Journal of the
Indian Society of Agricultural Statistics

Vol. XVI] 1964 [No. 1

YIELD TRENDS OF RICE AND WHEAT IN FIRST TWO FIVE-YEAR PLANS IN INDIA

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1. INTRODUCTION

COMPARABLE and reliable series of data on the yield of several food crops, based entirely on random sampling crop-cutting surveys, initiated by the Indian Council of Agricultural Research in 1943, have become available over a large part of the country. The value of these data, as perhaps the most critical indicator of the agricultural progress under the successive five-year plans, will increase steadily as years pass. The yield of rice and wheat which are the most important foodgrains on which the major part of plan efforts devoted to foodgrains, have been concentrated for improving their yield and for which the series was the longest, were examined by the author for the period 1946–47 to 1955–56 in an earlier article by the author.* These data extended over 65% of the area under each of these two crops in the country and covered the states of Uttar Pradesh, Bihar, West Bengal, Assam, Madhya Pradesh, Bombay, Andhra Pradesh and Madras for rice and Punjab, Uttar Pradesh, Bihar, Madhya Pradesh and Bombay for wheat. The main interest of the analysis was the comparison of average yield during the first five-year plan period, 1951–52 to 1955–56, with the average for the immediately preceding period of five years treated as a control. Results showed that the average yield per acre was higher by 5·4% for rice and 11·8% for wheat in the plan period than in the preceding quinquennium. The increase in rice yield was contributed by three states—Madras, Andhra Pradesh and West Bengal and that in wheat by all the five states, although the increase in Bihar was not

* "Recent Trends in the Yield of Rice and Wheat in India"—V. G. Panse, *Indian Journal of Agricultural Economics*, 1959, **14**, 11–38.

significant statistically. The differential effect of weather factors on yield is a complication in such an analysis and the comparison of quinquennial averages is a safeguard which averages out these disturbances to a large extent, but cannot eliminate them altogether. An attempt was made to adjust the yields of both rice and wheat for inequalities of rainfall over the series of years under study by means of a regression analysis. This analysis was ineffective in so far as wheat was concerned, but the adjusted rice yields showed that, but for inequalities of rainfall, an average increase of 8·0% would have been secured during the plan period as compared to the pre-plan period.

We have now extended the analysis of the yield data on rice and wheat to the end of the second plan period in 1960–61. Maintenance of strict geographical comparability is essential for drawing valid conclusions in regard to changes in yield over time, and the yield data for analysis were confined to an identical coverage of districts, divisions and states for the period of fifteen years, 1946–47 to 1960–61, which is the subject of the present study. With the gradual extension of crop-cutting surveys to wider areas, yield data for rice based on these surveys have become available for more districts, divisions and one more state, Mysore, over a part of this period and a separate analysis of yields with a more comprehensive coverage has, therefore, been possible for the ten-year period, 1951–52 to 1960–61, comprising of the first and second five-year plan periods. We shall term the yield data for rice covering the entire fifteen years period as forming series I and those covering the latter ten years of this period over a wider geographical coverage as series II. The districts, divisions and states for which yield data were analysed are shown in Table I for rice and in Table II for wheat. Areas for which yield data for rice became available for series II only are marked with an asterisk in Table I. In wheat there was no further extension of crop-cutting surveys during the period under study to make any further data available for forming a second series for analysis. The area covered by crop-cutting surveys on wheat accounted for 65% of the area under this crop.

Around the year 1956 there was a further reorganization of the states, but for the purpose of the present study the data were analysed and the results are presented according to the old political boundaries for ease of comparison with pre-1956 data. It may be assumed that by the end of the second five-year plan, the pattern of extension and other agricultural services in areas which have formed part of the new states will have been stabilized and when the present analysis is extended to include the third and subsequent five-year plan periods, it

will be desirable to present the results for the various states according to their present political boundaries.

As stated already, crop-cutting surveys on rice covered 65% of the area under this crop in India as far as series I is concerned and their coverage has increased to about 72% for series II. Apart from the rice-growing areas of Mysore State, other important additions were the Telangana Division consisting of 7 districts in Andhra Pradesh and the Deccan Division of Bombay State.* The district of Manbhum in Chota Nagpur Division of Bihar no longer figures as a separate district as it was merged administratively with the neighbouring districts. Orissa continues to be without trustworthy yield data on rice in the absence of crop-cutting surveys.

Crop-cutting surveys need strengthening both by extension to new areas in order to make the coverage as complete as possible and also by intensification in existing areas by increasing the number of crop-cuttings in each district in order to improve the precision of district estimates of yield. Today this precision is low, the standard errors of average yield at the district level ranging up to 10% or some times higher even for major districts. For this reason, district-wise yields were pooled by divisions, which are compact administrative groups of up to 7 districts, by weighting the district yields with corresponding crop acreages. It was these divisional yields, which had standard errors ranging from 2 to 7% annually, that were used in the present analysis. For states, of course, the average annual yields have a high precision, the standard error being 1·5% or less for Uttar Pradesh and below 3·0% for other states. Annual estimates of divisional yields for each state are given in Tables III to X for series I and in Tables XI to XIX for series II for rice and in Tables XX to XXIV for wheat. State-wise yield figures for rice are given in Tables XXV and XXVI for series I and II and for wheat in Table XXVII.

The principal interest in the present study is to ascertain the magnitude of change in the yield rates of rice and wheat during the first and second five-year plans as compared to the yield rates of these

* Yield data now embrace the autumn rice crop also in Bihar and Assam, while they were confined earlier to the winter crop in these two states. There has been an extension of the crop-cutting surveys to the summer crop in Madras. In Mysore State the entire rice crop is covered. Both aus and aman crops in West Bengal, the early and late paddy in Uttar Pradesh and the first and second crops in Andhra Pradesh were included in series I already while in Bombay and Madhya Pradesh only one rice crop is grown.

crops during the pre-plan quinquennium, 1946–47 to 1950–51. It is important also to determine how far these changes could be ascribed to plan efforts as distinct from the changes arising from the influence of weather and other uncontrolled seasonal conditions. The first step towards this end is to partition the variation observed in the annual divisional yields in different states recorded in Tables III to XIX for rice and Tables XX to XXIV for wheat into appropriate components. This splitting is done with the help of a statistical technique known as the analysis of variance. The analysis of variance shows the following components relevant to the present study:

2. Method of Analysis

(*a*) Variation between three sets of five years representing pre-plan period, first plan period and second plan period. This may be further divided into variation between pre-plan and first plan periods and between first and second plan periods. Although components of this particular subdivision are not statistically independent, they are the most meaningful for our purpose.

(*b*) Variation between individual years within each five-year period.

(*c*) Variation between divisions.

(*d*) Variation representing interaction between three five-year periods and divisions.

(*e*) Uncontrolled variation representing interaction between individual years within periods and divisions.

The comparison of the component (*e*) with (*a*) will show whether the average yield levels during different five-year periods were significantly different, that is whether there were real differences between these yield levels as characterising the three five-year periods or they could be accounted for by seasonal fluctuations in annual yields in different areas of the state. Such inference from this test will be valid only for the particular period of fifteen years under study. But it is often found that component (*b*) representing variation in annual yields for the state as a whole is substantially and significantly larger than component (*e*). This latter variation must then be taken into account in order to judge whether the influence of plan effort on yield level is adequate to raise this level to a degree where the improvement will stand out as significant after allowing for the annual variations due to climate and other uncontrolled factors that are to be expected in the yield level of the state as a whole. Component (*c*) representing permanent

differences in the yield levels of the variations of the different divisions of the state arising from physical and other characteristics of the different divisions are of no interest in our present enquiry; but component (*d*) representing differential reaction of different divisions to plan effort in raising yield are of some interest, as indicating the divergent response of the individual divisions in a state to plan effort.

An attempt was also made to study the influence of rainfall, which is the most important factor in the climate in relation to crops, on the yield of rice and wheat. The object to find out how far inequalities of rainfall during different periods had affected yield comparisons between these periods and to free these comparisons from the effect of this factor to the extent possible by adjustment in yield with the help of a simple regression analysis.

We shall consider the results of our analysis for rice and wheat separately.

3. Rice: Analysis of Variance

The analysis of variance for rice is given in Table XXVIII for series I and in Table XXIX for series II. Tests of significance based on interaction of divisions with years (component *e*) and on variation between years within periods (component *b*) are both shown in these tables. Here we discuss the results of the present test, as interpreting the differences between average yields as actually observed in the three five-year periods from 1946-47 to 1960-61. It will be seen from Table XXVIII that except Assam, the variation in yield between the three five-year periods, representing the pre-plan, first plan and second plan periods, was highly significant in all other states. A break up of this variation into two comparisons, *viz.*, pre-plan *versus* first plan and first plan *versus* second plan reveals that both comparisons were significant only for Andhra Pradesh and Madras States, where they were highly significant. Among other states, only West Bengal gave a significant comparison between the pre-plan and first plan periods, while Uttar Pradesh, Bihar, Madhya Pradesh and Bombay gave significant comparisons, which were also highly significant, only between the first and second plan periods.

The analysis of variance given in Table XXIX for series II corroborates these findings for the first and second plan periods, except to add an important finding for Mysore State that the comparison between the two periods was highly significant in this state also. These comparisons may be translated into comparisons of yield per acre over the three periods. These are shown in Table XXX for series I and Table XXXI for series II. These are weighted averages, with the divisional

area under rice as weight. The standard errors shown in Table XXXI are appropriate for these weighted averages. It will be seen from Table XXX that there was a significant increase of 89 lb. per acre of rice in West Bengal during the first plan period as compared to the pre-plan years. The only other significant increases were those in Andhra Pradesh and Madras. These were substantial increases per acre of 155 lb. and 143 lb. respectively. The all-India average showed a small but significant increase of 40 lb. per acre due to increases in these three states. During the second plan period Uttar Pradesh, Bihar and Madhya Pradesh States recorded moderate but significant increases ranging from 63 to 97 lb. per acre over their first plan yields. Three other states, Bombay, Andhra Pradesh and Madras, recorded significant but more substantial increases of 127, 122 and 160 lb. per acre respectively. Compared to the increases during the first plan period, Andhra Pradesh has shown a somewhat smaller increase in the second plan, but Madras has maintained its earlier record. As a result of several more states contributing an increase in the second plan, as compared to the first plan, the all-India increase in the second plan period has doubled that in the first plan. The all-India increase in the second plan was 80 lb. or 1 md. per acre. Assam is one state which has shown no increase whatever either during the first or the second plan period. Results in Table XXXI for series II require no comment except that Mysore State has shown the largest increase of 214 lb. per acre among states in the second plan yield over its yield during the first plan period. The percentage increases in yield over the first or the second plan in states which recorded a significant increase in either plan ranged between 10 and 15 or 16% or an average increase per year from 2 to 3%. Mysore was an exception which showed an increase of 20% during the second plan as compared to the first plan, an average annual increase of 4%. For the country as a whole, there was an average annual increase in the yield of rice of 1·1% during the first plan period and of 2·0% during the second plan period. Trends in yield in different states and the country as a whole for 15 years embracing the two plan periods and the pre-plan period of five years are shown in Fig. 1. Also included in the figure is the yield for Mysore State over the 10-year period of the two plans.

