CHAPTER V

MAIN FINDINGS AND THEIR EXPLANATION

The main findings which have been obtained from the analysis and processing of the data, collected through the investigation of different farms in the districts of Midnapore and 24-Parganas, are presented in this chapter with their explanation. The results here relate to the use of man-days on the agricultural holdings and to the seasonal work and periods of idleness in agriculture. This will lead to the analysis of employment and underemployment of labour in agriculture.

‘Norm’ regarding the requirement of man-days per acre:

For comparing our collected data relating to the employment of man-days on the holdings, that is, the data on man-days used ‘actually’ per acre with ‘what should be’ used per acre, account has been taken of a certain norm. It may be necessary, here, to think of controlled farms of various sizes worked by wage labour as well as family labour serving as norms for the man-days necessary for rice crop, particularly Aman. Underemployment in the present project, as mentioned in the last part of Chapter I, has been measured in terms of the difference between the standard which is indicated by the norm and the actual work performance. In this case, a difference has been
noted between the units of labour, measured in man-days, as used in
the controlled farms, taken as norm and those used in our
sample farms. For the purpose of the present study, the controlled
farms, spread over five villages in Midnapore and one village in
24-Parganas, working under the control and supervision of the
Department of Agriculture, Calcutta University, have been consi-
dered as standard units. The locations of the experimental holdings
in the villages were selected by this Department on the basis of
'Representative sampling technique.' In each village the experi-
mental area consisted of contiguous plots of lands belonging to
a number of cultivators.

In the district of Midnapore, five locations in five ad-
joining villages (in a lateritic zone) measuring approximately
between 1.5 and 2 hectares in contiguous plots were selected.
Among these five locations (with varying conditions) there exist
some differences of soil conditions (some more sandy, some less
porous, some loamy soil and some clayloam). The experiments were
carried out in the vicinity of the Agrarian Research centre, Seva
Bharati, under the Seva Bharati Society, Midnapore. Both local
and H.Y.V. varieties of crops were taken into consideration. Irres-
pective of locations and varieties, labour hour was observed to be
positively correlated with farm size. Different varieties are
selected according to soil type representing different locations and
other available resources. These must be adaptability of a variety
into the local condition for determining the efficiency of a crop.
Another investigation was conducted in a Gangetic alluvial region of the district of 24-Parganas. Three different sizes of holdings (1.0 hectare, 1.5 hectare & 2 hectares) having two replications in each were taken for rice (Aman) cultivation. Each holding was in a contiguous area and the soil is clay loam. The varieties of rice employed in this study were selected on the basis of their previous performances in the locality and recommendations of the Government of West Bengal.

In view of the fact that it is difficult to get a standard—that is, the standard number of man-days which ought to be used on the holdings—against which our actual data should be compared, the farms controlled by this Department of Agriculture can be fairly taken as standard units. Here, it will not be incorrect to assume that the units of labour are employed in these farms, if and only if these are required. It is because these farms are run by the Department of Agriculture of Calcutta University which makes experiments with these controlled farms with a view to ensuring efficient farm management and making possible multiple cropping in rain-fed single-crop areas. Naturally, these farms are more intensively cultivated compared to our sample farms.

The areas around these controlled and experimental farms are mostly single crop (Aman) and rain-fed areas which bear close resemblance to most of the areas covered by our sample farms; even the major part of the agricultural areas of the State of West Bengal. In our case again, the climatic condition, the soil condition and water management are nearly the same as between the
Experimental farms and our sample farms. The cultivation operation of these controlled and experimental farms has been conducted with the use of both hired and family labour (in case of family farms controlled by the Agriculture Department). This Department of Agriculture of Calcutta University has been undertaking the task of financing the cultivation operation and also has been facilitating the use of improved as well as other types of seeds-varieties, fertilisers, etc., for both types of cultivation — H.Y.V. variety and local variety. Interest free crop loan was provided by this Department as an incentive to meet the capital requirements towards the cost of seeds and fertilisers which was to be realised after harvest of the crop each year. These farms have carried out the cultivation of both H.Y.V. crop as well as local crop. Of course, we have considered here only the case of Aman with which we are concerned because our sample farms are mostly Aman-producing ones. The supply of inputs to the farmers, in the aforesaid controlled farms has been made by the Agriculture Department with an eye to the limited means and capacity of the farmers so that after this Department will wash its hands off these farms and, setting an example of efficient farm management, will leave it to the farmers themselves, the latter do not find it difficult to carry on. After all, mixed inputs are supplied in this case inasmuch as improved varieties are required for H.Y.V. cultivation and the less improved types for the cultivation of local crop varieties. The basic similarity between these controlled
farms and our sample farms is, thus, like the former; the
latters are also mostly in the regions of single-crop and
rain-fed areas, using both family and hired labour and em­
ploying mixed inputs (in which case, of course, the uses of
improved varieties are very little, so far as the sample
farms are concerned).

Now, an estimate has been made of the rate of utilisa­
tion of man-days in these controlled farms, that is, the use
of man-days per acre, for a full cultivation operation of
rice (mainly Aman) covering the different stages of cultiva­
tion starting from land preparation to thrashing.

A study (1) was made during 1966-1970, covering these
controlled farms, on the aspect of farm management and mul­
tiple cropping in single crop areas, under the guidance of the
Department of Agriculture, Calcutta University. The results
of this study are very important insofar as they reveal the
actual use of man-days on these holdings (taking both the
family and hired labour together). For ensuring efficient
farm management and multiple cropping in rainfed single-crop
areas, in the controlled farms, the effort was directed towards
making use of the man-days to the required and desired extent,
along with proper uses of other factor inputs. Hence, in
course of experiments in these farms, all sorts of economic
behaviour regarding farming operations were sought to be ra­
tionalised in order that there could not be any wastage of man-days
or any wasteful expenditure on the uses of various factor resources.

