Chapter VI: Estimation of Output
The chief aim of agriculture, like any other productive activities, is to maximise output. But the level of output differs from region to region, from village to village and even from one farm to another. The level of output depends, to a large extent, on the relative factor endowments of different areas. But agricultural output is dependent mainly on two factors: cultivated area of land and the yield per unit of land cultivated. Yield depends upon such factors - as the quality or fertility of land, other agro-climatic conditions and the technology in use.

Since land is the most productive asset of agriculture, the level of output depends largely on the size of land under cultivation. But the quantity and quality of land available for cultivation varies from village to village and from region to region. It is generally assumed that larger size of holding means larger output and vice-versa. A large size of holding can absorb more labour than the small and marginal farms. Larger the holding size more is the requirements for labour; and more labour leads to more output. The small and marginal farms not only have less employment potential but are generally inadequate to absorb even the family labour. This leads to the predominance of disguised and under-employment problems in agriculture of the developing economy.

Holding size reflects the general economic conditions of the farm households. Larger the holding size, greater
is likely to be the prosperity of the farm households and vice-versa. Besides, large holdings are relatively more amenable to mechanisation, and are economically and technologically more viable than the small and marginal farms. But in jhum cultivation, which constitutes the most popular method of cultivation in Mizoram, the employment of modern technology is limited by the method itself, and settled cultivation is likely to have better scope for technological improvement which tends to raise the level of output both in absolute and average terms.

Thus, the level of output is supposed to be positively related to the holding size and the level of employment. At the same time, a large farm is likely to have more employment potential and is economically and technologically more viable for scientific cultivation than the small holdings.

But the adequacy and inadequacy of land and output depends largely on the size of the family. A large family means more requirement for all necessities, conveniences and especially those of foodgrains that lead to greater requirement for land. A large family is also supposed to have greater supply of labour than the smaller families. The level of output and holding size which is sufficiently large for a small family may be far below the requirements of the large families. Therefore, a positive relation between family and holding size may be postulated.
In Mizo society especially among the jhumias, land is distributed according to family size. As such, a large family is likely to have a larger size of holding, and is supposed to produce more output than the small families; and a larger size of holding is supposed to yield higher levels of output. Thus, the size of the family, holding size and output are supposed to be positively related. Therefore, if the family size differs significantly between jhum and settled cultivators, this may lead to significant differences between holding size and output between the two modes of production, such differences between output levels should be attributed to the size differences of the holdings via differential family sizes.

For considering the size distribution both the holdings and the families have been classified into appropriate size groups. In order to overcome the difficulty that may arise due to size groups that may be so large as may render meaningful analysis difficult, central value is used as a representative statistics. In view of the Arithmetic mean being generally sensitive to the presence of extreme values, Median is also used as the measure of central value so that such aspects may not be hidden by the Arithmetic Mean.

In view of the above considerations, we have tried to examine the nature of the size distribution of the farm.
households with respect to their influence on output. As
the supply of family labour depends upon the family size,
it may be interesting to examine if the productivity of
land and labour differ between holdings of different size
groups and between the settled and jhum holdings. We
have therefore, examined the relative land-labour produc-
tivity in settled and jhum cultivation.

6.1 Size of Family and Output

The family size is an important factor as a source
of labour supply and hence as a determinant of the holding
size, consumption requirements and dependency ratio all of
which have important impacts on output. As the state faces
labour shortage, labour supply may exercise constraining
influence on output even otherwise. In general, larger
the size of the family, more is the supply of labour and
vice-versa.

Mean and Median Differences of Family Size

We have examined the Mean and Median differences
of the family size between jhum and settled cultivations.
The median family size of jhumias in the two villages taken
together is 6.83. As against this, the mean size of the
family of jhumias is 7.68 which is greater than the median
size. The mean and median family size of settled cultiva-
tors are 8.25 and 7.95 respectively. In this case also,
the mean size is slightly greater than the median family size. On this bases, we assumed that whether we test the difference between the mean or median family size of jhum and settled cultivators, it should meet our analytical purpose qualitatively and quantitatively. Thus, we have examined both the mean and median family size of jhum and settled cultivators. Since the two samples are assumed to have been drawn independently from the same population, the standard error of the mean difference has been calculated by formula (1). The standard error of the mean differences is .41, while the observed difference is .57. Thus, the ratio of the observed difference to the standard error is 1.39, which is not significant statistically. The standard error of median difference is .73, whereas the observed difference is 1.12. The ratio between the observed median difference to the standard error is equal to 1.5, which is also not significant statistically. These results both conform to our hypothesis that testing of the mean and median differences should yield similar results both qualitatively and quantitatively. Thus, the difference between the family size of the two types of cultivators is statistically zero.

