

**IMPACT OF HIGH-YIELDING VARIETIES  
PROGRAMME ON PRODUCTION OF MAJOR**

**CEREALS IN MAHARASHTRA**

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**BY  
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PROGRAMME ON PRODUCTION OF MAJOR  
CEREALS IN MAHARASHTRA**

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by  
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## PREFACE

The present study is an attempt to examine the performance of important cereal crops grown in the State of Maharashtra during the period 1956-57 to 1972-73. The study is confined to cereals since the new variety of seeds have so far been developed only for these cereal crops. Various studies conducted, so far, have been at a micro-level. The present attempt is to cover a larger area such as a region or a State and study the impact of the new varieties on production and productivity and spell out the constraints that come in the way of the extension of these varieties. This study examines both macro- as well as micro-level data which pertain to the State as a whole and also to the agro-climatic zones, demarcated by the Directorate of Agriculture, Maharashtra State.

The study was undertaken under the guidance of Prof. Nilakantha Rath of Gokhale Institute of Politics and Economics, Poona. I am highly obliged to Prof. Nilakantha Rath who not only provided the initial stimulus but encouraged me to probe the problem through his critical observations and timely advice. His deep insight into the problems of Indian agriculture was invaluable in the interpretation of the data.

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CHAPTER I  
INTRODUCTION

The State of Maharashtra has never in recent history been able to produce all the foodgrains consumed by its population. The State contains about 9 per cent of the total population of India, but except in 1960-61 when it produced a little over 9 per cent of total, in no other year has it been able to produce more than around 8 per cent of the total foodgrains produced in the country. Naturally, it had all along to depend on imports from other States of the Union and from other countries. This in itself might not be particularly disturbing. But what is disturbing is that during the last decade and a half the share of Maharashtra in total production of foodgrains in the country has steadily declined, so much so that in the last few years it has come down to 5 per cent or even lower. This is mainly because the production of foodgrains in the country as a whole has increased at an annual compound rate of 2.64 per cent (1960-61 to 1971-72)<sup>1</sup> while that of Maharashtra declined at the rate of 2.9 per cent. During the same period not only the production of foodgrains declined but the production of almost all the other agricultural commodities has declined except that of sugarcane. Production of important commodities like pulses, cotton, groundnut and other edible oilseeds has declined at a compound growth rate of 3.01, 3.30, 3.99 and 2.03 per cent

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<sup>1</sup> Planning Commission, Government of India, Draft Fifth Five Year Plan, 1974-79, Part II, p. 48.

respectively. It is particularly disturbing that during the period of the so-called Green Revolution (i.e., after 1964-65) the compound rate of growth of production of foodgrains in India has been 2.67 per cent, while in Maharashtra the compound growth rate has been hardly 0.75 per cent.<sup>2</sup> Compared to the decade before 1964-65 the growth rate of foodgrains in the State severely declined in later years: from 2.20 per cent (during 1952-53 to 1964-65) to 0.75 per cent (during 1964-65 to 1972-73). This naturally calls for explanation.

After the introduction of new hybrid/high-yielding varieties, various organizations and scholars conducted studies to assess its impact on different aspects of farming. All these studies have been conducted at a micro-level. These micro-studies were mostly directed towards some particular aspect of the green revolution with a view to arriving at estimates of the requirements to be met, based on the assumption that the area under these varieties will be increasing at a fast pace in view of the higher output-input ratios of these varieties. The higher output-input ratios of these varieties were essentially the ones from various research stations rather than the results from the cultivators' own experiences. Rarely has the objective of these studies been to assess the impact of the new varieties on

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2 These growth rates have been computed excluding the years of serious decline in production in Maharashtra (1965-66, 1971-72 and 1972-73).

production and productivity of the crop. Significant improvement in production and productivity was taken for granted, since agronomic studies had reported such increases on experimental farms.

By and large, the studies were conducted with a view to assessing the tempo of adoption of these varieties by the farmers. Often the attention was focussed on a single aspect, such as the credit requirement for the cultivation of these more expensive varieties or possibilities of generation of additional labour employment, both for family and hired labour, to handle the expected higher yields etc. An attempt to assess the actual performance of these varieties at the farm level and the reasons for the differing response of various crops has rarely, in fact never, been made. The constraints faced by the cultivators were not given much attention.

So far, we have not come across a study (except, of course, routine official statistical reporting) which covers a larger area such as a region or a state and has studied the impact of the new varieties on production and productivity and spelt out the constraints that come in the way of the extension of these varieties. A detailed examination of the impact of these new varieties at the farm level is therefore of particular importance as this might help us to identify the difficulties faced by farmers and the other limitations of the programme. It was, therefore, deemed fit to select

a wider region, Maharashtra State, to conduct the study with a view to assessing the impact of the new varieties on production and productivity of foodgrain crops, particularly cereals, and also pointing out the constraints coming in the way of its adoption. This calls for a study of the performance of these varieties at a regional level, with the help of macro- as well as micro-level data.

This study examines the performance of major cereal crops grown in the State of Maharashtra during the period 1956-57 to 1972-73, the latest year for which the relevant data are available. The study is confined to foodgrains, more specifically to cereals since the new variety of seeds have so far been developed only for some cereal crops. The only non-cereal non-food crop for which such variety of seed has been developed is cotton. But the data pertaining to this new variety of cotton is limited to two years only and as such are not adequate to draw any worthwhile conclusions, though some meaningful observation could still be made. In view of this limitation and inadequacy it was deemed fit to include such observations on cotton in the Appendix.

Jowar, Bajra, Rice and Wheat are the important cereals grown in Maharashtra. The area under these crops accounts for about 51 per cent of the total cropped area and 78 per cent of the area under foodgrains and about 82 per cent of the total production of foodgrains in the State. The performance of foodgrain production, therefore, depends



largely on the performance of production of these crops.

For a proper analysis and appreciation of the magnitude and nature of the problem, it is proposed to examine the performance of the selected crops, particularly during the period of the so-called 'Green Revolution' (i.e., after 1964-65). The detailed analysis pertains to the State as a whole as well as the sub-regions demarcated on the basis of agro-climatic conditions.

CHAPTER II

PROBLEMS DISCUSSED IN THE LITERATURE CITED

In the introductory chapter we have tried to spell out the need for a study, 'Impact of high-yielding varieties programme on production of major cereals in Maharashtra'. In the light of the observations made, it is deemed necessary to study the introduction, extension and impact of high-yielding varieties of these crops in some detail. It is not proposed to undertake a full-fledged study of these varieties in relation to the aspects spelt above, but only to review various studies already made in these respects, since our study is not directed towards the response of the individual farmers as such. It will be proper in the nature of things to review only that literature which will have direct bearing on the method of the study proposed by us and only make a cursory mention of the studies that are directed more towards the organization of the high-yielding varieties programme.

The introduction of hybrid/high-yielding varieties to replace the local and the other improved varieties has been one of the main strategies for increasing production and thus meeting the deficit of foodgrains in the country. These varieties have been evolved in respect of all the major foodgrain crops; wheat, Rice, Jowar, Bajra, Maize, etc., and these have been tested on the experimental farms and on cultivators' fields.

It is a well-known fact that the high-yielding

varieties are responsive to heavy doses of fertilizers and the other inputs as compared to the other varieties in vogue. The fertilizer dosage prescribed is two to three times that for the traditional varieties.

Since the inception of the high-yielding varieties programme in India, a number of studies were initiated by different scholars and agencies. The Ministry of Food and Agriculture, Government of India, pioneered such studies through the Agro-Economic Research Centres located at different university centres and research institutes. Another important agency is the Programme Evaluation Unit of the Planning Commission. The various Agricultural Universities, colleges and other research institutes also initiated a number of studies with varying objectives.

For the purpose of review, the studies conducted so far have been grouped into four categories. The four categories so made are based mainly on the basis of the aspects looked into by respective studies. However, a watertight division of such studies is neither possible nor desirable for the reason that ultimately all the studies touch on all problems related to the introduction of such varieties. The four groups can be spelt out as below :

- i) Fertilizer experiments/trials conducted on experiment stations or farmers' fields
- ii) Studies relating to the operational aspects of high-yielding varieties programme
- iii) Studies pertaining to seed production of high-yielding varieties, and

iv) Studies generally relating to the adoption of the new varieties.

Of the above-mentioned categories, the first <sup>is</sup> two are a bit more important, for our purpose, than the others. Secondly, these studies essentially look into the same aspects at two different levels under differing conditions. The studies under the first category are conducted on the basis of data available from experimental trials. The exercises have been undertaken to determine the optimum doses for different crops in various parts of the country with a view to maximizing the net returns to the producer. The studies under the second category were carried out on the basis of the data collected from the actual use of fertilizers by the farmers in their fields or the data pertaining to the trials conducted on farmers' fields.

T. P. Abraham and Mohanti, G.S.<sup>1</sup> used extensively data on fertilizer trials conducted in cultivators' fields in the country on the major cereals and cash crops beginning with 1949. They worked out optimum doses for wheat, rice, maize, cotton and sugarcane. With given price and given total supply they worked out the optimum application of fertilizers for farms in different size groups.

M. C. Saxena and O. P. Gautam<sup>2</sup> have a similar study

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<sup>1</sup> Abraham, T.P. and Mohanti, G.S., "Optimal Fertilizer Dressing and Economics of Manuring," Indian Journal of Agricultural Economics, Vol. 20, No. 2, April-June 1965, pp. 1-20.

<sup>2</sup> Saxena, M.C. and Gautam, O.P., "Response of Hybrid Maize to Levels of Nitrogen and Phosphatic Fertilization," Indian Journal of Agricultural Economics, Vol. 21, No. 2, April-June 1966, pp. 71-76.

for hybrid maize. They used experimental stations data. They, however, determined the optimum dose separately for nitrogen and phosphorous.

D. K. Desai and S. P. Doshi<sup>3</sup> carried out a similar exercise using data obtained from experimental farms. Fitting Cobb-Douglas production function and determining the total requirement of the plant nutrients they prepared alternative plans for different combinations of fertilizers with a view to minimizing the cost.

T.P. Abraham and S. K. Raheja<sup>4</sup> fitted production function using only irrigation and fertilizer data obtained from experimental farms to represent inputs and production data for wheat and rice for the years 1951-52 to 1964-65. The exercise was carried out separately for all India and Southern and Eastern regions for rice and Western and Northern regions for wheat. The contribution of fertilizer was found to be significant in case of rice, in case of wheat and contribution of irrigation dominated.

A. S. Kahlon and J. L. Kaul<sup>5</sup> made an attempt to study

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3 Desai, D.K. and Doshi, S.P., "Economics of Fertilizer Use," Indian Journal of Agricultural Economics, Vol. 17, No. 2, April-June 1962, pp. 65-73.

4 Abraham, T.P. and Raheja, S.K., "An Analysis of Growth of Production of Rice and Wheat Crops in India," Indian Journal of Agricultural Economics, Vol. 22, No. 3, July-September 1967, pp. 1-15.

5 Kahlon, A.S. and Kaul, J.L., "Comparative Study of Economics of High-Yielding Varieties of Wheat - Punjab State," Indian Journal of Agricultural Economics, Vol. XXIII, No. 4, October-December 1968, pp. 79-86.

the economics of fertilizer use on semi-dwarf high-yielding wheat - Kalyan 227 - and two tall growing indigenous improved wheat varieties, namely C-273 and C-306 cultivated in the State of Punjab. Data were obtained from the fertilizer experiments conducted in the Punjab Agricultural University research station. The production surface of quadratic nature was fitted in each case. It was concluded that the extra profit obtained by using nitrogen and phosphorus with the variety K-227 was more than in case of the local tall varieties.

I. J. Singh and K. C. Sharma<sup>6</sup> examined the relationship between the quantity of nitrogen applied and wheat yields on the Mexican red and Indian amber varieties of wheat. The data used were obtained from fertilizer experiments conducted at U.P. Agricultural University, Pantnagar. The data were available for three years 1965-67. It appears that authors have fitted quadratic response function to mean yields of all the three years put together. The profit maximizing dosages of nitrogen are closer to the minimum recommended by agronomists. This suggests that agronomists in their recommendations are probably maximizing output rather than net income of farmers.

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<sup>6</sup> Singh, I.J. and Sharma, K.C., "Response of Some Mexican Red and Indian Amber wheats to Nitrogen," Indian Journal of Agricultural Economics, Vol. IXIII, October-December 1968, No. 4, pp. 86-93.

Harpal Singh,<sup>7</sup> J. P. Dubey, Y. M. Upadhyaya and S.P. Kohli<sup>8</sup> have also conducted similar studies and indicated that Kalyan 227 gives better response to higher doses of nitrogen.

Studies on similar lines were conducted by P. N. Saxena and A. S. Sirohi,<sup>9</sup> B. R. Murty,<sup>10</sup> V. H. Shah<sup>11</sup> and M. S. Swaminathan,<sup>12</sup> suggesting that high-yielding varieties of wheat, jowar, bajra, maize are more responsive to higher doses of fertilizers.

In the above and in many other similar studies the cut-off point for fertilizer use is decided at the point of maximum profit. However, if increased production is the

7 Harpal Singh, "Economics of Nitrogen Use in High-Yielding and One Indian Tall Variety of Wheat," Indian Journal of Agricultural Economics, Vol. XXIII, No. 4, October-December 1968, pp. 144.

8 Dubey, J. P., Upadhyaya, Y. M. and Kohli, S. P., "Response of Dwarf wheats to Nitrogen," Indian Journal of Agricultural Economics, Vol. XXIII, No. 4, October-December 1968, pp. 144-45.

9 Saxena, P.N. and Sirohi, A.S., "Response of Mexican Dwarf and Indian Tall Varieties of Wheat to Nitrogen Application," Journal of the Post-Graduate School, I.A.R.I., Vol. 5, June 1967, No. 1, pp. 123-48.

10 Murty, B.R., "Response of Hybrids of Sorghum (Jowar) and Pennisetum (Bajra) to Nitrogen," Journal of the Post-Graduate School, I.A.R.I., Vol.5, June 1967, No.1, pp.149-57.

11 Shah, V.H., "An Analysis of Response of Hybrid Maize to Nitrogen," Journal of the Post-Graduate School, I.A.R.I., Vol. 5, June 1967, No. 1, pp. 158-68.

12 Swaminathan, M.S., "A Resume of the Data on the Response of Dwarf Varieties of Wheat and Hybrids of Maize, Jowar and Bajra to Nitrogen," Journal of the Post-Graduate School, I.A.R.I., New Delhi, Vol. 5, June 1967, No. 1, pp. 169-73.



goal then the cut-off point needs to be where the production i.e. yield tapers off so that instead of optimum dosage the prescribed dosage will be lower and fertilizers which are in short supply can be further diffused for larger production.

All the studies cited above have been directed to see the response of high-yielding and local varieties of a crop to different levels of fertilizers and find out the economically optimum level of it. The experimental data, generally, pertain to three years. We have, so far, not come across a study directed to see the yield fluctuations of new as well as traditional varieties from one year to another within a research station or between one research station and another in the same region with standard dose of fertilizer. This aspect, we consider, is more important for the adoption of a variety to a greater extent. If the new variety shows as high a rate of fluctuation in yield from year to year as the traditional variety, it may not be preferred by the cultivators because of higher cost of production and the risk of loss, unless the average yield rate is very much higher than in case of the traditional varieties.

Extensive studies on an all-India basis were carried out on the basis of the data collected from the actual use of fertilizers by the farmers in their fields or the data related to the trials conducted on farmers' fields by two

leading institutions: National Council of Applied Economic Research<sup>13</sup> and Programme Evaluation Organization<sup>14</sup> to explore the factors influencing the adoption of fertilizers. These studies observed that such characteristics as the size of holding, irrigation and the extent and type of tenancy influenced the use of fertilizers. Further, inadequacy of credit restricted the consumption of fertilizers.

D. K. Desai and B. M. Sharma<sup>15</sup> have studied the characteristics of two groups of farmers, those using fertilizers and those not using it. They found the differences between these two groups in regard to the size of holding, the extent of literacy and irrigation are, only, apparent but not statistically significant. Their observation was that the dose of fertilizers used by farmers was less as compared to the recommended standard dose and hence made little contribution to production.

B. S. Minhas and T. N. Srinivasan<sup>16</sup> obtained the data

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13 National Council of Applied Economic Research. Factors Affecting Fertilizer Consumption (Problem and Policies). New Delhi, 1964.

14 Programme Evaluation Organization. Study on the Use of Fertilizers and Agricultural Production. Planning Commission, Government of India, New Delhi, 1967.

15 Desai, D.K. and Sharma, B.M., "Technological Change and Rate of Diffusion," Indian Journal of Agricultural Economics, Vol.21, No.1, January-March 1966, pp. 141-54.

16 Minhas, B.S. and Srinivasan, T.N., "New Agricultural Strategy Analysed," Yojana, Vol. 10, No. 1, January 26, 1966, pp. 20-24.

from fertilizer trials and studied the response of new varieties of wheat to fertilizers as compared to the response of the traditional varieties. In a fairly sophisticated exercise they examined first the additivity of the responses of three different types of fertilizers. The new varieties of wheat studied by them included Lerma Rojo, Sonora-63 and Sonora-64 and the traditional varieties included cultivation under dry and irrigated conditions. Their results suggested that the new varieties did imply a substantial shift in the production function. The optimum dose would be much lower on cultivators' fields compared to the doses recommended for the new varieties. In the case of the traditional varieties, however, the optimum doses would be much higher than the actual doses applied by the farmers.

M. S. Avdhani and V. N. Amble<sup>17</sup> have made a study of the yield rates of high-yielding varieties of major cereal crops. Data were collected from simple fertilizer trials on cultivators' fields. The data were analysed and the response-relationships were determined for different crops during the years 1967-68 and 1968-69. It was found that the relationship between the inputs like nitrogen and phosphorous and yield rates of high-yielding varieties of crops is linear

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17 Avdhani, M. S. and Amble, V. N., "Study of the Yield Rates of High-Yielding Varieties of Major Cereal Crops," Journal of the Indian Society of Agricultural Statistics, Vol. 22, December 1970, pp. 57-59.

Robert W. Herdt,<sup>18</sup> Shyamal Roy,<sup>19</sup> S. C. Jain et al<sup>20</sup> and V. N. Misra<sup>21</sup> have conducted, more or less similar studies and tried to find the relationship between the inputs like nitrogen and phosphorous and the yield rates of high-yielding varieties of wheat and rice.

In most of the above studies, the data pertains to a very small period, one to three years only. The authors tried to find out the relationship between fertilizer inputs and yield rates of high-yielding varieties, particularly of wheat and rice. But no one has tried to point out the reasons for better or poorer relationship. The prescribed fertilizer doses were much higher and the authors have neither pointed out the reasons for different levels of fertilizer application by different groups of farmers, nor the constraints faced by the farmers in using the recommended doses of it (N and P) except in one or two studies where

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18 Herdt, Robert W., "Nitrogen Response of Rice : 1968. A.I.C.D.I.P. Trials," Economic and Political Weekly, March 27, 1971, Vol. VI, No. 31, pp. A33-A36.

19 Roy, Shyamal, "Fertilizer Application on High-Yielding Varieties," Economic and Political Weekly, December 26, 1970, Vol. 52, pp. A175-A180.

20 Jain, S.C., Garg, R.C. and Singh, S.J., "Productivity of Resource on Wheat Crop in Tarai Agriculture," Agricultural Situation in India, March 1971, Vol. XXV, No. 12, pp. 1265-68.

21 Misra, V. N., "Farm Structure and Fertilizer Use," Agricultural Situation in India, January 1971, Vol. XXV No. 10, pp. 1061-67.

higher price of fertilizer was considered the reason for lesser use of fertilizer. We felt it necessary that one should try to see the causes for better or otherwise relationship of fertilizer doses and yield rates of high-yielding varieties in comparison with local varieties. Similarly it is necessary to study the constraints faced by the farmers in using recommended doses of inputs, nitrogen and phosphorous.

(ii) Apart from the above fertilizer studies, there are some studies conducted by Agro-Economic Research Centres located at different universities and research institutes and Programme Evaluation Organization of the Planning Commission.

The main objective of the studies conducted by the Agro-Economic Research Centres was to assess the credit requirement of the cultivators for growing high-yielding varieties as against the local varieties. Besides this main objective, the studies are also aimed at assessing the operational aspect of the programme in general with particular reference to the role of extension agency, acceptance behaviour of the farmers belonging to different categories, marketing problems etc.

