use of 3p sampling, which these field operations were determined in a frame work of guidelines, and by measuring of volume of industrial and firewood trunks, a number of the trees having an annually cutting permits for each of them will carry out and the obtained results will generalize to all of the trees of the same cutting permits, which in comparison with the hundred percent volume renewal will be more precisely.

ACKNOWLEDGMENT

In this manner, the others appreciate from the directors of forests and pastures organizations of Iran that have provided the background of this study.

REFERENCES

- Beers, T.W., 1977. Practical correction of boundary overlap. *South. J. Appl. For.*, 1: 16-18.
- Bickford, C.A., C.E. Mayer and K.D. Ware, 1963. An efficient sampling design for forest inventory: the northeastern forest resurvey. *J. Forest.*, 61: 826-883.
- Gregoire, T.G., 1998. Design-based and model-based inference in survey sampling: Appreciating the difference. *Can. J. Forest Res.*, 28: 1429-1447.
- Gregoire, T.G. and H.T. Valentine, 1999. Composite and calibration estimation following 3P sampling. *Forest Sci.*, 45: 179-185.
- Grosenbaugh, L.R., 1952. Plotless timber estimates - new, fast, easy. *J. Forest.*, 50: 32-37.
- Kangas, A., 1994. Classical and model based estimators for forest inventory. *Silva Fennica.*, 28: 3-14.
- Mohajer, M., 2005. *Silviculture and Growing of Forest*. 2nd Edn., Tehran university Publication, Tehran.
- Newton, C.M., T. Cunia and C.A. Bickford, 1974. Multivariate estimators for sampling with partial replacement on two occasions. *Forest Sci.*, 20: 106-116.
- Schreuder, H.T. and G.B., Wood, 1986. The choice between design-dependent and model-dependent sampling. *Can. J. Forest Res.*, 16: 260-265.
- Scott, C.T. and M. Kohl, 1994. Sampling with partial replacement and stratification. *Forest Sci.*, 40: 30-46.
- Van Deusen, P.C., 1989. Multiple-occasion partial replacement sampling for growth components. *Forest Sci.*, 35: 388-400.
- Zobiri, M., 2000. *Biometry forest*. 2nd Edn., Tehran University Publication, Tehran, pp: 401.