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# **Measurement of Wastage and Therefore of Efficiency of Education**

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### ABSTRACT

#### *Measurement of Wastage and therefore of Efficiency of Education*

*The paper first brings out the need for preparing proper data base for framing and then implementation of national policies on education. Such a data base will also help to increase the efficiency of education. Then it discusses briefly the theory of investment in human capital (Adhvaryu, 1969 and IIEP, 1988). This theory ultimately leads to the concepts of internal and external efficiency of any course of education, making together the efficiency of education as a whole. The internal efficiency of the course is in regard to the simple intake and out put of students in the course. It, therefore, deals with, so to say, possible wastage in the education system owing to dropouts and stagnation in the course. The external efficiency of terminal and non-terminal courses deals with the wastage due to non-utilisation of the out puts partially or wholly. Amongst the various true cohort methods, which alone can provide a perfect solution to controlling the different types of wastage; it comes out (Tikkiwal, B.D. and Tikkiwal, G.C.; 1993) that Rao and Tikkiwal, B.D.'s measures (1966) are the best ones to be used in such studies. Therefore, the paper then discusses their estimation procedure; as there is need to conduct the studies on sampling basis, because of the limitations of cost and time and because of the need for collection of reliable data without any non sampling errors. In order to fulfil the need for proper data base in developing countries, where it is most needed to increase the other-wise low efficiency of education; some international efforts, of the kind made in these countries for developing agricultural statistics, are called for.*

### RESUME

#### *Mesure des pertes et, partant, de l'efficacité de l'éducation*

*Cet exposé met d'abord en évidence le besoin de préparer une base appropriée de données d'encadrement puis de mettre en œuvre des politiques nationales d'éducation. Une telle base de données va aussi contribuer à améliorer l'efficacité de l'éducation. Ensuite, il aborde brièvement la théorie de l'investissement du capital humain (Adhvaryu, 1969 et IIEP, 1988). En définitive, cette théorie mène aux concepts d'efficacité interne et externe de tout cursus d'éducation, faisant de l'efficacité de l'éducation un tout. L'efficacité interne du cursus est fonction du simple nombre d'étudiants admis et sortants du cursus. Ce résultat est donc dû à ce que l'on pourrait appeler d'éventuelles pertes du système éducatif en raison des abandons et d'une stagnation dans les cours. L'efficacité externe des cursus finaux et non finaux est liée aux pertes dues à la non-utilisation de tout ou partie des diplômés. Parmi les différentes vraies méthodes xxx (cohort ?) qui sont les seules à pouvoir fournir une solution parfaite de contrôle des différents types de gaspillage, il ressort (Tikkiwal, B.D. et Tikkiwal, G.C.; 1993) que les mesures B.D. de Rao et Tikkiwa sont les plus aptes à être utilisées dans de telles études. Cet exposé traite donc de la procédure d'estimation, en ce sens qu'il faut conduire les études sur la base d'un échantillonnage en raison des limitations liées au coût et au temps, et en raison du besoin de recueillir des données fiables exemptes de toute erreur non due à l'échantillonnage. Afin de répondre au besoin d'une propre base de données dans les pays en développement, où elle est le plus souvent nécessaire pour améliorer l'efficacité de l'éducation, sinon très peu efficiente, certains efforts internationaux du type de ceux réalisés dans ces pays pour développer les statistiques agricoles s'imposent.*

## 1. Introduction

Since Sixties in the last century, there is growing awareness, particularly in developing countries, that the investment in education is one of the key factors in a nation's economic, social and cultural development. At the same time, emerging financial pressures in developing countries are being evinced by educational expenditures. In the face of limited financial resources available to these countries, a fatal disparity is noted between educational efforts on the one hand and outputs in term of educational attainment of the masses and required man power on the other.