The studies undertaken by the Programme Evaluation Organization have a wider coverage of the objectives. They are aimed at evaluating the whole programme in different aspects like research and demonstration, the rate of

acceptance, productivity and expenditure pattern etc. Besides these objectives, the studies done in 1968-69 also cover the aspects of income, saving and investment decisions of the selected farmers.

The findings of the above studies can be summarized as follows: (1) The high-yielding varieties are accepted in those areas where the geo-climatic conditions are favourable to give sufficiently higher yields as compared to the local varieties. If the yields are marginally higher, they are not preferred to the local varieties because the latter have the advantage of lower cash expenditure per acre with marginally lower yields and much less risk and uncertainty. (2) Secondly the demand for new inputs like fertilisers and plant protection chemicals has increased at a higher rate than that for the traditional inputs like labour.

The conclusions of the above studies are based on one or two years' data. Conclusions arrived at from such data can be of a general nature. Secondly, it seems that significant improvements in production and productivity of high-yielding varieties were taken for granted, since agronomic studies had reported such increases on experimental farms, rather than cultivators' own experiences. By and large the studies were conducted with a view to assessing the tempo of adoption of the new varieties by the farmers. An attempt to assess the actual performance of these varieties at farm level and the reasons for the differing responses to various

crops has rarely been made. The constraints faced by the farmers in cultivating these varieties were not given much attention. We, therefore, feel that a detailed examination of the impact of these new varieties at the farm level is of particular importance as this might help us to identify the difficulties faced by the farmers and other limitations of the programme.

(iii) There are some studies related to the seed production of high-yielding varieties. D. K. Desai and D. A. Patel<sup>22</sup> have attempted to study the salient problems of the management of hybrid bajra seed industry. Their analysis shows that area planned for hybrid bajra seed industry is in excess of what is required. Procurement prices fixed by the Government are high and the supply increasing more than demand.

A study conducted by D. A. Patel and D. K. Desai<sup>23</sup> in Mysore State indicates that the seed production of hybrid maize and jowar with protection of fixed procurement prices is very profitable to the seed growers.

Brian Lockwood and T. A. Moulik<sup>24</sup> in their study

22 Desai D. K. and Patel, D. A., "Management of Seed Industry (A Case Study on Hybrid Bajra Seed in Gujarat State). Indian Institute of Management, Ahmedabad, 1968

23 Patel, D. A. and Desai, D. K. Management in the Seed Industry : A Study on Hybrid Maize and Jowar Seeds in Mysore State. Indian Institute of Management, Ahmedabad, 1970.

24 Lockwood, Brian and Moulik, T.A., "Seed Development in a Delhi Village," Economic and Political Weekly, March 27, 1971, Vol. VI, No. 13, pp. A11-A16.

pointed out that farmers found that the production of dwarf wheat seed was profitable and they switched over to it. In the initial years this change-over was more marked among the large farmers.

A note by Anonymous in Economic and Political Weekly<sup>25</sup> narrated unhappy episode about hybrid jowar seed production undertaken by the Government of Maharashtra which ultimately ended in holding unsold stocks of seeds worth Rs.12 crores. Further, it is pointed out that prices offered to farmers (seed growers) were unrealistically high, which was responsible for many farmers undertaking the seed production. The supply exceeded the demand.

All the above studies show that the prices paid to the seed growers were very high and therefore production of seeds of different crops was more than the required. But, so far, we have not come across any study except a note by Anonymous in Economic and Political Weekly showing gaps between actual procurement of seed of a new variety by a Government, its distribution among farmers and actual utilization by the farmers. This would have helped to judge the wastage of such costly seed by the farmers and reasons for this non-utilization of new seed.

(iv) There are some studies relating to the adoption aspect

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<sup>25</sup> Anonymous, "Seed Without Grain," Economic and Political Weekly, May 16, 1970, Vol. V, No. 20, p. 790.



of the new high-yielding varieties, particularly of wheat and rice. Using the data from I.C.A.R. source, Robert W. Herdt<sup>26</sup> has argued that the relative profitability is an important factor which influenced the acceptance of the high-yielding varieties of wheat and the rejection of high-yielding rice. The slower acceptance of HYV rice as compared to HYV wheat may be because of (i) difference in the responsiveness of HYV rice and wheat to fertilizers or (ii) larger quality-based price discounts for HYV rice than HYV wheat. The analysis shows that the HYV wheat varieties are as good as the local wheat varieties in quality, whereas the HYV rice varieties are inferior to the local rice varieties in quality. Sometimes, the HYV rice varieties are found to be inferior to the local rice varieties not only in quality but also in yield rate. It was, thus, not profitable for the farmers to accept the HYV rice varieties.

B. S. Joon et al<sup>27</sup> have shown that farmer's knowledge about the finer technicalities of growing HYV and the credit facility are two factors which influence the acceptance of the high-yielding varieties.

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26 Herdt, Robert W., "Profitability of High-Yielding Wheat and Rice," *Economic and Political Weekly*, December 27, 1969, Vol. IV, No. 52, pp. A197-A200.

27 Joon, B.S. et al, "Response of Farmers Towards the High-Yielding Varieties," *Indian Journal of Extension Education*, Vol. 6, September-December 1970, pp. 58-62.

The study by Jaiswal et al<sup>28</sup> concluded that high-yielding varieties programme for paddy and wheat can be successfully implemented among farmers having irrigational facilities irrespective of their size of holding, provided necessary arrangements are made for the supply of input factors to them.

B. Sivaraman<sup>29</sup> has studied the National demonstration data. The analysis shows that year to year yield fluctuations in wheat are normal. The yield returns in rice, jowar, maize and bajra have shown wide fluctuations. Wide fluctuations of yields under field conditions show that in some seasons there may not be any return at all. Added to this the small and marginal farmers are always at a disadvantage under the field conditions in getting a fair return for investment.

F. S. George and V. V. Choukidar<sup>30</sup> have studied the production and marketing pattern of paddy in West Godavari district. The results of their study reveal that the farmers prefer local varieties of rice in kharif season than HYV rice.

28 Jaiswal, N.K. et al, "Effects of Size of Holding and Irrigational Facilities on Adoption of High-Yielding Varieties," Indian Journal of Extension Education, Vol. 6, March-June 1970, pp. 8-16.

29 Sivaraman, B., "Scientific Agriculture Is Natural to Scale--The Fallacy and the Remedy," Journal of the Indian Society of Agricultural Statistics, Vol. XXV, No. 1, June 1973, pp. 75-90.

30 George, P.S. and Choukidar, V.V. and Dave, M.B., Consumption Pattern and Preferences for Rice : A Study in Andhra Pradesh, India. Indian Institute of Management, 1972.

However, adoption of HYV rice is more in rabi season. The reasons for these findings are, however, not given.

G. Parthasarathy and D. S. Prasad<sup>31</sup> in a study pointed out that the pace of progress of HYV rice programme in kharif season is slow because of low profitability. The reasons given are :

- (a) Lower product prices in kharif as compared to rabi
- (b) The product response of fertilizers is known to be lower in kharif than in rabi.

Lastly, the authors have stated that the recommended optimum dose of fertilizer in kharif for HYV rice should have been far less as compared to rabi. If a lower optimum dose during the kharif is prescribed it might adversely affect the present yield rate. However, a detailed study in the matter seems to be necessary.

These and similar other studies have pointed out the differing response to various high-yielding varieties, but rarely, in fact never, a comparative study has been attempted to find out the reasons for the differing response of cultivators to different crop varieties.

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<sup>31</sup> Parthasarathy, G. and Prasad, D.S., "Seasonwise Progress of High Yielding Varieties in Andhra Pradesh : Role of Economic Variables," Economic and Political Weekly, Vol. VI, No. 39, September 25, 1971, pp. A117-A122; and a Report - Department of Co-operation and Applied Economics, Andhra University, Waltair, June 1971.

All the studies enumerated earlier have been conducted at a micro-level. The areas under various crops whether HYV, improved or local are additive within a given region. The economy of the individual cultivators is not additive and to that extent the impact of this new technology on the region's economy will not be properly depicted. The previous micro-studies were more or less directed towards the particular aspects of the green revolution with a view to arrive at estimates of the requirements to be met, the necessary assumption being that the areas under these varieties will be increasing at a faster pace. The constraints faced by the cultivators since the introduction of the new varieties were not given much attention, and wherever such constraints have been spelt out, it was only incidental to the study. Even the studies directed mainly to the extension aspect of these varieties have not given much attention to such constraints.

The successful adoption of these new varieties was more or less taken for granted and hence the majority of the studies conducted referred to institutional aspects such as credit needs etc. These studies, therefore, are least helpful to assess the impact on area and production of these new varieties even within a small region. To the extent, agricultural surplus is an essential key to further development, it is desirable that some study be conducted to assess the impact of the new varieties on production and productivity at a regional level, preferably a State, particularly in a

State like Maharashtra which has been losing its share of total all-India foodgrain production. While it was expected that with the introduction of the new varieties production and productivity will increase, the results appear contrary. The State of Maharashtra, plagued with continuing deficits to meet the foodgrain requirement of its population needs to look into the matter with some concern.

The new inputs are essentially nothing but more efficient processes to meet the existing known demand. Considering this, the new agricultural inputs, namely, HYV seed, fertilizers etc. will have to satisfy at least the two minimum conditions as stated below.

(i) The same final product to meet the existing known demand a little better mainly by reducing cost and thus increasing the net income to the cultivator, and

(ii) A slightly different and improved product (the improvement may be qualitative or quantitative) to meet the same known demand but a little better.

Even in condition (ii) it is implied that while the cost might rise, the yield as a result of these new processes is of such an order that it yields larger income to the cultivator than what was previously possible.

Actually the new varieties were introduced with a view to increasing foodgrain production by increasing the productivity rather than increasing the area under the crops. If one

has to look into the impact of these new varieties on production and productivity, he will have to cover a larger area, preferably a region or a State, rather than individual farms as in case of micro-studies. The sources of data etc. have been spelt out in Chapter III. It will be our endeavour not only to assess the impact on production and productivity but also, to the extent possible, spell out the constraints that really come in the way of the extension of these varieties.

CHAPTER III

PLAN OF THE STUDY AND THE METHOD ADOPTED

We have, already, pointed out in the earlier two chapters that the State of Maharashtra is not only plagued with continuing deficits in foodgrain production but losing its share of total all India foodgrain production, and the matter needs to be looked into with some concern. The main objective of the present study is to examine the performance of major foodgrain crops, particularly cereals, in respect of production and productivity in the State. The available data relating to production, area and yield rates of the selected crops will be examined, in general, for the period 1956-57 to 1972-73 the latest year for which the data are available and in particular for the period of the so-called 'Green Revolution' (i.e., after 1964-65), during which hybrid and high yielding varieties were introduced. It will be our endeavour not only to examine the performance in respect of production and productivity of the newly introduced hybrid/high-yielding varieties but, also, to the extent possible, to spell out the reasons for differing behaviour of these varieties in the State and the constraints that come in the way of the extension of these varieties.

Jowar, Bajra, Rice and Wheat are the important cereals grown in Maharashtra. The area under these crops accounts for about 51 per cent of the total cropped area and 78 per cent of the area under foodgrains and about 82 per cent of the total production of foodgrains in the State. The study



is confined more specifically to the above cereals since the new variety of seeds have so far been developed only for these cereal crops in the State. The only non-cereal non-food crop for which such a variety of seed has been developed is cotton. But the data pertaining to this new variety of cotton is limited to two years only and as such are not adequate to draw any worthwhile conclusions. It was, therefore, deemed fit to include such observations on cotton in the Appendix.

Each of the above selected crop will be studied separately, though the approach will be the same in each case. The crop performance is examined not only for the State as a whole, but for each of the different agro-climatic regions into which the State has been divided. The State has been divided into nine agro-climatic zones, taking into account the pattern of rainfall, soil conditions and crops grown. But since this involves partitioning some of the administrative districts between two or more zones, the zones have been reduced to seven so as to take the whole administrative district into a single zone. These seven zones and the districts covered by each are given in Statement I.

Firstly, the performance of the crop is examined in terms of the trend rates of growth, arrived at by fitting exponential curves, to the data on area, per hectare yield rate, and total production during the period 1956-57 to 1972-73 and separately for the pre-high-yielding varieties

(1956-57 to 1964-65) and post-high-yielding varieties (1964-65 to 1972-73) periods.

The two aspects of the growth rate of production of individual crops are first examined to clear the way for a more detailed examination of the data relating to the high-yielding varieties in this context.

(a) The first is to see if the trend of area under the crop has been very different from the trend in gross cropped area and/or area under kharif or rabi crops, as the case may be. This will tell us if there has been a change in the relative area under the crop, which may be due to change in either relative price or relative yield rates or both.

(b) The second aspect is to examine the trend in area of the crop under irrigation, which will partly answer the above question.

The above examination of the data will show how well or ill the particular crop has fared during the last two decades, and how far changes in area and yield rate have contributed to this. The sources of data are the official statistics published in the Season and Crop Reports of the State government.

We then turn to the performance of the high-yielding varieties of this crop in the State, to see to what extent the performance of this crop has been affected by the adoption

of high-yielding varieties. There are two different estimates (both of official origin) of area under high-yielding varieties in the State. We will examine each; and make our best estimates of the area figures. Similarly for per hectare yield estimates, we will check on the official estimates. To check the official estimates of yield rates of high-yielding varieties, we will use data from agronomic experiments conducted at different agricultural research stations in the State, Fertilizer and varietal trials carried out on farmers' fields, as well as data from small sample surveys conducted by us for the particular crops, in one village in each case. This helps us to arrive at a better judgement about the extension of these high-yielding varieties in the State and its different agro-climatic regions during the last decade.

These estimates raise the further query as to why the new varieties have performed in the farmers' fields in the manner noted above. We will try to examine this question in three ways.

(a) Firstly, we will try to see if the average yield rates are much lower than the rates achieved in the experiment stations and in fertilizer and varietal trials on farmers' fields.

(b) Secondly, are the rates of yield too low considering the extra costs involved? Or, what amounts to the same, how does the average net income from these varieties compare

with that from the traditional varieties of the crops? And, finally,

(c) What are the basic limitations of these varieties in actual experience. The uncertainty of yield due to variations in weather and/or pests and diseases, and the costs associated with the preventive measures against the latter.

The relevant data are obtained from the reports on the experiments into these crops conducted in the different agricultural research stations in the State during the last 20 years, the reports on the Fertilizer and Varietal trials on the farmers' fields and our own survey of sample farmers in villages specifically selected for the purpose.

Statistical methods of fitting trend lines, computing coefficients of variation and analysis of variance have been used wherever necessary, in conducting the exercise.

**Statement I : The Agro-Climatic Zones of Maharashtra**

Sr. No.	Agro-climatic zone on broad lines	Divisional headquarters	Districts covered
1.	Paddy, Machani and horticultural crop under heavy rainfall of Konkan. Terracing drainage and soil conservation methods and agri. silviculture practices	Bombay	Greater Bombay, Thana, Kolaba, Ratnagiri
2.	Amenable to cotton, sugarcane, oilseeds, wheat millets and vegetable development as well as horticultural development, grapes, bananas and chikus	Nasik	Nasik, Dhulia and Jalgaon
3.	Precarious rainfall zone which is very often in the grip of famine, scarcity farming with intensive contour bunding, well irrigation, grass required for production of rural compost, organic and green manures and silt removal including bulldozing, tractor ploughing to build up the fertility of soil	Poona	Ahmednagar, Poona and Sholapur
4.	Fertile districts a natural belt of sugarcane, paddy, wheat and jowar cultivation	Kolhapur	Satara, Sangli and Kolhapur
5.	More or less compact and homogeneous area growing jowar in kharif and rabi seasons	Aurangabad	Aurangabad, Parbhani, Dhir, Nanded and Osmanabad
6.	Predominantly cotton and jowar growing area under moderate rainfed conditions	Amraoti	Buldhana, Akola, Amraoti and Yeotmal
7.	Paddy, cotton and jowar areas under assured rainfall and better irrigation facilities	Nagpur	Wardha, Nagpur, Bhandara and Chandrapur

**Source :** Government of Maharashtra, Performance Budget - 1974-75, Agriculture and Co-operation Department (Agriculture), Bombay 1974.

CHAPTER IV

PERFORMANCE OF THE MAJOR CEREALS

#### 4.0 Jowar

Jowar is the most important foodgrain grown in Maharashtra: it accounts for about 30 per cent of the total area under crops (average of 5 years ending 1972-73) and a little less than half (about 46 per cent) of the total area under foodgrains and a little over 40 per cent of the total production of foodgrains in the State. The performance of the State in the field of foodgrain production therefore depends to a very large extent on the performance of jowar production.

Jowar is grown in the State in both the kharif and rabi seasons. Kharif jowar occupies about 43 per cent of the total area under jowar and accounts for about 58 per cent of its total production. (These are averages for years 1968-73.) The rest is rabi jowar. Areas where the monsoon precipitation in the beginning of the season (i.e. from the beginning of June to the middle of July) is both adequate and reasonably certain and where soil is not of heavy black type, jowar is grown in the kharif season. In the other areas, where rainfall is uncertain and/or inadequate in the beginning of the kharif season but fair in its later part, and where the soil is of heavy black type with better moisture retentivity, jowar is grown as a rabi crop. The Poona zone and the western part of the Aurangabad zone are predominantly rabi jowar areas, while the Amravati zone and the eastern part of the Aurangabad zone are predominantly kharif jowar area. The Nasik, Kolhapur and Nagpur zones have more or less equal proportion of area

under kharif and rabi jowar. In view of the soil-climatic conditions under which the two types of jowar are grown in the State, it had been anticipated that it will be easier to grow hybrid jowar under unirrigated conditions in the kharif season, while hybrid rabi jowar can be successfully grown only under irrigated condition. For these reasons, we propose to discuss the performance of kharif and rabi jowar separately.

The period covered is from 1956-57 to 1972-73, the last year for which data on acreage, production, etc., are available. It is not possible to go back to years before 1956-57, because separate statistics for rabi and kharif jowar are not readily available for those years, for all regions of the State.

#### Trend of Total Jowar Production

During the 17 years since 1956-57 production of jowar in Maharashtra did not register any increase. Table 4.0.1 shows that the total annual production fluctuated between 3 and 3.4 million tonnes, excluding the years of severe drought and famine, and the year of 1960-61 when the total production recorded was 4.3 million tonnes - a level attained never before or after. There was a small perceptible increase over the years 1956-57 to 1964-65. But after 1964-65, i.e., during the years the new hybrid seed was introduced, the total production has shown, if anything, a declining trend, even if one



Table 4.0.1 : Production, Area and Yield of Jowar in Maharashtra 1956-57 to 1972-73 and Their Rates of Growth

Sr. No.	Year	Production in '00 tonnes	Area in '00 hectares	Yield kgs./hectare
1.	1956-57	30535	57413	531
2.	1957-58	30001	77469	522
3.	1958-59	32549	61043	533
4.	1959-60	28763	58116	494
5.	1960-61	43372	67497	642
6.	1961-62	29872	64484	463
7.	1962-63	34322	63937	536
8.	1963-64	33062	64300	514
9.	1964-65	33298	63180	527
10.	1965-66	23302	63238	368
11.	1966-67	31011	63255	490
12.	1967-68	32932	72436	454
13.	1968-69	32535	58802	553
14.	1969-70	29452	55293	532
15.	1970-71	15636	57147	273
16.	1971-72	19202	61487	312
17.	1972-73	12457	49944	481
<u>Compound growth rates (per cent)</u>				
1.	1956-57 to 1972-73	-3.92	-0.37	-2.29
2.	1956-57 to 1969-70 (excl. 1965-66)	-0.03	0.05 (excl. only 1972-73)	-0.54 (excl. only 3 years)
3.	1956-57 to 1964-65	1.3	1.5	-0.22
4.	1964-65 to 1972-73	-9.99	-2.5	-3.12
5.	1964-65 to 1969-70 (excl. 1965-66)	-1.64	-1.56 (excl. only 1972-73)	-0.42 (excl. 3 years)

excludes the severe drought years from the picture. Annual compound growth rates, (calculated by fitting exponential curves with the method of least squares) for the entire period as also for the two sub-periods are given in Table 4.0.1. The annual growth rate for the entire period of 17 years was -3.92 per cent. This negative (though statistically insignificant) trend was largely due to the very poor production recorded during the last 3 years, 1970-73. If we exclude these three years, as well as the year 1965-66, which was also a year of severe drought, the annual compound growth rate for the period since 1956-57 comes to -0.03 per cent. It means the general level of jowar production in the State remained unchanged. As it is, during the first 9 of these 17 years, from 1956-57 to 1964-65, production of jowar increased at about 1.3 per cent per annum. But after 1964-65, there was a declining trend, with the rate of growth being -9.99 per cent. Even if the poor crop years are excluded, the rate of growth in the later years turned out to be -1.64 per cent. Thus, it appears that what little growth had been gained during the pre-hybrid period, had been lost in the period after introduction of hybrid jowar, and the net result has been stagnancy in jowar production during the last two decades. Naturally, years of drought, particularly when occurring consequently, made the situation worse.