Our test of the mean and median differences in the holding size reported in the previous chapter have shown that the size of holding in settled cultivation is
significantly larger than that of jhum. The estimated results of the correlation between the two factors - family size and holding size - has shown that the coefficient of correlation is significant in both the cases; and the explained proportion of the variation in holding size is 64 per cent in jhum, while it is 9 per cent in settled cultivation. The calculated values of the regression coefficients have shown that an unit increase in the family size of jhumias is followed by a .39 acres increase in the holding size, while an unit increase in the family size of the settled cultivators leads to an increase in the holding size by .125 acres.

**Mean and Median Difference of Output**

We have also tested the mean and median differences of output with respect to the size of the family. The calculated values of the mean and median output in jhum are 19.8 quintals and 17.39 quintals respectively for settled cultivation. The standard error of the mean difference of output is .64, while the observed difference is .50. Thus, the ratio of the mean difference to the standard error is 8.125 which is statistically significant. Thus, on an average, the settled cultivation yields significantly higher level of output than jhum cultivation. In fact, the average level of output of the settled cultivation is 1.6 times of the corresponding output level of jhum cultivation. Thus,
the conversion of jhum into settled holdings is a desirable objective on economic grounds. This will mitigate the food deficit of the state to some extent. It will also ameliorate the economic conditions of the farmers. It will lead towards optimum use of land resources, and it will also prevent the environmental degradation associated with the jhum. The differential levels of output of the two modes of cultivation also warrants the investment required for the conversion programmes. Over a period of time, the differential output will itself pay for the requisite investment.

The observed difference between the median output levels of the two modes of cultivation is 5.91 and the standard error is 2.48. The ratio of the difference to the standard error is 2.48 which is statistically significant at 5% level. Thus, this result also conforms to our hypothesis that testing of mean or median difference should yield more or less similar results.

The nature and extent of interrelation between the family size and the level of output is examined by means of regression-correlation analysis worked out for jhum and settled cultivation separately. The coefficient of correlation between these two variables in jhum cultivation is .74, while it is .36 for the settled cultivation. In both the cases, the coefficient of correlation is significant corresponding values being 9.49, and 3.2, for 74 and 69 degrees of
freedom. Thus, 55 per cent of the total variation in the output of jhum cultivation is accounted by the variation of the family size which may be acting as a proxy of the supplies of land and labour to the cultivating households. But the family size accounts for only 13 per cent of the total variation of output in settled cultivation which is relatively low, though significant. Factors other than family size explain 45 per cent of the total variation of output in jhum, while such factors explain as much as 87 per cent of the total variation in the output of settled cultivation. In this case, the large number of observations appears to have made the correlation coefficient significant in spite of its low magnitude.

In view of the significant correlation between these two variables, we have fitted the regression equation by means of Ordinary Least Squares Method. The estimated equations are given below:

\[
\begin{align*}
Q_j &= 14.97 + 0.63F_j \\
\text{R}^2 &= 0.55 \\
t &= (9.49) \\
F &= (90.44) \\
Q_s &= 23.28 + 0.2F_s \\
\text{R}^2 &= 0.13 \\
t &= (3.2) \\
F &= (10.31)
\end{align*}
\]

where \(Q_j\) and \(F_j\) refer to output and family size of jhum respectively and \(Q_s\) and \(F_s\) refer to the output and family size of settled cultivation respectively.
The estimated parameters have the expected values and are significant in both cases. Correspond to an unit increase in the family size, the output level of jhum increases by .63 quintals, so this equation gives empirical support to our hypothesis that the level of output depends upon the size of the family. But the relation is relatively weak in case of the settled cultivation. Correspond to an unit increase in the family size, the level of output increases by .2 quintals. Even otherwise, this relation appears to be weak as has been explained earlier.

6.2 Size of Holding and Output

Output generally depends upon the quantity of factor inputs, their quality and the technology employed in the production process. So far as agriculture is concerned, the quantity and the quality of land cultivated is the single most important factor input. Size of holding generally reflects the potential inputs of land into the agricultural processes. In fact, the availability of other factor inputs like labour, the nature and level of technology, water, fertilizers, power, high quality seeds, etc. are highly interrelated with the holding size.