As for Midnapore, the average number of man-days in this case has been worked out at 55. This figure indicates the standard number of man-days which should be employed per acre for the full cultivation operation of Aman crop; inasmuch as these 55 man-days have been used per acre in the controlled and experimental farms in Midnapore. And here, this figure may be taken as a norm for this district. (See the Appendix to this chapter, Section 5A.1)

Regarding the district of 24-Parganas, (for one village covered by the controlled farms) we may note that the standard number of man-days which should be used per acre in this district has been worked out at 65. The 65 man-days have been used per acre for a full cultivation of Aman crop by the controlled farms in 24-Parganas. This figure may be taken as the norm for this district. (See the Appendix to this chapter, Section 5A.1)

Average for five districts in West Bengal regarding the use of man-days per acre:

Here, we may refer to a Study Report (2), based on a sample survey, made by the Socio-Economic and Evaluation Branch of the Government of West Bengal which since 1962 has been
conducting a survey on "Farm Management and cost of production of crops", covering the districts of 24-Parganas, Nadia, Hooghly, Burdwan and Birbhum. In this sample survey, as many as 30 villages were covered, taking 6 villages per district and the number of holdings covered was 240 in the aggregate, taking in this case, 8 holdings in each village. Both irrigated (either irrigated by canal or tubewell) and non-irrigated holdings were brought under the coverage of the field study.

This field study was started in the kharif of 1962 in which year 21 villages were included in the study. From 1963, 30 villages were taken up. While studying this survey report, we have taken into account the figures relating to area, output, man-days, woman-days and child-days both of family labour and hired labour corresponding to each of the eight holdings of each village under survey, for both Aus and Aman crops, from 1962-63 onwards; and here the latest-available figures which we have taken into consideration correspond to 1966-67. Hence, we have covered the figures corresponding to the years 1962-63, 1963-64, 1965-66, and 1966-67 (save and except the year 1964-65).

Four years' average (i.e. 1962-63, 1963-64, 1965-66 and 1966-67) of the number of man-days used per-acre for the cultivation of both the Aus and Aman crops covering all the sample villages, spreading over the five districts of this State, has been worked out. In the process of working out this figure, all woman-days and child-days have been converted into man-days
in order to have a homogeneous unit. The conversion ratio here is 1 woman-day = 3/4 man-day and 1 child-day = 1/2 man-day. Man-days have been calculated for both the family and hired labour. For the cultivation of Aus and Aman crops, taken together, the average has been worked out at 54 man-days per acre, covering both the family and hired labour. The break-up in family and hired labour is 16 man-days per acre for family labour + 38 man-days per acre for hired labour. (See the Appendix to this chapter, Section 5A.2)

Taking into consideration the cultivation of Aman crop only, the average has been worked out to be 11 man-days per acre for family labour and 45 man-days per acre for hired labour. Hence, taking both the family and hired labour together, the average is 56 man-days per acre. (See the Appendix to this chapter, Section 5A.2)

These average figures, covering the districts of 24 -Parganas, Nadia, Hooghly, Burdwan and Birbhum, spread over approximately four years, undoubtedly present a clear picture of the average of what actually is in these different districts of the State of West Bengal.

It is clear that these figures have representative character, inasmuch as these are the results of an extensive sample survey. At this stage, taking a look at the norm figures, as shown before, what is worthy of note is that the
average of these figures available for both Midnapore and 24-Parganas (for the cultivation of Aman crop) comes out to be 60, our norm for Midnapore being 55 and for 24-Parganas 65. As per estimate made by the Socio-Economic and Evaluation Branch of the Government of West Bengal, the average of man-days used per acre for Aman cultivation, for the five districts of West Bengal (Districts of 24-Parganas, Nadia, Hooghly, Burdwan and Birbhum), calculated over four years, is 56. Hence, in the field of Aman cultivation, the average of the norm figures for the districts of Midnapore and 24-Parganas does not differ much from the four years' average (regarding the number of man-days used per acre for Aman cultivation) for the aforementioned five districts of the State of West Bengal. The former is 60 and the latter is 56.

Therefore, the figures corresponding to the controlled farms (or experimental farms) in our survey districts do not appear to be arbitrary; otherwise the average of these figures could not have been so close to the average of the actual figures for the five different districts of this State. As is evident here, in the field of Aman cultivation, the labour-employment activities of the controlled farms in the districts of Midnapore and 24-Parganas bear close resemblance to the average employment pattern of the different districts in West Bengal.
But in our statistical analysis we have not used the average for these five districts for comparison with our sample data, inasmuch as we are concerned only with districts of Midnapore and 24-Parganas. The separate norm which is available for each of these two districts best serves our purpose of working out the rate of wastage of man-days in the cases of our sample farms in these districts. In other words, reference has been made in the sample surveys being conducted by the Socio-economic and Evaluation Branch of the Department of Agriculture, Government of West Bengal only as a check. This check has confirmed that our "norms" regarding the number of man-days required per acre for Aman cultivation have not been set arbitrarily, but closely correspond to the reality of West Bengal's agricultural economy.

Finally, it may also be mentioned, an estimate of labour requirement in the cultivation of Aman paddy (Local variety) in the context of agriculture of the State of West Bengal, made by the Farm Finance Division, United Bank of India, on the basis of its survey during 1970-72, may also be cited in this case in support of our 'norm'. The Farm Finance Division of U.B.I. made an estimate of what should be the requirement of labour considering the different stages of paddy cultivation like ploughing and seeding, transplantation, weeding, fertilisers and pesticides, harvesting and threshing. The estimate is worked out at 59 man-days per acre approximately.
FINDINGS OF THE CASE STUDY

A. District: Midnapore

(a) Average number of man-days used:

In the case of 170 farm households in Midnapore which we have covered under our survey, the total number of man-days actually used on these holdings for a full cultivation operation, particularly of Aman crop, covering all the six stages of cultivation (as mentioned before) is 89658. Here, the total number of man-days actually used in terms of family labour and the total number used in terms of hired labour have been added up for each of these 170 families. All the six stages of cultivation (particularly with reference to Aman crop) have been taken into account for each of the 170 holdings to find out the number of man-days actually used at every stage of cultivation in terms of both family labour and hired labour. The different number of man-days for the six different stages have been added together to get its total number used by each household on its total operated holding. The average of man-days, used on the total of 1111.5 acres of land holdings (since these 170 families have the total land coverage of 1111.5 acres) by 170 families in Midnapore, is equal to $89658/1111.5 = 80.66$. This is the average number of man-days used per acre by these sample farms.
(b) Average wastage of man-days:

For these 170 farm families in this district, the total acreage of holdings, taking all these farms into account, is 1111.5. The total number of man-days actually used on these holdings by all these farms is 89688. The norm regarding the requirement of man-days per acre in Midnapore is, as we noted earlier, 55. Now, denoting the total size of holdings by \( \Sigma X \) (where \( X \) as a variable stands for the size of holdings of each sample farm) and the total number of man-days actually used by \( \Sigma Y' \) (where \( Y' \) as a variable stands for the actual number of man-days used on a holding of size \( X \)) and taking 'a' as norm (which is a constant), we may get the figure of the wastage of man-days per acre by finding out the value of

\[
\frac{\Sigma Y'}{\Sigma X} = a
\]

which indicates the rate of wastage. The details about the derivation of this formula have been shown in the Appendix to this chapter, Section 5A.3.