The stagnancy of jowar production has been due to stagnancy in both area under jowar and the yield rate over the 17 years. Table 4.0.1 shows that taking all the 17 years

into account, the annual compound growth rate of area under jowar was  $-0.37$  per cent (statistically insignificant), which means there was virtually no change in the general level of area devoted to jowar in the State. If we exclude the last year, 1972-73 (a year of widespread drought and famine) from the picture, the annual growth rate for the whole period comes to  $0.05$  per cent. During the first 9 years area under jowar registered increase at the rate of  $1.5$  per cent per annum; but during the subsequent 8 years (excluding 1972-73) area registered decline at the rate of  $1.56$  per cent per year.

The yield rate of jowar also showed no significant change if one excludes the years of poor yield due to severe drought. The compound growth rate for the whole period (excluding 3 years of very poor yield) was  $-0.54$  per cent per annum. During the two sub-periods the growth rates were  $-0.22$  and  $-0.42$  per cent only. It meant the rate of yield per hectare did not change significantly and certainly did not show any increase, not even during the years when the new hybrid jowar seed was being extended to the farmers.

The picture of stagnancy of jowar production in Maharashtra during the last 20 years is thus complete, with no redeeming features in both area and rate of yield per hectare. It is necessary to examine the reasons for this stagnancy, particularly in the context of the new hybrid seeds which have been in the market for the last whole decade.

#### 4.1 Kharif Jowar

As noted earlier, kharif jowar accounts for a little less than half the total area under jowar and a little above half the total production of jowar in the State. The somewhat higher rate of yield per hectare of kharif jowar is because of the less unfavourable conditions under which it is grown in the State than rabi jowar.

The total production of kharif jowar in the State has fluctuated between 1.4 and 1.8 million tonnes (excluding the years of severe drought, and 1960-61, the year of exceptionally high production) during 1956-57 to 1972-73 (see Table 4.1.1) without showing any increasing trend. The annual compound growth rate of production for the period of 17 years comes to -2.68 per cent (refer Table 4.1.1A). This decline, however, is due to the inclusion of the 3 or 4 years of very low production on account of drought, particularly towards the end of the period. Excluding the last three years and 1965-66, another drought year, we find the annual compound growth rate to be only 0.28 per cent, which indicates virtual stagnancy in kharif jowar production. Nor is there any significant difference in growth rates during the pre-hybrid and post-hybrid seed periods. The annual growth rate from 1956-57 to 1964-65 was -0.19 per cent while for the later period, 1964-65 to 1969-70 (excluding the drought years) it was 1.43 per cent. The few non-drought years of the post-hybrid seed period show a mild, and statistically insignificant, upward trend.

**Table 4.1.1 : Production of Kharif Jowar in Maharashtra and Its Agro-Climatic Zones  
- 1956-57 to 1972-73 (1960-61=100)**

Sr. No.	Year	(Production in '00 tonnes)							
		Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra State
1.	1956-57	4 100.00	1712 71.18	102 46.79	2358 69.05	4955 72.46	7613 107.50	2117 102.27	18861 85.62
2.	1957-58	2 50.00	1958 81.41	96 44.03	2541 74.41	3585 52.43	4657 65.76	1360 65.70	14199 64.46
3.	1958-59	2 50.00	1456 60.54	81 37.15	2431 71.18	3823 55.91	5001 70.61	1887 91.16	14681 66.65
4.	1959-60	1 25.00	1933 80.37	143 65.60	2548 74.61	3653 53.42	4004 56.54	992 47.92	13274 60.26
5.	1960-61	N.A.	2405 100.00	218 100.00	3415 100.00	6838 100.00	7082 100.00	2070 100.00	22028 100.00
6.	1961-62	4 100.00	1748 72.68	165 75.69	2598 76.08	4066 59.46	4482 63.29	938 45.31	14001 63.54
7.	1962-63	N.A.	2647 110.06	53 24.31	2888 84.57	3831 56.02	4736 66.87	1436 69.37	15591 70.78
8.	1963-64	1 25.00	1831 76.13	318 145.87	2911 85.24	4202 61.45	4503 63.58	1195 57.73	14961 67.91

(continued)

Table 4.1.1 : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolha- pur	Auran- gabad	Anra- vati	Nagpur	Maha- rashtra State
9.	1964-65	N.A.	2283 94.93	217 99.54	2669 78.15	4552 66.57	5500 77.66	1661 80.24	16882 76.64
10.	1965-66	1 25.00	434* 18.04	121 55.50	2008 58.90	3505 51.26	3830* 54.08	1554 75.07	11453* 51.99
11.	1966-67	2 50.00	1459 60.66	159 72.93	2017 59.06	3888 56.86	4563 64.43	1706 82.41	13794 62.61
12.	1967-68	2 50.00	1871 77.80	62 28.44	2079 60.88	5082 74.32	5477 77.34	1636 79.03	16209 73.57
13.	1968-69	2 50.00	1850 76.92	41 18.81	2091 61.23	4694 68.64	7561 106.76	2320 112.08	18559 84.24
14.	1969-70	3 75.00	1536 63.87	51 23.39	1702 49.84	4508 65.92	6905 97.50	1762 85.12	16467 74.74
15.	1970-71	3 75.00	920* 38.25	145 66.51	2014 58.97	1821* 26.63	3006* 42.44	791 38.21	8700 39.48
16.	1971-72	1 25.00	784* 32.60	153 70.18	2259 66.15	1986* 29.04	4564 64.44	1117 53.96	10864 49.31
17.	1972-73	1 25.00	1017* 42.29	15 6.88	494* 14.46	2015* 29.47	3927* 55.45	1189 57.44	8658* 39.30

**Table 4.1.1A : Annual Compound Growth Rates of Production of Kharif Jowar in Maharashtra, 1956-57 to 1972-73**

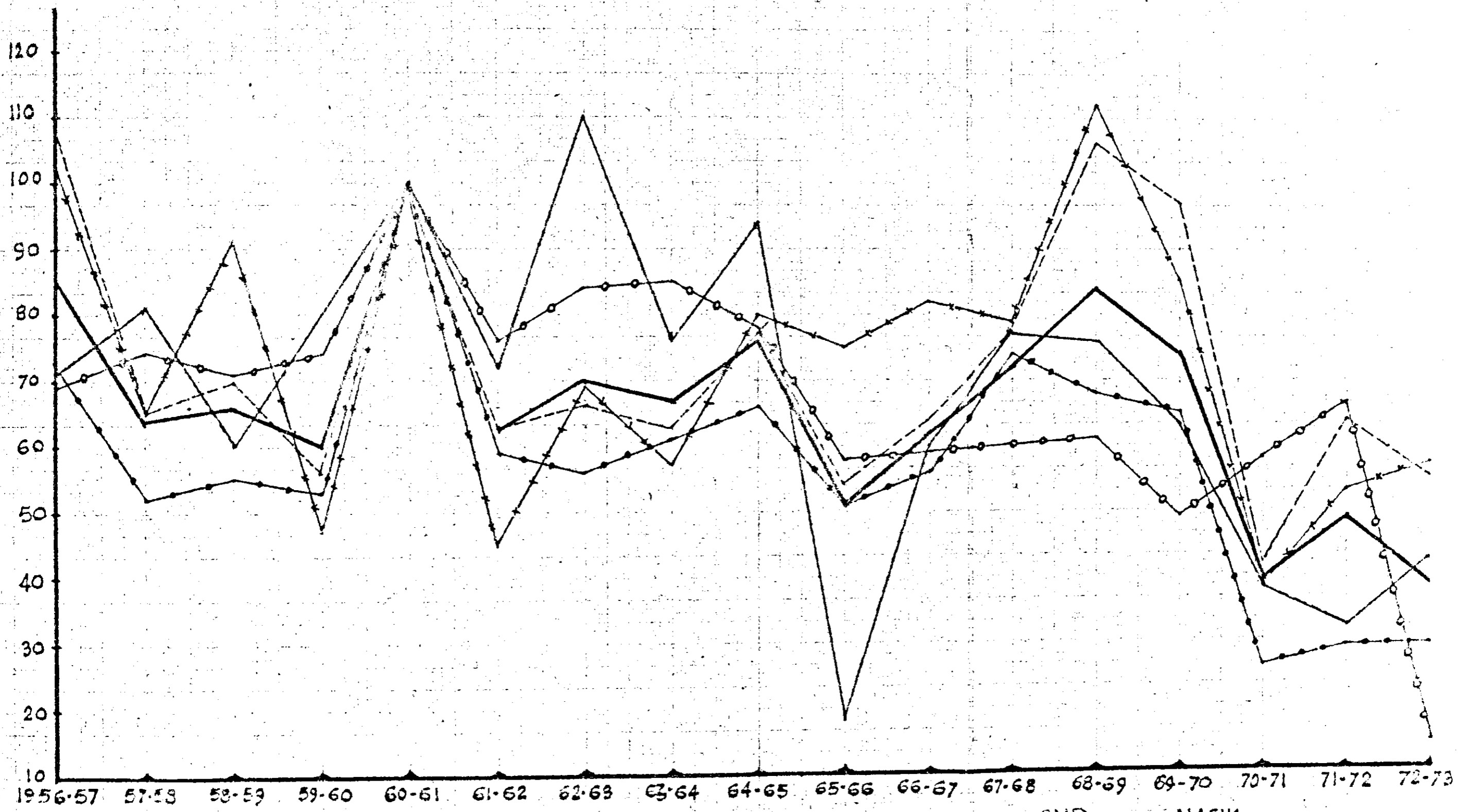
Sr. No.	Period	Maha-rashtra	Auran-gabad	Amra-vati	Nasik	Kolha-pur
1.	1956-57 to 1972-73	-2.68* (0.28)	-3.85* (0.30)	-1.26 (0.06)	-4.30* (0.23)	-4.79* (0.35)
@2.	1956-57 to 1969-70 (except 1965-66)	0.28 (0.07)	0.4 (0.01)	0.39 (0.00)	-0.59 (0.02)	-2.25* (0.36)
3.	1956-57 to 1964-65	-0.19 (0.00)	0.41 (0.00)	-2.33 (0.09)	3.39 (0.25)	2.11 (0.26)
4.	1964-65 to 1972-73	-6.23 (0.34)	-11.00* (0.52)	-2.37 (0.05)	-4.10 (0.05)	-11.00 (0.37)
@5.	1964-65 to 1969-70 (except 1965-66)	1.43 (0.07)	3.13 (0.19)	0.44 (0.00)	-5.44 (0.35)	-1.97 (0.15)

Note : Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.1.1.

• SCALE —  
HORIZONTAL — 2 CM = 1 YEAR  
VERTICAL — 1 CM = 10% CROP



AND  
PRODUCTION OF KHARIF JOWAR IN MAHARASHTRA AND ITS  
AGRO CLIMATIC ZONES 1956-57 TO 1972-73

- NASIK \_\_\_\_\_
- KOLHAPUR \_\_\_\_\_
- AURANGABAD \_\_\_\_\_
- AMRAVATI \_\_\_\_\_
- NAGPUR \_\_\_\_\_
- MAHARASHTRA STATE \_\_\_\_\_



The stagnancy in production during the last two decades has been due to stagnancy in both acreage under kharif jowar as well as its yield per hectare. Excepting a year of very severe drought, the total area under kharif jowar fluctuated between 2.4 and 2.6 million hectares (refer Table 4.1.2). The annual compound growth rate for the 17 years, excluding 1971-72, was -0.1 per cent (see Table 4.1.2A). During the pre-hybrid period, upto 1964-65, there was no trend - up or down - of area under kharif jowar. During the subsequent period, the area under the crop registered a mild declining trend (growth rate -1.05 per cent excluding 1971-72, and -1.4 per cent including 1971-72). This slow decline in acreage under kharif jowar during the period of new hybrid seed calls for some explanation, and we shall turn to it when we examine the trend in kharif jowar acreage in the different agro-climatic zones of the State.

Like acreage, yield per hectare of kharif jowar also showed no significant trend during these two decades. Of course, the annual compound growth rate for the entire period was -2.46 per cent, but this was mainly due to the severe drought conditions in the last 3 years (see Table 4.1.3A). Excluding these 3 years and 1965-66, we find the yield rate to be virtually unchanged over the entire period (growth rate 0.19 per cent). During the period of hybrid seeds (excluding the drought years) growth rate was 2.1 per cent, but statistically insignificant.

**Table 4.1.2 : Area under Kharif Jowar in Maharashtra and Its Agro-Climatic Zones  
- 1956-57 to 1972-73**

(Area in '00 hectares)									
Sr. No.	Year	Bombay	Nasik	Poona	Kolha- pur	Auran- gabad	Amra- vati	Nagpur	Maha- rashtra State
1.	1956-57	6 150.00	2073 90.29	172 98.85	2587 96.85	8105 105.18	9280 98.99	3376 100.03	25599 100.01
2.	1957-58	5 125.00	2032 88.50	193 110.92	2688 100.64	7380 95.77	9156 97.67	3308 98.01	24762 96.74
3.	1958-59	5 125.00	2105 91.68	176 101.15	2678 100.26	7800 101.22	9744 103.95	3436 101.81	25944 101.36
4.	1959-60	4 100.00	2210 96.25	185 106.32	2664 99.74	7565 98.17	8876 94.69	2788 82.61	24292 94.90
5.	1960-61	4 100.00	2296 100.00	174 100.00	2671 100.00	7706 100.00	9374 100.00	3375 100.00	25600 100.00
6.	1961-62	4 100.00	2159 94.03	310 178.16	2625 98.28	7419 96.27	8937 95.34	2866 84.92	24320 95.00
7.	1962-63	4 100.00	2191 95.43	339 194.83	2680 100.34	7615 98.82	9352 99.76	3519 104.27	25700 100.39
8.	1963-64	3 75.00	2120 92.33	350 201.15	2668 99.88	7818 101.45	9062 96.67	3108 92.09	25129 98.16

(continued)

Table 4.1.2 : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra State
9.	1964-65	3 75.00	2082 90.68	303 174.14	2625 98.28	8216 106.62	9051 96.55	3252 96.35	25532 99.74
10.	1965-66	5 125.00	2239 97.52	281 161.49	2576 96.44	8033 104.24	9472 101.04	3504 103.82	26110 101.99
11.	1966-67	6 150.00	2335 101.70	226 129.88	2495 93.41	8061 104.61	9724 103.73	3540 104.89	26387 103.07
12.	1967-68	6 150.00	2204 95.99	250 143.68	2237 83.15	8270 107.32	9687 103.34	3268 96.83	25922 101.25
13.	1968-69	5 125.00	2041 88.80	239 137.35	2107 78.78	7517 97.55	10023 106.92	3384 100.27	25316 98.88
14.	1969-70	6 150.00	1866 81.27	202 116.09	2246 84.09	7605 98.69	9648 102.92	3265 96.74	24838 97.01
15.	1970-71	5 125.00	1988 86.58	179 102.87	2256 84.46	7683 99.10	9305 99.26	3013 89.27	24429 95.07
16.	1971-72	5 125.00	1625* 70.17	172 98.85	2375 88.91	5753* 74.66	9557 101.95	3266 96.77	22753* 88.87
17.	1972-73	4 100.00	1871 81.49	168 96.55	1550* 58.03	7788 101.06	9650 102.94	3061 90.70	24092 94.11

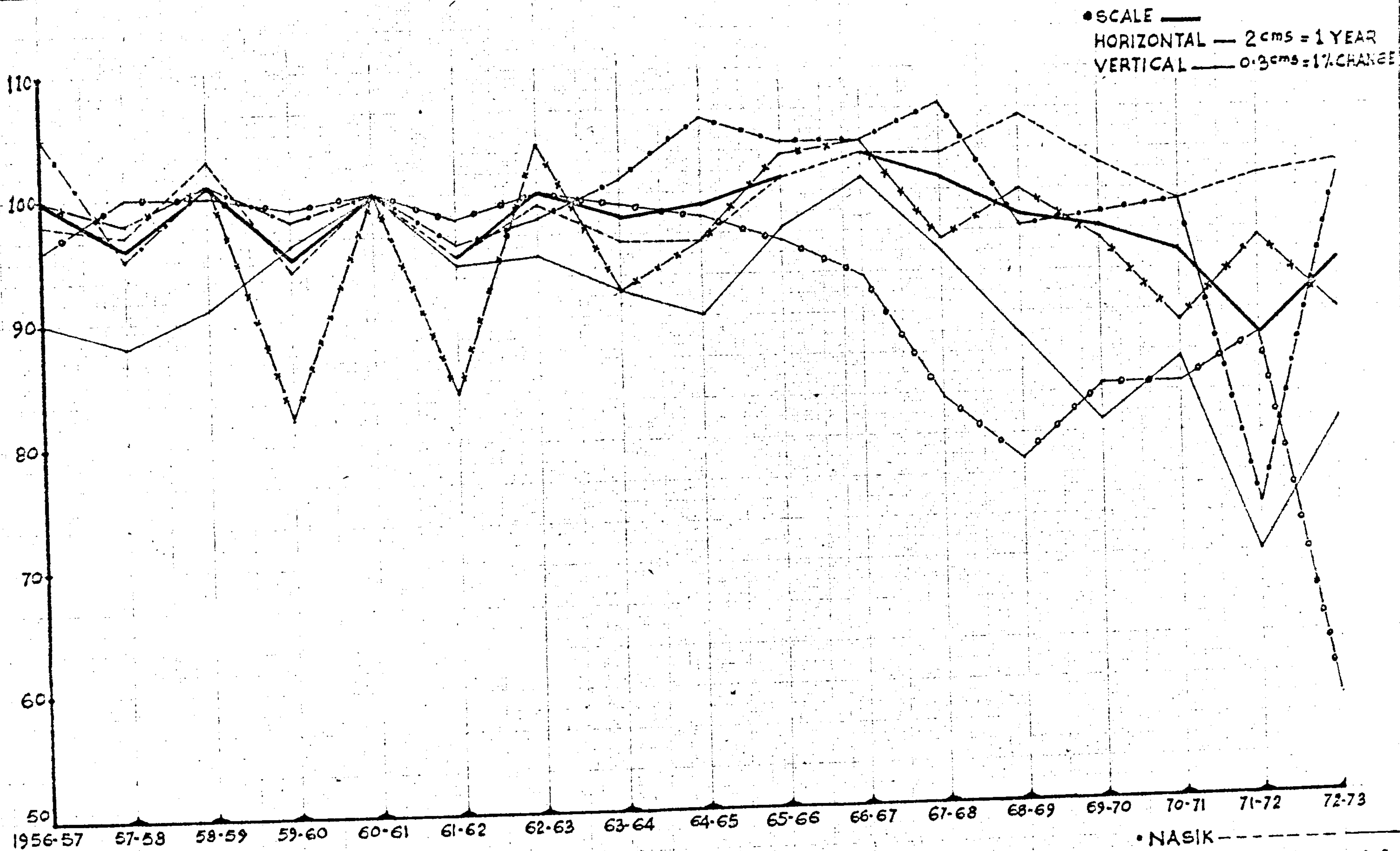
**Table 4.1.2A : Annual Compound Growth Rates of Area under Kharif Jowar in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Auran-gabad	Amra-vati	Nasik	Kolha-pur
1.	1956-57 to 1972-73	-0.17 (0.08)	-0.43 (0.07)	0.32* (0.22)	-0.93* (0.28)	-2.07* (0.55)
@2.	1956-57 to 1972-73 (except 1971-72)	-0.1 (0.03)	0.01 (0.01)	- -	-0.56 (0.17)	-1.36 (0.62)
3.	1956-57 to 1964-65	0.00 (0.00)	0.27 (0.04)	-0.34 (0.17)	0.34 (0.06)	0.04 (0.01)
4.	1964-65 to 1972-73	-1.40 (0.67)	-2.33 (0.33)	0.32 (0.09)	-3.13* (0.59)	-4.25* (0.54)
@5.	1964-65 to 1972-73 (except 1971-72)	-1.05 (0.74)	-0.9 (0.44)	- -	-2.3 (0.56)	-2.07 (0.43)

Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ For Kolhapur the excluded year is 1972-73, and not 1971-72. (See the starred years in Table 4.1.2.)