Larger farms have greater employment potentials than the small and marginal farms; and such farms offer greater scope for high level technology. A farm which has more
employment potential and is economically and technologically viable has greater output potential. As such a large farm is supposed to produce more output than the small and marginal farms. In short, larger the size of holding, higher will be the level of output, and smaller the size of holding lower will be the level of output.

Therefore, the analysis of the differences of the mean and median holding size under jhum and settled cultivation may throw light on the differential output levels of the two modes of cultivation. The mean size of holdings under jhum and settled cultivation are 3.656 and 4.35 acres which are greater than the corresponding median size of holdings of 3.255 and 4.29 acres respectively. Thus, the mean holding size under settled cultivation is 1.19 times the holding size under jhum. But the corresponding median holding size under settled cultivation is 1.52 times the corresponding median holding size under the jhum.

The mean size of output is expected to be higher than the median size of output of the two types of cultivation. The mean size of output of jhum in the two villages taken together is 21.63 quintals, while the corresponding median size of output is 18.46 quintals. Similarly, the mean size of output in the settled cultivation is 24.88 quintals as against the median size of output of 21.4 quintals. Thus, the mean output level of the settled field
is 1.15 times the average output of jhum, while the median output is 1.16 times the median output of jhum. Thus, the values of the mean and median output levels conform to the hypothesis that the mean size of output is likely to be greater than the median output level. These results show that the productivity of land under settled conditions exceeds the corresponding average productivity of land under jhum.

On the basis of these results, we believe that the analytical inferences would not differ qualitatively and quantitatively, whether we test the mean difference or the median difference of holding size and output of the jhum and settled cultivation. But we have examined the mean and median differences of the holding size both in terms of the mean and median differences. Since the two samples are independent and drawn from the same universe, the standard error of the mean and median differences have been calculated by formula (1) and (2) respectively.

The calculated standard error of the mean difference of output is .53 while the observed difference between the mean size of output of the two types of cultivation is 3.25. The ratio of the observed difference to the standard error is equal to 6.13, which is statistically significant. These differential output levels may be attributed to the differences of holding size. The mean and median holding size are smaller under jhum than the corresponding size of
holding of settled cultivation. The mean and median size of holding of the two types of cultivation differ significantly, the corresponding t values being 3.7 and 4.5 respectively.

The observed difference between the median output levels of jhum and settled cultivation is 3.44, while the standard error of the difference is 2.8. The ratio of the observed difference to the standard error is 1.23 which is not significant statistically. Since our interest is not to find out the representative level of output but to find the difference in the average level of output between the two types of cultivation, the mean difference test and its statistical significance is quite enough to solve the purpose irrespective of the non-significance of the median difference.

On the basis of the above evidence, the correlation or association between the holding size and output levels may be expected to be high. We have directly tested the hypothesis by means of regression-correlation analysis worked out for jhum and settled cultivation separately. The coefficient of correlation between these two variables for jhum is .77, while it is .6 for the settled cultivation. In both the cases, the coefficient of correlation is statistically significant correspond t values being 10.26 and 6.23 for 74 and 69 degrees of freedom.
Thus, 59.3 per cent of the total variation in the output of jhum is explained by the changes in the size of holdings. Consequently, 40.7 per cent of the overall variation of output is explained by factors other than the holding size. Against this, changes in holding size explain only 36 per cent of the overall variation of the output of settled cultivation. The residual factors, thus, explain as much as 64 per cent of the output variation in this case. Therefore, these other factors excercise much greater degree of influence on output in case of the settled than the jhum cultivation. This is also evident from the estimated regression equations for the two cases which are as follows:

\[
\begin{align*}
\theta_j &= 18.4 + 0.88 L_j & R^2 &= 0.5929 \\
\theta_s &= 22.5 + 0.544 L_s & R^2 &= 0.36
\end{align*}
\]

where \(\theta_j\) and \(\theta_s\) refer to output, and \(L_j\) and \(L_s\) refer to holding size in jhum and settled cultivation respectively.

The estimated parameters have the expected values and are significant in both the cases. Correspond to an unit increase in the holding size, the level of output in jhum increases by 0.88 quintals. So this equation gives empirical support to our hypothesis that the size of output depends upon the size of holding.
In settled cultivation, an unit increase in the holding size leads to an increase in the level of output by .544 quintals. So, this equation also lends empirical support to our hypothesis. These increases at the margin also support our view that holding size exercises greater influence on output of jhum than that of settled holdings.