Substituting the values of this formula for Midnapore, we get

Rate of wastage = \( \frac{89688}{1111.5} = 55 \)

\[= 80.66 - 55 = 25.66 \]
Hence, after studying 170 families in Midnapore district, we have taken note of the phenomenon that these families, on an average, make a wastage of man-days to the extent of 25.65 (man-days per acre). Thus, what is revealed by the data in Midnapore is that more man-days are employed per acre for Aman Cultivation (taking both the family labour and the hired labour together) than what should be. With given technology and capital, this disparity between the number of man-days used on the holding, and the number of man-days, as it should be used, corroborates the hypothesis of surplus labour in these farms. The extent of this surplus is indicated by the rate of wastage, meaning thereby, by how much the actual use of man-days per acre exceeds the required number of man-days per acre. This excess amounts to the surplus labour. Wastage of labour in the sample farms may be due to (a) faulty planning, (b) lack of complementary inputs, (c) ignorance, (d) motivations, customs, obligations, social prestige etc.

(c) Average number of days of employment:

For these 170 sample farms again, we found out the total number of days of employment in a year for the cultivation of Aman, occasionally supplemented by the cultivation of Aus, vegetables, Boro and quite a few commercial crops. The totals of the different number of days of employment corresponding to these 170 different farm families add up to the grand total of 29805 days of employment for all these farms taken together. The average number of days of employment is
then \( \frac{29805}{170} = 175.32 \) days a year.

(d) Average number of days of Unemployment:

As regards the total period of employment we have already noted that for 170 families in Midnapore there is a total of 29805 days of employment. The average has been worked out as 175.32 days. Now, it may be argued, based on our empirical verification, that family labour or hired labour may be put to work on land for about 25 days a month, on an average. This is true for both the districts (Midnapore and 24-Parganas).

365 days of employment cannot be expected of a farmer or an agricultural labourer. The maximum period of employment for a sample holding, as revealed in our field investigation, is 300 days. This period of employment here means the period of work necessary for more than one cropping (say, multiple cropping) and also the time spent for non-agricultural activities during the off-season by both the farmers and landless agricultural labourers. Here, it may be pointed out that the Agricultural Labour Enquiry Committee (Source: Report of the First Agricultural Labour Enquiry Committee, India, 1950-51) in India observed that considering the whole of India the highest figure regarding the period of employment for agricultural labourers was 289 days. It is in the Report of the Congress Agrarian
Reforms Committee (Source: Report of the Congress Agrarian Reforms Committee, India, 1949) it was observed that in certain part (agricultural region) of India the work of an average cultivator spanned over about 280 days.

Now, it is assumed that 300 days of employment per year should be desired and is feasible. In the case under review, we can deduct the average number of days of employment from this desired period of employment of 300 days a year so as to get the average number of days of unemployment. Thus,

\[ 300 - 175.32 = 124.68 \text{ days} \]

These 125 days approximately are the average number of days of unemployment, as revealed by the sample survey of 170 farms in Midnapore. Thus, in Midnapore, for a period of a little more than four months in the year the seasonal unemployment persists for such land-holding cultivators.

(e) Landless labourers

Average number of days of employment -

As for 68 families of landless agricultural labourers in Midnapore, the total number of days of employment a year stands at 11844. In this case, account is taken of the days devoted by these labourers both to the different stages of cultivation in agriculture and to the various types of non-
agricultural activities as well as the activities ancillary to agriculture. We have already noted that the landless labourers have to be engaged in some off-season work and some sort of secondary occupations, though not to the required extent, apart from purely agricultural work. Therefore, the days used for both agricultural and non-agricultural pursuits have been taken into consideration. In this case, the average number of days of employment for these 68 families is 11844/68 = 174.17 days a year.

(f) Landless labourers: Average number of days of unemployment

In the case of landless agricultural labourers in Midnapore, it has already been noted that the average number of days of employment is 174.17 per year, after surveying as many as 68 families within this class of labourers. Now, for this class, the average number of days of unemployment is

$$300 - 174.17 = 125.83$$

Thus, the landless agricultural labourers in this district remain seasonally idle, with absolutely no work, for a period of about 126 days a year, that is, about 4 months and 6 days.
B. District 24-Parganas:

(a) Average number of man-days used:

Turning our attention to the district of 24-Parganas on the front of labour employment, it may be noted that for the 190 farms, as covered in this district, the sum total of the number of mandays actually used on these holdings is 115580. The average number of mandays employed, therefore, comes out to be \( \frac{115580}{1433.5} = 80.63 \). Here, 1433.5 acres is the total size of holdings covered by all the 190 families in this district.

(b) Average wastage of mandays:

In the case of 190 sample farms in the district of 24-Parganas, the value of \( \Sigma Y \) has come out to be 115580. The value of \( \Sigma X \) is 1433.5. The value of 'a' in this case, as mentioned before, is 65.

\[
\text{Rate of wastage} = \frac{115580}{1433.5} - 65
\]

\[
= 80.63 - 65 = 15.63
\]

So we can conclude here that for the 190 sample farms in 24-Parganas, the wastage of mandays per acre, on an average, is to the extent of 15.63. To this extent, therefore, there is surplus use of the units of labour (measured in
mandays) on land (taking both the family and the hired labour together). Hence, there exist the cases of underemployment both in the districts of Midnapore and 24-Parganas. There is only a difference of degree. In Midnapore the extent of this underemployment is found to be greater than that in 24-Parganas. In Midnapore actual number of man-days used per acre is greater than the number, which should be used per acre by about 26 (man-days). The corresponding figure for 24-Parganas is approximately 16 (man-days).

The greater wastage of man-days in Midnapore is perhaps due to, among other factors, mainly, zero opportunity cost of labour, used on the farms, and the lack of alternative employment opportunities which is not so in the district of 24-Parganas. Much higher rate of urbanisation and industrialisation in 24-Parganas and greater availability of the sources of secondary occupations in this district actually count in this case. However, 24-Parganas, as well, suffers from the problem of underemployment, the extent of which is much less than that in Midnapore.