In the context of education in India, a country who is better of than most other developing countries, the education commission (1964-66), while discussing the problem of expansion of school education, observed in its report (Sec. 7.23, p. 157) that the most important problem during the following ten years was to improve the quality of education and to reduce stagnation and wastage due to dropouts to the minimum. While discussing the problem in higher education, the education commission observed (Sec. 11.12 to 11.26, pp. 278-79) to the effect that there was general feeling in India that the situation in higher education was unsatisfactory and even alarming in some ways, that the average standards were falling and that rapid expansion had resulted in a lowering of quality. The unsatisfactory state of affairs in education, as observed by the commission, continues by and large even after thirty years or so. This is inspite of the fact that there have been serious efforts to remedy the situation.

The National Policy on Education (NPE) in India, prepared in 1986 (see MHRD, Pande, and Sharma) by Govt. of India, came in trouble very soon. There was serious opposition to the policy by some notable citizens; who organised an All India Education Convention in Madras in February, 1989. This convention ended with a call for country wide massive campaign against this NPE. In the back drop of this, the Govt. of India announced the appointment of a committee to review NPE in 1990. All such things can be avoided in future to a great extent; if we have proper data base for framing and then implementation of such policies.

Unfortunately we do not have any worth-while machinery for collecting regularly the requisite educational data. Otherwise, such a data base will also help in effecting efficiency at

different levels of education in different parts of the country. At present the data base for even economics of education is very weak (Panchamukhi, 1997) :

"The recent official data on say, sectoral use of educated manpower (e.g., data on medical doctors in districts and states), the latest expenditure data, level-wise, object-wise and region wise, and source-wise data about funds, etc., are not available at all. While this is the unsatisfactory position about the macro level data; the vast data collected by different researchers at the micro level are not at all compiled systematically at one place. National and / or regional data archives for education may be suggested as an urgent initiative to help researchers in economics of education in particular."

The immediate steps should be taken to remedy the above situation, particularly when we have necessary technical know-how to begin with. We discuss this below.

## 2. The Theory of Investment or Man Power Approach

The human capital consists in the generation of necessary man power by way of having required skilled and unskilled labour, doctors, engineers etc. for adequate economic, social and cultural development. The human resources have to be processed in order to render them more productive or productive at all, as natural resources are processed. A doctor or engineer is regarded as a piece of capital; as a machine turned out from an iron ore is. The next question is what expenditure should constitute the investment in creating necessary human capital. This we discuss below.

### (a) The investment value in creating necessary human capital

At a particular level, the necessary human capital is created by training human beings through the specified courses of education of specified duration. In training human beings, i.e. students, through a specified course, there is expenditure in running the course by either state or central or private agency. The students or their parents or guardians also spend money during the period of the course. Depending upon the level of course, the students are undergoing, there may even be loss of earnings suffered by the students in terms of lost opportunities for jobs. What is germane to the whole problem of educational investment is to select a concept of costs which may provide guidelines for the framing of a public policy. Viewed thus , the cost of a given course of education is taken as the expenditure incurred by either state or central or a philanthropic private agency in running that course, after ignoring the expenditure incurred by the concerned students or their parents or guardians and also the opportunity cost, if any.

**In order that a given course is run on qualitative basis, the said cost on the course will consist of appropriate expenditures made in maintaining certain standards regarding the following characteristics, after carefully preparing first the structure and content of the course, looking to its utility later on for the students who pass out the course :**

- (i) Number of students or size for which the facilities are to be provided for the specified course.
- (ii) Size of the teaching staff or student – teacher ratio. Apart from the size, we need efficient teaching staff.
- (iii) Capital equipment including buildings, equipment, laboratories, library facilities, etc.
- (iv) Hostel facilities for those students for whom it is necessary to live in the hostels.
- (v) Facilities for extra-curricular activities.
- (vi) Sound administration and proper atmosphere around in the institution running the specified course (s).
- (vii) Some other specific characteristics required to meet in running the specified course in a formal manner.

There are attempts to prepare necessary indicators for facilities (Mehta, 1999) so as to ensure their quality in running such courses.