AREA UNDER KHARIF JOWAR IN MAHARASHTRA AND ITS AGRO CLIMATIC ZONES - 1956-57 TO 1972-73

- NASIK ————
- KOLHAPUR ————
- AURANGABAD ————
- AMRAVATI ————
- NAGPUR ————
- MAHARASHTRA STATE ————

**Table 4.1.3 : Per Hectare Yield Rate of Kharif Jowar in Maharashtra and Its Agro-Climatic Zones - 1956-57 to 1972-73**

Sr. No.	Year	(Yield kgs./hectare)							
		Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra State
1.	1956-57	672 67.20	825 78.87	593 47.10	911 71.17	611 68.58	820 108.46	627 101.45	736 85.48
2.	1957-58	377 37.70	963 92.06	497 39.48	945 73.83	485 54.68	508 67.19	411 66.50	573 66.55
3.	1958-59	397 39.70	691 66.06	460 36.54	907 70.86	490 55.24	513 67.86	549 88.83	565 65.62
4.	1959-60	444 44.40	874 83.56	772 61.32	956 74.69	482 54.34	451 59.65	355 57.44	546 63.41
5.	1960-61	N.A.	1046 100.00	1259 100.00	1280 100.00	887 100.00	756 100.00	618 100.00	861 100.00
6.	1961-62	1000 100.00	808 77.25	531 42.17	990 77.34	548 61.78	546 72.22	330 53.40	592 68.76
7.	1962-63	N.A.	1206 115.30	156 12.39	1070 83.59	503 56.71	506 66.93	410 66.34	608 70.61
8.	1963-64	333 33.30	863 82.50	908 72.12	1092 85.31	537 60.54	497 65.74	387 62.62	595 69.10

(continued)

Table 4.1.3 : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra State
9.	1964-65	N.A.	1095 104.68	718 57.03	1017 79.45	554 62.46	607 80.29	514 83.17	661 76.77
10.	1965-66	200 20.00	194* 18.54	429 34.07	780 60.94	437* 49.27	361* 47.75	447 72.33	439* 50.99
11.	1966-67	333 33.30	623 59.56	706 56.07	808 63.12	482 54.34	468 61.90	485 78.48	522 60.63
12.	1967-68	333 33.30	847 80.97	247 19.62	929 72.58	638 71.93	565 74.73	504 81.55	633 73.52
13.	1968-69	400 40.00	904 86.42	172 13.66	992 77.50	624 70.35	754 99.73	685 110.84	733 85.13
14.	1969-70	500 50.00	823 78.68	252 20.01	758 59.22	593 66.85	716 94.71	540 87.38	663 77.00
15.	1970-71	600 60.00	463* 44.26	810 64.33	893 69.76	237* 26.72	323* 42.72	263 42.55	356* 41.35
16.	1971-72	200 20.00	482* 46.08	890 70.69	951 74.29	345* 38.89	478 63.23	342 55.34	477* 55.40
17.	1972-73	250 25.00	544* 52.00	89 7.07	319* 24.92	259* 29.20	407* 53.83	388 62.78	359* 41.69

**Table 4.1.3A : Annual Compound Growth Rates of Yield Per Hectare of Kharif Jowar in Maharashtra, 1956-57 to 1972-73**

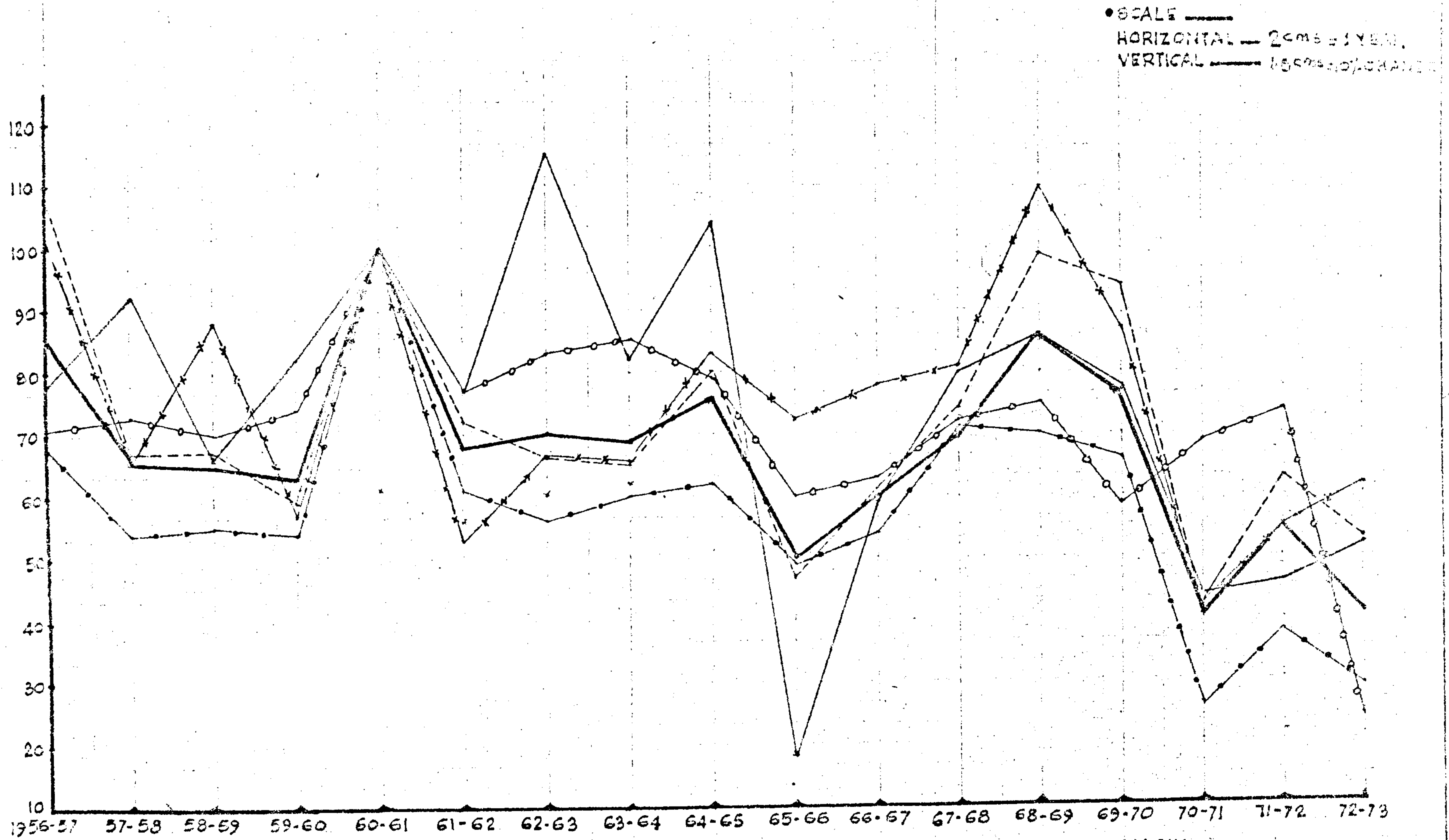
Sr. No.	Period	Maha-rashtra	Auran-gabad	Amra-vati	Nasik	Kolha-pur
1.	1956-57 to 1972-73	-2.46* (0.26)	-3.39* (0.28)	-1.69 (0.11)	-3.46 (0.10)	-2.87 (0.25)
@2.	1956-57 to 1969-70 (except 1965-66)	0.19 (0.00)	0.59 (0.02)	-0.08 (0.00)	-0.36 (0.00)	-0.89 (0.1)
3.	1956-57 to 1964-65	-0.15 (0.00)	0.16 (0.00)	-1.84 (0.06)	3.06 (0.24)	2.1 (0.27)
4.	1964-65 to 1972-73	-4.85 (0.24)	-8.74 (0.40)	-2.10 (0.04)	-1.15 (0.00)	-6.74 (0.27)
@5.	1964-65 to 1969-70 (except 1965-66)	2.1 (0.11)	2.91 (0.25)	-0.18 (0.00)	-3.1 (0.09)	0.10 (0.00)

Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance of 5 per cent level.

@ The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.1.3.





YIELD RATE OF KHARIF JOWAR IN MAHARASHTRA AND ITS AGRO-CLIMATIC ZONES - 1956-57 TO 1972-73

- NABIK ———
- KOLHAPUR ———
- AURANGABAD ———
- AMRAYATI ———
- NAGPUR ———
- MAHARASHTRA STATE ———

On the whole, therefore, we find stagnancy in production, area and yield of kharif jowar in the State during the last two decades. Since the introduction of hybrid jowar seed, a slow but sure decline in area under kharif jowar is the only significant development noticed.

Kharif jowar is mainly grown in 5 agro-climatic zones of the State, of which the Amravati and the Aurangabad zones account for about 70 per cent of the total area, Nagpur zone for about 13 per cent, and the rest is equally divided between Nasik and Kolhapur zones. During the entire period, both Aurangabad and Amravati zones have shown near stagnancy in production, (for both the growth rates come to 0.4 per cent, excluding the drought years), in yield rate (for Amravati it was -0.08 per cent and for Aurangabad 0.59 per cent), as well as in area under the crop (for Amravati 0.32 per cent, for Aurangabad 0.01 per cent).

The trend was not very different in these two zones during the later years of this period - the years of hybrid jowar seed. Total production in the years since 1964-65 (excluding the years of severe drought) remained stagnant in Amravati zone. In Aurangabad zone production recorded an increase of 3.1 per cent per year during the pre-drought period, which was, of course, completely wiped out in the subsequent 3 drought years. This increase was partly because the production in the earlier years of this period was low on account of seasonal fluctuations; if the production in the later period

is compared with that during the pre-1964-65 period, it shows no upward trend. The same was the situation with regard to area and yield rate in the non-drought years since 1964-65 in these two zones. Area in Amravati showed a rate of growth of 0.3 per cent and in Aurangabad of -0.9 per cent, both small and insignificant. Yield rate in Amravati showed a growth rate of -0.18 per cent; in Aurangabad it was 2.91 per cent, but for the same season as mentioned for production above.

Thus the two zones accounting for the bulk of the production of and area under kharif jowar in the State showed stagnancy on all fronts. However, the two kharif jowar growing zones in Western Maharashtra - Nasik and Kolhapur - showed a different trend in the later half of the period. Like the other zones in the State, production of kharif jowar in Nasik showed no significant change over the entire period (growth rate -0.6 per cent excluding the drought years). But Kolhapur showed a declining growth rate of -2.25 per cent. During the same period area under kharif jowar in Nasik zone remained more or less unchanged (growth rate, -0.56 per cent), as did yield per hectare. But in Kolhapur zone, while yield rate remained stagnant, area showed a slow decline (growth rate -1.36 per cent). This decline in Kolhapur in the area under kharif jowar was a development of the post-hybrid-seed period; even excluding the drought year of 1972-73, the growth rate of area since 1964-65 was -2.07 per cent (and inclusive of 1972-73 it was -4.25 per cent). In Nasik zone also area under kharif jowar significantly declined during this period, at

the rate of 2.3 per cent.

The declining trend in the area under kharif jowar in the Nasik and Kolhapur zones during the years before the last 2 or 3 years of drought seem largely to account for the slight downward trend in the total kharif jowar area in the State, noted earlier. The reason for this decline appears to be the diversion of some land from under kharif jowar to bajra during the latter part of the 1960's. In fact, from 1965-66 to 1969-70 the area under bajra in the State increased continuously from 1.8 million to 2.1 million hectares - a total increase of over 16 per cent in a matter of four years. This increase in area was also accompanied by a steady increase in yield per hectare during the same period: it increased from a low of 202 kilograms in 1965-66 - a drought year to 402 kg. in 1970-71 - a level far above the highest reached any time in the past.<sup>1</sup> This very significant rise was due to the adoption of hybrid bajra seed by increasing number of farmers since 1967-68. (The sharp decline in the production, area and yield rate of bajra in the State in the years 1971-73, was only partly due to the drought conditions prevailing; a more serious development since 1971 has been the widespread affectation of bajra crop, beginning with the hybrid variety, by a soil-borne fungus disease called Downy Moldew. But that is a

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<sup>1</sup> The per hectare yield rates of bajra in the two years 1969-71 were 336 and 402 kg. - all higher than the previously recorded highest rate of 314 kg. in 1962-63.

different story, for a later chapter.) Kharif jowar did not register any comparable increase in yield rate during the same period, despite the fact that it also had a hybrid variety introduced simultaneously. This not only throws light on the poor efficiency of hybrid jowar in the kharif season in the State, but provides indirect evidence about the poor extension of that variety. This may be borne in mind when the performance of hybrid kharif jowar is examined in a later section.

The reason why under such circumstances there was no greater transfer of land from under kharif jowar to bajra than recorded, is that both bajra and kharif jowar are not grown side by side in all parts of the State. While kharif jowar is grown extensively in the Amravati and Nagpur zones, very little bajra is grown there. The two kharif jowar producing zones where bajra is equally or even more important are the Kolhapur and Nasik zones. In parts of Aurangabad zone also bajra is significantly grown. It is only in these zones that the area under bajra increased till 1970-71 at the cost of area under kharif jowar.<sup>2</sup> In the other zones growing kharif jowar, bajra

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2 There may be another possible reason for this transfer of area from under kharif jowar to bajra. The Maharashtra Government had for the last whole decade not only imposed a levy for purposes of procurement, at lower than market price, on all jowar and rice farmers but had a monopoly procurement or marketing scheme for jowar. No such policy applied to bajra. Bajra price in the open market ruled higher than the Government's monopoly procurement price of jowar. Consequently, it may be contended, those farmers who could switch over from kharif jowar to bajra on any part of their land, did so. While this is a reasonable assumption, it is not easy to separate the relative contributions of the price and the yield factors in the change recorded, particularly because the period is too short for any useful statistical exercise.

was not an important crop and therefore the jowar farmers had no alternative except to switch over to a rabi crop if the season permitted.

#### Performance of Hybrid Jowar

In the light of this stagnancy in production, area and rate of yield of kharif jowar during the last two decades, it is necessary to enquire into the performance of the factors that are considered to be crucial to the increase in yield rate and production, namely, extension of irrigation, and use of the new hybrid seed and chemical fertilizers.

Of the two factors mentioned above, irrigation may be dismissed as a factor of no relevance, since no more than 0.5 per cent of the total area under kharif jowar in the State is irrigated, as per official statistics.

The more interesting and relevant development during the last decade has been the hybrid jowar seed, which of course was to use significant quantities of chemical fertilizers in order to give higher yield. Separate cropwise data on application of fertilizer are not available. We shall examine only the available data on extension of use of the hybrid jowar seed.

Hybrid jowar seed was made available to the farmers in the State from 1966 onwards. It was felt at that time that this seed can be fruitfully used by the farmers in the kharif season, since the precipitation in the kharif season in the kharif jowar areas was adequate and reasonably distributed

over the period of growth of the plant. To facilitate plant growth and use of significant doses of fertilizer, irrigation was not considered a bottleneck for hybrid kharif jowar, unlike for hybrid rabi jowar. The new seed was first made available by the Government; and, although subsequently many private seed producers have begun marketing hybrid seed, the Government is still the biggest source of its supply. The Zilla Parishads were entrusted with the responsibility of distributing the seed to farmers. They have provided data about the extension of the area under this variety from year to year. Simultaneously, since 1968-69, the Statistician to the Director of Agriculture of the State Government conducted a sample survey in every district to estimate the area under the new varieties and their yield rates. These data, made available to us by the Director of Agriculture, provide a useful check on the Zilla Parishads' estimates.

While extension of hybrid jowar seed began in 1966-67, data about estimated area under hybrid jowar are available from 1968-69. Table 4.1.4 presents the estimate of the percentage of the total area under kharif jowar growing the hybrid variety, provided by the Zilla Parishad as well as the area estimated by the Statistician, Department of Agriculture. The Table shows that according to the estimate of the Zilla Parishads the highest spread of hybrid jowar was in 1968-69 and 1970-71 when about 19 per cent of the total kharif jowar area in the State had come under this variety. In the other

**Table 4.1.4 : Percentage of Kharif Jowar Area under Hybrid Variety, Estimated by (a) The Zilla Parishads, and (b) The Statistician to the Department of Agriculture, Maharashtra, 1968-69 to 1972-73**

Sr. No.	Zone	1968-69		1969-70		1970-71		1971-72		1972-73	
		As per Z.Ps.	As per Statistician	As per Z.Ps.	As per Statistician	As per Z.Ps.	As per Statistician	As per Z.Ps.	As per Statistician	As per Z.Ps.	As per Statistician
1.	Nasik	20.74	16.68	14.25	11.05	31.56	25.51	25.84	20.63	25.32	20.15
2.	Poona	3.82	3.38	8.09	5.13	33.34	24.13	35.16	32.82	69.47	54.03
3.	Kolhapur	4.97	3.71	14.33	10.43	17.47	13.54	19.85	16.38	38.43	29.85
4.	Aurangabad	10.83	7.31	10.95	7.67	22.63	17.24	11.16	9.18	11.69	9.91
5.	Amravati	30.54	26.16	13.39	11.86	18.06	15.88	11.21	9.80	9.74	9.18
6.	Hagpur	8.40	6.21	4.40	3.75	6.72	4.91	3.27	2.87	3.34	3.09
7.	State	18.55	15.04	11.56	9.26	19.25	15.58	12.18	10.28	13.03	11.13

**Source :** Statistician, Department of Agriculture, Maharashtra State, Poona, "Report of the Assessment Survey for Estimating the Yield Rates and Additional Production Resulting from Hybrid/High-Yielding Varieties Programme in Maharashtra," for the years 1968-69 to 1972-73.



three years, till 1972-73, it was much lower, between 11 and 13 per cent. The highest coverage was neither very high, nor did the data show any increasing trend or consistency. The Statistician's sample survey showed that the Zilla Parishads' estimates were somewhat over-estimates: the highest percentage was put at about 15.5 per cent and the lower level fluctuated between 9 and 11 per cent. The Zilla Parishad estimate was based primarily on the quantity of hybrid seed distributed. The Statistician's estimate was made by choosing a stratified random sample of villages (the strata based on the area estimates of the Zilla Parishad) and then making a complete count of the fields growing the crop in the sample village during the year. It is, however, necessary to note that the field investigation for the Statistician's survey was conducted by the same agency - the District Agricultural Officer and his staff - which is also responsible for hybrid seed distribution and for the reporting of area under it to the Zilla Parishad.

The Statistician's estimates show that the area under hybrid jowar was never very large, and there has been, if anything, a declining trend in it. This is reflected in the zonal figures as well. Of the two most important zones of kharif jowar, Amravati zone reportedly had 26 per cent - the highest - area under hybrid in 1968-69; it has been less than half this level in 3 out of the four subsequent years. In Aurangabad zone, the percentage of area under hybrid, after reaching 17 per cent in 1970-71, had drastically declined in

the subsequent two years. Of the significant kharif jowar zones in the State, Nasik zone had reported at least 20 per cent area under hybrid all the five years (except 1969-70). And, in the Kolhapur zone, the percentage of the total kharif jowar area under hybrid reportedly rose steadily from 4 per cent to 30 per cent in these five years. In terms of the Statistician's estimate, therefore, the extension of hybrid jowar in the kharif season had not been very encouraging (though better than in case of rabi jowar, as we shall see later) and had been showing a declining trend.

However, use of hybrid jowar seed on 10 to 15 per cent of the total kharif jowar area should be expected to make a visible difference in the average per hectare yield of kharif jowar as well as of total production, in view of the fact that its expected yield was much higher than that of the local varieties. Indeed, it may be proper to expect an increase in area under kharif jowar due to the hybrid seed. However, as we saw, area under kharif jowar remained stagnant in all the zones, excepting, curiously enough the two - Nasik and Kolhapur zones - where the area declined steadily, despite the estimated increase in area under hybrid. Nor did production show any significant increasing trend in any of the zones, as noted earlier. Could it then be that the yield performance of hybrid jowar was not as significant as was expected? It is necessary to examine the data on yield rates of hybrid and all jowar for the purpose.