6.3 Employment and Output

Labour is an indispensable input in each and every line of production. In agriculture also, the importance of labour as an input cannot be belittled. Agricultural productivity depends, to some extent on the labour services. More labour means more production and vice-versa. Besides, the quantum of labour employed in the production furnishes income and hence the means of livelihood of those who get employment. Wages, in fact, happen to be the sole source of income to most of the workers who do not own any other factor of production such as land and/or capital. But the labour absorption capacity differs from sector to sector and even within the same sectors of the economy. Labour absorption capacity depends largely upon the nature of technology that is used in the production process.

Thus, the difference of employment level in the two modes of cultivation is likely to have some effects in production and productivity. If there is no such difference, the difference in output, if it exist, has to be explained
in terms of factors other than employment. The total number of labour employed can be grouped into certain representative size groups with reference to output. In order to examine such differences we have tested both the mean and median differences of employment and output of the two types of cultivation.

The mean size of employment in jhum is 3.5, while the median size of employment is 3.27 which is less than the mean employment level. The mean and median employment levels in settled cultivation are 4.32 and 3.71, respectively. In this case also, the median is less than the mean; and it does not matter whether we test the difference between the mean or median levels of employment in settled and jhum cultivation. But we examined both the mean and median differences of employment in the two types of cultivation. It is obvious that the average employment generated by a settled cultivation per holding is 1.23 times the mean employment level in jhum. Similarly, the median employment level in settled cultivation per holding is 1.13 times the corresponding median level in jhum. Thus, the settled cultivation produces not only higher output level but it also furnishes more employment than the jhum. On both these counts one can recommend control, if not total elimination, of jhum.

The calculated standard error of the mean difference is .34, whereas the observed difference is .82. The ratio
of the difference to the standard error is 2.41 which is statistically significant at 5 per cent probability level. The standard error of the median difference is .34, while the observed difference is .44 which is 1.3 times the standard error and is not significant. These results do not support our hypothesis that it is immaterial whether we test the mean or median difference. Irrespective of the fact whether we adopt mean or median as a measure of central value, the employment in the settled cultivation is consistently higher than that of jhum, statistical non-significance of the median difference notwithstanding.

We have already found that the average output of settled holdings is greater than those under jhum. Therefore, the output and employment differences may be systematically inter-related with each other. But we cannot draw any firm conclusion about the labour production. In order to be more specific, we have, therefore, directly examined output per worker in jhum and settled cultivation. The level of output per workers in jhum is 5.5 quintals, while for the settled cultivation, it is 6.85 quintals. Thus, the labour productivity of the settled holdings is 1.25 times that of jhum. It is, thus, obvious that both the primary factors of production, viz. land and labour, are more productively and efficiently utilised in settled than jhum cultivation.
The correlation or association between the two variables - employment and output - may be expected to be high. Thus, the nature and extent of interrelation between the two variables is evaluated by means of regression-correlation analysis. To our surprise, we find that the correlation coefficient between these two factors is .7 for jhum and only .28 for the settled cultivation. However, both the correlation coefficient are significant corresponding values being (8.433) and (2.423) for 74 and 69 degrees of freedom.

The explained proportion of variation in output in jhum is as much as 49 per cent, while it is only 7.84 per cent of the total change in case of settled cultivation. Factors, other than the employment, explain as much as 51 per cent of the total variation in the output of jhum, while such factors explain as much as 92.16 per cent of the total variation in the output of settled cultivation. The low magnitude of the explained proportion of variation in case of settled cultivation implies that the factors, other than labour, are more important determinants of output. Use of land-augmenting and output-raising inputs like water, fertilizers, etc., may hold the key to the explanation of the variation of output in settled cultivation.

In view of these results, we have fitted the regression equations to the data by means of Ordinary Least
Squares Method. The estimated equations are as follows:

\[
O_j = 18.57 + .56 E_j \quad R^2 = .49
\]
\[
t = (8.432) \quad F = (71.098)
\]
\[
O_s = 25.12 + .2 E_s \quad R^2 = (.0784)
\]
\[
t = (2.423) \quad F = (5.9)
\]

where \(O_j\) and \(E_j\) refer to output and employment of jhum and \(O_s\) and \(E_s\) refer to that of settled cultivation respectively.