It will be observed from Table XXVIII that the mean square for years within the five-year periods, component (*b*) of the variation, is substantially and in most states significantly larger than the interaction of division with years. This means that apart from fluctuation of yield due to seasonal conditions in different divisions of the states, there is a gross annual variation in seasonal conditions affecting the

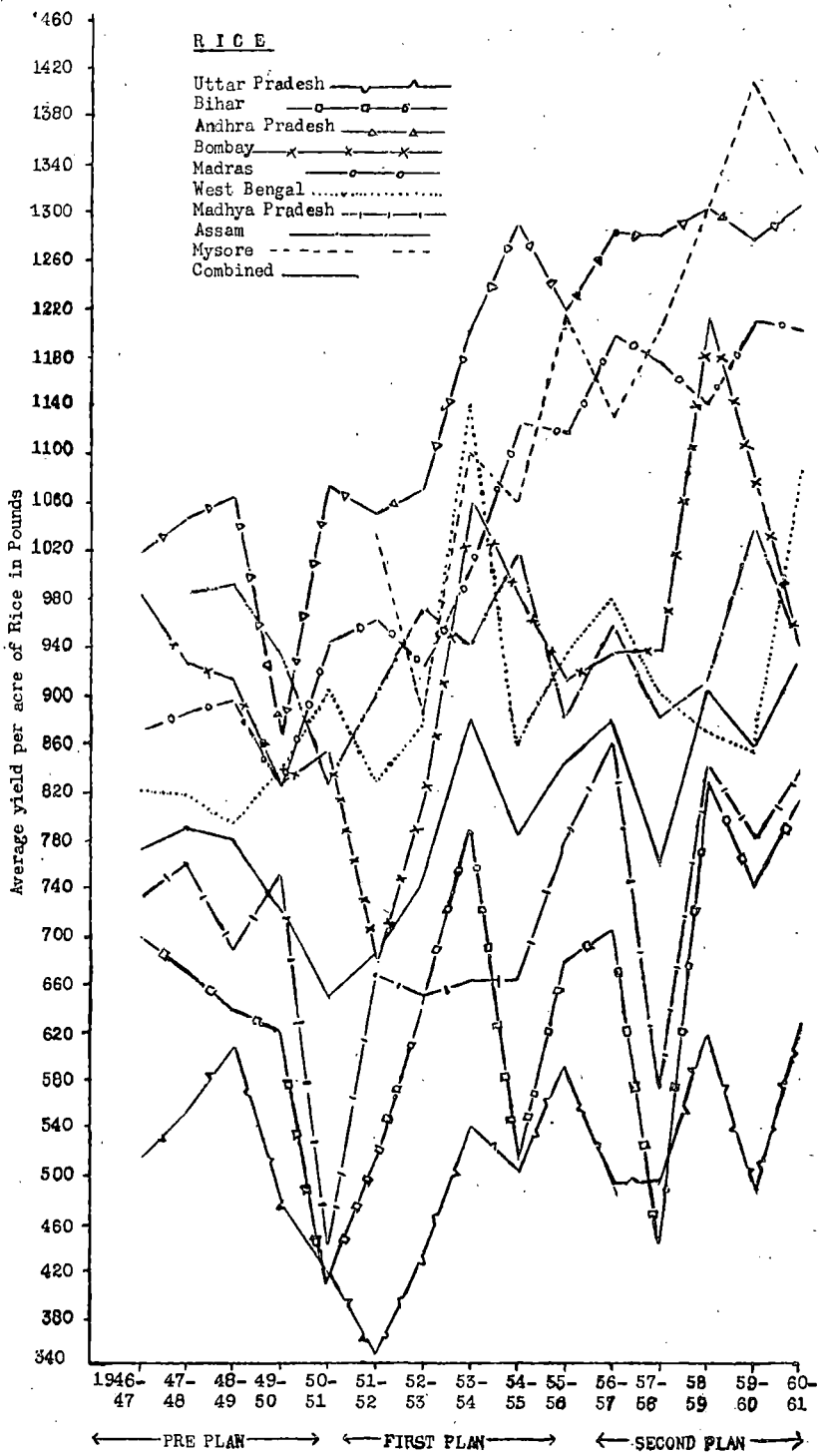

FIG. 1. Trends in average yield of rice in India, lb. per acre, 1946–47 to 1960–61.

yield of the state as a whole. We have described above the significance of the plan effort in relation to yield of rice against the background of the annual seasonal conditions experienced actually by the different states during the period of 15 years under study. In view of the large magnitude of the annual variation, however, it is desirable to allow for this variation also along with the fluctuations among the different divisions in assessing the significance of the plan effort in improving yield. This more rigorous assessment will indicate in which states the plan effort is sufficiently impressive to result in improvement of yield that can stand out without being swamped by uncontrolled annual variation in seasonal conditions likely to be met with in future.

Table XXVIII shows that the mean square for annual variation in state yield is lowest in Assam which is also a small compact area consisting of only one division. Madras, Andhra Pradesh and West Bengal (another small area consisting of two divisions) form the next group, while in Uttar Pradesh, Madhya Pradesh and Bombay the mean square for annual variation is substantially larger, Bihar having the largest variation among all states. The annual variation of yield in Mysore as estimated from the 10-year period of the two plans is also relatively low as seen from Table XXIX. Some light on the annual variation in yield in different states is thrown by the data recorded in Table XXXII. The states with low annual variation in yield are characterized either by heavy rainfall or most extensive irrigation. Assam has a rainfall of over 90 inches annually, while Andhra Pradesh and Mysore States have more than 90% of their rice area irrigated. Madras belongs to the same category, with its Southern division having irrigation for 94% of its rice area, two other divisions, Carnatic and Central, served by irrigation for 80% or more of their rice acreage and the West Coast division which has apparently no irrigation having a rainfall over 120 inches. States with larger seasonal variation in the yield of rice have much lower rainfall, usually around 40–50 inches and also a much smaller fraction of their rice area under irrigation. The fact that states with a relatively low annual coefficient of variation in yield are also the states with the highest average yields of rice in the country underlines the importance of providing maximum irrigation to rice areas in other states in order to attain high stable yields of rice.

Retesting the significance of mean square between plan periods against the mean square for years within period [component (*b*) above], it is observed from Table XXVIII that difference between the mean yield during the first plan and the pre-plan period is no longer significant in West Bengal, but the difference in Andhra Pradesh and Madras

States continues to be highly significant. The high significance of the difference in the latter two states also continues between the first and the second plan periods on the new test. The difference between these two periods also continues to be significant, although at a lower level, in Uttar Pradesh and Bombay but that in Bihar and Madhya Pradesh is no longer significant. From Table XXIX, it will be seen that the difference between the two plan periods continues significant in Mysore State, although at a lower level on the new test. We may note that we have tried to reduce the stringency of this test by eliminating from the mean square between years within periods any discernible linear trend among the individual years which could be ascribed reasonably to a steadily increasing effect of plan effort on yield.

We may summarize our findings as showing that only two states, Andhra Pradesh and Madras, have made a steady progress over both plans in increasing their yield of rice per acre. This progress is substantial enough to stand out as highly significant against the seasonal variation in yield in these states. Mysore, Bombay and Uttar Pradesh belong to the next category recording a highly significant increase in yield during the second plan period, which retains its significance, although at a lower level, when tested against annual variation likely to be met with in future. Bihar and Madhya Pradesh States showed significant increases during the second plan period and West Bengal showed a similar increase during the first plan period, but none of these increases was large enough to maintain significance when compared to the natural annual variation in yield in these states. Assam is one state which, as stated earlier, has made no change whatever in its yield either in the first or the second plan. Actually Assam would appear to have among the most favourable seasonal conditions, which are characterized by a very small degree of variation from year to year (Table XXXII) for responding to plan effort for increasing yield. This effort will have to be very much greater in states like Bihar, Uttar Pradesh and Madhya Pradesh, with their much larger coefficients of annual variation, to register an increase in yield which will stand out against this variation.

4. Rice: Influence of Rainfall on Yield

That the effectiveness of plan effort in raising the yield level of rice in any area is subject to natural variation in yield due to seasonal conditions or climate is well brought out in the foregoing analysis. In fact the analysis was aimed at testing and measuring the effectiveness of plan effort over and above the influence of climate on annual yields. Another way of approaching this problem would be to eliminate the differential influence of climate on annual yields by adjusting them

suitably so that yields in the different plan periods could be compared under a uniform set of climatic conditions. In practice this is impossible. For, climate is a conglomerate of numerous interacting meteorological factors which affect crop growth and production directly as well as indirectly by their influence on the spread of diseases and pests of crops. Elegant statistical methods based on regression analysis have been developed by R. A. Fisher for studying the influence on crop yields of weather factors like rainfall, temperature, sunshine, etc., and their seasonal distribution. The calculations involved are, however, laborious and the results not very satisfying, since even after adjustment, a major portion of variation in annual yield remains behind, only a small fraction of it being accounted for by the adjustment.

All the same, an attempt was made in the present study to analyse the relationship between rainfall and yield, since rainfall is a major climatic factor affecting the cultivation of rice in India. For simplicity, only the total annual rainfall was considered. It was assumed that, since the total precipitation was the chief component of seasonal rainfall, this analysis would account for the greater part of variation in yield due to this factor, even if effects due to peculiarities of the distribution of rainfall in the season were obscured. For this analysis both the actual rainfall and its deviation from the normal rainfall of the region were employed. The reason for the latter steps was the possibility that the cultivation methods of rice and level of production in a region had adjusted themselves to the characteristic or normal rainfall of the region and a comparison of the response of rice to departures from the normal rainfall of the region would be more sensitive than to deviations from the average regional rainfall for a short period of 10–15 years. In Tables III to XIX are included annual rainfall figures along with the yield for each division. Like yields, these rainfall figures were computed as weighted averages of district rainfall figures available in meteorological tables, the weights being the district area under rice. Normal rainfall figures for districts are also given in meteorological tables, these being based on records of 40–60 years. Divisional averages were computed from these as weighted averages.

A second degree regression equation was fitted to yield data based on annual rainfall as also on annual deviations from normal rainfall. The analysis of regression for each state is given in Table XXXIII and the adjusted yields on the basis of regression in Table XXXIV which also includes unadjusted yields for comparison. Regression of yield on rainfall was significant in four states, Uttar Pradesh, Bihar, West Bengal and Bombay. In these states, reduction in the residual mean

square was greater when regression was taken on deviations from normal rainfall than on actual rainfall, indicating a closer relationship of yield with the former which had been anticipated. While lack of significant relationship between rainfall and yield in Andhra Pradesh, Madras and also Mysore can be understood because of irrigation extending over almost the entire rice area in these states, although irrigation in Mysore, based largely on tanks, is itself dependent on rain. In Assam heavy rainfall is the explanation. The result for Madhya Pradesh, however, showing no significant influence of rainfall on yield is difficult to explain, with a moderate rainfall and limited irrigation in this state. It will be seen from Table XXXIII that the typical regression coefficients are a relatively large positive linear coefficient and a small negative quadratic coefficient, although linear coefficients are somewhat lower when calculated from deviation from normal rainfall than from actual rainfall. This means that higher rainfall as well as higher excess of rainfall from the normal for the region increases the yield of rice, but the rate of increase tends to slow down with very high rainfall. This is a very important finding since it means that additional water-supply to the rice crop over and above that secured from normal rainfall can be relied upon to raise the yield to a higher level than at present in several states. Once again we reach the conclusion that extension of irrigation to rice areas is a positive measure for increasing production and not merely a protection against uncertainties of rainfall. Under pressures of growing population the cultivation of rice has obviously spread to areas where it cannot meet its full demand for water from local rainfall.

A study of adjustments in yield on the basis of its regression on rainfall, shown in Table XXXIV, indicates a generally upward adjustment in the first plan as compared to pre-plan years which can be interpreted as pointing to a deficiency in rainfall in most states during the first plan. The most outstanding adjustment was in West Bengal where after adjustment the first plan yield was higher by 133 lb. per acre than the pre-plan yield, while this difference was only 89 lb. in the unadjusted yield. The change due to adjustment was much less apparent in the difference between yields for the second plan and the first plan and it was generally in the direction of scaling down this difference. Here the reduction of difference in Mysore State from 214 lb. in unadjusted yields to 165 lb. in the yields adjusted for deviation from normal rainfall was the most striking. Apparently rainfall was on the whole slightly better than normal during the second plan period in contrast to the deficit observed during the first plan period. A more detailed and

critical analysis of the relationship between rainfall and yield of rice particularly in the states which are largely dependent on rainfall for the cultivation of this crop will be profitable.