(c) Average number of days of employment:

Coming to the figure of the number of days of employment in the case of the 190 families of landholding cultivators in 24-Parganas, we find a little better picture as
compared to the employment situation obtaining in Midnapore district. In the district of 24-Parganas for such 190 families, the sum total of the number of days of employment has been worked out at 36215. From this figure the average number of days of employment for these families has been worked out by finding out the value of the ratio $\frac{36215}{190} = 190.61$. Hence, in 24-Parganas the agricultural families get more days of employment per year than their counterparts in Midnapore, the average number of days of employment being 190.61 in the former and 175.32 in the latter.

(d) Average number of days of unemployment:

In respect of 190 landholding families of 24-Parganas, we have taken note of as many as 36215 days as the total number of days of employment. Here, the average number of days of employment has been worked out at 190.61 per year. In this case, the average number of days of unemployment is

$$300 - 190.61 = 109.39$$

Thus, the period of seasonal unemployment in this case spans over roughly about a little more than 3 months and a half.

(e) Landless labourers: Average number of days of employment

For 76 families of landless agricultural labourers in
24-Parganas, the sum total of the number of days of employment has come to the figure of 14359 (days). This includes both the days of primary and secondary or off-season work. To get the average, we turn to the ratio $14359/76 = 188.93$ days. Thus, the landless labourers in 24-Parganas find themselves employed for about 189 days on an average, per year, while such labourers in Midnapore get about 174 days of employment annually, on an average.

A longer period of employment of both the landholding cultivators and the landless agricultural labourers in 24-Parganas definitely points to the fact that 24-Parganas is a more developed district, economically and industrially, and that the wave of urbanisation has touched it to a far greater extent. It is, here, statistically corroborated while looking at the employment pattern in agriculture.

(f) Landless labourers: Average number of days of unemployment -

While considering the families of landless agricultural labourers in 24-Parganas, we have come to notice that the average number of days of employment, covering as many as 76 such families in this district, is 188.93. Now the average number of days of unemployment, in this case, comes out as follows

$300 - 188.93 = 111.07$
Thus the landless labourers in cases of our sample holdings in 24-Parganas get no work for about 3 months and 21 days per year. It is to be pointed out, in this case, that the period of seasonal unemployment both among the landholding class of cultivators and the landless class of agricultural labourers is longer in Midnapore than in 24-Parganas. This again is the confirmation of the fact that in 24-Parganas there exist greater provisions for jobs for the cultivators and the agricultural labourers during the off-season, when they are threatened with the grim consequences of seasonal unemployment. This is mainly due to the fact that in matter of industrial-urban development the district of 24-Parganas enjoys a superior position as compared to the district of Midnapore and, this apart, the former's proximity to the city of Calcutta helps provide some off-season work.
Statistical Correlations: Number of man-days used, family size and size of holding

Now we can turn the spotlight of our discussion to certain aspects of statistical correlations. First, we may have correlation between the number of man-days actually used on the holding \( X_1 \) and the family size \( X_2 \). Next, we may find out correlation between this \( X_1 \) and size of holding \( X_3 \). Thereafter, the correlation between \( X_2 \) and \( X_3 \) may be found out.

Here, through such correlations we can study how the changes in the number of man-days used, i.e. \( X_1 \), are influenced by the changes in the family size i.e. \( X_2 \), and also by the changes in the size of holding, i.e. \( X_3 \). Again we may find out correlation between family size \( X_2 \) and size of holding \( X_3 \). Hence both for the 170 families in Midnapore and for the 190 families in 24-Parganas we may note the correlations between (i) \( X_1 \) and \( X_2 \), (ii) \( X_1 \) and \( X_3 \) and (iii) \( X_2 \) and \( X_3 \), which are denoted by (i) \( r_{12} \), (ii) \( r_{13} \) and (iii) \( r_{23} \), respectively.

For details about the formulae of the correlation coefficients \( r_{12} \), \( r_{13} \), and \( r_{23} \), we may turn to the Appendix to this chapter (Section 53.3).
to this chapter (Section 5A.4). By substituting the values of $X_1$, $X_2$, and $X_3$ in the equations as shown in the Appendix, the values of the above correlation coefficients for both the sets of families in the two districts have been worked out.

A. District Midnapore

After substituting the values of $X_1$, $X_2$, and $X_3$ for the 170 families in this district, we get the values of the correlation coefficients $r_{12}$, $r_{13}$ and $r_{23}$ as follows:

$$r_{12} = 0.52$$

Thus in Midnapore, the actual use of the number of man-days on the holdings is positively correlated with the family size to the order of 0.52. Thus use of man-days will increase with the increase in family size but to the extent shown by the value of $r_{12}$. The correlation is here neither too high nor too low.

$$r_{13} = 0.93$$

In this case, the correlation figure is very high. This means that there is a high positive correlation between the use of
man-days and the size of holding. If the latter increases, the former will rise quite significantly.

And 

\[ r_{23} = 0.53 \]

Here, the correlation is positive but is of moderate order. Family size, in the district of Midnapore has moderate (neither very high nor very low) correlation with the size of holding.

Now let us come to the partial correlations. In this case first we consider the correlation between \( X_1 \) and \( X_2 \) eliminating \( X_3 \). That is, the value of \( r_{12.3} \) is to be found out. Next, we consider the correlation between \( X_1 \) and \( X_3 \) eliminating \( X_2 \). Here, the value of \( r_{13.2} \) is to be found out. For the formulae of partial correlations we may turn to the Appendix (Section 5A.4).

After substitution of the values of simple correlations in these formulae, we get

\[ r_{12.3} = 0.083 \]

and

\[ r_{13.2} = 0.900 \]

Now we can note that in the district of Midnapore the positive correlation between the number of man-days
actually used on the holding and the family size is not high if we eliminate the influence of the size of holding. Thus, without eliminating the influence of the size of holding the correlation between the number of man-days used and the family size is 0.52 and after elimination, that is, taking $X_3$ as constant, this correlation comes down to 0.08. This means that the rather strong relationship between number of man-days used and family size as indicated by 0.52 is misleading. Actually, if the size of holding is kept fixed, then the relationship between number of man-days used and family size will be very negligible indeed.

As for the correlation between the number of man-days used and the size of holding, eliminating the influence of the family size in this case, that is, taking $X_2$ as constant, the figure is quite high. Here, this correlation between $X_1$ and $X_2$ is as high as 0.90. The interesting point is that if we take into account the influence of the family size, the said figure does not change very much. It only increases a little. Thus, taking the influence of $X_2$ into consideration, the positive correlation between $X_1$ and $X_3$ in Midnapore is 0.93.