Fortunately, the Statistician had conducted a random sample crop-cutting experiment to estimate the yield rates of hybrid kharif jowar during the five years since 1968-69. These data for each of the years and zones are given in Table 4.1.5. The data show that by and large the yield rate of hybrid jowar was quite high compared to the performance of local jowar in the State. The average yield rate of hybrid kharif jowar over the five years, 1968-73, was estimated at 1536 kg. per hectare. This was about 2-1/2 times as high as the average yield of kharif jowar in the State during the 12 years preceding 1968-69 (611 kg/ha). The same phenomenon was also recorded for the various kharif jowar zones, as will be seen from the Table.

With such high rate of yield it is not surprising that the estimated total production of hybrid kharif jowar in the State<sup>3</sup> came to account for a much higher proportion of the total production of kharif jowar than the proportion of hybrid area to total kharif jowar area. These percentages, zone-wise are given in Table 4.1.6. The Table shows that during these five years production of hybrid kharif jowar accounted for between 26 and 60 per cent of the total production of kharif jowar, while, as we have noted, even in the best year the area under hybrid kharif jowar was not more than 15.5 per cent of the total area. Indeed, the zonal figures in some years seem to have pierced the ceiling; in Poona zone in 1972-73 hybrid

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<sup>3</sup> Estimated by the Statistician by multiplying the estimated area by the estimated yield rate.

**Table 4.1.5 : Average Yield of Kharif Jowar and Hybrid Kharif Jowar in Maharashtra - 1956-57 to 1972-73**

		(Yield kgs./hectare)													
Sr. No.	Year	Nasik		Poona		Kolhapur		Aurangabad		Auravati		Nagpur		Maharashtra	
		Kh. Jowar	Hy-brid	Kh. Jowar	Hy-brid	Kh. Jowar	Hy-brid	Kh. Jowar	Hy-brid	Kh. Jowar	Hy-brid	Kh. Jowar	Hy-brid	Kh. Jowar	Hy-brid
1.	1956-57	825		593		911		611		820		627		736	
2.	1957-58	963		497		945		485		508		411		573	
3.	1958-59	691		460		907		490		513		549		565	
4.	1959-60	874		772		956		482		451		355		546	
5.	1960-61	1046		1259		1280		887		756		618		861	
6.	1961-62	808		531		990		548		546		330		592	
7.	1962-63	1206		156		1070		503		506		410		608	
8.	1963-64	863		908		1092		537		497		387		595	
9.	1964-65	1095		718		1017		554		607		514		661	
10.	1965-66	194		429		780		437		361		447		439	
11.	1966-67	623		706		808		482		468		485		522	
12.	1967-68	847		247		929		638		565		504		633	
Average		836		606		974		554		550		470		611	
13.	1968-69	904	1839	172	1688	992	1688	624	2133	754	1559	685	1559	733	1670
14.	1969-70	823	2029	252	2090	758	2290	593	2145	716	1720	540	1720	663	1916
15.	1970-71	463	2020	810	1656	893	1978	237	1313	323	1084	263	831	356	1357
16.	1971-72	482	1704	890	2109	951	2074	345	820	478	1459	342	1603	477	1474
17.	1972-73	544	1667	89	1369	319	965	259	1034	407	1431	388	1269	359	1262
Average		643	1852	442	1782	782	1799	462	1489	536	1451	448	1397	517	1536

**Source :** The yield rates for the all kharif jowar were calculated from the Season and Crop Reports of the State Government. The hybrid data are from the Statistician, Department of Agriculture.

**Table 4.1.6 : Estimated Total Production of Hybrid Kharif Jowar as a Percentage of the Total Production of All Kharif Jowar in Maharashtra, 1968-69 to 1972-73**

Sr. No.	Zone	1968-69	1969-70	1970-71	1971-72	1972-73
1.	Nasik	33.85	27.25	111.34	72.88	61.80
2.	Poona	33.29	42.54	49.34	77.83	828.40
3.	Kolhapur	6.30	31.54	30.01	35.70	90.40
4.	Aurangabad	24.97	27.76	95.54	21.80	39.61
5.	Amravati	54.07	28.51	53.29	29.94	32.30
6.	Nagpur	14.12	11.96	15.56	13.49	10.09
7.	State	34.27	26.78	59.37	31.74	39.11

kharif jowar production formed 828.4 per cent of the total kharif jowar production of that zone; in Nasik zone, in 1970-71 hybrid production formed 111.3 per cent of total production of kharif jowar; in Aurangabad zone in 1970-71 hybrid production formed 95.5 per cent of the total production of kharif jowar! These, and similar other figures in the Table are too "good" to be true! Data from the individual districts (not presented here) showed more such instances where the resultant estimated yield rate of local jowar was negative or near zero during one or other of these five years - a ridiculous position indeed!

This evidence suddenly throws all the data collected and reported by the Statistician (and the Z.P.'s) into the melting pot. But before we begin forming judgments about what

may be wrong, it is necessary to give these data a fair chance. It may be argued that the Statistician's sample survey could possibly yield such ridiculous results in zones where the sample size was very small because of the smallness of area under kharif jowar in the district/zone. Now, while one may agree with this proposition (which, however, requires that such data should not be used without checking for these flaws), the sample data from other areas with extensive kharif jowar and hybrid cultivation should not be subject to the same error. But we find that in the Aurangabad zone in 1970-71 only 17 per cent area under hybrid accounted for 95.5 per cent of total kharif jowar production which meant that the yield rate of local jowar on the remaining 83 per cent land was only 13 kg. per hectare! Indeed, if one compares the estimated yield rate of local jowar in different zones during these five years (after deducting the estimated area and production of hybrid from the officially estimated total area and production of kharif jowar) then one finds that they are by and large much lower than the yield rates of (local) kharif jowar in the same zones during the 12 years before the introduction of hybrid seed. This is too much to accept as even plausible.

This raises the whole question of the reliability of the available data. If the yield rate of local variety kharif jowar during the years since 1968-69 appears too low to be believed, the source of error may lie either in the estimated total production of kharif jowar during these years, or in the

Statistician's estimate of production of hybrid jowar. Now, it is not easy to question the estimation of jowar production by the Government, particularly during the last 5-7 years relating to our enquiry. There has been no change in the method of estimating total yields through crop-cutting experiments over the last 15 years or so. It is, however, sometimes suspected that due to political pressure (local or other) yield estimates have been tampered with, or doctored, in order to make the impact of adverse season appear more serious than was in fact the case. It is very difficult to verify such allegation. It appears, from the data in Table 4.1.5 that the average yield rates (for all kharif jowar) recorded in the years 1970-71 or 1972-73 the years of severe drought in different zones - were lower than the lowest rate recorded in the 12 pre-hybrid years since 1956-57. This may be real, or it may be the result of some doctoring - one cannot say for certain. One may only note, for whatever it is worth, that in the zones in which the recorded yields were particularly low in these years, there was a massive turnout of rural workers in scarcity relief works organized by the State, a phenomenon unprecedented in the previous decade or more. What is more relevant is the fact that in the non-drought years of these five years, particularly in 1968-69 and 1969-70 the average yield rate of kharif jowar recorded was fully comparable with the rates of yield recorded in good years of the earlier decade, in all the zones. And yet, if the Statistician's estimate of area and yield rate of hybrid is accepted, then the calculated yield

rate of local jowar in these two years turns out to be much lower than the general level of yield in the previous decade, particularly in zones like Nasik and Kolhapur and even Aurangabad. This is rather difficult to accept. One may therefore conclude that it is more likely that the error lies in the Statistician's estimate of production of hybrid kharif jowar during the five years.

To question the estimated production of hybrid kharif jowar is to question the estimated area under hybrid and/or the estimated yield rate. We have already noted the manner in which Statistician's sample survey data about area under hybrid was collected. The yield estimates are based on crop-cutting estimates on two plots selected at random from all the enumerated hybrid jowar growing plots in every sample village. The selection of sample plots and the crop-cutting experiments were also conducted by the same agricultural agency of the Zilla Parishad which distributed hybrid seed and reported the area under hybrid crop. One has no way of finding out whether this fact in any way affected the sample survey information. We, however, propose to examine the data relating to the yield rate of hybrid kharif jowar in (i) the different agricultural experiment stations in the State, (ii) the trials conducted on farmers' fields by the agricultural extension agency, and (iii) the sample farms in a village in the Marathwada zone of the State surveyed by us. This might help us to form a judgment about the reliability of the Statistician's estimated yield rate of hybrid kharif jowar.



Experiment on hybrid jowar in the kharif season have been conducted in various agricultural experiment stations in the State since 1966-67. The experiments have been for different types of treatments, namely, seed rate, plant population, spacing, and application of N, P, and K. We have collected the results of all the experiments on hybrid kharif jowar (unirrigated) in all the experiment stations in the State. For the purposes of analysis we have noted experiment results relating to the following standard treatments for all the different experiments in each of the 7 years since 1966-67. The standard treatment referred to is as follows :

Time of sowing	1st week of June to 1st week of July
Seed rate	7.5 kg/hect.
Plant population	1.44 lakh/hect.
Spacing between rows and plants	45 x 15 cms
Farmyard manure	12 cartload/hect.
Fertilizers :	
Nitrogen	80-100 kg/hect.
Phosphoric acid	62       "
Potash	62       "
Plant protection	As and when needed.

The agricultural experiment station at Parbhani (in Aurangabad zone) is the oldest and most important station for research on jowar in the State. During the 7 years 1966-73, 23 different experiments were carried out on hybrid jowar in this station. The average yield rate of all these experiments (for the standard treatments) was 3870 kg/hect. But the

variation around this mean was quite large: it varied from 2210 kg in one experiment in 1971-72 to 5325 kg in another in 1969-70. The coefficient of variation was 24.85 per cent. This was the only experiment station in Aurangabad zone for jowar. The average yield of hybrid kharif jowar for the five years 1968-69 to 1972-73 in Aurangabad zone estimated by the Statistician was 1489 kg/hect and the yields ranged between 820 and 2145 kg/hect.

The comparison of the data from the research stations in the other zones with the Statistician's for the zones, gives similar results. These are tabulated in Table 4.1.7. This suggests that the Statistician's estimated yield rate of hybrid kharif jowar in different districts/zones cannot be considered as over-estimates judged by the performance standard in the experiment stations in the zones.

Similarly, it may be useful to compare the Statistician's estimates with the average yield rates recorded in fertilizer and varietal trials (FVT) in cultivators' fields, conducted by the Department of Agriculture over 7 years, 1966-67 to 1972-73. The relevant data are also presented in Table 4.1.7, in columns 10 to 12. The data show that the average yield of hybrid kharif jowar recorded in the FVTs in the each zone was somewhat higher than the yield rate estimated by the Statistician in those zones, excepting possibly Kolhapur zone (Satara district). Here again there is no evidence to suspect over-estimation of the yield rate by the Statistician in the sample survey.

**Table 4.1.7 : Estimated Average Yield Rates of Hybrid Kharif Jowar from Different Sources**  
(Yield kgs./hectare)

Sr. No.	Division	District/ Research Station	Zonewise estimated yield by the Statistician			Yield at Research Stations			Districtwise yield of P.V.T.s		
			Aver- age (4)	Mini- mum (5)	Maxi- mum (6)	Aver- age (7)	Mini- mum (8)	Maxi- mum (9)	Aver- age (10)	Mini- mum (11)	Maxi- mum (12)
1.	Nasik	-	1851.6	1666.6	2028.8	-	-	-	-	-	-
		Dhulia	-	-	-	4212	3052	7045	-	-	-
		Jalgaon	-	-	-	4297	3572	5635	-	-	-
2.	Poona	-	1782.3	1368.8	2109.3	-	-	-	-	-	-
3.	Kolhapur	-	1799.1	965.4	2290.2	-	-	-	-	-	-
		Kolhapur	-	-	-	4116	4099	4133	-	-	-
		Sangli	-	-	-	-	-	-	1710	1110	2440
		Satara	-	-	-	-	-	-	786	660	970
		Karad	-	-	-	6233	5234	7233	-	-	-
		Digraj	-	-	-	5146	4703	5578	-	-	-
4.	Aurangabad	-	1489.2	819.8	2145.0	-	-	-	-	-	-
		Parbhani	-	-	-	3870	2210	5325	1180	830	1430
		Nanded	-	-	-	-	-	-	2184	1700	3010
		Osmanabad	-	-	-	-	-	-	1798	1340	2680
		Bhir	-	-	-	-	-	-	1673	1490	2010
5.	Amravati	-	1450.7	1083.6	1720.4	-	-	-	-	-	-
		Amravati	-	-	-	3491	2967	4059	1540	1000	2310
		Achlapur	-	-	-	4816	4123	5541	-	-	-
		Akola	-	-	-	2687	1422	4199	1755	1180	2790
		Yeotmal	-	-	-	3937	2240	5154	2381	1420	3030
		Buldhana	-	-	-	2751	1816	4002	2666	2230	3080
6.	Nagpur	-	1397.5	831.1	1720.4	-	-	-	-	-	-
		Nagpur	-	-	-	3334	1831	4356	1876	1130	2890
		Kutki	-	-	-	3161	3170	4477	-	-	-
	State	-	1535.7	1262.0	1916.2	-	-	-	-	-	-

The third set of data with which we propose to compare the Statistician's estimates, are the data collected by us in one village in Nanded district of Aurangabad zone. We made a purposive selection of one village, Kalambar, in Nanded district which is an important kharif jowar producing district. This village was considered by the Agricultural Officers concerned as one of the most developed villages, with considerable lift irrigation, sugarcane crop and a well developed hybrid programme. We selected at random 20 cultivators growing hybrid jowar in 1974-75, and collected from them information about the area under and production of hybrid jowar, for that year and the previous three years. From this survey it was found that the average yield of hybrid jowar in the village in 1974-75 was 1187 kg/hec. In none of the previous 3 years was the average yield of these 20 cultivators higher than this, the lowest annual average being 957 kg/hect. in 1972-73. The Statistician's estimate of the average yield of hybrid kharif jowar in Nanded district are given below side by side our estimate for the particular village surveyed.

Year	Yield rate (kg/hect.)	
	Statistician's estimate	Village surveyed
1968-69	2595	N.A.
1969-70	2277	N.A.
1970-71	1186	N.A.
1971-72	995	1087
1972-73	1033	980
1973-74	N.A.	957
1974-75	N.A.	1187

It is true that it is not proper to compare the data relating to one particular village in a district with the average of sample data from the district as a whole. However, in view of the fact that this village was purposely chosen as a developed village particularly in terms of hybrid jowar, one might expect the performance of yield rate in this village to be better than the average and not poorer than the average for the district. Comparing the data for the two years, 1971-73, for which yield data from both sources are available, one finds the two fairly comparable. Therefore one can say that the yield rate for the years 1970-71 onwards estimated by the Statistician are not over-estimates. The same, however, cannot be said about the yield estimates by the Statistician for the earlier two years, 1968-69 and 1969-70, when the yield levels were put at about 26 and 23 quintals per hectare respectively. These levels were more than double the levels recorded in the three subsequent years. It is not possible to attribute this sharp decline to drought conditions, for in that case the yield level in our surveyed village in 1974-75, a very normal year, should have been much higher than the 1187 kg. reported. The Statistician's estimate for these two earlier years may, however, be plausible if we consider the yield rate to be that relating to irrigated hybrid kharif jowar only. For, we find that the few hectares under irrigated hybrid jowar in our surveyed village had recorded yield levels of 21 to 26 quintals/hct. during the 4 years 1971-75. But, if we interpret the yield estimates by the Statistician for the earlier years

to relate to irrigated hybrid kharif jowar mainly, then we immediately run into trouble with the Statistician's estimate of area under hybrid kharif jowar in these years. We shall discuss this point in the context of examination of the Statistician's estimate of area under hybrid kharif jowar, to which we now turn.

Since the preceding discussion shows that there is no strong direct or circumstantial evidence to suspect serious over-estimation of yield rates by the Statistician, it follows that his estimation of area under hybrid in different years might be the source of error. However, independent source of estimation of area under hybrid kharif jowar in the State is not easily available. The only sample survey data from which relevant information may be obtained is the enquiry into the cost of production of crops conducted in the State since 1971-72, under the auspices of the Directorate of Economics and Statistics of the Union Ministry of Agriculture. This is conducted on a properly stratified random sample of farms in the State as a whole, covering 400 farmers. The Report of the first year shows that out of the 746.33 hectares devoted to kharif jowar (or mixtures including jowar) only 21.83 hectares, i.e., 3.01 per cent of the total kharif jowar area was under hybrid. In the next year, 1972-73, the percentage of area under hybrid jowar to the total area under kharif jowar was also equally small, 3.98 per cent.<sup>4</sup> This is in

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<sup>4</sup> For the first year see "Report on Cost of Production of Jowar in Maharashtra during 1971-72," (mimeographed), Directorate of Economics and Statistics, Ministry of Food and

sharp contrast to the proportion of area under hybrid in the kharif season estimated by the Statistician for the whole State: 10.28 per cent in 1971-72 and 11.13 per cent in 1972-73. This is clear evidence of the gross over-estimation of area under hybrid kharif jowar by the Statistician.

If further evidence is needed, we may refer to the result of our village-survey in Nanded district, mentioned earlier. As we saw, the estimated yield rate of hybrid kharif jowar during the two years 1968-70, made by the Statistician were as high as the yield rates of irrigated hybrid jowar lands in our surveyed village during the 4 years, 1971-75, and more than double that on the unirrigated plots in the same period. Therefore we suggest that the high rates of yield, estimated by the Statistician, during 1968-70 would relate to irrigated lands only. Official statistics show that during these two years only 1500 hectares of kharif jowar area had been irrigated in the district, while the Statistician estimated the total area under hybrid jowar in these two years at 21.6 and 10.2 thousand hectares respectively. It again goes to show that in this district apparently the yield estimates were for irrigated hybrid jowar, and the related area estimates were gross over-estimates.

This long review of the performance of hybrid kharif

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Agriculture, New Delhi, December 1974. For the next year, the data were made available by the Department of Agricultural Economics of the Mahatma Phule Krishi Vidyapeeth, Rahuri, which is conducting the survey.

jowar in Maharashtra during the years since its introduction in 1966-67, shows that it has been able to make precious little contribution to breaking the prolonged stagnancy in the production of jowar in the State. The officially estimated yield rate of hybrid kharif jowar does not appear to be an over-estimate, but the area under this variety appears to be grossly over-estimated. It is most likely that taking the State as a whole, the area under hybrid kharif jowar has never been more than a fraction, say  $1/4$  to  $1/2$ , of the 9 to 15 per cent estimated for the various years since 1968-69.

If we, therefore, assume that the area under kharif hybrid jowar did not exceed more than 4 per cent of the total kharif jowar area in any of the five years, 1968-69 to 1972-73, we may expect to get some comparable results in respect of yield rate. It has, already, been mentioned that the officially estimated yield rates of hybrid jowar do not appear to be an over-estimates. With the given yield rates of hybrid jowar and 4 per cent area under it, we have calculated total production of hybrid kharif jowar for each year and for the period 1968-69 to 1972-73. Further we have estimated and compared yield rates of local jowar in different zones for these five years. It can be seen that these yield rates are, by and large, comparable to the yield rates of (local) kharif jowar; in the same zones and in the State as a whole; for the 12 years previous to the introduction of hybrid seed. This, to an extent, suggests the possibilities of over-estimation



of area under hybrid kharif jowar and at the same time indicates that the area under hybrid kharif jowar may not have been more than 4 per cent of the total kharif jowar area in the State and in individual zones also.

#### Causes of Failure of Hybrid Jowar

We shall be concerned here with another important question raised by our findings so far. We have seen that there is no reason to suspect the estimated average yield rate of hybrid kharif jowar in the State to be a serious over-estimate. We have also seen that these yield rates have been much higher, at least two times or more, than the estimated yield rate of local kharif jowar. If the farmers obtained such higher yields from hybrid jowar under unirrigated condition in the kharif season, then why was the adoption of this variety of seed as tardy and poor as shown above? This is the crucial question to which answer is sought in what follows.

As we have seen, the average yield of hybrid kharif jowar, as estimated by the Statistician, was much higher than the yield rate of local jowar. The estimated yield rate of hybrid jowar, for the State as a whole, ranged from 1262 kg/hct. to 1916 kg/hct. during the period 1968-69 to 1972, but the highest yield rate of local jowar during the 12 previous years was recorded as 861 kg/hct. for the State as a whole. The same picture emerges for the individual crop-zones of the State: the highest average yield of local jowar was almost always lower than the lowest yield of hybrid jowar in each of these zones, as can be seen from Table 4.1.5.