5. Wheat: Analysis of Variance

Annual divisional yields of wheat for five states, Punjab, Uttar Pradesh, Bihar, Madhya Pradesh and Bombay are shown in Tables XX to XXIV for the fifteen years 1946–47 to 1960–61. This represents a coverage of about 65% of the area under wheat in India. Unlike rice, crop cutting was not extended to any new areas or states before the commencement of the first plan period to provide any further comparisons beyond those based on data given in Tables XX to XXIV.

The analysis of variance for the yield of wheat in different states is shown in Table XXXV. Compared to the mean square for interaction between divisions and years [component (e) in the analysis of variance] the mean square between first plan and pre-plan period is significant in all states except Bihar, while that between first and second plan periods is non-significant in all states except Madhya Pradesh, that for Bihar approaching the level of significance. Mean yields for different periods and standard errors of difference are shown in Table XXXVI for each state. These are weighted averages with the divisional areas under wheat as weights. Mean yield in the first plan period was uniformly higher than in the pre-plan period in all states, although the difference was not significant in Bihar. The increase ranged to as much as 25% and 27% in Madhya Pradesh and Bombay, giving an average annual increase in yield of 5% for these two states. In contrast to this, there was no further increase in yield of even a small magnitude in any state during the second plan period as compared to the first plan period. Surprisingly enough there was a decrease in yield in Madhya Pradesh and Bihar of nearly half a maund per acre, which was significant in Madhya Pradesh.

It is a curious situation that after an appreciable all-round increases in the yield of wheat per acre during the first plan, there should be no increase at all during the second plan in any state and a disturbing decrease in two states. It should be remembered, however, that there was a widespread rust epidemic on the wheat crop in India, during the year 1946–47, and it continued to show some effect during the next two years. The epidemic was most severe in Madhya Pradesh and Bombay States, reducing their average yield to barely one maund per acre in 1946–47 (Table XXVII). In some divisions of these states the crop was all but wiped out (Tables XXIII and XXIV). These are

also the states which showed the largest proportional increase in yield during the first plan. The inference follows that the apparent increase in the first plan in these two states particularly and in other states also is merely the result of recovery from the rust epidemic that occurred during the pre-plan period, rather than any positive improvement in yield from planned effort. The fact that there is no further increase in yield in any state during the second plan period supports this inference and the conclusion appears inevitable that unlike rice, plan effort has made no impact on the yield rate of wheat either in the first or the second plan.

To test further whether the significant increases during the first plan (as also the significant decrease in Madhya Pradesh during the second plan) would continue to stand out as real, against the annual variation in the yields likely to be met with in future, the mean squares between periods in the analysis of variance in Table XXXV were compared with mean squares between years within periods (component *b*) after eliminating any trend that may be observed among individual years. These latter squares are several times larger than the mean squares for component (*e*), the interaction between divisions and years. On this new test all significance of mean squares either for differences between pre-plan and first plan periods or between first plan and second plan periods is wiped out leading to the conclusion that the increases in yield in the first plan as well as decreases in yield observed in Madhya Pradesh and Bihar during the second plan could reasonably be accounted for by large disturbances in annual yields due to climate and other associated factors like rust. The trends in wheat yield per acre in different states over the fifteen-year period, 1946–47 to 1960–61, are shown in Fig. 2.

6. Wheat: Influence of Rainfall on Yield

Although our earlier attempt to study the variation in wheat yield in relation to rainfall proved negative in the sense that the annual rainfall divided into two periods, monsoon and post-monsoon, showed no significant relationship with yield in any state, we were led to re-examine this question with reference to Bihar and Madhya Pradesh States, because of the decrease in yield observed in the two states during the second plan period. The total annual rainfall was split into two periods, June to October and November to May, and a joint regression of divisional yields on the rainfall in these two periods was studied in each state. The result was again negative as the regression failed to account for any portion of the annual variation in yield. Obviously some other factors in the climate, like temperature, humidity, etc., are

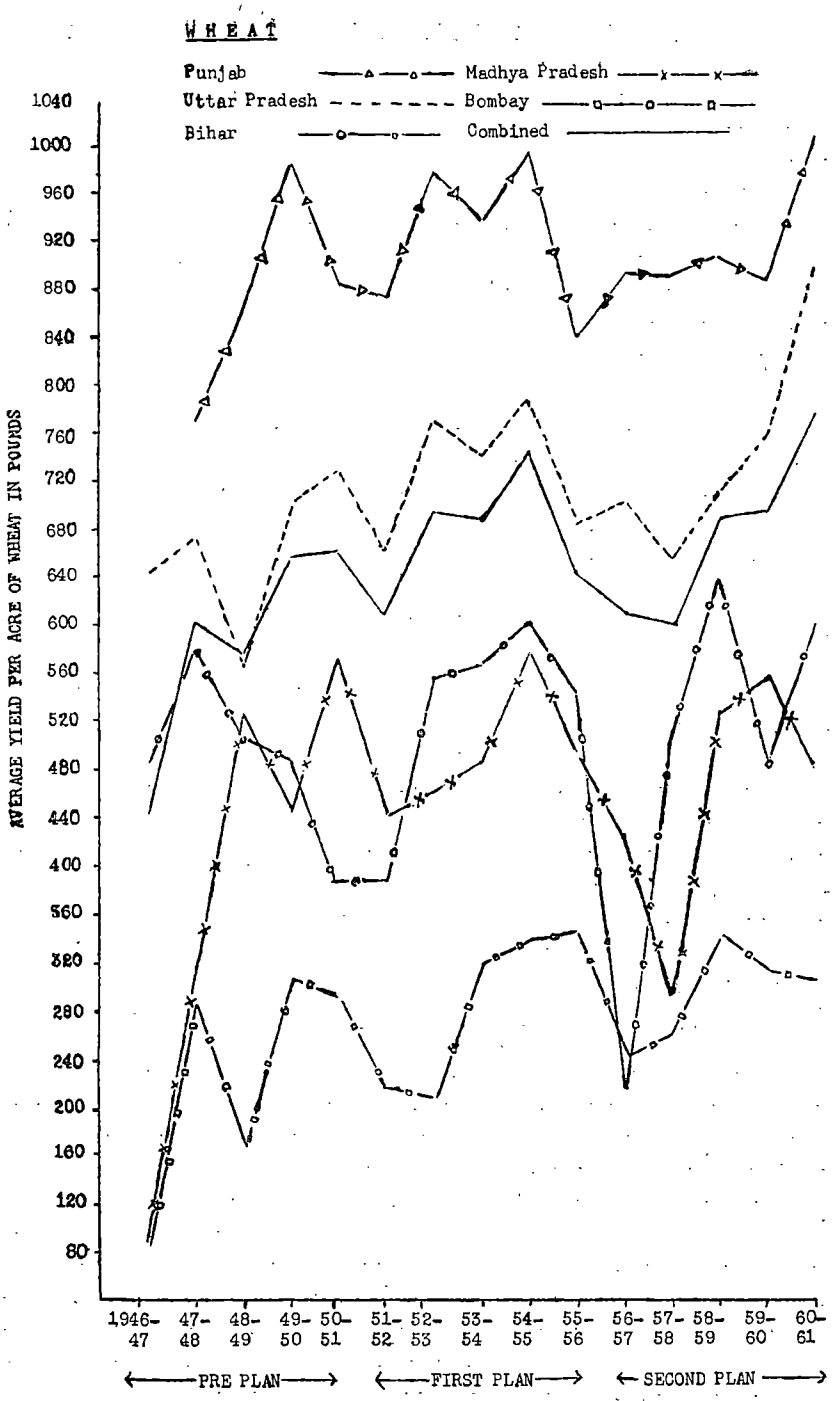

FIG. 2. Trends in average yield of wheat in India, lb. per acre, 1946–47 to 1960–61.

responsible, and a more critical analysis of this problem is called for. Like rice, we have recorded in Table XXXVII yields of wheat, their annual coefficients of variation, annual rainfall and extent of irrigation of the wheat area. These present an interesting pattern. Bombay and Madhya Pradesh with the smallest proportion of their wheat area under irrigation show the largest coefficients of variation, which are understandably larger than the coefficients of variation for the yield of rice in these two states. Bihar and Uttar Pradesh show distinctly lower coefficients of variation in the yield rates for wheat, which in fact are of the same order as for the yield of rice in these two states. The situation is rather puzzling in the case of Uttar Pradesh where in several divisions the greater portion of the wheat area is under irrigation and a much lower coefficient of variation should be expected. Perhaps irrigation, which is normally light for wheat is resorted to in many areas of the state only when considered absolutely necessary for saving the crop rather than as a normal measure for increasing yield. In contrast, Punjab shows the lowest coefficient of variation with only 50% of its wheat area under irrigation, presumably because irrigation is practised regularly and in adequate measure. Punjab yield of wheat is also the highest among the different states and extension of irrigation to other wheat areas in the country is perhaps even more important than rice for raising the yield of wheat per acre substantially.

7. Summary and Conclusion

In the present paper, we have extended our study on the trends of yield per acre of rice and wheat in India to the end of the second plan period, *i.e.*, 1960–61. Results of crop-cutting surveys in important rice and wheat-growing states and covering over 70% of the area under rice and 65% of the area under wheat in the country have been analysed for a period of 15 years. This period covers a pre-plan period of five years from 1946–47 to 1950–51 and the first and the second five-year plan periods.

The main objective of the study is to find out whether and to what extent the two five-year plans have made their impact on the yield rate for rice and wheat in different states and in the country as a whole. The annual yield in any area is subject to the profound influence of climate. This influence may work in the direction of increasing or lowering yield, thereby either exaggerating the effect of planned effort and even misleading one to ascribe to planned effort an observed increase in yield which was really due to favourable climate, or if this influence was adverse, in lowering the effect of planned effort on yield or wiping it out entirely. A major precaution taken against this difficulty in the

present study is to compare quinquennial averages of yield, rather than annual yields. This has the effect of reducing the influence of climate on yield, as positive and negative changes in annual yield due to climate would largely cancel out and the quinquennial average will be affected by only a fraction of the climatic influence to which annual yields are subject. Further even this residual influence is sought to be assessed by means of the statistical technique known as the analysis of variance and allowed for by the calculation of standard errors in comparing the average quinquennial yields. We have used two tests for this purpose. One utilized the natural variation in annual yield among the different divisions of a state within each five-year period as a measure of the influence of climate, over the actual period of 15 years studied. The assumption here was that we were interested in ascertaining and estimating the effect of planned effort on yield against the background of overall climate, favourable, unfavourable or indifferent, actually experienced over the particular set of 15 years under study. We may also want to take a broader view of the influence of planned effort on raising yield by assessing whether the increase in yield is of a sufficient magnitude to withstand the annual climatic variations in the state yield, such as are likely to be met with normally, rather than confining this assessment to a particular period of years. This more rigorous test can be made by testing the mean square between plan periods, against the mean square for years within plan periods after removing any possible trend in the latter. Both tests have been made in the present study.

An interesting and important offshoot of the second test is to show that a certain minimum increase in the average yield over any plan period as compared to the average yield in the previous plan or any other quinquennial period is necessary to provide a reasonable assurance that it is the result of plan effort and not a fortuitous increase arising from annual variations in state yields due to climate and other associated factors. For rice this minimum increase is as high as 150–180 lb. per acre in states of Madhya Pradesh, Bombay and Bihar. In Madras, Assam and Andhra Pradesh, where rice yield are more stable, this figure ranges from 50–90 lb. In wheat the range is from 70–110 lb. per acre, the higher values being associated with Bihar and Madhya Pradesh.