As far as non-formal way of running a specified course is concerned, there are certain studies dealing with the economic aspects of open learning system (Panchmukhi, 1997). We do not discuss them in this paper. However, what we present below would be partly relevant for efficient running of such courses also.

Having determined the value of investment in a specified course of education at a particular level, it is natural to ask about the nature of return of investment in the said specified course and then measure the same if possible. We discuss this aspect below.

**(b) The nature of return of investment in a specified course and its measure**

For courses/ programmes, meant to impart the spiritual, moral and social values amongst the persons at different levels, it is difficult to develop measures for the return of investment made in running such courses / programmes. But, they directly contribute to better social life, better work culture and indirectly thereby to a life with greater prosperity for individuals, and with greater national income when taken as a whole. For most other courses, we do have measures for the return of investment in these courses. We discuss some of the important courses below.

A primary level course is required for each and every citizen of a country to make him a worthy citizen of the country. This has thus a social value. Apart from this, the pupils completing the course do migrate generally to the higher primary, the secondary, higher secondary and then to higher educational courses and thus supply necessary man power required to sustain and lift the economy of the country. However, this kind of return from investment in the course can not be easily measured. So what we do is to try to ensure that a person going through the course should complete the course without any stagnation and he should not drop out.

But, when this does not happen, he contributes to the waste. This kind of wastage of resources in education is a major waste in developing countries and it is measurable. The efforts are there to control this wastage. When we go to higher courses general or technical for medicine and engineering etc., this kind of wastage is not serious there. But, there is considerable wastage in as much as a good many of such trained persons do not get jobs suited to their training.

The rate of return of investment in a specified course is measured by two different methods: (i) Direct and (ii) Indirect. The direct method is based on the calculation of the rate of return to investment in education in terms of the growth rate of the economy traceable to educational expenditure on the course; while the indirect one consists in ascertaining the efficiency of educational outlays in providing the requisite quantity and quality for the course.

While a search for a precise rate of return to educational expenditure may prove a wild good chase, it is not even indispensable to policy for planning educational out lays. For this purpose, one has to ascertain the economic efficiency of expenditure on education. Such an approach is not only a convenient hypothesis but an indispensable guide line for planning educational out lays at different levels. At micro level, this approach helps in initiating a particular programme of education, first in developing proper structure and content of the programme and then in providing proper cost components to various characteristics discussed in part (a) of this section to run the programme efficiently.

The direct method based on approximations in the rate of return may lead to very strange conclusions of the kind found in a recent study (Shanmugam and Madheswaran, 1998):

"More investments and higher subsidies on the education below college level would be more beneficial for both individual and society than that on higher level."

This conclusion of the study leads to the advice to the parents or guardians of the students that they should not send their wards for higher education. Instead, they should ask them to enter the employment market after their completion of some lower level education.

What is in fact needed is to ensure that our trained persons should get jobs suited to their training through proper planning and implementation of general and technical programmes of education. For this and for preventing stagnation and drop out of students from the courses, we need data on recently developed measures of wastage, which satisfy certain desirable criteria. Before we discuss the relevant details of these measures, we present below the situations, where in we require these measures, along with the requisite criteria for the measures.

### **3. The Situations Requiring the Measures of Wastage and the Requisite Criteria for the Measures**

When the rate of return is measured by indirect method; the theory of investment in human capital (Adhvaryu, 1969 and IIEP, 1988), discussed in Section 2, ultimately leads to the concepts of internal and external efficiency of a given course of education. The word 'course' here has a wider connotation. It may mean the primary, higher primary, secondary, higher secondary school education. It may also mean any technical, medical, three year degree, M.A./M.Sc./M.Com. etc. programmes. The internal efficiency of the course is in regard to the simple intake and output of pupils / students in the course. It, therefore, deals with, so to say, possible wastage in the educational system owing to dropouts and stagnation in the course. The external efficiency of a non – terminal course at school or higher levels refers to the utilisation of the outputs of the course either for specified jobs or for their going in for further education. The external efficiency of terminal courses refers to the utilisation of their outputs for specified jobs only. The external efficiency, therefore, deals in both the cases with the wastage due to non utilisation of the outputs partially or wholly.