This proves that the effect of the family size on the number of man-days used is, of course, there but the
effect is not very strong. Here, it remains a fact that the effect of the size of holding on the actual number of man-days, used on the holding, is very strong and much stronger than the effect of the family size.

B. District 24-Parganas:

Reverting to the case study of 24-Parganas in the matter of these correlation aspects we get the following picture.

As regards 190 families in this district, after substitution of the values of $X_1$, $X_2$ and $X_3$, we get the values of the correlation coefficients $r_{12}$, $r_{13}$ and $r_{23}$ as follows:

$$r_{12} = 0.69$$

Here, $X_1$ or the number of man-days used and $X_2$ or the size of the family is positively correlated. Thus with the rise in $X_2$, $X_1$ will also increase and the rise is to the extent of 0.69. It is more or less high. Here, this correlation figure is a little higher than what it is in Midnapore. The effect of the size of holding is not eliminated in this case. This correlation figure is higher in 24-Parganas than the corresponding figure in Midnapore.
Here, the positive correlation between $X_1$ and $X_3$ is very high.
The effect of $X_2$ or the family size, here, is not negated. The figures of 24-Parganas and Midnapore in this case are nearly the same.

$$r_{13} = 0.95$$

Thus, the family size and the size of holding is positively correlated, the correlation figure being more or less high, that is, of the order of 0.63. It is a little higher than what it is in Midnapore.

Now let us come to the values of the partial correlations. Here, after substitution of the values of simple correlation we get the values of $r_{12.3}$ and $r_{13.2}$ as follows:

$$r_{12.3} = 0.43$$

Eliminating the influence of $X_3$ (the size of holding) the correlation between $X_1$ and $X_2$ comes to the tune of 0.43(£o). Here, $X_3$ is taken constant, but without taking it constant, the above correlation is of the order of 0.69. Hence, the strong relationship between the number of man-days used and the family size as indicated by 0.69 is also misleading, because keeping the size of holding fixed, the above rela-
tionship becomes weak. The fall of the correlation figure (showing the correlation between the number of man-days used and the family size) due to the negation of the influence of $X_2$, here, is greater in Midnapore, as compared with that in 24-Parganas.

And now $r_{13.2} = 0.92$

The correlation between $X_1$ and $X_3$ is very high, even after elimination of the influence of $X_2$. Whereas, including the influence of $X_2$ this figure registers a very slight increase, that is, the figure there reads 0.95. Here, also, as in Midnapore, though the effect of family size on the number of man-days, actually used, has made itself felt, never-the-less, the effect here is not very strong. The effect of the size of holding in this case is obviously all the greater, as evidenced from the lower value of $r_{12.3}$ as compared with the value of $r_{12}$.

Some general observations:

This brings us to the point that the actual number of man-days used on the holdings is positively correlated with both the size of family and the size of holding. Thus, with the increase in the family size or in the size of holdings, there will be rise in the employment of man-days on the holdings. This holds true in both the cases of Midnapore
and 24-Parganas. In Midnapore as well as in 24-Parganas both the correlations between $X_1$ and $X_2$, that is, $r_{12}$, and between $X_1$ and $X_3$, that is $r_{13}$, have positive values. What is more, in both the districts there is higher correlation between $X_1$ and $X_3$ than between $X_1$ and $X_2$. Again, the partial correlations between $X_1$ and $X_2$, eliminating $X_3$, in both Midnapore and 24-Parganas (i.e. the values of $r_{12.3}$) are much lower than the correlations between $X_1$ and $X_3$, eliminating $X_2$ (i.e. the values of $r_{13.2}$) in these districts. But the difference between the value of $r_{12.3}$ and that of $r_{13.2}$ is much wider in the case of Midnapore.

All the foregoing analyses bring us to the conclusion that, the effect of $X_2$ or family size on $X_1$ is smaller than that of $X_3$ or the size of holding. This is borne out by two considerations:

(a) $r_{12} < r_{13}$

(b) $r_{12.3} < r_{13.2}$

It is statistically corroborated in both the districts.

That the size of holding has very strong effect on the number of man-days used means that with the increase, as
for example, in the size of holding of a farm, there will be significant rise in the number of man-days used by that farm on its holding. Here it is imperative on the part of the farmers to make use of more man-days for the farming operations for the larger size of holdings. Thus, as cultivable tracts expand in size, more labour-hours or labour-days are to be used for cultivating the increased size of holdings. Hence, it is quite obvious that the positive correlation between the number of man-days used and the size of holding must be very high.

But the increase in the family size cannot influence the number of man-days to the extent to which the increase in the size of holding can. For one thing, if the members of a farm family increase in number, it does not necessarily mean that the new members will be put to the task of farming operations. If there exist opportunities for non-farming occupations where the opportunity cost of farm members may be much higher, there may be off-farm migration. Higher level of educational attainment and lower age structure of the new members of the farm family, may favourably influence the trend of off-farm migration. This apart, individual temperament, choice and preference pattern of the family members regarding the occupational activities count much in this case. Thus, mere increase in family size cannot significantly raise the number of man-days
used on the holdings. Of course, the correlation between the number of man-days used and family size can not be inverse (negative). But the correlation, though positive, can not be high.

So it is not surprising that the effect of the size of holding is stronger than that of the size of family on the number of man-days used on the holdings.

In the case of an agriculture-dominated economy like that of ours, structural unemployment gets mixed up with underemployment. In our agriculture where the man-land ratio is quite adverse, the population keeps pressing heavily on land and thereby aggravates the crisis of underemployment. As statistically verified in our sample survey, there is excess supply of man-days per acre. Hence, employment, labour units, measured in man-days, in this case, with regard to a more or less given size of holding is made much in excess of what should be made for this size for their being gainfully employed. This surplus use of man-days per acre, the rate of wastage of labour-units (measured in man-days) used on the holdings clearly indicates that there exist on the holdings redundant labour units, consequent upon the excessive labour pressure on a more or less given unit of land. This is due to maladjustment between the rate of growth of labour and the rate of land utilisation and hence a structural imbalance
between labour and land. Thus, after all, the phenomenon of intermingling of structural unemployment and disguised unemployment has been statistically verified in our sample survey. It is here that one major problem of underemployment, that is, the structural one of disguised unemployment comes to its own.