In rice, plan effort has made a definite impact on yield, the average countrywide yield being raised by 40 lb. per acre during the first plan and by 80 lb. per acre further during the second plan. The latter figure would be 86 lb. if all data for crop cutting extended to additional areas including Mysore State are taken into account. The largest

and most consistent increases were contributed by Madras and Andhra Pradesh States, these being 143 and 155 lb. per acre during the first plan and 160 and 122 lb. per acre during the second plan. These increases retained their significance when tested against annual climatic variation in yields in these states, indicating that they were not brought about because of any particularly favourable climatic conditions during those years. No other state showed such positive increase in yield during the first plan. West Bengal did show an average increase of 89 lb. per acre, but it could not be considered significant when tested against annual variation in yield in the state. It should be noted that this state did not show any further increase in yield during the second plan, which supports the indication that the earlier increase was at least partly influenced by climatic conditions during the particular years. In the second plan several states contributed to increased yield of rice these being Mysore (for which crop-cutting data for estimating increase in yield during the first plan are not available), Bombay, Uttar Pradesh, Bihar and Madhya Pradesh. The increase was highest in Mysore, being 214 lb. per acre, Bombay with an increase of 127 lb. per acre came next while the other three states showed increases of less than 100 lb. per acre. The increases in Mysore, Bombay and Uttar Pradesh only were established more firmly in that they maintained their significance when tested against natural annual variations of yield in these states. The tempo of planned effort was thus distinctly greater during the second plan than in the first and raised the rice yield in the country by 16%, when compared to the pre-plan yield level. Assam was one state which showed no improvement in yield, either in the first or the second plan, although a high rainfall and other relatively stable favourable environmental conditions should bring about a quick response to planned effort in this state.

In an attempt to probe into the nature of the effect of climate on the yield of rice, the relationship between annual rainfall and yield was studied. Except in Andhra and Madras where most of the rice area is served with irrigation from canals and other large works, annual rainfall showed a significant influence on yield. This was so even in Mysore where practically the entire rice area is served by tanks; but these tanks which are mostly small are also at the mercy of the seasonal rainfall for their capacity to supply irrigation. The relationship between rainfall and yield is such that yield increases with increase in rainfall even beyond the normal rainfall for the region. Obviously under pressure of growing population rice cultivation has spread to areas where the normal rainfall is inadequate to meet the full requirement of

the crop and extension of irrigation to rice area is an important measure for increasing rice yield. In fact, irrigation and use of fertilizers, while simultaneously spreading the use of strains developed from Indo-Japanica crosses which can respond to large doses of fertilizers, are the principal methods of raising rice yield substantially and these measures need to be pressed forward with all possible speed, considering that over the two plans rice yield has increased by only one and a half maund per acre and there is still a large scope for further increase.

In contrast to rice, the conclusion from the present study in regard to wheat is that there is no evidence of any impact of planned effort on increasing the yield of wheat per acre in any state either in the first or the second plan. Undoubtedly the average countrywide yield on the basis of our study for five states, Punjab, Uttar Pradesh, Bihar, Madhya Pradesh and Bombay, was nearly 12% higher in the first plan period than in the pre-plan quinquennium and all states individually contributed to this result with increases ranging from 5% in Punjab to as much as 27% in Bombay State. Increases in four states, with the exception of Bihar, were highly significant when tested against variation among annual yields in different divisions of a state. This significance, however, completely disappeared when the test was made against annual variations in the state yield, indicating that the increase could be explained by seasonal differences. In fact, in 1946–47 there was a severe rust epidemic in the wheat belt of the country and in some areas the crop was all but wiped out. The effect of this epidemic on yield extended over the next two years in some areas. The epidemic was severest in Madhya Pradesh and Bombay and these were the two states that showed the largest proportional increase of 25 and 27% in the first plan period. The conclusion is that the increase in yield observed in the first plan was a measure of the recovery of the crop from the rust epidemic that it had suffereed during the pre-plan period. Further support to the conclusion that the increase observed in the first plan period was due to extraneous factors and not due to any planned effort is given by the fact that the average second plan yield in the country stood at exactly the same level as in the first plan. No change was observed in the individual states also, except for a disconcerting decrease of 37 and 36 lb. per acre in Bihar and Madhya Pradesh, which should be ascribed to climate. It is a serious matter that little or no planned effort has gone into raising the yield level of wheat in any state, when the importance of wheat among foodgrains is only next to rice. Causes for this lack of effort need to be investigated into and remedied urgently.

Like rice, the relationship between rainfall and yield was studied for wheat also in an attempt to find at least a partial explanation of the climatic influence. For this purpose the annual rainfall was split into two portions, monsoon and post-monsoon, and a joint relationship of these subtotals of rainfall with yield was analysed. The result was negative in that no evidence of any relationship could be found. The depression in yield during the second plan period in Bihar and Madhya Pradesh could also not be explained on this basis. This is a curious result when it is remembered that the wheat crop is much more at the mercy of rainfall, than rice since a lower proportion of the wheat area is irrigated. Some other factors like humidity, temperature, distribution of rainfall, etc., would seem to play a more important role and deserve critical investigation.

The present series of crop-cutting surveys on food-grains and other crops, as we mentioned at the beginning of this paper, form the most vital and reliable means for a critical evaluation of successive five-year plans in relation to the level of crop yields. The importance of continuing this series and strengthening it further cannot be over-emphasised. Today there is a considerable degree of non-response in several states in the conduct of crop-cutting and supervision of the field work is also not on an adequate scale. The district estimates of yield do not have sufficient precision and we have for this reason compiled divisional estimates for our analysis. Analysis with district-wise data would be much more penetrating, will help in spotting out weak areas in relation to planned effort and would be more rewarding in any attempt to discriminate between the influence of planned effort and other factors like those of climate on yield level. For this purpose the aim of crop-cutting surveys should be to provide district-wise estimates of important food and non-food crops with a reasonable level of accuracy, that is with a standard error within 5%. This requires concentration of all available financial and technical resources on strengthening the primary reporting agency and supervision of fieldwork in the states, in imparting proper training to the field staff and in improving the technical competence of state organizations directing this work, instead of dissipating these resources in all kinds of experimentation with plot sizes and field agencies, which has no relevance to our needs.

8. Acknowledgements

The yield data for 1956–57 to 1960–61 for all states except West Bengal were extracted from the reports of the crop survey wing of the National Sample Survey. Figures for West Bengal were supplied by

the Director of the Statistical Bureau. Data on crop acreages were obtained from the reports of the Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India. Rainfall data were supplied for the respective states by the Director of Bureau of Economics and Statistics, Andhra Pradesh, Director of Statistics, Assam, Director, Central Bureau of Economics and Statistics, Bihar, Deputy Director of Agriculture (Statistics), Gujarat, Director of Statistics, Kerala, Director of Land Records, Madhya Pradesh, Director of Statistics, Madras, Director of Agriculture, Maharashtra, Director of Statistics, Mysore, Statistician, Department of Agriculture, Punjab, Land Reforms Commissioner, Uttar Pradesh and Director of Statistical Bureau, West Bengal. The authors' thanks are due to these officers and organizations for their help in making these data available. The author also wishes to acknowledge the painstaking and careful work done by Shri M. K. Bose in the computation and compilation of the data and assistance given by Shri A. L. Punhani.

TABLE I

Districts, Divisions and States for which yield data on rice are analysed

State	Division	District
1. Andhra Pradesh	1. Circars	1. Vizagapatam
		2. East Godavari
		3. West Godavari
		4. Krishna
		5. Guntur
		6. Srikakulam*
	2. Carnatic	1. Nellore
	3. Central	1. Chittoor
	4. Telangana*	1. Mahbubnagar*
		2. Adilabad*
		3. Nizamabad*
		4. Medak*
		5. Karimnagar*
		6. Nalgonda*
2. Assam	1. Plains	1. Cachar
		2. Darrang
		3. Kamrup
		4. Lakhimpur
		5. Nowgong
		6. Sibsagar
		7. Goalpara*
3. Bihar	1. Patna	1. Patna
		2. Gaya
		3. Shahabad
	2. Tirhut	1. Saran
		2. Champaran
		3. Muzaffarpur
		4. Darbhanga
	3. Bhagalpur	1. Monghyr
		2. Saharsa
		3. Bhagalpur
		4. Purnea
		5. Santal Parganas

TABLE I (*Contd.*)

State	Division	District
	4. Chotanagpur	1. Hazaribagh 2. Ranchi 3. Palamau 4. Singhbhum 5. (Manbhum)†
4. Bombay	.. 1. Gujarat	1. Kaira 2. Panch Mahals 3. Surat 4. Broach* 5. Baroda*
	2. Karnatic	1. Belgaum 2. Dharwar 3. Kolhapur*
	3. Konkan	1. Thana 2. Kolaba 3. Ratnagiri 4. Kanara
	4. Deccan*	1. West Khandesh* 2. Nasik* 3. Poona* 4. North Satara*
5. Madhya Pradesh	.. 1. Jabalpur	1. Jabalpur 2. Mandla 3. Sagar
	2. Nagpur	1. Chanda 2. Chhindwara
	3. Chattisgarh	1. Bhandara 2. Balaghat 3. Drug 4. Bilaspur 5. Raipur
6. Madras	.. 1. Carnatic	1. Chingleput 2. South Arcot

TABLE I (*Contd.*)

State	Division	District
	2. Central	1. North Arcot
		2. Tiruchirapalli
		3. Salem*
	3. South	1. Tanjore
		2. Madurai
		3. Ramnathapuram
		4. Tirunelveli
	4. West Coast	1. Malabar
		2. South Kanara
7. Mysore*	1. Mysore*	1. Mandya*
		2. Mysore*
		3. Hassan*
		4. Chikmagalur*
		5. Shimoga*
	2. Bangalore*	1. Chitaldrug*
		2. Tumkur*
		3. Kolar*
		4. Bangalore*
8. Uttar Pradesh	1. Meerut	1. Saharanpur
		2. Muzaffarnagar
	2. Rohilkhand	1. Bareilly
		2. Budaun
		3. Shahajahanpur
		4. Pilibhit
		5. Bijnor*
		6. Moradabad*
	3. Allahabad	1. Etawah
		2. Kanpur
		3. Fatehpur
		4. Allahabad
	4. Varanasi	1. Varanasi
		2. Mirzapur
		3. Jaunpur
		4. Ghazipur
		5. Ballia

TABLE I (*Contd.*)

State	Division	District
	5. Gorakhpur	1. Gorakhpur
		2. Basti
		3. Azamgarh
		4. Deoria
	6. Lucknow	1. Lucknow
		2. Unao
		3. Rae Bareli
		4. Sitapur
		5. Hardoi
		6. Kheri
	7. Faizabad	1. Faizabad
		2. Gonda
		3. Bahraich
		4. Sultanpur
		5. Partapgarh
9. West Bengal	.. 1. Burdwan	1. Burdwan
		2. Birbhum
		3. Bankura
		4. Midnapur
		5. Howrah
		6. Hooghly
	2. Presidency	1. 24-Parganas
		2. Nadia
		3. Murshidabad
		4. West Dinajpur
		5. Malda
		6. Jalpaiguri

* Areas without an asterisk are those for which yield data by crop cutting are available for fifteen years, 1946–47 to 1960–61, while those with asterisks are additional areas for which yield data are available only for ten years, 1951–52 to 1960–61, through extension of crop-cutting surveys to those areas.

† This district was merged with neighbouring districts in 1956.