We are required to measure wastage for different types of courses under the following two situations.

In Situation, 1, unless a student passes the last stage of the course, he is regarded to have wasted the years of his study in the course. For example, in the course on primary education (Grades I-V), it is regarded necessary that a student undergoing the course completes all the grades; otherwise he is regarded as having wasted the years of his study in the course. This is due to the fact that certain studies (Gadgil and Dandekar, 1955) have led to the finding that a student, who drops out of the course before completion of primary education lapses into illiteracy in due course. Like the course on primary education, most other courses at higher levels belong to situation 1.

In Situation 2, we adopt the concept of incremental gains in learning outcomes. According to this concept, as one moves from one stage of the course to another, he gains in learning. So when he leaves the course after completion of a particular stage, he wastes only the years meant for stages later than that stage. For example, this concept may be used up to secondary education in schools, after the primary, wherein each year of further education adds to the utility for the student in the school. That, there can be more than two situations, is discussed in the following section.

We now present Tikkiwal, G.C.'s criteria (1978) which the measures of wastage should satisfy, in addition that they should be capable of being used in both the situations. Before we do so, we give rationale behind these criteria.

Firstly, when the theory of investment in human capital is viewed from the point of view of planning educational outlays at different levels in the context of overall national development; the economic efficiency of expenditure on education has to be optimized. This can be done only

if we study the problem of wastage from block/ panchayat samiti level to district, state and the national level. Such a thing is possible only through appropriate sampling strategy. That means the various measures of wastage should be statistically amenable.

Secondly, the economic efficiency of expenditure for any given course of education is inversely proportional to the total wastage consisting of three components : (i) wastage due to dropouts, (ii) wastage due to stagnation, and (iii) wastage due to non-utilisation of training in the course. As the efficiency lies between 0 and 1, so the various components of wastage should lie between 0 and 1, in addition that they should be additive.

Thirdly, as these measures of wastage are to reflect on the economic efficiency of expenditure, the different components of wastage should depend upon the respective components of time spent by the batch of students in the given course, as the cost of the course depends upon time. At the same time they should be free of measuring unit of time.

The above considerations, thus, lead to the following criteria, which the measures of wastage for a given course should satisfy :

- (3.1) The different measures of wastage for a given course should be non-negative, additive and should lie between 0 and 1.
- (3.2) They should depend upon the respective components of time spent by the batch of students undergoing the course. At the same time, they should be free of the measuring unit of time.
- (3.3) They should be amenable to statistical treatment.

#### 4. Measures Based on the Cohort Method

The wastage for a batch of students, to be termed as cohort<sup>1</sup> and the students of the batch as its members, occurs at two stages :

- (i) The first one during the period of the members/ students of the cohort undergoing the course; and
- (ii) The second one after their completing the course.

The first stage arises due to those members of the cohort who leave the course without completing it and is termed as wastage due to dropouts. The type II wastage arises due to those members of the cohort who complete the course in a period more than the minimum prescribed for the course and is termed as wastage due to stagnation.

The wastage at the second stage arises due to those members of the cohort who complete the course but are unable to utilise subsequently the training in the course. It is to be noted that this type of wastage is of greater importance, at higher stages of education, over the other two; while reverse is the case at the lower stages.

For presenting various measures of wastage based on cohort method, we present below relevant notations.

For a given course of education, let

$d$  = duration of the course;

$k(\geq d)$  = the period of observation for each member of cohort admitted to the course;

$W_t$  = measure of total wastage;

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<sup>1</sup> Frost (1939) made use of the word 'Cohort' as early as 1935. He studied mortality rates from tuberculosis in successive birth Cohorts (generations) using the rudiments of what has come to be called age-period-cohort analysis.