It may not, however, be considered surprising or very impressive that the average estimated yield rate of hybrid jowar was much higher than that of local kharif jowar. After all, hybrid jowar, unlike local jowar, is grown in well-manured and fertilized fields. Comparison of yield rates on hybrid and local jowar plots made by the Statistician, or the comparison of the yield rates for our sample of 20 farmers in the Nanded village, is subject to this limitation. The same difficulty arises with the yield data for hybrid and local jowar available from the agronomic experiments in the agricultural research stations of the State, because the rate of fertilizer (N, P, K) input was generally twice as high in experiments with hybrid than with local jowar.

The only set of data that came nearest to our purpose relate to the Fertilizer and Varietal Trials (FVT) conducted by the Department of Agriculture on the farmers' fields during the period from 1966-67 to 1972-73. The treatments for these trials, with local and hybrid seed, were almost similar, though of course they were subject to variation in care of the crops by the cultivators. The summary of the results in the different districts is given in Table 4.1.8. It appears that while the mean yield rates of hybrid kharif jowar were higher than those for local jowar in all districts, the difference was rather small (in case of Nagpur the average yield rate for local jowar was higher than for hybrid). A statistical test of significance for the two means - a 't' test - for each district

**Table 4.1.8 : Average Yield of Kharif Jowar under Fertilizer and Varietal Trials on Cultivators Fields in Different Districts 1966-67 to 1971-72 (with 52 kgs. Nitrogen and 28 kgs. Phosphoric Acid Per Hectare)**

Sr. District No.	(Yield kgs./hectare)							
	Local varieties			Hybrid varieties			'F' Value	't' Value
	Average yield	Standard deviation	Coefficient of variation	Average yield	Standard deviation	Coefficient of variation		
1. Parbhani	771 (6)	174	22.56	1180 (3)	255	21.61	2.674	2.490**
2. Nanded	1315 (6)	225	17.11	2184 (7)	420	19.23	3.392	4.239**
3. Osmanabad	1023 (6)	302	29.52	1798 (7)	447	24.86	2.124	3.369**
4. Bhir	1188 (6)	126	10.60	1673 (3)	238	14.22	4.482	3.540**
5. Nagpur	2043 (6)	229	11.20	1876 (7)	641	34.16	7.634**	0.566
6. Akola	1216 (6)	323	26.56	1755 (7)	609	34.70	3.457	1.820
7. Amravati	1366 (3)	463	33.89	1540 (3)	559	36.29	14.540	0.340
8. Yeotmal	1588 (6)	608	38.28	2381 (7)	691	29.02	1.255	2.038
9. Buldhana	-	-	-	2666 (3)	347	13.01	-	-
10. Sangli	1418 (6)	376	26.51	1710 (7)	500	29.23	1.714	1.097
11. Satara	843 (6)	85	10.08	786 (3)	133	16.92	3.078	0.695

Figures in brackets indicate the number of observations on which average is based.

showed that except for the four districts of the Aurangabad zone, the means were not significantly different in all the other districts. It means that the yield performance of hybrid in experiments on farmers fields were not uniformly superior to that of local jowar.

It may, however, be said that the insignificance or otherwise of the test result may be mainly due to the smallness of the sample observations in most districts. To overcome this handicap, we have pooled the individual 't' values of all the districts separately for hybrid and local varieties by converting the 't' to  $x^2$  and then making a  $x^2$  test by following Fisher's method in his Statistical Methods for Research Workers, Ch. IV, Section 21.1, pp. 97-98. The test shows that taking all the districts together, the mean yield of hybrid jowar in the FVT's was significantly higher than that of local jowar. Though the pooled test for the mean yield in matter of FVT trials turns out significant, it may not be improper to draw attention to the small difference in case of a number of districts. Such demonstration results could not possibly have been very encouraging for the farmers to take up hybrid jowar in their respective regions.

The more significant aspect of the difference between the yields of hybrid and local jowar is the variation in the yield rate from year to year and from district to district. It had been expected that hybrid jowar, being a shorter duration crop than local jowar, would be subject to variation in weather over the growing season, to a lesser extent, and therefore the

year-to-year fluctuation in its yield would be significantly less than in case of the local variety. If, however, this expectation were to turn out to be wrong, then the very fact of high fluctuation in yield from year to year would be a very discouraging factor for cultivators. For, if hybrid jowar yields more than local jowar, it also costs proportionately higher, and a farmer will naturally hesitate to stake a larger expenditure than a smaller one if the chances of a poor crop are as high (if not higher) in case of the former as in case of the latter.

Similarly, wide variation in the performance of hybrid jowar among regions/districts of the State, if noted, would be another disturbing factor from the point of view of adoption of the crop in different regions. The extension agency has been advocating a standard set of treatments or inputs applications and is holding out the prospect of a standard yield. If the actual performance in different regions/districts of the State is different, it would not be unfair to say that the extension advocacy is misleading, and may also prove a deterrent for the farmers in many regions.

In view of these considerations, it is necessary to examine not only the difference between the mean yield rates of hybrid and local jowar, but also the available evidence about the fluctuations in the yield rates of the two varieties from year to year, as well as from region to region. Three sets of data are available to us for the purpose: (a) the

Statistician's estimates of yields of hybrid and local jowar in different districts during the 5 years since 1968-69, (b) the results of the P.V. Trials on hybrid and local varieties in different districts; and (c) the result of agronomic experiments on hybrid and local varieties in the different experiment stations in the State. We now proceed to examine these data one by one.

The data on fluctuations from year to year can be examined by comparing the relative variances with the help of an F test, or by comparing the coefficients of variation. Since the mean yield level of hybrid jowar was always higher than that of local jowar, the coefficient of variation is a better measure of fluctuations than the F test for the difference in the two variances. The F test carried out for small number of observations in individual districts or centres may be plagued by the problems associated with small sample size. Therefore pooling of the data may give better results. Besides, the number of observations is sometimes more than the number of years for which the data are available; this creates a problem of variation within years, that can be separated through an analysis of variance, before examining variation between years. All these steps with the available data are fully explained and presented in the Appendix. Here we shall only present the summary results.

The Statistician's estimates of average yield rates of the two varieties are available for 5 years, 1968-69 to

1972-73, for 20 districts. An F test for the difference between the variances of the two varieties was not significant for 18 of the 20 districts; however, it was significant when the data for the 20 districts were pooled, showing variance of hybrid jowar to be significantly larger. The coefficient of variation of the yield rate of hybrid jowar was smaller than that of local in half of the 20 districts, and not markedly different in the other half. But the coefficient of variation with pooled data for hybrid was lower (28.99 per cent) than that for local jowar (39.33 per cent). Thus, overall it appeared that while the absolute variance of the yield-rate of hybrid jowar was higher than that of local jowar, its percentage variation around its mean was lower than that of local jowar.

The second set of data relate to F.V. Trials on the farmers' fields, conducted over 7 years, from 1966-67 to 1972-73, in 10 districts. Here again the F test showed the variances of the yield rates of hybrid and local jowar not to be significantly different in 9 of the 10 districts. But test of significance with pooled data showed the variance of hybrid was significantly higher, (as was the case with the Statistician's survey). The comparison of the coefficients of variation, however, showed a different picture: in 7 out of the 10 districts the coefficient of variation was higher for hybrid jowar, and also with pooled data the coefficient of variation of hybrid was as large as, or slightly larger than, that of

local jowar (29.31 per cent and 27.67 per cent respectively). Thus, while the Statistician's survey showed somewhat lower fluctuations of hybrid jowar yield, FVT data did not reveal any significant difference.

The data from the different agricultural research stations of the State were more, but rather difficult to handle for our purpose, as explained in the Appendix. Test of significance for the difference in the variances of the yield rates of the two varieties could be carried out for only 3 research stations. For only one station, Achalpur, was the F value statistically significant, showing larger variance of hybrid jowar yield rate. However, pooling the data for the three stations, the F test showed the variance of hybrid jowar to be significantly higher. Similarly, a comparison of the coefficients of variation of these two varieties in each of these three stations showed that in Achalpur they were about the same, where as in Parbhani and Akola that of hybrid jowar was lower. The coefficient of variation with the pooled data showed hybrid with lesser variation in yield rate from year to year.

The examination of the three sets of data for year-to-year variation in the yield rates of hybrid and local jowar does not give an unequivocal answer. In the first place never was the variance of yield rate of hybrid jowar lower than that of local jowar; in many instances, and certainly when the district data were pooled, the variance of hybrid jowar yield



rate turned out to be significantly higher. Secondly, however, the coefficients of variation of the yield rates of the two varieties did not consistently show that it was less for hybrid jowar. While according to the Statistician's survey half the districts showed no improvement in such variation of hybrid jowar, the FVT's showed the opposite tendency, that is the coefficient of variation was larger for hybrid than for local in most of the districts. In case of the experimental data, the performance was different in different districts. One is therefore led to the conclusion that, on the basis of available statistical evidence, hybrid has not been able to show consistently lesser year to year fluctuation in yield rate than local jowar.

The variation in yield rate of hybrid jowar from district to district (or centre to centre) was also quite large. The coefficient of variation of yield of hybrid jowar estimated by the Statistician was 41.82 per cent, which, though somewhat lower than that of local jowar (52.1 per cent), was quite high. In case of F.V.T. the results were similar: the coefficients of variation between districts was 53.56 per cent and 71.14 per cent respectively. The experiment station data also showed similar results. In fact, the range of variation between the highest and lowest average-yield centres was quite large, 3546 kg., the highest yielding centre recording more than double the yield in the lowest average-yield centre.

Since the seasonal fluctuation in yield rate of hybrid is almost as large, in many instances, as of local jowar, it

is natural that cultivators would be reluctant to put in the much larger cost that production of hybrid jowar entails. The high variation in yield rate of hybrid between regions, subject to some treatment and hence costs aggravates the problem. Given the estimated mean yield and coefficient of variation in yield between years as well as the estimated cost of production of hybrid jowar, in case of the F.V.T.'s, we find that there is a 21 per cent probability that a cultivator will not be able to recover his cost of production during a year. Similarly, if we consider the coefficient of variation between districts, it appears that in about 35 per cent of the districts the cultivators may not be able to recover the cost of production of hybrid jowar. These probabilities are of course much lower if one takes the experiment station data into account, mainly because the yield rates there were relatively higher. But, as we saw, the F.V.T. data appeared nearer the prevailing conditions. It is not therefore surprising that cultivators by and large were reluctant to use hybrid jowar seed in the kharif season.

The high variability in yield rate and the consequent high risk in incurring the larger costs in turn would lead to a lesser use of fertilizers and/or the insecticides than would otherwise have been justified, and consequently to lower yield. We have noted earlier that the average yield of hybrid jowar on the 20 sample farms in our surveyed village was smaller than the average yield of the FVT on farmers' fields (and only

comparable to the Statistician's estimate of the actual average yield of hybrid in the district), though the average input of fertilizers by these farmers was not lower than that in the FVT farms. One possible reason for the low yield rate on the fields of our sample farmers may be the inadequate application of insecticides and pesticides. Indeed, the attack of the midge fly has, during the last five years in Maharashtra, proved the greatest deterrent to hybrid jowar. Apparently, the scientists were unprepared for this, and could identify the trouble only after one year of severe crop loss on many farms in 1970-71. The real point, however, is that the recommended and required spraying of insecticides turns out to be very expensive. In the first place, unless every one sprays his standing crop at the same time, spraying may be ineffective, and the equipment for spraying is not available to everyone in the village when needed (except to the rich and/or the powerful). Secondly, if a shower of rain comes soon after spraying, the chemical goes waste and spraying has to be repeated, which increases cost and inconvenience. But, most important of all is the requirement of large amount of water for spraying. This is important enough to deserve somewhat extended treatment. The farmers of hybrid kharif jowar in Maharashtra have been advised by the extension department to give four sprayings during the crop season. The total water required for these four sprayings is 2250 litres per hectare (that is, 225 bucketfuls of 10 litre buckets, or, about 13 oil-drumfuls of 175 litre capacity). Now, in a crop grown

under unirrigated conditions in the dry agricultural regions of Maharashtra, where wells are few and streams and rivers far away, this surely is a very tall order. The farmers have to fetch water in bullock-carts from distant places (assuming a source of water exists in the neighbourhood) and that will mean bringing much more water than required, to account for the wastage in transit. In rainy season muddy water won't do: the nozzles of the sprayers get choked. The cultivators in course of our survey repeatedly brought these facts to our notice. This shows that even for hybrid kharif jowar meant to be grown under unirrigated conditions, water is a serious constraint. Furthermore, the application of insecticides becomes ridiculously expensive when one finds that at a certain stage extension experts have advocated pouring of insecticide-mixed water on each shoot of jowar individually. We quote the instruction to this effect below :

"Third Spraying :- The third spraying should be given 15 days after the second spraying. This spraying is necessary to control army worms, stem borers, aphids and jassids, etc., in the growing shoots of the jowar plant. It has been observed that the above insects are not properly controlled by mere ordinary spraying. Therefore, the specified quantity of insecticides mixed in appropriate quantity of water, should be poured on each individual shoot with the help of a small-spraying-basket or mug or small tin."<sup>5</sup>

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5 English translation of the original Marathi in  
 "अनुजित पिकांच्या लागवड पध्दती," कृषि संचालनालय, महाराष्ट्र राज्य,  
 पुणे, १९७३, पा. क्र. ४७-४८.

It is needless to attempt an estimate of the labour cost of such an operation!

It is therefore not surprising that farmers, by and large, have put in less than recommended quantities of fertilizers and insecticides, and of course harvested lesser yields. The result has been discouraging. Indeed, our survey of the 20 farmers in one village shows that the average net income of a farmer from one acre of hybrid jowar was no higher than his average net income from one acre of local jowar grown by him. The data are presented in Table 4.1.9.

All the inputs including the home-supplied inputs, as well as the outputs, in the above Table, have been valued at market prices current during the year of survey (1974-75). The net profit (gross value of produce - estimated value of all inputs) of hybrid and of local jowar for the 20 farmers is reproduced below.

	<u>Hybrid</u> Rs./acre	<u>Local</u> Rs./acre
<b>I. <u>Irrigated farms</u></b>		
(a) Irrigated jowar	675	568
(b) Unirrigated jowar	363	333
<b>II. <u>Unirrigated farms</u></b>		
(i) Large	274	270
(ii) Medium	331	281
(iii) Small	199	180
(iv) All	272	268

It is clear from the above that hybrid jowar yielded a somewhat higher profit per acre than local only under irrigated

**Table 4.1.9 : Per Acre Expenditure on and Receipts from Hybrid and Local Kharif Jowar for a Sample of 20 Farmers in a Village in Nanded District, Maharashtra, 1974-75**

(in Rs.)													
Sr. No.	Item/Group	Irrigated Group				Unirrigated Group					Over all Dry Jowar		
		Irrigated Jowar		Dry Jowar		Large		Medium		Small		Rs.	%
		Rs.	%	Rs.	%	Rs.	%	Rs.	%	Rs.	%		
<b>Hybrid Jowar</b>													
1.	Preparatory tillage	76.10	10.55	64.91	13.84	63.67	13.99	62.31	14.00	61.00	18.09	62.97	14.76
2.	Application of F.Y.M.	93.30	12.92	34.66	7.39	35.92	7.89	42.87	9.64	32.40	9.61	36.46	8.55
3.	Application of Fertilizer	236.90	32.82	136.70	29.15	124.70	27.40	129.39	29.09	103.65	30.74	123.61	28.98
4.	Seed and Sowing	34.50	4.77	35.41	7.55	33.63	7.39	35.82	8.06	28.50	8.45	33.34	7.82
5.	After care	39.60	5.48	34.50	7.36	25.50	5.60	24.00	5.39	19.80	5.87	25.95	6.08
6.	Irrigation	22.73	3.15	-	-	-	-	-	-	-	-	-	-
7.	Plant Protection	180.80	25.05	142.00	30.29	151.00	33.18	129.00	29.00	79.60	23.62	125.40	29.42
8.	Harvesting and Thrashing	38.00	5.26	20.66	4.42	20.67	4.55	21.40	4.82	12.20	3.62	18.73	4.39
9.	Total Expenditure	721.93	100.00	468.84	100.00	455.09	100.00	444.79	100.00	337.15	100.00	426.46	100.00
	Yield in quintals: Grain	9.50		5.66		4.96		5.28		3.65		4.75	
	Fodder	19.00		11.32		9.92		10.56		7.30		9.50	
	Value of Yield in Rs.												
	Grain	1235.00		735.80		644.80		686.40		474.50		617.50	
	Fodder	161.50		96.22		84.32		89.76		62.05		80.75	
	Total	1396.50		832.02		729.12		776.16		536.55		698.25	
	Profit/Loss	+674.57		+363.18		+274.03		+331.37		+199.40		+271.79	
<b>Local Jowar</b>													
1.	Preparatory tillage	94.62	18.06	65.08	22.73	66.21	27.37	65.18	26.97	60.25	34.67	64.18	27.43
2.	Application of F.Y.M.	121.25	23.16	54.66	19.08	56.08	23.18	54.00	22.34	32.30	18.59	49.26	21.05
3.	Application of Fertilizer	181.00	34.55	86.42	30.17	43.50	17.98	42.06	17.40	17.58	10.12	47.39	20.26
4.	Seed and Sowing	17.00	3.25	18.25	6.37	19.12	7.91	19.68	8.14	19.85	11.42	19.22	8.22
5.	After care	37.12	7.08	36.00	12.56	35.00	14.47	38.25	15.83	27.00	15.54	34.06	14.56
6.	Irrigation	20.30	3.87	-	-	-	-	-	-	-	-	-	-
7.	Plant Protection	28.50	5.45	12.68	4.43	-	-	-	-	-	-	1.17	0.50
8.	Harvesting and Thrashing	24.00	4.58	13.33	4.66	22.00	9.09	22.50	9.32	16.80	9.66	18.66	7.98
9.	Total Expenditure	523.79	100.00	286.42	100.00	241.91	100.00	241.67	100.00	173.78	100.00	233.94	100.00
	Yield in quintals: Grain	5.87		3.33		2.75		2.81		1.90		2.70	
	Fodder	17.61		10.00		8.25		8.43		5.70		8.10	
	Value of Yield in Rs.:												
	Grain	880.50		499.50		412.50		421.50		285.00		405.00	
	Fodder	211.32		120.00		99.00		101.16		68.40		97.20	
	Total	1091.82		619.50		511.50		522.66		353.40		502.20	
	Profit/Loss	+568.03		+333.08		+269.59		+280.90		+179.62		+268.26	

conditions. Under unirrigated condition, which is the only relevant condition in Maharashtra, hybrid jowar showed no improvement over the local. This becomes even more important when one notes that the labour input per acre of hybrid was not higher than that of local jowar. All the increase in yield goes to meet the extra cost of the material inputs, leaving nothing to the cultivators. This is the average picture; about half the farmers surveyed showed some net profit while the other half showed a net loss. This being the situation, it is not surprising that not many farmers cared to grow hybrid jowar in the village, and, of course, in the State.

Indeed, it was surprising that in spite of this poor performance of hybrid jowar in the village, as large an area was under hybrid as reported. What is more, most of the irrigated and the large and medium farmers in our sample had grown hybrid to a greater or lesser extent during the 4 consecutive years ending 1974-75. This was not quite consistent with the reported poor profitability of hybrid, and needed some explanation. On enquiry, it was found that a significant number of large and medium farmers, irrigated and otherwise, were growers of state-certified hybrid jowar seed, for which they obtained the necessary supply of fertilizers and insecticides at regulated prices from the Government, as well as technical supervision by government officials. Their produce - certified seed - was purchased by the Government at about Rs. 6.50 a kilogram. (Our cost-return estimates as well as the area estimates do not include the seed-growing area.) At this

price it was certainly very profitable for them to grow seed, even if the yield rate was not very high. Because they were approved seed growers, they also felt obliged to grow some hybrid jowar for ordinary commercial purposes. (It would otherwise look odd! Besides, the VLW will have to fulfil his target for distribution of hybrid seed!) Moreover, a seed-growing plot had to have land within a radius of 150 metres free from jowar that might result in cross pollinization. Therefore, the seed farmers saw to it that the neighbouring plots, if of other farmers, were either not planted to jowar or planted with hybrid jowar, such that flowering of these plots will be later than on the seed plots. For this purpose they either paid the neighbouring farmers to grow such crops or themselves take the land on rent (mostly unrecorded lease) and grow it themselves. This explains why despite such poor performance of commercial hybrid jowar in the village many farmers continued to grow it year after year. Naturally, where such special conditions did not prevail, it is no wonder the area under hybrid jowar fluctuated from year to year and generally declined.