TABLE II

Districts, Divisions and States for which yield data on wheat are analysed

State	Division	District
1. Punjab	1. Ambala	1. Hissar
		2. Rohtak
		3. Gurgaon
		4. Karnal
		5. Ambala
	2. Jullundur	1. Kangra
		2. Hoshiarpur
		3. Jullundur
		4. Ludhiana
		5. Ferozepur
		6. Amritsar
		7. Gurdaspur
2. Uttar Pradesh	1. Meerut	1. Dehra Dun
		2. Saharanpur
		3. Muzaffarnagar
		4. Meerut
		5. Bulandshahar
	2. Agra	1. Aligarh
		2. Mathura
		3. Agra
		4. Mainpuri
		5. Etah
	3. Rohilkhand	1. Bareilly
		2. Bijnor
		3. Budaun
		4. Moradabad
		5. Shahajahanpur
		6. Pilibhit
	4. Allahabad	1. Farrukhabad
		2. Etawah
		3. Kanpur
		4. Fatehpur
		5. Allahabad
	5. Jhansi	1. Jhansi
		2. Jalaun

TABLE II (*Contd.*)

State	Division	District
	5. Jhansi (*Contd.*)	3. Hamirpur
		4. Banda
	6. Varanasi	1. Varanasi
		2. Mirzapur
		3. Jaunpur
		4. Ghazipur
		5. Ballia
	7. Gorakhpur	1. Gorakhpur
		2. Basti
		3. Azamgarh
		4. Deoria
	8. Lucknow	1. Lucknow
		2. Unao
		3. Rae Bareli
		4. Sitapur
		5. Hardoi
		6. Kheri
	9. Faizabad	1. Faizabad
		2. Gonda
		3. Bahraich
		4. Sultanpur
		5. Partapgarh
		6. Barabanki
3. Bihar	1. Patna	1. Patna
		2. Gaya
		3. Shahabad
	2. Tirhut	1. Saran
		2. Champaran
		3. Muzaffarpur
		4. Darbhanga
	3. Bhagalpur	1. Monghyr
		2. Bhagalpur
		3. Saharsa
		4. Purnea
		5. Santal Parganas

TABLE II (*Contd.*)

State	Division	District
4. Madhya Pradesh	1. Jabalpur	1. Saugar 2. Jabalpur 3. Mandla 4. Hoshangabad 5. Nimar
	2. Nagpur	1. Betul 2. Chhindwara 3. Wardha 4. Nagpur 5. Chanda
	3. Chattisgarh	1. Bhandara 2. Drug 3. Raipur 4. Bilaspur 5. Balaghat
	4. Berar	1. Akola 2. Amraoti 3. Buldana 4. Yeotmal
5. Bombay	1. Gujarat	1. Ahmedabad 2. Broach
	2. Deccan	1. West Khandesh 2. East Khandesh 3. Nasik 4. Ahmednagar
	3. Karnatak	1. Belgaum 2. Bijapur 3. Dharwar

TABLE III

Divisional yield lb. per acre of rice and annual rainfall in inches, Uttar Pradesh, Series I, 1946–47 *to* 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Meerut	Yield	773	503	764	509	589	450*	555	685	557	519	908	800	936	813	839
	Rainfall	38·2	35·6	40·9	32·0	45·3	23·6	33·3	38·9	32·5	49·9	60·2	43·3	49·8	39·2	36·2
2. Rohilkhand	Yield	585	522	479	484	462	365	350	553	476	561	478	686	754	518	808
	Rainfall	41·7	35·9	43·9	44·4	38·7	28·5	28·5	44·1	40·9	55·2	49·0	40·3	62·4	37·9	65·1
3. Allahabad	Yield	529	629	667	636	493	640	433	591	629	668	624	609	729	548	762
	Rainfall	31·7	32·5	55·2	39·0	34·5	33·9	32·6	46·8	33·1	46·1	43·3	31·0	39·4	30·9	45·7
4. Varanasi	Yield	608	419	566	472	367	363	391	511	255	648	524	331	635	499	687
	Rainfall	50·0	32·3	65·1	44·2	44·6	31·4	35·0	48·0	25·5	46·0	56·8	35·4	37·1	32·4	36·2
5. Gorakhpur	Yield	521	600	687	492	429	251	477	546	549	524	426	420	585	432	568
	Rainfall	46·4	43·0	56·3	46·6	37·9	31·9	41·0	57·8	35·5	77·0	69·3	43·5	55·2	44·9	42·3
6. Lucknow	Yield	444	577	529	431	440	368	401	507	588	661	558	568	574	529	591
	Rainfall	32·5	42·4	42·2	46·0	35·2	26·2	32·7	46·0	41·9	51·6	39·7	35·7	44·1	26·4	54·5
7. Faizabad	Yield	416	557	595	427	359	323	435	503	499	583	416	499	546	397	517
	Rainfall	38·7	44·8	50·1	40·9	34·1	28·4	35·9	57·2	36·9	72·1	46·3	41·0	47·3	35·7	53·3

Calculated value in the absence of crop-cutting results.

TABLE IV

Divisional yield lb. per acre of rice and annual rainfall in inches, Bihar, Series I, 1946–47 to 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Patna	Yield	694	477	646	561	329	415	602	752	468	711	704	587	921	771	872
	Rainfall	53·8	34·9	55·4	42·2	40·0	32·9	41·4	50·1	33·4	37·3	50·3	31·9	40·9	41·5	39·2
2. Tirhut	Yield	549	610	594	555	253	437	599	618	473	533	576	351	743	585	692
	Rainfall	38·3	47·8	52·6	55·4	37·5	47·0	48·1	77·4	43·7	57·8	58·2	40·1	55·1	39·0	48·5
3. Bhagalpur	Yield	661	695	561	543	386	482	617	762	533	650	729	411	824	749	855
	Rainfall	49·3	47·4	56·4	58·8	55·1	49·4	53·6	75·4	51·5	53·9	68·0	39·6	53·3	63·4	52·9
4. Chota Nagpur	Yield	937	859	790	813	635	695	732	963	574	792	822	405	828	842	883
	Rainfall	60·5	49·1	58·8	51·3	59·2	46·4	51·2	76·3	41·6	45·5	56·9	46·0	46·5	56·9	52·7

TABLE V

Divisional yield lb. per acre of rice and annual rainfall in inches, West Bengal, Series I, 1946–47 to 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Burdwan	Yield	866	841	784	841	985	935	949	1249	881	998	1028	1041	925	935	1183
	Rainfall	60·9	46·2	60·5	50·6	60·5	47·7	50·2	56·3	40·0	54·5	62·5	45·0	44·9	65·9	50·9
2. Presidency	Yield	754	783	801	831	780	677	769	976	828	837	910	718	798	747	956
	Rainfall	68·6	64·4	80·9	67·1	71·7	68·4	71·1	73·4	66·1	80·0	74·8	57·1	68·9	80·7	61·3

TABLE VI

Divisional yield lb. per acre of rice and annual rainfall in inches, Assam, Series I, 1946–47 *to* 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Plains	Yield	*	979	989	926	825	898	968	939	1017	881	956	882	910	1038	933
	Rainfall		111·6	99·2	90·6	71·6	92·2	102·9	90·3	89·6	98·6	96·6	96·4	96·4	80·3	90·2

* No crop-cutting survey in 1946–47.

TABLE VII

Divisional yield lb. per acre of rice and annual rainfall in inches, Madhya Pradesh, Series I, 1946–47 *to* 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Jabalpur	Yield	519	582	542	508	205	464	380	443	485	560	697	242	545	517	449
	Rainfall	67·3	69·0	65·5	53·4	54·6	44·1	56·8	41·2	49·2	52·8	67·9	47·8	59·5	61·0	52·0
2. Nagpur	Yield	749	927	776	777	430	733	700	779	831	839	893	638	842	830	740
	Rainfall	48·4	49·8	48·0	58·7	37·4	43·7	28·9	57·0	50·3	66·3	55·7	57·5	51·3	77·2	49·5
3. Chattisgarh	Yield	747	758	692	772	460	678	671	670	659	792	874	595	874	802	891
	Rainfall	56·3	66·9	54·3	57·5	48·1	44·1	44·5	46·8	43·3	53·7	61·8	46·3	58·9	56·2	50·1

TABLE VIII

Divisional yield lb. per acre of rice and annual rainfall in inches, Bombay, Series I, 1946–47 *to* 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1660–61
1. Gujarat	Yield	878	646	358	616	589	108	382	750	704	610	729	453	884	840	537
	Rainfall	47·2	30·6	19·8	34·9	43·6	19·8	30·5	48·4	62·1	45·9	58·0	33·2	59·8	71·0	34·3
2. Konkan	Yield	1068	1010	1082	949	962	929	1069	1289	1155	1113	1040	1147	1343	1078	1129
	Rainfall	111·9	97·8	118·1	116·3	96·5	114·9	88·2	124·8	139·5	148·3	139·4	117·9	157·0	148·3	118·9
3. Carnatic	Yield	808	935	846	793	1084	887	764	885	969	802	978	1269	1458	1527	1032
	Rainfall	56·2	40·3	47·4	29·4	51·8	41·2	41·4	69·3	55·8	34·2	42·9	37·8	27·5	34·6	33·1

TABLE IX

Divisional yield lb. per acre of rice and annual rainfall in inches, Andhra Pradesh, Series I, 1946–47 *to* 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Circars	Yield	1019	1102	1084	859	1104	1113	1089	1255	1333	1233	1244	1265	1308	1280	1319
	Rainfall	34·3	44·3	38·6	47·1	37·7	37·8	45·2	35·8	49·8	43·4	49·4	26·9	54·4	46·7	40·0
2. Carnatic	Yield	876	556	923	820	814	485	899	910	963	1102	1526	1377	1272	1115	1181
	Rainfall	59·4	24·7	32·8	31·4	31·8	31·9	24·1	32·5	44·7	21·6	47·6	33·0	42·8	27·8	50·5
3. Central	Yield	1163	1026	975	1055	1102	1045	1154	1196	1360	1199	1238	1290	1264	1493	1286
	Rainfall	49·3	25·5	28·4	31·6	27·8	23·5	29·5	36·7	38·8	28·0	29·4	21·6	31·9	41·1	32·3

TABLE X

Divisional yield lb. per acre of rice and annual rainfall in inches, Madras, Series I, 1946–47 *to* 1960–61

Division		Year														
		1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Carnatic	Yield	868	769	717	747	821	918	936	1002	1077	1220	1153	1126	1119	1194	1138
	Rainfall	73·3	32·9	36·0	29·3	32·9	35·5	30·1	49·7	52·6	40·5	45·8	40·0	37·0	35·8	58·9
2. Central	Yield	1096	980	942	1050	1171	1106	1143	1166	1288	1387	1387	1360	1067	1154	1266
	Rainfall	47·9	30·3	30·1	30·5	26·7	27·8	31·2	40·6	38·0	35·1	42·7	31·1	28·9	26·2	38·1
3. South	Yield	788	982	987	799	1031	1014	928	1078	1209	1090	1256	1249	1247	1299	1236
	Rainfall	54·8	27·6	30·8	31·6	33·2	31·0	26·9	42·9	42·4	37·8	35·6	46·1	28·3	33·6	47·0
4. West coast	Yield	865	746	840	773	760	821	778	784	898	859	969	950	1028	1100	1153
	Rainfall	159·5	128·8	144·6	122·3	134·5	116·0	99·3	125·4	157·5	142·4	118·5	133·0	129·0	177·9	147·1

TABLE XI

Divisional yield lb. per acre of rice and annual rainfall inches, Uttar Pradesh, Series II. 1951–52 *to* 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Meerut	Yield	*450	555	685	557	519	908	800	936	813	889
	Rainfall	23·6	33·3	38·9	32·5	49·9	60·2	43·3	49·8	39·2	36·2
2. Rohilkhand	Yield	318	370	505	440	514	488	625	715	552	749
	Rainfall	29·4	30·0	42·9	40·0	51·4	50·7	41·6	58·9	36·3	55·8
3. Allahabad	Yield	640	433	591	629	668	624	609	729	548	762
	Rainfall	33·9	32·7	46·8	33·1	46·1	43·3	31·0	39·4	30·9	45·7
4. Varanasi	Yield	363	391	511	255	648	524	331	635	499	687
	Rainfall	31·4	35·0	48·0	25·5	46·0	56·8	35·4	37·1	32·4	36·2
5. Gorakhpur	Yield	251	477	546	549	524	426	420	585	432	568
	Rainfall	31·9	41·0	57·8	35·5	77·0	69·3	43·5	55·2	45·0	42·3
6. Lucknow	Yield	368	401	507	588	661	558	568	574	529	591
	Rainfall	26·2	32·7	46·0	41·9	51·7	40·0	35·7	44·1	26·4	54·5
7. Falzabad	Yield	323	435	503	499	583	416	499	546	397	517
	Rainfall	28·4	35·9	57·2	36·9	72·1	46·3	41·0	47·3	35·7	53·3

* Calculated value in the absence of crop-cutting results.