$W_{fs}$  = measure of wastage at the first stage;  
 $W_{ss}$  = measure of wastage at the second stage;  
 $W_d$  = measure of wastage due to dropouts;  
 $W_s$  = measure of wastage due to stagnation;  
 $N$  = number of members in the cohort;  
 $N_1$  = number of members of the cohort who complete the course in exactly  $d$  years;

$N_{2i}$  = number of members who complete the course in  $(d+i)$  years,  
where  $i=1,2,\dots,k-d$ ;

$N_2 = \sum_{i=1}^{k-d} N_{2i}$  = number of members who complete the course in  $(d+i)$  years

for all  $i \geq 1$ ;

$N_{3i}$  = number of members who dropout of the course after spending  $i$  years in it, where  
 $i=1,2,\dots,k$ ;

$N_3 = \sum_{i=1}^k N_{3i}$  = total number of members who drop out of the course without completing it;

$M$  = number of members, out of  $(N_1+N_2)$ , who are unable to join the profession  
requiring the course;

$U_1 = \sum_{i=1}^k iN_{3i}$  = total number of years spent by the members, out of  $N$ , who dropout of the  
course up to the period  $k$ ;

$U_2 = \sum_{i=1}^{k-d} iN_{2i}$  = total number of additional years spent in the course by delayed successful  
members;

$U_3 = M \times d$ ;

$U = d(N_1+N_2) + \sum_{i=1}^k i(N_{2i} + N_{3i})$ , the total number of years spent in the course by the  $N$   
members of the cohort, where each of  $N$  members is observed for a period  $k(\geq d)$   
and where  $N_{2i} = 0$  for  $k-d < i \leq k$ .

Further, let the population of  $N$  members be classified into the following  $(2k-d+1)$  mutually  
exclusive classes.

$C_1$  = the class of those members who complete the course in exactly  $d$  years;

$C_{2i}$  = the class of those members who complete the course in  $(d+i)$  years,  
where  $i=1,2,\dots,k-d$ ;

$C_{3i}$  = the class of those members who drop out of the course after spending  $i$  years in  
the course, where  $i=1,2,\dots,k$ .

It is to be noted that the size of the class  $C_1$  is  $N_1$ , of  $C_{2i}$  is  $N_{2i}$ ,  $i=1,2,\dots,k-d$  and of  $C_{3i}$  is  
 $N_{3i}$ ,  $i=1,2,\dots,k$ .

Since measures due to Rao and Tikkiwal, B.D. (1966) alone satisfy all the three criteria given  
in Sec.2 and since at the same time they can be utilised in different situations ( Tikkiwal, B.D. and  
Tikkiwal, G.C.,1993 ), we present them below.

Rao and Tikkiwal defined the measures of different types of wastage as follows :

$$(4.1) \quad W_d = \frac{U_1}{U}, \quad W_s = \frac{U_2}{U}, \quad W_{fs} = W_d + W_s, \quad W_{ss} = \frac{U_3}{U}, \quad \text{and} \quad W_t = W_{fs} + W_{ss}$$

These measures obviously satisfy Criterion 3.2. Since the following inequality relations hold

$$(4.2) \quad \left\{ \begin{array}{lll} \text{(i)} \quad 0 \leq U_1 \leq U & \text{(ii)} \quad 0 \leq U_2 < U & \text{(iii)} \quad 0 \leq U_1 + U_2 \leq U \\ \text{(iv)} \quad 0 \leq U_3 \leq U & \text{(v)} \quad 0 \leq U_1 + U_2 + U_3 \leq U; \end{array} \right.$$

the various measures of wastage, due to the two authors, are easily seen to lie between 0 and 1. They are non - negative and additive by definition. Thus, these measures satisfy Criterion 3.1 as well. That, they satisfy the remaining third Criterion 3.3, is clear from the following Sections 5 and 6.

That, these measures can be used in Situation 1, is obvious. They can also be used in Situation 2 with only slight modification is discussed by the two authors earlier (1993). Besides these two situations, described in Section 3, there are others too. For example, if some members of the cohort utilise the training partially, either by remaining underemployed or getting a job requiring the training only partly; then this situation is not covered by either situation. However, by suitably modifying Rao and Tikkiwal's measure of wastage at the second stage; it can be easily met. Since such a situation is common in developing countries; these measures have the additional advantage.