#### 4.2 Rabi Jowar

As noted earlier, rabi jowar accounts for about 57 per cent of the total area under jowar and 42 per cent of the total production of jowar in the State. The somewhat lower rate of yield per hectare of rabi jowar is because of the less favourable conditions under which it is grown in the State than kharif jowar.

The total production of rabi jowar in the State fluctuated between 1.1 to 1.8 million tonnes (excluding the years of severe drought and 1960-61, the year of exceptionally high production) during the 17 years under review (Table 4.2.1). But during this period production of rabi jowar did not show any increasing trend. On the other hand, if one takes all the 17 years into account the annual compound growth rate of production comes to -5.27 per cent (Table 4.2.1-A) (statistically significant). This decline, however, is due to the inclusion of the 3 years of very low production, on account of drought, towards the end of the period. Excluding those three years, the annual compound growth rate is -0.58 per cent, which is statistically insignificant, and indicates stagnancy in rabi jowar production. There is a significant difference, however, in growth rates during the pre-hybrid and post-hybrid seed periods. The annual growth rate from 1956-57 to 1964-65 was +3.1 per cent, while for the later period 1964-65 to 1972-73 (excluding the drought years) it was -1.96. Even the non-drought years of

**Table 4.2.1 : Production of Rabi Jowar in Maharashtra and Its Agro-Climatic Zones - 1956-57 to 1972-73 (Production in '00 Tonnes)**

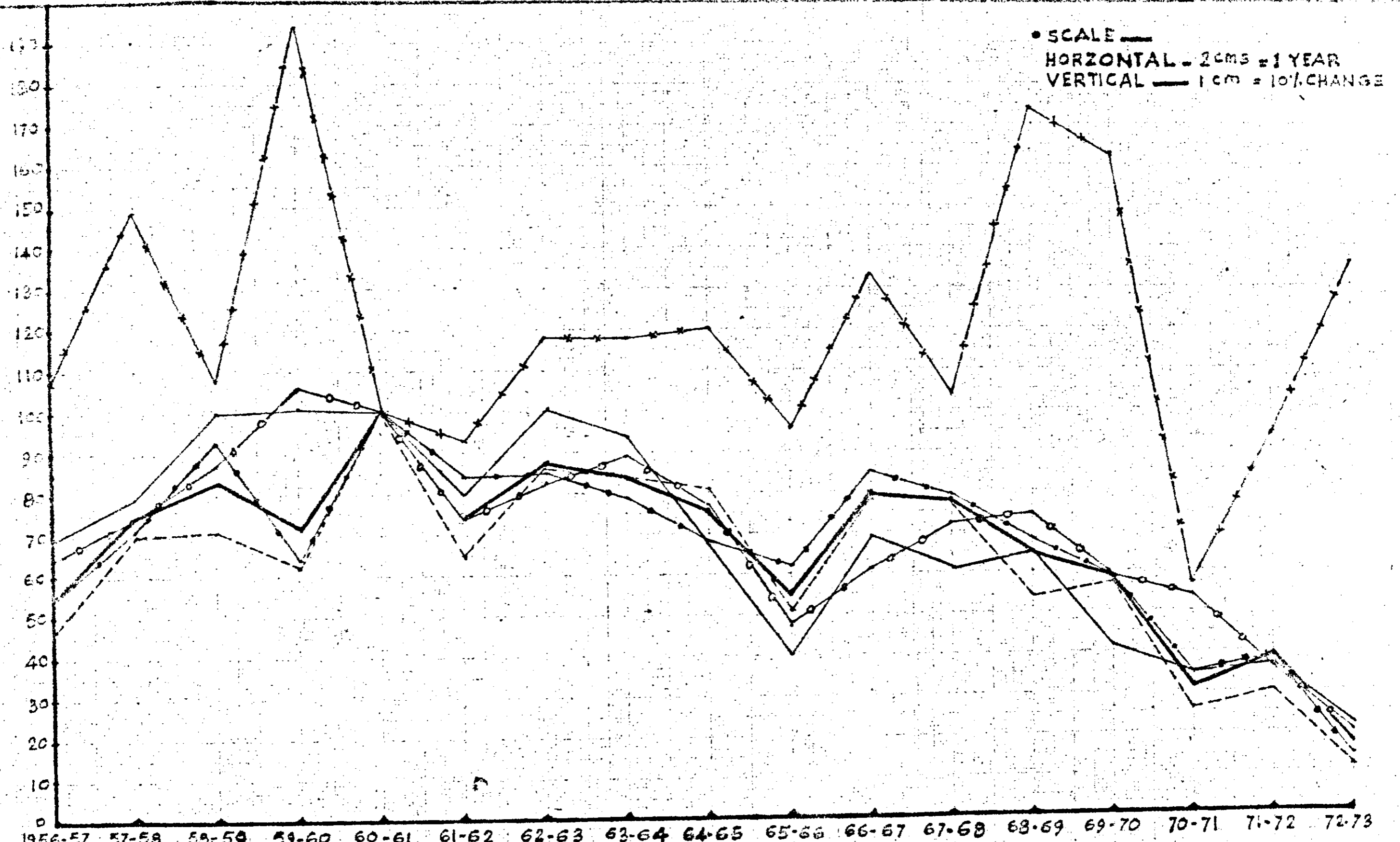
Sr. No.	Year	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra State
1.	1956-57	893 69.44	4995 47.83	956 64.86	4091 54.89	3 150.00	735 107.28	11674 54.69
2.	1957-58	1026 79.78	7314 70.04	1095 74.29	5340 71.65	4 200.00	1023 149.12	15802 74.03
3.	1958-59	1298 100.93	7518 71.99	1283 87.04	7005 93.99	7 350.00	747 108.89	17868 83.67
4.	1959-60	1304 101.40	6497 62.21	1575 106.85	4774 64.05	5 250.00	1334 194.46	15489 72.79
5.	1960-61	1286 100.00	10443 100.00	1474 100.00	7453 100.00	2 100.00	686 100.00	21344 100.00
6.	1961-62	1036 80.56	6825 65.35	1091 74.01	6262 84.02	19 950.00	638 93.00	15871 74.36
7.	1962-63	1287 100.08	9067 86.82	1213 82.29	6346 85.15	7 350.00	811 118.22	18731 87.76
8.	1963-64	1213 94.32	8803 84.29	1324 89.82	5939 79.68	11 550.00	811 118.22	18101 84.81
9.	1964-65	866 67.34	8478 81.18	1135 77.00	5100 68.43	8 400.00	829 120.84	16416 76.91
10.	1965-66	518 40.28	5334 51.07	707 47.96	4626 62.07	1 50.00	663 96.65	11849 55.51
11.	1966-67	896 69.67	8148 78.02	904 61.33	6363 85.37	7 350.00	899 131.05	17217 80.66
12.	1967-68	790 61.43	8231 78.82	1068 72.45	5911 79.31	3 150.00	720 104.96	16723 78.35
13.	1968-69	848 65.94	5693 54.51	1096 74.35	5139 68.95	3 150.00	1197 174.49	13976 65.48
14.	1969-70	541 42.07	6025 57.69	882 59.84	4413 59.21	4 200.00	1120 163.26	12985 60.84
15.	1970-71	460 35.77	2725 26.09	798 54.14	2556 34.29	2 100.00	395 57.58	6936 32.49
16.	1971-72	483 37.56	3778 36.18	534 36.23	2894 38.83	2 100.00	647 94.31	8338 39.06
17.	1972-73	288 22.39	1202 11.51	298 20.22	1072 14.38	1 50.00	938 136.73	3799 17.80

**Table 4.2.1-A : Annual Compound Growth Rates of Production of Rabi Jowar in Maharashtra - 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Nasik	Poona	Kolha-pur	Auran-gabad	Hagpur
1.	1956-57 to 1972-73	-5.27 (0.39)*	-6.85 (0.80)*	-5.94 (0.34)	-5.38 (0.16)	-5.55 (0.37)*	-0.72 (0.01)
2.	1956-57 to 1969-70	-0.58 (0.14)	-4.46 (0.63)*	-0.14 (0.08)	-1.46 (0.01)	-0.44 (0.00)	+1.00 (0.07)
3.	1956-57 to 1964-65	+3.1 (0.50)	+0.20 (0.01)	+5.30 (0.42)	+1.30 (0.05)	+2.10 (0.09)	-1.30 (0.02)
4.	1964-65 to 1972-73	-13.88 (0.80)*	-9.99 (0.75)*	-17.36 (0.67)*	-10.46 (0.49)*	-14.98 (0.63)*	-0.20 (0.01)
5.	1964-65 to 1969-70	-1.96 (0.05)	-2.79 (0.04)	-4.19 (0.33)	+0.70 (0.00)	-1.35 (0.03)	+5.2 (0.32)

Note:- 1) Figures in brackets are  $r^2$ , upto 2 places after decimal.

2) \* shows significant at 5 per cent level.



PRODUCTION OF RABI JOWAR IN MAHARASHTRA & ITS AGRO CLIMATIC ZONES - 1956-57 TO 1972-73

- NASIK —————
- KOLHAPUR ————○———
- AURANGABAD ————●———
- DOONA —————
- NAGPUR ————x———
- MAHARASHTRA STATE ————

the post-hybrid seed period show a statistically insignificant downward trend.

The stagnancy in production during the last two decades has been due to stagnancy in both acreage under rabi jowar as well as its yield per hectare. Excepting a year of very severe drought, the total area under rabi jowar fluctuated between 3.2 and 4.0 million hectares (Table 4.2.2). The annual compound growth rate for the 17 years, excluding 1972-73, was 0.0 per cent (Table 4.2.2-A). During the pre-hybrid period, upto 1964-65, the annual compound growth rate was +2.9 per cent, statistically insignificant. During the subsequent period, the area under the crop registered a declining trend (growth rate -1.28 per cent excluding 1972-73 and -2.95 per cent including 1972-73; both statistically non-significant). This decline, though statistically insignificant, in acreage under rabi jowar during the period of new hybrid seed calls for explanation, and we shall turn to it when we examine the trend in rabi jowar acreage in the different agro-climatic zones of the State.

Like acreage, yield per hectare of rabi jowar also showed no significant trend during the two decades (Table 4.2.3). Of course, the annual compound growth rate for the entire period is -4.68 per cent, statistically significant, but this is mainly due to the severe drought conditions in the last three years (Table 4.2.3-A). Excluding these three years, we find the yield rate practically unchanged over the

**Table 4.2.2 : Area under Rabi Jowar in Maharashtra and Its Agro-Climatic Zones - 1956-57 to 1972-73 (Area in '00 Hectares)**

Sr. No.	Year	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra State
1.	1956-57	2037 85.77	16207 75.20	2445 96.87	9073 70.24	8 160.00	2044 80.92	31814 75.93
2.	1957-58	2011 84.67	16727 77.61	2323 92.04	9552 73.95	7 140.00	2087 82.62	32707 78.06
3.	1958-59	2606 109.73	17114 79.41	2605 103.21	9886 76.54	108 2160.00	2780 110.05	35099 83.77
4.	1959-60	2197 92.50	17261 80.09	2464 97.62	9774 75.67	10 200.00	2118 83.85	33824 80.73
5.	1960-61	2375 100.00	21551 100.00	2524 100.00	12916 100.00	5 100.00	2526 100.00	41897 100.00
6.	1961-62	2389 100.59	21228 98.50	2809 111.29	10963 84.88	38 760.00	2737 108.35	40164 95.86
7.	1962-63	2126 89.51	21224 98.48	2616 103.64	9827 76.08	12 240.00	2432 96.27	38237 91.26
8.	1963-64	2119 89.22	20889 96.93	2576 102.06	10989 85.08	20 400.00	2578 102.06	39171 93.50
9.	1964-65	1886 79.41	20307 94.23	2442 96.75	10431 80.76	15 300.00	2567 101.62	37648 89.86
10.	1965-66	1421 59.83	20162 93.55	2345 92.91	10336 80.02	4 80.00	2860 113.22	37128 88.61
11.	1966-67	1737 73.14	19734 91.57	2352 93.18	10365 80.25	14 280.00	2666 105.54	36868 87.99
12.	1967-68	1505 63.37	19820 91.97	2263 89.66	10220 79.13	8 160.00	2698 106.81	36514 87.15
13.	1968-69	1431 60.25	17479 81.10	2236 88.59	9573 74.12	8 160.00	2759 109.22	33486 79.92
14.	1969-70	1064 44.80	15772 73.18	2024 80.19	8891 68.84	9 180.00	2695 106.69	30455 72.69
15.	1970-71	1166 49.09	16671 77.35	2718 107.68	9434 73.04	12 240.00	2717 107.56	32718 78.09
16.	1971-72	1632 68.71	19385 89.95	2487 98.53	12499 96.77	10 200.00	2721 107.21	38734 92.45
17.	1972-73	1015 42.74	12642 58.66	2568 101.74	7045 54.54	4 80.00	2578 102.06	25852 61.70

**Table 4.2.2A : Annual Compound Growth Rates of Area under Rabi Jowar in Maharashtra - 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Nasik	Poona	Kolha-pur	Auran-gabad	Nagpur
1.	1956-57 to 1972-73	-0.85 (0.01)	-4.70 (0.70)*	-0.67 (0.05)	-0.30 (0.03)	-0.55 (0.04)	+1.40 (0.39)*
2.	1956-57 to 1971-72	0 (-)	+2.30 (0.22)	+0.10 (0.00)	- -	+0.20 (0.00)	- -
3.	1956-57 to 1964-65	+2.90 (0.05)	-0.76 (0.04)	+3.60 (0.68)*	+0.70 (0.16)	+1.80 (0.20)	+2.60 (0.34)
4.	1964-65 to 1972-73	-2.95 (0.36)	-5.21 (0.44)	-4.12 (0.55)*	+0.90 (0.07)	-2.17 (0.15)	-0.14 (0.01)
5.	1964-65 to 1971-72	-1.28 (0.13)	-4.10 (0.28)	-2.34 (0.37)	- -	+0.30 (0.01)	- -

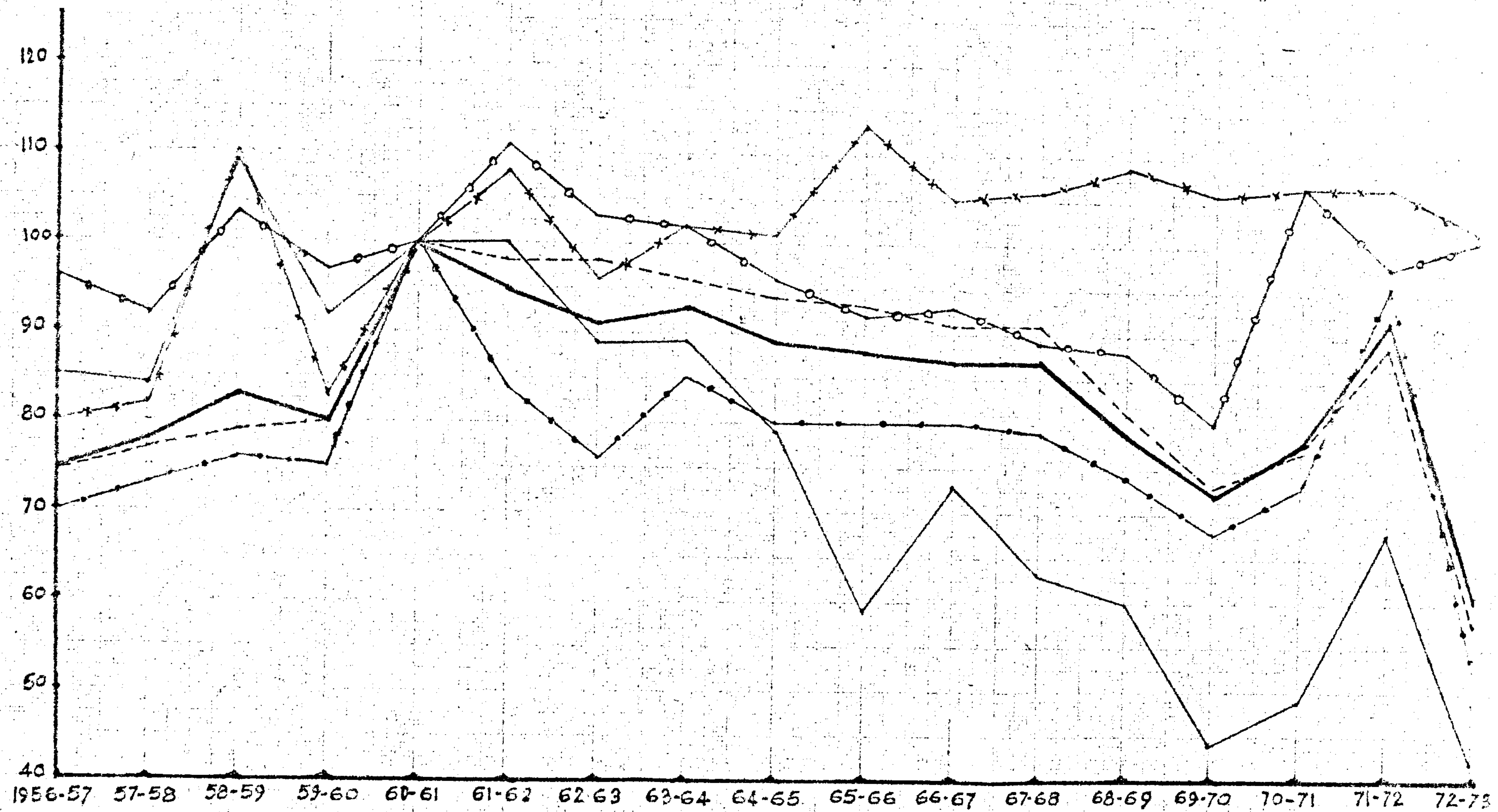
Note:- 1) Figures in brackets are  $r^2$ , upto 2 places after decimal.

2) \* shows significant at 5 per cent level.

3) The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.2.2.