This pressure of population on agricultural lands, it is clear, gets heavier but the surplus agricultural population, as evidenced in the cases of our sample holdings, do hardly find any opportunity for off-farm migration. Thus, the opportunity cost of this surplus labour is zero. What is more, our agriculture has not yet acquired the capacity to absorb, on a large scale, either better technical methods (e.g., system of I.Y.V. cultivation) so that the labour units may be put to more intensive uses or the system of multiple cropping in which case there may be more extensive (extending over a long period of time) use of labour. After all, it remains a fact, as revealed by our sample survey, that there exist agrarian excess or surplus population in the agricultural sector of our survey districts. Its explanation may be found in adverse man-land ratio, zero opportunity cost, lack of either intensive or extensive use of labour in agriculture, and structural readjustment between land and labour, etc., etc.

Size of holding, it may be pointed out here, has been noted in our findings as a very vital factor of consideration in matter of employment of man-days per acre. It
has been statistically verified in our study that there is a very high and strong correlation (positive correlation) between the number of man-days used on the holdings and the size of holding. The effect of this size of holding, as noted in our study, is even much stronger than the effect of the family size on the number of man-days used. This goes to indicate that there is much significance of the size of holding, so far as the employment of man-days or investment of labour in agriculture is concerned. Our definition of underemployment in terms of area or acreage aspect, as explained in chapter I, finds its logic in it.

In our study, again, the extent of disguised unemployment, as evident in the districts of Midnapore and 24-Parganas, has a definite connection with the extent of seasonal unemployment, as revealed by our sample survey in these districts. Had there been shorter periods of seasonal unemployment, there would have been less intensity of the problem of disguised unemployment. For one thing, seasonally idle labourers are definitely underutilised when, as observed in the cases of our sample holdings, they try to eke out their living during the slack season being engaged in some less productive activities where their full labour potential is underutilised. Again, it is due to the seasonal variation of demand for labour in agriculture that the labourers in this sector are to do the amount of work which is much less than
what they are potentially capable of doing. It is because these labourers are capable of doing the work for a much longer period of time and, as a matter of fact, they would have been provided with more days' work but for the slump of demand in some particular seasons. Another major problem of under-employment, that is, the seasonal one of unemployment becomes evident in this case.

We have statistically verified in our survey that there is seasonality in agriculture of our survey districts in this State of West Bengal. Seasonal idleness is, here, more a rule than an exception. The man behind the plough has not yet been able to ignore the vagaries of nature. Crop rotation or multiple cropping in agriculture are the things for which we have yet a long way to go. A good system of water management in our agriculture is still a far cry. In our sample coverage in both the districts, under our survey, (namely, Midnapore and 24-Parganas) even an area of 20% has not yet been covered under proper irrigation. The improved method of high-yielding cultivation is not yet within the reach of scores of cultivators of these districts. For the very limited progress of this type of cultivation in which labour can be used more intensively and the snail-pace movement of progress of the system of multiple cropping or crop rotation whereby labour can be put to more extensive use, the year over, the worries of off-season unemployment persist. In our study we have come to note in the
context of our sample farms that the landless agricultural labourers, here, on an average, remain seasonally unemployed for about 4 (four) months in a year. The cultivation of the major crop like local Aman can at best give employment to a labour for about 6 (six) months. After this period of work, the land-less agricultural labourers, as revealed by our field investigation, are somehow to manage to get themselves engaged in various other work, of less productive types, where they are found engaged for not more that 2 months on an average. In fact, the remaining 4 months have nothing to give to this unwieldy labour class.

Now, it is clear that the interaction of a host of factors, like poor irrigation system, adverse man-land ratios, lack of multiple cropping, absence of technically improved methods of farming, faulty planning, non-economic motivations, and a very low rate of off-farm migration, etc. prevents more productive utilisation of the force of underemployed labour comprising both the disguised unemployed and the seasonally unemployed. Problems of disguised and seasonal unemployment are the two major problems of underemployment. Putting it the other way round, these two problems of underemployment are said to be the seasonal one.
of unemployment and the structural one of disguised unemployment. Naturally, therefore, all plans for improvement of the employment situation in agriculture must be oriented toward an effective control over these two major problems of underemployment.

The hypothesis of surplus labour in agriculture has, after all, been statistically verified in the cases of our sample farms spreading over the survey districts of Midnapore and 24-Parganas. As a matter of fact, both the two aspects of underemployment — disguised unemployment and seasonal unemployment — can be said to characterise, most notably, the agricultural employment problem of our two survey districts which cover about one-third of the total land area of the State of West Bengal.

Now, let us turn to some of our final conclusions over this issue of agricultural employment and put up certain proposals for improvement against a realistic perspective. A model of labour utilisation at this stage may also be developed in order to prove that the aggregate disequilibrium of demand for and supply of labour in agriculture is the main destabilising factor on the agricultural employment front. For this we turn to the next chapter.
APPENDIX TO CHAPTER V

SECTION 5A. 1

Derivation of Norms

A. District — Midnapore:

As for Midnapore, for each of the five villages covered by the controlled farms by the Department of Agriculture, Calcutta University, the following five figures may be noted. In this case, each such figure indicates the actual use of man-days in the farming operations of the said farms in each village. For different varieties of rice crop, different labour hours are worked out corresponding to each village. And, for each village, we get a mean value of all these different labour-hours.

<table>
<thead>
<tr>
<th>Village</th>
<th>Labour-hours for different varieties</th>
<th>Mean of labour-hours (per-hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>355, 1046, 736, 875, 540</td>
<td>810</td>
</tr>
<tr>
<td>II</td>
<td>745, 530, 496</td>
<td>607</td>
</tr>
<tr>
<td>III</td>
<td>845, 1044, 353, 798, 1076</td>
<td>924</td>
</tr>
<tr>
<td>IV</td>
<td>755, 860, 697, 322, 785, 806</td>
<td>788</td>
</tr>
<tr>
<td>V</td>
<td>395, 856</td>
<td>876</td>
</tr>
</tbody>
</table>

From the above figures, the labour-days per hectare taking 8 hours per day as the normal working period and also the labour-days per acre, taking the conversion ratio: as 1 hectare = 2.5 acres, have been worked out as follows:
The average number of man-days per acre, in this case, is $199.2/5 = 39.84$. Or, this can be taken approximately as 40. To this 15 labour-days per acre necessary for land-preparation have been added, which were not taken into account in the original estimation of labour-hour per-hectare. Thus, the standard number of man-days per-acre which should be used for a full cultivation operation of Aman variety of rice crop in the district of Midnapore has been worked out at $40 + 15 = 55$. This figure is, then, the norm for this district.

B. District 24 - Parganas:

Regarding the district of 24 - Parganas, for one village covered by the controlled farms, the following figure is available. This figure is, as well, a mean for the village.
concerned.