TABLE XII

Divisional yield lb. per acre of rice and annual rainfall in inches, Bihar, Series II, 1951–52 to 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Patna	Yield	412	597	747	465	707	702	584	916	766	867
	Rainfall	32·9	41·5	50·1	33·4	37·3	50·4	31·9	40·9	41·5	39·1
2. Tirhut	Yield	426	570	599	462	519	556	353	710	558	682
	Rainfall	47·3	48·4	77·0	43·7	58·1	58·5	40·4	55·2	39·1	48·6
3. Bhagalpur	Yield	471	588	722	514	633	694	403	772	717	815
	Rainfall	50·0	54·7	75·8	51·7	55·5	68·8	39·9	54·0	62·9	53·3
4. Chota Nagpur	Yield	642	673	895	544	739	745	408	759	777	815
	Rainfall	46·4	51·5	76·0	41·9	45·9	57·1	46·4	46·7	56·9	53·0

TABLE XIII

Divisional yield lb. per acre of rice and annual rainfall in inches, West Bengal, Series II, 1951–52 to 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Burdwan	Yield	935	949	1249	881	998	1028	1041	925	935	1183
	Rainfall	47·7	50·2	56·3	40·0	54·5	62·5	45·0	44·9	65·9	50·9
2. Presidency	Yield	677	769	976	828	837	910	718	798	747	956
	Rainfall	68·4	71·1	73·4	66·1	80·0	74·8	57·1	68·9	80·7	61·3

TABLE XIV

Divisional yield lb. per acre of rice and annual rainfall in inches, Assam, Series II, 1951–52 to 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Plains	Yield	829	893	910	929	878	905	883	833	886	866
	Rainfall	98·2	108·3	96·2	95·7	107·3	98·2	100·2	99·8	84·4	94·5

TABLE XV

Divisional yield lb. per acre of rice and annual rainfall in inches, Madhya Pradesh, Series II, 1951–52 to 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Jabalpur	Yield	464	380	413	485	560	697	242	545	517	449
	Rainfall	44·1	56·8	41·2	49·2	52·8	67·9	47·8	59·5	61·0	52·0
2. Nagpur	Yield	733	700	779	831	839	893	638	842	830	740
	Rainfall	43·7	28·9	57·0	50·3	66·3	55·7	57·5	51·3	77·2	49·5
3. Chattisgarh	Yield	678	671	670	659	792	874	595	874	802	891
	Rainfall	44·1	44·5	46·8	43·3	53·7	61·8	46·3	58·9	56·2	50·1

TABLE XVI

Divisional yield lb. per acre of rice and annual rainfall in inches, Bombay, Series II, 1951–52 *to* 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Gujarat	Yield	84	324	707	646	548	606	405	822	727	495
	Rainfall	18·7	31·3	45·0	60·0	45·4	56·8	31·9	58·1	70·2	32·7
2. Carnatic	Yield	792	707	823	966	824	988	1194	1228	1346	1147
	Rainfall	35·7	39·4	64·9	51·5	38·7	50·7	44·9	41·7	54·0	40·9
3. Konkan	Yield	929	1069	1289	1155	1113	1040	1147	1343	1078	1129
	Rainfall	114·9	88·2	124·8	140·0	148·2	139·4	117·9	157·0	148·3	118·9
4. Deccan	Yield	584	566	652	676	776	753	593	763	712	782
	Rainfall	22·8	21·1	26·7	29·4	37·7	44·5	30·3	39·8	42·2	37·4

TABLE XVII

Divisional yield lb. per acre of rice and annual rainfall in inches, Andhra Pradesh, Series II, 1951–52 *to* 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Circars	Yield	1092	1044	1181	1295	1201	1214	1212	1274	1251	1267
	Rainfall	37·8	45·2	35·8	49·8	43·4	50·6	37·1	56·1	46·0	40·3
2. Carnatic	Yield	485	899	910	963	1102	1526	1377	1272	1115	1181
	Rainfall	31·9	24·1	32·5	44·7	21·6	47·6	33·0	42·8	27·8	50·5
3. Central	Yield	1045	1154	1196	1360	1199	1238	1290	1264	1493	1286
	Rainfall	23·5	29·5	36·7	38·8	28·0	29·4	21·6	31·9	41·1	32·3
4. Telangana	Yield	561	568	773	680	614	647	795	1034	960	875
	Rainfall	30·6	23·7	43·6	35·0	45·5	46·4	35·2	38·2	48·8	31·3

TABLE XVIII

Divisional yield lb. per acre of rice and annual rainfall in inches, Madras, Series II, 1951–52 *to* 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Carnatic	Yield	923	950	1030	1070	1225	1160	1127	1115	1191	1141
	Rainfall	35·6	30·1	49·7	52·7	40·4	45·7	39·4	37·0	35·8	58·9
2. Central	Yield	1101	1197	1214	1319	1370	1438	1403	1216	1209	1317
	Rainfall	27·4	31·1	40·9	37·7	33·5	42·4	30·7	29·3	27·5	36·5
3. South	Yield	910	903	1078	1190	1089	1263	1249	1253	1306	1244
	Rainfall	31·0	26·9	42·9	42·4	37·9	35·6	46·1	28·3	33·6	47·0
4. West coast	Yield	767	777	789	900	864	970	950	1114	1080	1084
	Rainfall	116·0	99·3	125·4	157·5	142·0	118·4	133·0	128·9	177·7	146·7

TABLE XIX

Divisional yield lb. per acre of rice and annual rainfall in inches, Mysore, Series II, 1951–52 *to* 1960–61

Division		Year									
		1951–52	1952–53	1953–54	1954–55	1955 56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Mysore	Yield	1085	939	1165	1115	1237	1251	1319	1455	1509	1392
	Rainfall	44·5	41·2	66·1	53·2	39·4	60·6	51·6	55·2	66·2	48·6
2. Bangalore	Yield	843	656	906	865	1147	742	834	810	978	1061
	Rainfall	22·1	24·8	35·0	27·0	26·7	37·2	27·2	27·7	26·3	26·2

TABLE XX

Divisional yield lb. per acre of wheat and annual rainfall in inches, Punjab, 1946–47 to 1960–61

Division	Year														
	1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Ambala	*	890 28·1	936 24·8	1052 27·9	992 25·7	1053 14·8	1159 23·6	1054 26·7	1101 19·6	1023 23·4	1059 29·9	1003 22·7	1034 33·8	941 21·6	1114 28·3
2. Jullundur	*	733 45·3	836 37·2	961 36·9	843 45·8	796 23·6	908 26·4	894 34·5	952 32·7	742 44·1	806 39·9	831 29·1	839 41·3	856 31·7	956 31·1

* No cropcutting survey in 1946–47.

TABLE XXI

Divisional yield lb. per acre of wheat and annual rainfall in inches, Uttar Pradesh, 1946–47 to 1960–61

Division	Year														
	1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Meerut	558 34·6	763 30·3	737 38·8	866 30·2	914 41·8	886 25·7	839 30·4	942 33·4	877 30·5	698 45·6	710 49·9	737 40·1	768 46·0	854 31·1	1073 36·3
2. Agra	691 25·1	676 29·6	727 29·6	842 37·0	763 26·5	787 21·8	1109 28·0	842 21·6	875 24·9	869 36·0	790 32·6	751 27·9	871 42·0	912 23·7	1073 39·7
3. Rohilkhand	600 42·3	577 32·9	456 50·2	617 39·6	660 37·4	620 27·6	592 30·3	728 41·4	694 36·2	585 47·0	672 49·2	605 39·9	640 53·7	704 33·3	811 52·3
4. Allahabad	602 28·5	732 34·6	632 49·6	722 41·1	670 34·8	713 25·4	881 34·0	737 41·0	824 31·2	822 39·3	743 39·4	716 30·4	837 39·5	862 28·3	1009 46·7
5. Jhansi	510 33·8	580 37·8	633 42·4	678 33·3	718 29·6	509 33·2	597 36·5	610 36·2	867 33·9	784 36·7	824 37·5	605 31·3	890 41·4	827 29·5	1013 44·9
6. Varanasi	619 49·7	681 32·8	523 65·8	662 44·4	700 44·6	621* 31·5	742 34·8	740 48·0	737 25·4	653 46·3	479 56·9	465 35·3	575 37·4	721 32·4	733 36·5
7. Gorakhpur	818 46·7	761 44·5	488 57·9	789 46·9	644 38·2	597 32·6	789 41·6	676 55·9	789 35·2	608 78·5	582 68·0	649 43·9	587 57·1	758 47·4	733 43·2
8. Lucknow	685 32·3	701 42·7	536 42·1	602 46·5	753 33·3	609 23·3	750 34·2	682 45·8	703 42·4	570 51·1	764 39·5	642 35·8	641 44·4	588 26·4	785 56.6
9. Faizabad	700 38·5	626 46·0	418 51·3	564 45·4	665 33·7	532 26·8	750 36·6	631 56·2	765 38·4	626 71·0	600 46·1	608 41·7	569 47·4	651 37·2	738 52·5

* Calculated value in the absence of crop-cutting results.

TABLE XXII

Divisional yield lb. per acre of wheat and annual rainfall in inches, Bihar, 1946–47 to 1960–61

Division	Year	1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Patna		409	448	373	505	455	429	622	568	612	451	238	542	632	527	643
		58·1	35·7	57·5	42·2	41·0	33·1	41·9	50·1	33·5	37·9	52·3	30·7	40·9	41·8	38·5
2. Tirhut		523	702	593	526	364	338	479	629	511	600	297	516	621	502	522
		49·2	46·5	52·5	53·3	36·9	45·1	46·4	76·4	40·9	56·2	60·2	38·1	51·6	39·4	46·0
3. Bhagalpur		531	618	581	408	318	404	552	488	675	612	121	446	683	398	653
		43·6	45·5	56·0	62·3	50·0	46·8	46·5	61·1	46·0	54·6	69·9	35·3	51·5	52·5	54·5

TABLE XXIII

Divisional yield lb. per acre of wheat and annual rainfall in inches, Madhya Pradesh, 1946–47 to 1960–61

Division	Year	1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Jabulpur		118	378	625	516	681	451	509	549	678	535	460	324	592	637	563
		62·5	71·6	61·0	51·1	47·5	37·5	49·2	40·4	48·2	56·0	65·6	34·7	48·8	58·8	49·6
2. Nagpur		63	280	448	399	512	470	458	456	511	434	378	276	483	510	419
		46·3	47·7	47·6	53·3	31·6	39·8	25·0	43·6	49·3	57·1	46·6	28·0	47·2	59·0	33·8
3. Chattisgarh		110	226	405	377	340	390	462	412	464	491	270	251	332	446	337
		57·0	62·5	54·4	52·5	45·0	45·5	44·5	45·4	43·0	54·3	58·9	39·3	56·8	64·7	50·6
4. Berar		17	282	344	353	410	368	246	322	388	438	457	214	483	396	358
		40·1	35·6	40·0	48·0	26·8	27·4	24·3	32·9	36·0	43·2	35·3	11·3	36·0	53·5	27·4

TABLE XXIV

Divisional yield lb. per acre of wheat and annual rainfall in inches, Bombay, 1946–47 to 1960–61

Division	Year														
	1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Gujarat	275	395	167	380	342	327	280	376	403	363	247	158	386	313	360
	36·4	32·1	9·4	28·3	43·3	16·4	30·6	36·7	40·0	30·8	21·0	9·5	32·2	48·4	19·9
2. Deccan	28	316	299	376	347	274	192	369	375	406	260	335	461	409	356
	32·4	27·8	29·1	33·6	17·7	18·1	12·9	18·7	25·7	37·2	36·5	22·3	42·1	39·9	28·5
3. Carnatic	21	170	58	192	194	146	186	230	259	273	223	234	207	213	229
	40·9	29·5	33·5	25·3	37·5	33·4	29·1	51·1	40·5	29·8	38·5	34·0	24·1	29·3	30·7

TABLE XXV

Average yield lb. per acre of rice in different states, Series I, 1946–47 to 1960–61

State	Year														
	1946–47	1947–48	1948–49	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Uttar Pradesh	513	551	608	477	417	347	433	535	501	590	493	494	621	481	626
2. Bihar (W)	696	669	636	618	405	511	640	790	515	676	704	440	828	740	817
3. West Bengal	819	816	791	837	902	826	873	1130	858	927	977	902	870	852	1083
4. Assam (W)	*	979	989	926	825	898	968	939	1017	881	956	882	910	1038	933
5. Madhya Pradesh	728	758	686	750	435	663	647	659	659	776	861	569	842	779	837
5. Bombay	982	924	911	823	851	674	810	1059	980	910	933	936	1211	1063	92?
6. Andhra Pradesh	1011	1043	1062	867	1070	1048	1067	1208	1289	1215	1279	1280	1302	1275	1304
7. Madras	868	882	893	822	941	960	920	1009	1123	1115	1195	1174	1139	1208	1202
8. Combined (All-India)	769	786	775	721	646	683	740	879	781	840	875	757	900	854	933

* No crop-cutting survey in 1946–47. (W), Winter rice.