## 5. Estimators of Measures of Wastage

Let  $n$  be the number of members selected out of  $N$  members of the Cohort by simple random sampling scheme without replacement (SRSWOR). Out of  $n$  members in the sample, let  $n_1$  fall in  $C_1$ ,  $n_{2i}$  in  $C_{2i}$  ( $i=1,2,\dots, k-d$ ),  $n_{3i}$  in  $C_{3i}$  ( $i = 1,2, \dots, k$ ) such that  $n_1 + n_2 + n_3 = n$ , where  $n_2 = \sum_{i=1}^{k-d} n_{2i}$  and  $n_3 = \sum_{i=1}^k n_{3i}$ . Further, let estimators of measures of different types of wastage be obtained respectively by replacing capital letters by small letters in 4.1 of Section 4.

$$(5.1) \quad \left\{ \begin{array}{l} \text{Thus,} \\ w_d = u_1/u, \quad w_s = u_2/u, \quad w_{fs} = w_d + w_s, \quad w_{ss} = u_3 /u \\ \text{and} \quad w_t = w_{fs} + w_{ss} \\ \text{where, } u = \sum_{j=1}^n U_{.j}, \quad u_r = \sum_{j=1}^n U_{rj}, \quad , \quad \text{for } r = 1, 2, 3 \end{array} \right.$$

with  $U_{1j}$  denoting the time spent by the  $j^{\text{th}}$  member, in case he leaves the course before completing the same;  $U_{2j}$  denoting the stagnation period and  $U_{3j}$  is equal to  $d$  years, the duration of the course, if  $j$  th member completes the course; and  $U_{.j} = \sum_{r=1}^n (U_{rj}) > 0$ , for all  $j = 1, 2, \dots, n$ .

The biases and mean squares of these ratio-type estimators of measures of different types of wastage are discussed in the following section.

## 6. Biases and Mean Square Errors and Their Estimators

In this Section, we present the expressions of biases and mean square errors of the estimators of measures of different types of wastage, under first approximation. These expressions are obtained by using Tikkiwal, B. D.'s Lemma [(1960), Sec. 2, p. 113 ] and noting that

$$(6.1) \quad u = \left( \sum_{j=1}^n U_{.j} \right) = \left( \sum_{j=1}^N U_{.j} \right) \left\{ 1 - \left( \frac{\sum_{j=n+1}^N U_{.j}}{\sum_{j=1}^N U_{.j}} \right) \right\} = U \left( 1 - \frac{U_{N-n}}{U} \right)$$

Where  $U = \left( \sum_{j=1}^N U_{.j} \right)$  is the total time spent in the given course of education by all the  $N$  members

of the cohort and  $U_{N-n} = \left( \sum_{j=n+1}^N U_{.j} \right)$  is the total time spend in the given course by  $(N-n)$  members of the cohort, who are not in the sample. Therefore,  $(U_{N-n} / U) < 1$  and so the expression  $\left( 1 - \frac{U_{N-n}}{U} \right)^{-1}$  can be expanded as a series of powers of  $U_{N-n}$ , as required for the purpose.

The presentation of the expressions of biases and mean square errors for  $w_d$ ,  $w_s$  and  $w_{fs}$  require the following notations, in addition to those given in Section 4.

$$(6.2) \quad \begin{cases} P_1 = N_1 / N; P_2 = N_2 / N; P_{2i} = N_{2i} / N \text{ for } i = 1, 2, \dots, k-d \text{ and zero for } k-d < i \leq k; \\ P_{3i} = N_{3i} / N \text{ for } i = 1, 2, \dots, k; \\ \bar{U} = U/N \text{ and } \alpha = d^2 (P_1 + P_2) + \sum_{i=1}^k i^2 (P_{2i} + P_{3i}) + 2d \sum_{i=1}^{k-d} P_{2i} \end{cases}$$