The estimated parameters have the expected signs and values which are also significant in both cases. Correspond to an unit increase in the employment level, the output level of jhum increases by .56 quintals. So this equation has given empirical support to our hypothesis that output depends upon the level of employment.

But this relation, in settled cultivation, is relatively weak. Correspond to an unit increase in the employment level, output increases only by .2 quintals. Even otherwise, these results lend empirical support to the inferences that we have drawn from the analysis of correlation coefficient.

6.4 Production Function

We have also estimated the Cobb-Douglas Production Function by means of Ordinary Least Squares Technique. Area
under cultivation \(-L\), and the level of employment \(-E\), have been used to explain the level of output in jhum and settled cultivation separately. The estimated regression equations are reported below:

\[
\begin{align*}
\log \hat{O}_j &= 0.886 + 0.4 \log L_j + 0.5 \log E_j \quad R^2 = 0.98 \\
& (7.36) \quad (8.45) \quad F = 294 \\
\log \hat{O}_s &= 0.386 + 3.14 \log L_s + 1.15 \log E_s \quad R^2 = 0.95 \\
& (8.14) \quad (3.309) \quad F = 158.33
\end{align*}
\]

where \(O_j\), \(L_j\) and \(E_j\) refer to output, land and employment (labour) of jhum; and \(O_s\), \(L_s\) and \(E_s\) refer to those of settled cultivation, respectively.

The function fits the data well as the estimated functions explain 98 and 95 per cent of total variation in output in jhum and settled cultivation respectively. The elasticity coefficients have the expected signs and they are also statistically significant. The sum of the two elasticities in jhum is 0.9 which indicates that production is taking place under diminishing returns to scale. The returns for a scale can be discussed from the equation of the marginal and average productivities. The average productivity is to be evaluated at the Geometrical Mean Level and the marginal productivity can then be derived as follows:

\[
\hat{O} = aL^\alpha E^\beta
\]

(a) The marginal productivity of labour
\[ MP_L = \frac{\delta 0}{\delta L} = \alpha \cdot \alpha L^{k-1} E^\gamma \]
\[ = \alpha (a_L E^\gamma) L^{-1} \]
\[ = \frac{\delta 0}{\delta L} = \alpha (AP_L) \]

where the \( AP_L \) is the average productivity of land.

(b) Similarly, \( MR_E = \frac{\delta 0}{\delta E} = \beta (AP_E) \)

where the \( AP_E \) refers to the marginal productivity of labour.

Our calculation shows that the marginal and the average productivity of land in jhum cultivation are 1.4 and 3.5 respectively; whereas the marginal and average productivity of labour is a bit higher than this, having the value 1.6 and 3.7 respectively. Now if production takes place under constant returns to scale, the marginal and average productivity will be equal. Marginal productivity exceeds the average productivity only when production takes place under Increasing Returns to Scale. Thus, these results also confirm that there are Diminishing Returns to overall outlay as well as to the individual primary factors of production. The estimated factors-productivity also imply that the overall scale of operation exceeds the optimum scale. The diminishing returns could be averted if the operations are scaled down to the optimum level, which may not be conductive to growth though it may lead to the improvement in efficiencies.
As against the jhum, the sum of the two elasticities of output in case of settled cultivation is much greater than one which is indicative of the fact that the productive processes under settled cultivation operates under increasing returns. This is also confirmed by the estimated values of the marginal and average productivities of the factor inputs. The marginal productivity of land is 11.7 and the average productivity is only 3.7. Thus, the marginal productivity is approximately three times of the average productivity in settled cultivation. Similarly, the marginal productivity of labour is 3.2 while the average productivity is 2.8 which is slightly lower than the marginal productivity.

Thus, production under settled cultivation operates under overall Increasing Returns to Scale. Besides, the returns to the two primary factors are also increasing. Even more important than this is the fact that the marginal productivities of land and labour in settled cultivation are larger than their values in jhum. It suggests that if land is transferred from jhum to settled cultivation till the marginal factor productivities in both types of cultivation are equalised, the transfer would move the systems into optimality.

As Diminishing Marginal Returns could be averted by the updating of the technology, such transfer of land and labour from jhum to settled cultivation would be associated
with such technological improvement. The difference in the marginal and average productivities of the two primary factors between the two types of cultivation indicates that the investment required for the conversion of jhum into settled cultivation are warranted by the economic factors in the interest of the farmers themselves.