<table>
<thead>
<tr>
<th>Village</th>
<th>Labour-hours for different varieties</th>
<th>Mean of labour-hour (per hectare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>950,1103</td>
<td>1010</td>
</tr>
</tbody>
</table>

From the above figure, the labour-days per hectare and the labour-days per acre have been worked out in the same way as it has been done (shown earlier) in the case of Midnapore. Now, we get

<table>
<thead>
<tr>
<th>Village</th>
<th>Labour-days (per hectare)</th>
<th>Labour-days per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>126</td>
<td>50.4</td>
</tr>
</tbody>
</table>

The mean value of the number of man-days per acre, in this case, is thus 50.4 or approximately 50. Here, as well, like Midnapore and for the same reason as cited there, 15 man-days per acre have been added to the figure of 50. Therefore, the standard number of man-days which should be used per acre for a full cultivation operation of a man in the district of 24-Parganas has been worked out at 50 + 15 = 65. This figure, therefore, is taken as a norm for this district.
SECTION 5A.2

Working out of the average for five districts in West Bengal regarding the use of man-days per acre

As regards the cultivation of Aman crop, corresponding to different periods, the total estimates of areas, and of man-days, woman-days and child-days, both of family and hired labour, of all the sample holdings for the total selected villages spread over the districts of 24-Parganas, Nadia, Hooghly, Burdwan and Birbhum of the State of West Bengal are as follows:
<table>
<thead>
<tr>
<th>Period</th>
<th>Area (in acres)</th>
<th>Family Labour</th>
<th>Hired Labour</th>
<th>Total Number of man-days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Man-days</td>
<td>Woman-days</td>
<td>Child-days</td>
<td>Man-days</td>
</tr>
<tr>
<td>1962-63</td>
<td>644.70</td>
<td>10232.50</td>
<td>111.50</td>
<td>15.75</td>
</tr>
<tr>
<td>1963-64</td>
<td>310.80</td>
<td>3531.75</td>
<td>100.00</td>
<td>14.50</td>
</tr>
<tr>
<td>1965-66</td>
<td>1066.04</td>
<td>14384.60</td>
<td>824.75</td>
<td>182.70</td>
</tr>
<tr>
<td>1966-67</td>
<td>505.79</td>
<td>7190.00</td>
<td>126.75</td>
<td>124.50</td>
</tr>
<tr>
<td></td>
<td>2527.33</td>
<td>25266.85</td>
<td>1173.00</td>
<td>337.45</td>
</tr>
<tr>
<td></td>
<td>879.75</td>
<td>168.725</td>
<td>12945.00</td>
<td>273.25</td>
</tr>
</tbody>
</table>

Total Number of man-days:

- Family labour: 25266.85 + 879.75 + 168.725 = 26317.325 man-days
- Hired labour: 83339.53 + 12945.00 + 273.25 = 113816.78 man-days
Total area (acres)  |  Total man-days (family labour) |  Total man-days (hired labour)
--- | --- | ---
2527.33 | 26317.325 | 113816.78

Average (Man-days per acre):
For family labour: 11 (approx.)
For hired labour: 45

Man-days per acre, taking both family and hired labour: 56

Average number of man-days used for the cultivation of Aman and Aus crops taken together:

Total acreage | Total man-days (Family labour) | Total man-days (Hired labour)
--- | --- | ---
3053.04 | 47046.3575 | 115736.130

Average (Man-days per acre)
For family labour: 15 (approx)
For hired labour: 38 (approx)

Man-days per acre, taking both family and hired labour (for both Aman and Aus cultivation, taken together): 54.
SECTION 5A.3

Derivation of the formula for finding out the average wastage of man-days

To find out the average wastage of man-days (if there be any) in the cases of 170 farm families in the district of Midnapore and 190 families in the district of 24-Parganas, as have been covered under our field investigation in these two survey districts in the State of West Bengal, the mathematical formula adopted is as follows.

In the present system of equations, there are two variables and one constant. The variables are denoted by $X$ and $Y'$, while the constant is denoted by '$a$'. The sign $\Sigma$ denotes the aggregate over all holdings. The constant '$a$' is nothing but the norm (as already noted in chapter V) and $X$ is the size of holding. Thus, $aX$ means the number of man-days that should be used on the holding. Another symbol used here is '$Y$' which means the number of man-days wasted. So, here,

$$Y = Y' - aX$$

since $Y'$ is the number of man-days actually used on the holdings.

Rate of wastage (or number of man-days wasted per acre) is,
Therefore,

$$\frac{\sum (y' - aX)}{\sum X}$$

Now,

$$y = y' - aX$$

or,

$$\sum y = \sum y' - a\sum X$$

or,

$$\frac{\sum y}{\sum X} = \frac{\sum y'}{\sum X} - \frac{a\sum X}{\sum X}$$

or,

$$\frac{\sum y}{\sum X} = \frac{\sum y'}{\sum X} - a$$

Hence, \textit{Rate of Wastage} = \frac{\sum y'}{\sum X} - a

since \(\frac{\sum y}{\sum X}\) is the total number of man-days wasted per unit of the total size of holdings in acres, that is, the number of man-days wasted per acre.
A note on statistical concept and formulae of correlation coefficients

In statistical analysis, the problems of correlation are to show whether two variables, as for example, the number of man-days used per acre for rice cultivation and the size of the cultivating family, or again the family size and the size of holding, and so on, are related and, if so, in what way. In economic analysis, finding out the correlation between such variables, more often than not, becomes extremely useful for the explanation of certain economic phenomenon. There is, in statistical method, a practice of finding out the correlation between two variables. This is to work out a measure of such correlation. This measure of correlation is called correlation coefficient which, in statistical practice, is denoted by the symbol 'r'. This serves as a satisfactory measure of the general relationship between the two variables only when that relationship is of the linear type.

Now, the computation of 'r' gives a value which may be positive or negative. The value of 'r' fluctuates within a range where the higher limit is +1 and the lower limit is -1. If the variables are independent, the value of r = 0. If there is an exact linear relationship between the variables, the value of r = ±1. 
the value of $r = + 1$ for variables which increase together. If there is an exact linear relationship such that when one variable increases the other decreases, then $r = -1$. As the value of $r$ gets closer to $+1$ or $-1$, there is very high correlation and as it comes nearer 0 (zero), there is very low correlation. When $r$ is positive, we have a case of direct linear relationship, so that as one variable increases, the other also increases on the average. When the value of $r$ becomes negative, there is a case of inverse relationship between two variables, i.e. as one variable increases the other decreases on the average. Hence there may be positive correlation and also there may be negative correlation. The sign indicates whether the correlation is positive or negative, and the magnitude shows the degree of correlation.