**(a) Bias and Mean Square Error of  $w_d$**

$$(6.3) \quad B(w_d) = \left( \frac{1}{n} - \frac{1}{N} \right) W_d \left[ \frac{\alpha}{\bar{U}^2} - \frac{\sum_{i=1}^k i^2 P_{3i}}{\bar{U} \left( \sum_{i=1}^k iP_{3i} \right)} \right]$$

and

$$(6.4) \quad MSE(w_d) = \left( \frac{1}{n} - \frac{1}{N} \right) W_d^2 \left[ \frac{\alpha}{\bar{U}^2} + \frac{\sum_{i=1}^k i^2 P_{3i}}{\left( \sum_{i=1}^k iP_{3i} \right)^2} - \frac{2 \sum_{i=1}^k i^2 P_{3i}}{\bar{U} \left( \sum_{i=1}^k iP_{3i} \right)} \right]$$

**(b) Bias and Mean Square Error of  $w_s$**

$$(6.5) \quad B(w_s) = \left( \frac{1}{n} - \frac{1}{N} \right) W_s \left[ \frac{\alpha}{\bar{U}^2} - \frac{d}{\bar{U}} - \frac{\sum_{i=1}^k i^2 P_{2i}}{\bar{U} \left( \sum_{i=1}^k iP_{2i} \right)} \right]$$

and

$$(6.6) \quad \text{MSE}(w_s) = \left( \frac{1}{n} - \frac{1}{N} \right) W_s^2 \left[ \frac{\alpha}{\bar{U}^2} - \frac{2d}{\bar{U}} + \frac{\sum_{i=1}^k i^2 P_{2i}}{\left( \sum_{i=1}^k iP_{2i} \right)^2} - \frac{2 \sum_{i=1}^k i^2 P_{2i}}{\bar{U} \left( \sum_{i=1}^k iP_{2i} \right)} \right]$$

(c) **Bias and Mean Square Error of  $w_{fs}$**

$$(6.7) \quad B(w_{fs}) = \left( \frac{1}{n} - \frac{1}{N} \right) W_{fs} \left[ \frac{\alpha}{\bar{U}^2} - \frac{\sum_{i=1}^k i^2 (P_{2i} + P_{3i})}{\bar{U} \left( \sum_{i=1}^k i(P_{2i} + P_{3i}) \right)} - \frac{d \sum_{i=1}^k iP_{2i}}{\bar{U} \left( \sum_{i=1}^k i(P_{2i} + P_{3i}) \right)} \right]$$

and

$$(6.8) \quad \text{MES}(w_{fs}) = \left( \frac{1}{n} - \frac{1}{N} \right) W_{fs}^2 \left[ \frac{\alpha}{\bar{U}^2} + \frac{\sum_{i=1}^k i^2 (P_{2i} + P_{3i})}{\left( \sum_{i=1}^k i(P_{2i} + P_{3i}) \right)^2} - \frac{2 \left( \sum_{i=1}^k i^2 (P_{2i} + P_{3i}) + d \sum_{i=1}^k iP_{2i} \right)}{\bar{U} \left( \sum_{i=1}^k i(P_{2i} + P_{3i}) \right)} \right]$$

(d) **Bias and Mean Square Error of  $w_{ss}$**

We know that  $M$  is the number of students, out of  $(N_1 + N_2)$ , who are not able to join the profession requiring the course, so we assume that amongst such  $M$  students  $M_1 \in C_1$ ,  $M_{2i} \in C_{2i}$  for  $i=1, 2, \dots, k-d$ .

$$M_2 = \sum_{i=1}^{k-d} M_{2i}, \quad M = M_1 + M_2, \quad P_4 = \frac{M}{N} \text{ and}$$

$$P_{4i} = \begin{cases} M_{2i} / N, & i = 1, 2, \dots, k-d \\ 0, & \text{for all } k-d < i \leq k \end{cases}$$