TABLE XXVI

Average yield lb. per acre of rice in different states, Series II, 1951–52 to 1960–61

State	Year									
	1951–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Uttar Pradesh	343	432	530	496	584	494	495	622	487	626
2. Bihar	493	609	753	500	651	671	434	785	707	788
3. West Bengal	826	873	1130	858	927	977	902	870	852	1083
4. Assam	829	893	910	929	878	905	883	833	886	866
5. Madhya Pradesh	663	647	659	659	776	861	569	842	779	837
6. Bombay	605	718	953	904	849	862	857	1094	973	891
7. Andhra Pradesh	944	950	1080	1150	1072	1113	1133	1216	1178	1179
8. Madras	907	928	1031	1129	1126	1217	1191	1187	1215	1203
9. Mysore	1032	881	1100	1057	1216	1128	1205	1295	1406	1328
10. Combined (All-India)	670	726	866	777	833	864	764	899	848	920

TABLE XXVII

Average yield lb. per acre of wheat in different states, 1946–47 to 1960–61

State	Year														
	1946–47	1947–48	1948–49	1949–50	1950–51	1991–52	1952–53	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61
1. Punjab	*	773	864	989	886	871	981	941	999	839	894	892	908	887	1012
2. Uttar Pradesh	642	674	566	703	729	661	770	741	790	682	702	653	712	758	899
3. Bihar	483	583	507	488	389	389	557	568	604	545	218	510	641	488	606
4. Madhya Pradesh	89	327	526	453	576	441	462	486	580	493	422	293	528	560	482
5. Bombay	83	289	168	307	287	217	207	319	338	347	243	261	345	312	304
6. Combined (All-India)	440	604	577	655	662	610	694	687	745	642	609	600	688	694	781

* No crop-cutting survey in 1946–47.

TABLE XXVIII

Analysis of variance of annual divisional yields per acre of rice in different states, Series I

(Mean squares for component variation)

State	Between periods: Pre-Plan, 1st Plan and 2nd Plan				Between periods: 1st Plan *v.* Pre-Plan				Between periods: 2nd Plan *v.* 1st Plan			
	Degrees of freedom	Mean Square Component (*a*)	Significance against component (*b*)	Significance against component (*e*)	Degrees of freedom	Mean Square	Significance against component (*b*)	Significance against component (*e*)	Degrees of freedom	Mean Square	Significance against component (*b*)	Significance against component (*e*)
1. Uttar Pradesh	2	102581	*	†	1	18436			1	195466	*	†
2. Bihar	2	59251		†	1	1690			1	75864		†
3. West Bengal	2	27745		†	1	34694		*	1	1008		
4. Assam	2	234			1	262			1	26		
5. Madhya Pradesh	2	17587		†	1	1920			1	18501		†
6. Bombay	2	190716		†	1	1442			1	305626	*	†
7. Andhra Pradesh	2	422216	†	†	1	115072	†	†	1	324896	†	†
8. Madras	2	409041	†	†	1	220522	†	†	1	188925	†	†

State	Individual years within periods: Residual‡		Individual years within periods: Total		Divisions		Interaction of divisions with period		Interaction of divisions with individual years	
	Degrees of freedom	Mean Square Component (*b*)	Degrees of freedom	Mean Square Component (*b*)	Degrees of freedom	Mean Square Component (*c*)	Degrees of freedom	Mean Square Component (*d*)	Degrees of freedom	Mean Square Component (*e*)
1. Uttar Pradesh	9	23071†	12	37079	6	86404†	12	18210†	71§	5683
2. Bihar	9	59714†	12	70231	3	131920†	6	18219†	36	3304
3. West Bengal	9	19583	12	16399†	1	172673†	2	11531	12	3764
4. Assam	8	4357	11	3907	..	..	..	..	11	3907
5. Madhya Pradesh	9	36849†	12	41370	2	373404†	4	5339	24	2145
6. Bombay	9	47379	12	45936*	2	1002004†	4	54642	24	19721
7. Andhra Pradesh	9	8675	12	21813	2	188809†	4	47969*	24	14180
8. Madras	9	6493	12	14025	3	221131†	6	17448*	36	6128

* Significant at 5%. † Significant at 1% ‡ Residual mean square after fitting linear trend to annual values within each period.
§ One less due to fitted value.

TABLE XXIX

Analysis of variance of annual divisional yields per acre of rice in different States, Series II

(Mean squares of component variation)

State	Between periods (2nd Plan *v.* 1st Plan)				Individual years within periods				Divisions		Interaction of divisions with periods		Interaction of divisions with individual years	
					Residual‡		Total							
	Degrees of freedom	Mean Square Component (*a*)	Significance against Component (*b*)	Significance against Component (*e*)	Degrees of freedom	Mean Square Component (*b*)	Degrees of freedom	Mean Square Component (*d*)	Degrees of freedom	Mean Square Component (*c*)	Degrees of freedom	Mean Square Component (*d*)	Degrees of freedom	Mean Square Component (*e*)
1. Uttar Pradesh	1	200037	*	†	6	22140	8	39403	6	76766†	6	29246†	47§	5223
2. Bihar	1	70057		†	6	66670	8	65195	3	47433†	3	14201*	24	2347
3. West Bengal	1	1008			6	28705	8	23383	1	182023†	1	168	8	3693
4. Assam	1	436			6	1057	8	1088	..	..	..	..	8	1088
5. Madhya Pradesh	1	18501		*	6	32395	8	27386	2	279696†	2	7650	16	2260
6. Bombay	1	235316	*	†	6	30331	8	44898	3	752291†	3	52199*	24	12299
7. Andhra Pradesh	1	451350	†	†	6	9014	8	26316	3	510406†	3	57833*	24	15203
8. Madras	1	250272	†	†	6	1384	8	18241	3	208934†	3	15124*	24	4327
9. Mysore	1	97022	*	†	6	13942	8	30798	1	657031†	1	94806†	8	4657

* Significant at 5%. † Significant at 1%, ‡ Residual mean square after fitting linear trend to annual values within each period. § 1 d.f. less due to fitted value.

TABLE XXX

Average yield lb. per acre of rice in different states for pre-plan, First Plan and Second Plan periods, Series I

State	Pre-plan period (1946–47 to 1950–51)	1st plan period (1951–52 to 1955–56)	2nd plan period (1956–57 to 1960–61)	Difference (1st Plan — pre-plan)	Difference (2nd Plan — 1st plan)	S.E. of difference	Difference of yield of 1st Plan over pre-plan expressed as % increase	Difference of yield of 1st Plan over pre-plan expressed as Average % increase/year	Difference of yield of 2nd Plan over 1st Plan expressed as % increase	Difference of yield of 2nd Plan over 1st Plan expressed as Average % increase/year
1. Uttar Pradesh	513	480	543	(−) 33	63	21	(−) 6·4	(−)1·3	13·1	2·6
2. Bihar	605	626	705	21	79	18	3·5	0·7	12·6	2·5
3. West Bengal	833	922	936	89	14	28	10·7	2·1	1·5	0·3
4. Assam	930	941	944	11	3	42	1·2	0·2	0·3	0·1
5. Madhya Pradesh	671	681	778	10	97	24	1·5	0·3	14·2	2·8
6. Bombay	891	886	1013	(−) 5	127	57	(−) 0·6	(−)0·1	14·3	2·9
7. Andhra Pradesh	1009	1164	1286	155	122	64	15·4	3·1	10·5	2·1
8. Madras	881	1024	1184	143	160	27	16·2	3·2	15·6	3·1
9. Combined (All-India)	743	783	863	40	80	11	5·4	1·1	10·2	2·0

TABLE XXXI

Average yield lb. per acre of rice in different states for First Plan and Second Plan periods, Series II

	1st Plan period 1951–52 to 1955–56	2nd Plan period 1956–57 to 1960–61	Difference 2nd Plan − 1st Plan	Standard error of difference	Difference as % of yield in 1st Plan period	Average % increase/year
1. Uttar Pradesh	476	545	69	20	14·5	2·9
2. Bihar	600	677	77	15	12·8	2·6
3. West Bengal	922	936	14	27	1·5	0·3
4. Assam	888	875	−13	21	− 1·5	−0·3
5. Madhya Pradesh	681	778	97	25	14·2	2·8
6. Bombay	805	935	130	39	16·1	3·2
7. Andhra Pradesh	1038	1162	124	55	11·9	2·4
8. Madras	1024	1203	179	22	17·5	3·5
9. Mysore	1057	1271	214	35	20·2	4·0
10. Combined (All-India)	772	858	86	9	11·1	2·2

TABLE XXXII

Average yield of rice, annual rainfall, and area of rice irrigated in different states

State	Division	Pre-Plan			1st Plan			2nd Plan		C.V. (Between years and within period) (%)
		Average yield/acre (lb.)	Average rainfall (in.)	% area irrigated	Average yield/acre (lb.)	Average rainfall (in.)	% area irrigated	Average yield/acre (lb.)	Average rainfall (in.)	
1. Andhra Pradesh	Circar	1034	40·4	94·0	1205	42·4	94·1	1283	45·5	..
	Carnatic	798	36·0	96·2	872	31·0	98·3	1294	40·3	..
	Central	1064	32·5	93·0	1191	31·3	93·3	1314	31·3	..
	State	1009	39·5	94·2	1164	40·3	94·7	1286	44·1	13·2 (8·3)
2. Assam	Plains	930	93·3	25·3	941	94·7	32·5	944	92·0	6·7 (7·0)
3. Bihar	Patna	541	45·3	88·2	590	39·0	74·2	771	40·8	..
	Tirhut	512	48·6	10·3	532	54·8	9·0	589	48·2	..
	Bhagalpur	569	53·4	28·8	609	56·8	20·9	714	55·4	..
	Chota Nagpur	807	55·8	7·7	751	52·2	10·8	756	51·8	..
	State	605	51·1	31·1	626	50·2	27·9	705	49·0	41·1 (37·9)
4. Bombay	Gujarat	617	35·2	2·7	511	41·3	5·9	689	51·2	..
	Carnatic	893	45·0	42·0	861	48·4	37·0	1253	35·2	..
	Konkan	1014	108·1	3·0	1111	123·1	4·1	1147	136·3	..
	State	891	79·0	9·1	886	86·0	9·9	1012	94·5	23·8 (24·2)
5. Madhya Pradesh	Jabalpur	471	62·0	4·7	466	48·8	5·4	490	57·6	..
	Nagpur	732	48·5	44·0	776	49·2	42·4	789	58·2	..
	Chattisgarh	686	56·6	22·9	694	46·5	22·9	807	54·7	..
	State	671	56·4	23·2	681	46·9	23·1	778	55·3	31·0 (29·2)