**Calculation of the correlation coefficient:**

For the calculation of the correlation coefficient, that is, for the computation of $r$ we are to make use of some statistical formulae.

In our present problem (where the general relationship between the variables is assumed to be of linear type), we are to find out (i) the value of $r$ as between $X_1$ and $X_2$, that is, $r_{12}$; (ii) the value of $r$ as between $X_1$ and $X_3$, that
is, $r_{13}$; and (iii) the value of $r$ as between $X_2$ and $X_3$, that is, $r_{23}$. The corresponding formulae are:

(i) for the correlation between $X_1$ and $X_2$

$$
\gamma_{12} = \frac{n\Sigma X_1 X_2 - (\Sigma X_1)(\Sigma X_2)}{\sqrt{n\Sigma X_1^2 - (\Sigma X_1)^2} \times \sqrt{n\Sigma X_2^2 - (\Sigma X_2)^2}}
$$

(ii) for the correlation between $X_1$ and $X_3$

$$
\gamma_{13} = \frac{n\Sigma X_1 X_3 - (\Sigma X_1)(\Sigma X_3)}{\sqrt{n\Sigma X_1^2 - (\Sigma X_1)^2} \times \sqrt{n\Sigma X_3^2 - (\Sigma X_3)^2}}
$$

(iii) for the correlation between $X_2$ and $X_3$

$$
\gamma_{23} = \frac{n\Sigma X_2 X_3 - (\Sigma X_2)(\Sigma X_3)}{\sqrt{n\Sigma X_2^2 - (\Sigma X_2)^2} \times \sqrt{n\Sigma X_3^2 - (\Sigma X_3)^2}}
$$

In this system of equations, $n$ denotes the number of families. In our case, for Midnapore, $n = \text{170}$ and for 24-Parganas, $n = \text{190}$. As for other values in the equations, we find that:

For 24-Parganas:

$$
\Sigma X_1 = 115680.0 ; \quad \Sigma X_1^2 = 123979835.5 \\
\Sigma X_2 = 1517.5 ; \quad \Sigma X_2^2 = 16383.7 \\
\Sigma X_3 = 1433.5 ; \quad \Sigma X_3^2 = 18674.3
$$
\[ \sum x_1 x_2 = 1255451.5 \; ; \; \sum x_1 x_3 = 1488030.0 \]
\[ \sum x_2 x_3 = 15039.0 \]

and for Midnapore
\[ \sum x_1 = 89658.0 \; \; \sum x_1^2 = 85575503.0 \]
\[ \sum x_2 = 1204.5 \; \; \sum x_2^2 = 11333.0 \]
\[ \sum x_3 = 1111.5 \; \; \sum x_3^2 = 12915.8 \]
\[ \sum x_1 x_2 = 804159.4 \; \; \sum x_1 x_3 = 1017426.0 \]
\[ \sum x_2 x_3 = 9974.3 \]

These have been used to work out the values of \( \tau_{12}, \tau_{13} \) and \( \tau_{23} \) in chapter V.

As regards family size or \( x_2 \), for each family surveyed in either district each woman-unit and each child-unit have been converted into an equivalent number of man-units through the following conversion ratios:

1 female member = \( \frac{3}{4} \) male member and 1 child member = \( \frac{1}{2} \) male member. These are also called 'Efficiency ratios' of female and child labour respectively. In this way, the different family sizes have been made comparable.
Partial correlation:

One point that is to be noted while we consider the relation between two variables, say $X$ and $Y$, is that there may often be other variables which may have some influence on both $X$ and $Y$. This influence may distort the true relationship between $X$ and $Y$. The simple correlation between $X$ and $Y$ does not eliminate the influence of these influencing variables. As for example, in our case, we have noted the correlation as measured by $r_{12}$. However, the values of $r_{13}$ and $r_{23}$ indicate that $X_3$ also has some effect on both $X_1$ and $X_2$.

Now, we may like to know what the degree of relationship between $X_1$ and $X_2$ would be if the effect of $X_3$ could be eliminated from each. This purpose is served by using the partial (net) correlation between $X_1$ and $X_2$ eliminating $X_3$. In order to measure the partial correlation, we first deduct from $X_1$ the part that is explained by its linear regression on $X_3$ and similarly deduct from $X_2$ the part that is attributable to its linear regression on $X_3$. The simple correlation coefficient between the residuals is the partial correlation coefficient between $X_1$ and $X_2$ eliminating $X_3$, which is denoted by $r_{12.3}$. The coefficient $r_{13.2}$
likewise is the partial correlation coefficient between $X_1$ and $X_3$ eliminating $X_2$ and is meant to measure the relationship between $X_1$ and $X_3$ uninfluenced by the variable $X_2$.

The formulae for these partial correlation coefficients are:

\[
\gamma_{12:3} = \frac{\gamma_{12} - \gamma_{13} \cdot \gamma_{23}}{(1 - \gamma_{13}^2)^{\frac{1}{2}} \cdot (1 - \gamma_{23}^2)^{\frac{1}{2}}}
\]

\[
\gamma_{13:2} = \frac{\gamma_{13} - \gamma_{12} \cdot \gamma_{23}}{(1 - \gamma_{12}^2)^{\frac{1}{2}} \cdot (1 - \gamma_{23}^2)^{\frac{1}{2}}}
\]
We find from the values of the simple correlation coefficients (already obtained in 5A.4) that for Midnapore

\[
\begin{align*}
    r_{12} & = 0.26615281 ;
    r_{13} & = 0.85969984 \\
    r_{23} & = 0.27867841 ;
    r_{13} \cdot r_{23} & = 0.43946888 \\
    r_{12} \cdot r_{23} & = 0.654656
\end{align*}
\]

and for 24 - Parganas

\[
\begin{align*}
    r_{12} & = 0.48260809 ;
    r_{13} & = 0.89965225 \\
    r_{23} & = 0.3946356361 ;
    r_{13} \cdot r_{23} & = 0.588250215 \\
    r_{12} \cdot r_{23} & = 0.430845993
\end{align*}
\]

These have been used in order to obtain the values of

\[
\begin{align*}
r_{12.3} \text{ and } r_{13.2} & \text{ in chapter V.}
\end{align*}
\]
REFERENCES