Then,

$$(6.9) \quad B(w_{ss}) = \left( \frac{1}{n} - \frac{1}{N} \right) W_{ss} \left( \frac{\alpha}{\bar{U}^2} - \frac{d}{\bar{U}} - \frac{\sum_{i=1}^k iP_{4i}}{\bar{U} P_4} \right)$$

and

$$(6.10) \quad \text{MES}(w_{ss}) = \left( \frac{1}{n} - \frac{1}{N} \right) W_{ss}^2 \left( \frac{\alpha}{\bar{U}^2} + \frac{1}{P_4} - \frac{2(dP_4 + \sum_{i=1}^k iP_{4i})}{\bar{U} P_4} \right)$$

(e) **Bias and Mean Square Error of  $w_t$**

$$(6.11) \quad B(w_t) = \left( \frac{1}{n} - \frac{1}{N} \right) W_t \left( \frac{\alpha}{\bar{U}^2} - \frac{\beta}{\bar{U}\beta_1} \right)$$

and

$$(6.12) \quad MSE(w_t) = \left( \frac{1}{n} - \frac{1}{N} \right) W_t^2 \left( \frac{\alpha}{\bar{U}^2} + \frac{\beta_2}{\beta_1^2} - \frac{2\beta}{\bar{U}\beta_1} \right)$$

where

$$\beta = \sum_{i=1}^k i^2 (P_{2i} + P_{3i}) + d \sum_{i=1}^k i (P_{2i} + P_{4i}) + d^2 P_4, \quad \beta_1 = \sum_{i=1}^k i (P_{2i} + P_{3i}) + d P_4$$

and

$$\beta_2 = \sum_{i=1}^k i^2 (P_{2i} + P_{3i}) + d^2 P_4 + 2d \sum_{i=1}^k i P_{4i}$$

The expressions for the estimators of the above respective biases and mean square errors can now be obtained by substituting corresponding sample values as in Section 5.

## 7. Concluding Remarks

It is observed, in Section 1, that we need proper data base first for framing and then implementation of national policies on education in different developing countries. It is further observed that we have necessary technical know how to begin with. For want of space, only a glimpse of essential technical know-how is given in the Sections 2 to 6. An important alternate approach, which is not included here, to the sampling theory of measurement of wastage in education is due to Tikkiwal, G.C. and Tikkiwal, B.D. (1983).

We require large-scale sample surveys for preparing proper data base, on the lines what is being done in different countries for the collection of agricultural statistics. In such surveys, we generally require stratified multi-stage sampling designs. The necessary technical know-how described in the said sections is easily extendable to such designs.

There are certain useful tips for conducting surveys on large scale (Singh, 1980; Srivastava, 1980). Singh (p. 181) make a pertinent observation concerning sample design : "The survey objectives should determine the sample design. But the determination is actually a two-way process, because the problems of sample design often influence and change the survey objectives. We shall encounter examples of the ways in which the survey objectives and sample design interact to produce over-all designs." Over a period, such designs become optimum in the sense that maximum economy and efficiency is effected in such surveys.

Srivastava (p. 149) suggests the use of a master sample of schools through area sampling with some cautions regarding the use of such a master sample over a long period. The answer to the cautions lies in the adoption of some replacement pattern at some stages of sampling in preparing master sample each time a large scale sample survey is conducted. Such replacement patterns can be profitably borrowed from the theory of successive sampling, well developed in the literature (Tikkiwal, B.D.; 1979).

In framing and the implementation of national policies, we generally require the data at macro and micro levels simultaneously. But we can not afford sufficiently large samples at micro level in large scale sample surveys due to the paucity of funds. For such situations, the theory developed for small area statistics in agriculture is of help (Tikkiwal, B.D. and Tikkiwal, G.C.; 1998). In order to fulfil the need for proper data base in developing countries, where it is most needed to increase the

otherwise low efficiency of education; some international efforts, of the kind made in these countries for developing agricultural statistics, are necessary.

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