6. Madras	Carnatic	784	40·9	78·7	1031	41·7	83·2	1146	43·4	..	
	Central	1048	33·1	86·9	1218	34·5	93·1	1247	33·3	..	
	South	917	35·6	94·6	1064	36·2	94·7	1257	38·1	..	
	West Coast	797	137·9	0	828	128·1	0	1040	141·1	..	
	State	881	61·1	67·4	1024	59·2	69·3	1184	61·5	11·5	(7·8)
7. Uttar Pradesh	Meerut	628	38·4	60·0	553	35·6	57·5	859	45·7	..	
	Rohilkhand	506	41·8	16·1	461	39·4	16·9	649	50·9	..	
	Allahabad	591	38·6	17·9	592	38·5	20·7	654	38·1	..	
	Gorakhpur	546	46·0	10·7	469	48·6	10·9	486	51·1	..	
	Lucknow	482	39·7	0·7	505	39·7	0·7	564	40·0	..	
	Faizabad	471	41·7	6·6	469	46·1	8·1	475	44·7	..	
	Varanasi	486	47·2	0·7	434	37·2	0·5	535	39·6	..	
	State	513	43·2	9·2	480	43·1	9·9	543	44·9	35·4	(27·9)
8. West Bengal	Burdwan	863	55·7	31·6	1002	49·7	36·9	1022	53·8	..	
	Presidency	790	70·5	7·9	817	71·8	11·0	826	68·6	..	
	State	833	61·8	21·8	922	59·2	25·7	936	60·3	14·4	(15·8)
9. Mysore(10 years)	Mysore	..	..	..	1108	48·9	91·8	1385	56·5	..	
	Bangalore	..	..	..	883	27·1	93·2	885	28·9	..	
	State	..	..	..	1057	43·9	92·1	1271	50·2	16·5	(11·1)

* Figures in brackets are for coefficient of variation calculated from residual mean squares after eliminating linear trend within periods.

TABLE XXXIII

Analysis of regression and regression coefficients of yield of rice on rainfall

State		Regression based on actual rainfall		Regression based on deviation from normal rainfall	
		Components of mean square for uncontrolled variation ‡	Regression coefficient	Components of mean square for uncontrolled variation ‡	Regression coefficient
1. Uttar Pradesh ..	Linear	29103*	16·52	28699*	5·60
	Quadratic	28521*	−0·13	30512*	−0·18
	Residual	5012		4989	
2. Bihar ..	Linear	9436	11·47	14167*	4·12
	Quadratic	3692	(−) 0·08	11798*	(−) 0·21
	Residual	3112		2735	
3. West Bengal ..	Linear	21440*	9·38	23513†	13·20
	Quadratic	245	0·03	1410	(−) 0·17
	Residual	2348		2024	
4. Assam ..	Linear	2749	8·57	2648	1·51
	Quadratic	253	(−) 0·04	2	(−) 0·004
	Residual	4442		4481	
5. Madhya Pradesh ..	Linear	1992	2·92	2072	1·21
	Quadratic	120	(−) 0·02	129	(−) 0·02
	Residual	2244		2240	
6. Bombay ..	Linear	12939	10·62	12540	5·90
	Quadratic	100702*	(−) 0·05	155992†	(−) 0·21
	Residual	16348		13853	
7. Andhra ..	Linear	11945	(−) 0·06	11612	2·62
	Quadratic	782	2·95	394	0·05
	Residual	14891		14924	
8. Madras ..	Linear	2547	(−) 0·48	2187	(−) 0·47
	Quadratic	1097	0·01	9726	0·07
	Residual	6381		6138	
9. Mysore (10 years) ..	Linear	7956	7·80	5464	7·76
	Quadratic	48	(−) 0·02	910	(−) 0·18
	Residual	4875		5147	

‡ Components (*e*) in Tables XXVIII and XXIX. * Significant at 5%. † Significant at 1%.

TABLE XXXIV

Average yield of rice lb. per acre in pre-plan, and plan periods, unadjusted and adjusted for regression on rainfall

State	Unadjusted			Adjusted for regression on actual rainfall			Adjusted for regression on deviation from normal rainfall		
	Pre-Plan	1st Plan	2nd Plan	Pre-Plan	1st Plan	2nd Plan	Pre-Plan	1st Plan	2nd Plan
1. Uttar Pradesh	513	480	543	502	489	531	511	502	538
	(—) 33*	63		(—)13	42		(—) 9	36	
2. Bihar	605	626	705	598	628	709	598	633	706
	21	79		30	81		35	73	
3. West Bengal	833	922	936	832	953	955	810	943	951
	89	14		121	2		133	8	
4. Assam	930	941	944	935	936	944	930	938	947
	11	3		1	8		8	9	
5. Madhya Pradesh	671	678	778	668	689	775	667	689	774
	10	97		21	86		22	85	
6. Bombay	891	886	1013	841	854	986	890	904	1020
	(—) 5	127		13	132		14	116	
7. Andhra Pradesh	1009	1164	1286	998	1151	1264	1009	1160	1271
	155	122		133	113		151	111	
8. Madras	881	1024	1184	881	1027	1184	881	1024	1185
	143	160		146	157		143	161	
9. Mysore (10 years)		1057	1271		1033	1207		1077	1242
		214			174			165	
10. Combined (All India) Series I	743	783	863	737	789	862	736	793	864
	40	80		52	73		57	71	
11. „ Series II		772	858		776	853		780	860
		86			77			80	

* Increase or decrease in yield between two successive five year periods are shown between these periods in the second line below each state.

TABLE XXXV

Analysis of variance of annual divisional yields per acre of wheat in different states

(Mean squares for component variation)

State	Between periods											
	Pre-plan, 1st Plan and 2nd Plan				1st Plan *v.* pre-Plan				2nd Plan *v.* 1st Plan			
	Degrees of freedom	Mean Square Component (*a*)	Significance against Component (*b*)	Significance against Component (*e*)	Degrees of freedom	Mean Square	Significance against Component (*b*)	Significance against Component (*e*)	Degrees of freedom	Mean Square	Significance against Component (*b*)	Significance against Component (*e*)
1. Punjab	2	8813		*	1	17542		†	1	2952		
2. Uttar Pradesh	2	74120		†	1	99867		†	1	1054		
3. Bihar	2	8614			1	12649			1	13188		
4. Madhya Pradesh	2	58548		†	1	115348		†	1	17851		*
5. Bombay	2	16704		*	1	26940		†	1	154		

State	Individual years within periods				Divisions		Interaction of divisions with periods		Interaction of divisions with individuals years	
	Residual‡		Total							
	Degrees of freedom	Mean Square Component (*b*)	Degrees of freedom	Mean Square Component (*b*)	Degrees of freedom	Mean Square Component (*c*)	Degrees of freedom	Mean Square Component (*d*)	Degrees of freedom	Mean Square Component (*e*)
1. Punjab	8	9667	11	8687	1	215777†	2	5068	11	1497
2. Uttar Pradesh	9	32033	12	47610	8	92577†	16	12820*	95§	5641
3. Bihar	9	26627	12	40209	2	1430	4	8783	24	6277
4. Madhya Pradesh	9	22206	12	50028	3	87613†	6	4882	36	2973
5. Bombay	9	8666	12	14139	2	84733†	4	6157	24	3303

§ 1 d.f. less due to fitted value. * Significant at 5%. † Significant at 1%. ‡ Residual mean squares after fitting linear rend to annual values within each period.

TABLE XXXVI

Average yield lb. per acre of wheat in different states for pre-plan, first plan and second plan periods

State	Pre-Plan period (1946–47 to 1950–51)	1st Plan period (1951–52 to 1955–56)	2nd Plan period (1956–57 to 1960–61)	Difference		S.E. of difference	Difference of yield of 1st Plan over pre-Plan expressed as		Difference of yield of 2nd Plan over 1st Plan expressed as	
				1st Plan — pre-Plan	2nd Plan — 1st Plan		% increase	Average % increase/year	% increase	Average % increase/year
1. Punjab	879	925	919	46	(−) 6	20	5·2	1·0	(−)0·6	(−)0·1
2. Uttar Pradesh	661	729	745	68	16	17	10·3	2·1	2·2	0·4
3. Bihar	488	531	494	43	(−)37	30	8·8	1·8	(−)7·0	(−)1·4
4. Madhya Pradesh	394	493	457	99	(−)36	21	25·1	5·0	(−)7·3	(−)1·5
5. Bombay	225	286	293	61	7	22	27·1	5·4	2·4	0·5
6. Combined (All-India)	604	675	676	71	1	10	11·8	2·4	0·1	0·02

TABLE XXXVII

Average yield of wheat, annual rainfall, and area of wheat irrigated in different states

State	Division	Pre-Plan			1st Plan			2nd Plan		C.V. (Between years and within periods) (%)
		Average yield/acre (lb.)	Average rainfall (in.)	% area irrigated	Average yield/acre (lb.)	Average rainfall (in.)	% area irrigated	Average yield/acre (lb.)	Average rainfall (in.)	
1. Punjab	Ambala	968	26·6	51·3	1078	21·6	56·6	1030	27·2	..
	Amritsar	843	41·3	51·6	858	32·3	52·4	858	34·6	..
	State	879	37·1	51·5	925	29·0	53·7	919	32·0	9·9 (10·4)*
2. Uttar Pradesh	Meerut	768	35·1	59·7	848	33·1	60·7	828	40·7	..
	Agra	740	29·6	80·2	896	26·5	85·1	879	33·2	..
	Rohilkhand	582	40·5	26·2	644	36·5	24·1	686	45·7	..
	Allahabad	672	37·7	59·0	795	34·2	66·1	833	36·8	..
	Jhansi	624	35·4	23·0	673	35·3	22·0	832	36·9	..
	Varanasi	637	47·4	46·1	699	37·2	42·0	595	39·7	..
	Gorakhpur	700	46·8	75·9	692	48·6	78·6	662	51·9	..
	Lucknow	655	39·4	37·4	663	39·4	40·2	684	40·5	..
	Faizabad	595	43·0	59·2	661	45·9	60·4	633	45·0	..
	State	661	38·9	50·3	729	37·2	51·5	745	41·4	30·7 (25·2)
3. Bihar	Patna	438	46·9	47·7	536	39·3	28·2	516	40·8	..
	Tirhut	542	47·7	19·3	511	53·2	10·0	492	47·1	..
	Bhagalpur	491	51·5	5·7	546	51·0	3·6	460	52·7	..
	State	488	48·4	26·4	531	47·4	15·0	494	45·9	39·8 (32·4)
4. Madhya Pradesh	Jabalpur	464	58·8	1·8	544	46·3	2·4	515	51·5	..
	Nagpur	340	45·3	3·0	466	43·0	5·6	413	42·9	..
	Chattisgarh	292	54·3	0·2	444	46·5	0·2	327	54·1	..
	Berar	281	38·1	1·5	352	32·8	1·9	382	32·7	..
	State	394	52·5	1·9	493	43·9	3·0	457	47·5	55·7 (37·1)
5. Bombay	Gujarat	312	29·9	11·3	350	30·9	15·7	293	26·2	..
	Deccan	273	28·1	19·1	323	22·5	23·7	364	33·9	..
	Carnatic	127	33·3	1·6	219	36·8	1·7	221	31·3	..
	State	225	30·5	10·5	286	30·1	13·1	293	31·4	43·1 (33·7)

* Figures in brackets are for coefficient of variation calculated from residual mean squares after eliminating linear trend within periods.