• SCALE —  
 HORIZONTAL — 2 cms = 1 YEAR  
 VERTICAL — 2 cms = 10% CHANGE



AREA UNDER RABI JOWAR IN MAHARASHTRA & ITS AGRO CLIMATIC ZONES 1956-57 TO 1972-73

- NAGIK —————
- KOLHAPUR ————○———
- AURANGABAD ————●———
- POONA ————○———
- NAGPUR ————x———
- MAHARASHTRA STATE ————



**Table 4.2.3 : Per Hectare Yield Rate of Rabi Jowar in Maharashtra and Its Agro-Climatic Zones - 1956-57 to 1972-73 (Yield kgs./hectare)**

Sr. No.	Year	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra State
1.	1956-57	438 80.96	308 63.63	391 67.06	450 77.99	375 93.75	360 132.84	366 68.03
2.	1957-58	510 94.27	437 90.29	471 80.79	559 96.88	571 142.75	490 180.00	483 89.78
3.	1958-59	498 92.05	439 90.70	492 84.39	708 122.70	64 16.00	268 98.89	509 94.61
4.	1959-60	593 109.61	376 77.68	639 109.60	488 84.57	500 125.00	629 232.10	457 84.94
5.	1960-61	541 100.00	484 100.00	583 100.00	577 100.00	400 100.00	271 100.00	538 100.00
6.	1961-62	434 81.88	321 66.32	388 66.55	570 98.78	500 125.00	233 85.98	408 75.84
7.	1962-63	605 111.83	427 88.22	463 79.42	646 111.96	583 145.75	333 122.88	499 92.75
8.	1963-64	571 105.54	421 86.98	513 87.99	540 93.59	550 137.50	314 115.86	465 86.43
9.	1964-65	458 84.66	417 86.16	464 79.59	489 84.75	533 133.25	322 118.82	446 82.90
10.	1965-66	364 67.28	264 54.54	301* 51.63	447 77.47	250 62.50	231 85.24	329 61.15
11.	1966-67	515 95.19	412 85.12	384 65.87	613 106.24	500 125.00	337 124.35	486 90.33
12.	1967-68	525 97.04	415 85.74	471 80.79	578 100.17	375 93.75	266 98.15	468 86.99
13.	1968-69	593 109.61	326 67.35	479 82.16	537 93.07	375 93.75	434 160.15	417 77.51
14.	1969-70	508 93.90	382 78.92	436 74.78	496 85.96	444 111.00	416 153.50	426 79.18
15.	1970-71	395 73.01	163 33.68	294 50.43	271 46.97	167 41.75	154 56.82	212 39.40
16.	1971-72	296 54.71	195 40.29	215 36.68	231 40.03	500 125.00	237 87.45	215 39.96
17.	1972-73	284 52.49	95 19.62	116 19.90	152 26.34	250 62.50	364 134.32	147 27.32

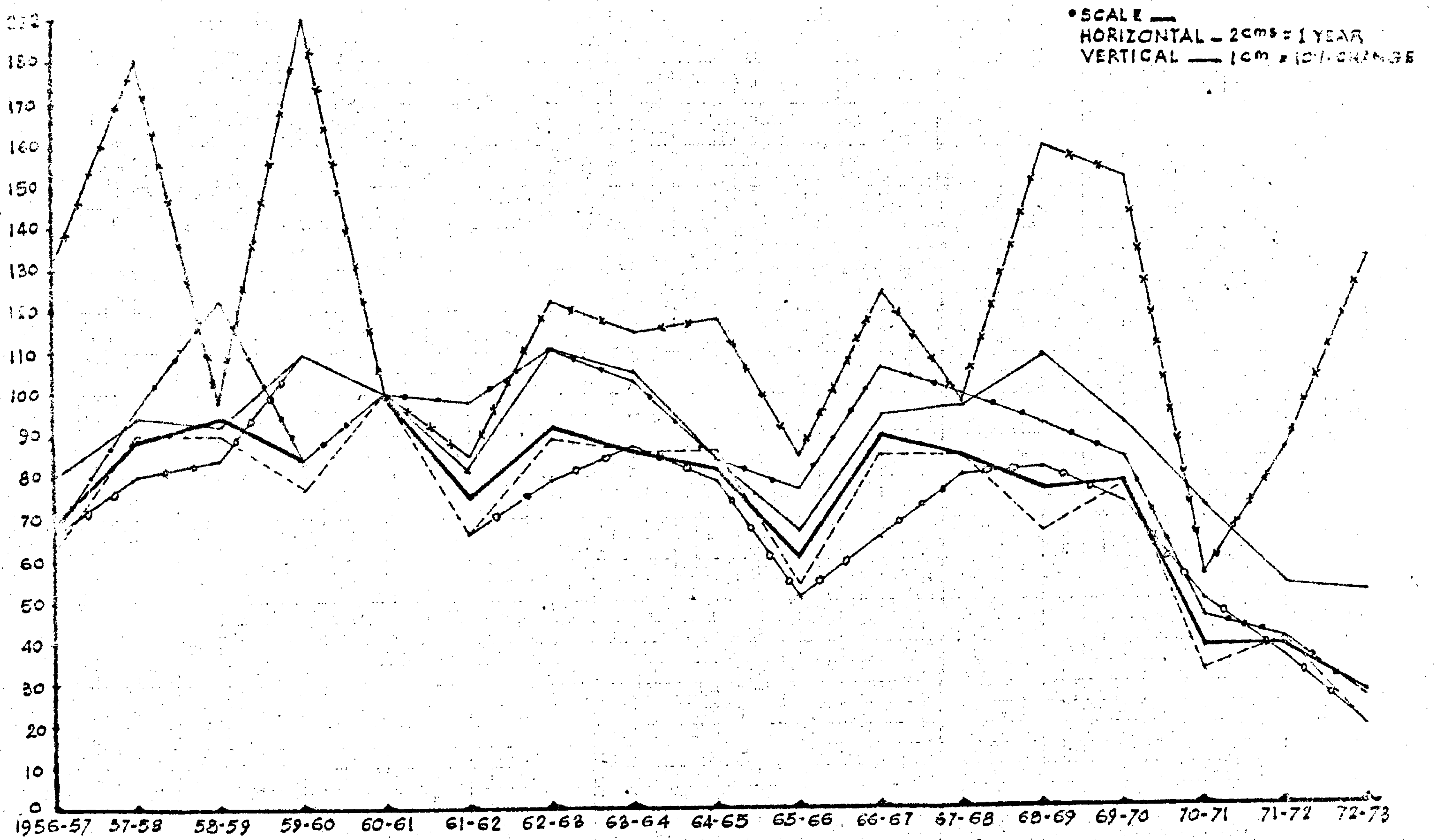
**Table 4.2.3A : Annual Compound Growth Rates of Yield Per Hectare of Rabi Jowar in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Nasik	Poona	Kolha-pur	Auran-gabad	Nagpur
1.	1956-57 to 1972-73	-4.68 (0.43)*	-2.23 (0.25)*	-5.31 (0.40)*	-5.07 (0.41)*	-5.03 (0.42)*	-2.26 (0.07)
2.	1956-57 to 1969-70	-0.49 (0.02)	+0.20 (0.01)	+0.55 (0.02)	-0.35 (0.01)	-0.28 (0.01)	-0.28 (0.00)
3.	1956-57 to 1964-65	+0.90 (0.04)	+0.90 (0.04)	+1.50 (0.07)	+0.60 (0.01)	+0.30 (0.00)	-3.82 (0.07)
4.	1964-65 to 1972-73	-11.69 (0.61)	-5.05 (0.29)	-13.58 (0.59)*	-11.24 (0.48)*	-13.10 (0.63)*	-0.90 (0.01)
5.	1964-65 to 1969-70	+1.30 (0.03)	+5.70 (0.39)	+0.60 (0.00)	+3.70 (0.14)	+1.60 (0.06)	+5.20 (0.36)

Note: 1) Figures in brackets are  $r^2$ , upto 2 places after decimal.

2) \* shows significant at 5 per cent level.

3) The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.2.3.



YIELD RATE OF RABI JOWAR IN MAHARASHTRA & ITS AGRO CLIMATIC ZONES - 1956-57 TO 1972-73

- NASIK \_\_\_\_\_
- KOLHAPUR \_\_\_\_\_
- AURANGABAD \_\_\_\_\_
- POONA \_\_\_\_\_
- NAGPUR \_\_\_\_\_
- MAHARASHTRA STATE \_\_\_\_\_

entire period (growth rate  $-0.49$  and statistically insignificant). During the period of hybrid seeds (excluding drought years) growth rate was  $+1.3$  per cent, but statistically insignificant.

On the whole, therefore, we find complete stagnancy in production, area and yield rate of rabi jowar in the State during the last two decades. Since the introduction of hybrid jowar seed, a slow but sure decline in area under rabi jowar is the only significant development noticed.

Rabi jowar is mainly grown in 5 agro-climatic zones of the State, of which the Poona and Aurangabad zones account for about 80 per cent of the total area. Nasik zone for about 6 per cent and the rest is equally divided between Kolhapur and Nagpur zones. During the entire period, both Poona and Aurangabad zones have shown stagnancy in production (growth rate for Poona was  $-0.14$  per cent and Aurangabad  $-0.44$  per cent, excluding the drought years), in yield rate (for Poona  $+0.55$  per cent and Aurangabad  $-0.28$  per cent), as well as in area under the crop (for Poona  $0.10$  per cent and Aurangabad  $0.20$  per cent).

The trend was slightly different in these two zones during the later years of this period - the years of hybrid jowar seed. Total production in the years since 1964-65 (excluding the years of severe drought) recorded a declining trend in both Poona and Aurangabad zones (growth rate in Poona was  $-4.19$  per cent and in Aurangabad  $-1.35$  per cent,

both statistically insignificant). The area under rabi jowar in Poona showed a declining rate of growth of -2.34 per cent, statistically insignificant, while Aurangabad recorded a small and insignificant upward trend (+0.30 per cent). Yield rate in Poona showed a growth rate of +0.60 per cent, in Aurangabad it was +1.60 per cent. This increase was partly because the yield rate in the year 1965-66 was low on account of adverse seasonal conditions. Compared to the pre-1964-65 period, yield rate of the later years does not show a significant upward trend.

Thus the two zones accounting for the bulk of production and area under rabi jowar in the State showed almost stagnancy on all fronts. The other two rabi jowar growing zones in Western Maharashtra, Nasik and Kolhapur, showed similar trend in the later half of the period. Production in both Nasik and Kolhapur zones during the entire period (excluding the drought years) showed a declining trend. In Nasik the growth rate was -4.46 per cent, statistically significant; and in Kolhapur -1.46 per cent, statistically insignificant. During the same period area under rabi jowar in Nasik zone showed an upward trend though statistically insignificant (growth rate +2.30 per cent), and yield rate remained unchanged (growth rate +0.20 per cent). In Kolhapur zone, during the entire period, both area under rabi jowar and yield rate remained stagnant, (growth rate of area was -0.30 per cent and yield rate -0.35 per cent excluding drought

years). During the post-hybrid seed period in Kolhapur zone area under rabi jowar registered a small upward trend (growth rate +0.90 per cent). Similarly production and yield rate showed upward trend (growth rate of production +0.70 and yield rate +3.70 excluding the drought years). In Nasik zone, during the post-hybrid seed period, while yield rate increased (growth rate +5.7 per cent excluding drought years 1970-71 to 1972-73), area and production showed a declining trend (growth rate of area -4.10 per cent excluding 1972-73 and production -2.79 excluding 1970-71 to 1972-73, the drought years). This decline in the area, in Nasik, under rabi jowar was development of the post-hybrid seed period; excluding the drought year of 1972-73, the growth rate of area since 1964-65 was -4.10 per cent and inclusive of 1972-73 it was -5.21 per cent.

The significant declining trend in the area under rabi jowar in the Poona and Nasik zones during the years before the last two or three years of drought seem to largely account for the slight downward trend in the total rabi jowar area in the State as noted earlier. The reason for this decline appears to be the diversion of some land from rabi jowar to wheat during the later part of the 1960s. In fact, from 1965-66 to 1971-72 area under wheat in Poona, which was equivalent to about 52 per cent of the total rabi jowar area, increased continuously from 84 thousand to 1.26 lakh hectares - a total increase of over 27 per cent in a matter of 4 years. Similarly, area under wheat in Nasik, Kolhapur and Aurangabad

divisions increased by 8, 5 and 3 per cents respectively, during the same period. This increase in area was also accompanied by increase in yield per hectare of wheat during the same period. In Poona it increased from a low yield of 426 kgs. in 1965-66 to 647 kgs. in 1972-73 - a level far above the highest reached any time in the past. (The highest recorded yield during the years 1956-57 to 1964-65 was 491 kgs. per hectare.) This very significant rise was due to the adoption of high yielding varieties of wheat seed. Rabi jowar did not register any comparable increase in yield rate during the same period, despite the fact that it had hybrid variety introduced simultaneously. This not only throws light on the poor efficiency of hybrid jowar in the rabi season, but provides indirect evidence about the poor extension of that variety. This may be borne in mind when the performance of hybrid rabi jowar is examined in a later section.

The reason why under such circumstances there was no greater transfer of land from rabi jowar to wheat than recorded, is that both rabi jowar and wheat are generally not grown in the same parts of the State. Rabi jowar is grown extensively in Poona zone, while comparatively little wheat is grown there. In Aurangabad zone where rabi jowar is mostly grown in all the districts except Nanded, wheat is predominantly grown only in Aurangabad district. In Nasik zone, rabi jowar is mainly grown in Dhulia district whereas wheat is mainly grown in Nasik district. It is only in such zones or districts in which both rabi jowar and wheat are

grown simultaneously that the area under wheat increased at the cost of area under rabi jowar. In the other zones or districts growing rabi jowar, wheat was not an important crop, and transfer of area was not technically and economically feasible.

In the light of the stagnation in production, area and rate of yield of rabi jowar during the last decade and half, it is necessary to enquire into the performance of the factors that are considered to be crucial to the increase in yield rate and production, namely, extension of irrigation and use of the new hybrid seed and chemical fertilizers.

Of the two factors mentioned above, about 7.5 per cent of the total area under rabi jowar in the State is irrigated as per official statistics and there is no significant change in it during the post-hybrid seed period (Table 4.2.4).

The more interesting and relevant development during the last decade has been the hybrid jowar seed, which was to use significant quantities of chemical fertilizers to give improved yield. As mentioned earlier, separate cropwise data on application of fertilizers are not available, we shall examine only the available data on extension of use of the hybrid jowar seed.

Like in case of kharif jowar, there are two different estimates of area under hybrid rabi jowar.

While extension of hybrid jowar seed began in 1966-67,



Table 4.2.4 : Area under Irrigated Rabi Jowar in Maharashtra, 1956-57 to 1971-72

(Area in '00 hectares)				
Sr. No.	Year	Gross irrigated cropped area in Maharashtra	Total area under rabi jowar	Area under irrigated rabi jowar
1.	1956-57	10802	31814	2227
2.	1957-58	10842	32707	2169
3.	1958-59	11023	35099	2271
4.	1959-60	11717	33824	2536
5.	1960-61	12182	41897	2609
6.	1961-62	12336	40164	2729
7.	1962-63	12782	38237	2827
8.	1963-64	13130	39171	3019
9.	1964-65	13639	37648	3023
10.	1965-66	13880	37128	3059
11.	1966-67	14133	36868	2366
12.	1967-68	14762	36514	2840
13.	1968-69	15568	33486	2780
14.	1969-70	16232	30455	2675
15.	1970-71	15703	32718	2395
16.	1971-72	16216	38734	2819

data on estimated area under hybrid jowar are available from 1968-69. Table 4.2.5 presents the estimate of the percentage of the total area under rabi jowar growing the hybrid variety, provided by the Zilla Parishad and estimated by the Statistician, Department of Agriculture side by side. The Table shows that the area under hybrid rabi jowar was never more than 0.80 per cent in the State. However, according to the estimate of the Zilla Parishads the highest spread of hybrid jowar was in 1968-69 when about 0.79 per cent of the total rabi jowar area had come under this variety. In the other three years till 1971-72 it was much lower, between 0.10 and 0.43 per cent. This was practically negligible and it did show a declining trend. The Statistician's sample survey showed that, even these small estimates of the Zilla Parishads were somewhat over-estimates. The highest percentage was put at about 0.57 per cent and the lower level fluctuated between 0.09 and 0.43 per cent.

The Statistician's survey shows that the area under hybrid jowar was never of any significance in the past and there has been, if anything, a declining trend in area under the crop. (Virtually there was no area under these varieties in the year 1971-72.) This is of course reflected in the zonal figures.

It was expected that the introduction of hybrid varieties of jowar in rabi season will make a visible difference in the average per hectare yield rate of rabi jowar as

**Table 4.2.5 : Percentage of Rabi Jowar Area under Hybrid Variety as Estimated by (a) The Zilla Parishads and (b) The Statistician to the Department of Agriculture, Maharashtra, 1968-69 to 1971-72**

Sr. No.	Zone	1968-69		1969-70		1970-71		1971-72	
		As per Z.Ps.	As per Statistician	As per Z.Ps.	As per Statistician	As per Z.Ps.	As per Statistician	As per Z.Ps.	As per Statistician
1.	Nasik	0.19	0.21	0.28	0.27	1.38	0.95	0.53	0.48
2.	Poona	0.96	0.72	0.54	0.50	0.34	0.25	0.16	0.14
3.	Kolhapur	-	-	-	-	-	-	-	-
4.	Aurangabad	0.99	0.66	0.47	0.30	0.32	0.20	-	-
5.	Nagpur	-	-	-	-	-	-	-	-
6.	State	0.79	0.57	0.43	0.35	0.31	0.22	0.10	0.09

well as of total production, in view of the fact that its expected yield was much higher than that of the local varieties. Indeed, it may be proper to expect an increase in area under rabi jowar due to the hybrid seed. In fact, as we saw, area under rabi jowar remained stagnant in all the zones. Nor did production show any significant increasing trend in any of the zones, as noted earlier. Could it then be that the yield performance of hybrid jowar in rabi season was not as significant as was expected? It is necessary to examine the data on yield rate of hybrid and all rabi jowar for the purpose.

The Statistician to the Director of Agriculture of the State had conducted a random sample crop-cutting experiments to estimate the yield rate of hybrid rabi jowar during the four years since 1968-69. These data for each of the years and zones are given in Table 4.2.6. The data show that by and large the yield rates of hybrid jowar were quite high compared to the traditional performance of local jowar in the State. The average yield rate of hybrid rabi jowar over the four years 1968-72 was estimated at 1948 kgs./hectare. This was about more than 4 times as high as the average yield of rabi jowar in the State and about 2 times as that of irrigated rabi jowar during the 12 years preceding 1968-69 (454 kgs./hectare, and 1046 kgs./hectare under irrigation). The same phenomenon was also recorded for the various rabi jowar zones as will be seen from the Table.

**Table 4.2.6 : Average Yield of Rabi Jowar and of Hybrid Rabi Jowar in Maharashtra, 1956-57 to 1971-72**

(Yield kgs./hectare)

Sr. No.	Year	Nasik		Poona		Aurangabad		Maharashtra	
		Rabi jowar	Hybrid jowar	Rabi jowar	Hybrid jowar	Rabi jowar	Hybrid jowar	Rabi jowar	Hybrid jowar
1.	1956-57	438		308		450		366	
2.	1957-58	510		437		559		483	
3.	1958-59	498		439		708		509	
4.	1959-60	593		376		488		457	
5.	1960-61	541		484		577		538	
6.	1961-62	434		321		570		408	
7.	1962-63	605		427		646		499	
8.	1963-64	571		421		540		465	
9.	1964-65	458		417		489		446	
10.	1965-66	364		264		447		329	
11.	1966-67	515		412		613		486	
12.	1967-68	525		415		578		468	
Average		504		393		555		454	
13.	1968-69	593	1915.5	326	2217.4	537	1656.6	417	2025.9
14.	1969-70	508	1756.0	382	2434.1	496	1898.6	426	2285.5
15.	1970-71	395	1466.0	163	1902.6	271	1297.7	212	1676.9
16.	1971-72	296	1790.6	195	1810.8	-	N.A.	215	1806.3
Average		448	1732.1	266	2091.2	434	1617.3	317	1948.4

With such high rate of yield it is not surprising that the estimated total production of hybrid rabi jowar in the State (multiplying the estimated area by the estimated yield rate) came to account for a much higher proportion of the total rabi jowar production than the hybrid area of total rabi jowar area. These percentages, zonewise, are given in Table 4.2.7. The Table shows that during these four years production of hybrid rabi jowar accounted for between 0.76 and 2.79 per cent of the total production of rabi jowar, while as we have seen even in the best year the area under hybrid rabi jowar was not more than 0.57 per cent of the total area.

Now we propose to examine the data relating to the yield rate of hybrid rabi jowar in (i) the different agricultural experiment stations in the State, (ii) the trials conducted on farmer's fields by the agricultural extension agency, and (iii) the sample farmers in a selected village in the Marathwada zone of the State surveyed by us. This might help us to form a judgement about the reliability of the Statistician's estimated yield rate of hybrid rabi jowar.

Experiments on hybrid jowar in the State, in rabi season have been conducted at Parbhani and Mohol (district Sholapur) stations only. Since 1966-67 the experiments have been conducted for different types of treatments, namely, seed rate, plant population, spacing, application N, P and K etc. We have collected the results of all the experiments on hybrid rabi jowar from both the experiment stations. For

**Table 4.2.7 : Estimated Total Production of Hybrid Rabi Jowar as a Percentage of the Total Production of All Rabi Jowar in Maharashtra, 1968-69 to 1971-72**

Sr. No.	Zone	Years				Average
		1968-69	1969-70	1970-71	1971-72	
1.	Nasik	0.67	0.93	3.54	2.92	1.76
2.	Poona	4.88	3.23	3.00	1.32	3.31
3.	Aurangabad	2.06	1.15	0.98	-	1.50
	State	2.79	1.92	1.78	0.76	1.96

purposes of analysis we have noted experiment results relating to the following standard treatments for all the different experiments since 1966-67. The standard treatment referred to is as follows :

1. Time of sowing	3rd week of September to 1st week of October
2. Seed rate	7.5 kgs./hectare
3. Plant population	1.44 lakh/hectare
4. Spacing between rows	45 cms.
5. Farmyard manure	10-12 cart-loads/hectare
6. Fertilizers :	
Nitrogen	50 kgs./hectare
Phosphoric acid	25 kgs./hectare
Potash	25 kgs./hectare
7. Plant protection	As and when required.

The agricultural experiment stations at Parbhani (Aurangabad zone) and Mohol (Poona zone) are the oldest and most important stations for research on rabi jowar in the State. At Parbhani station during 7 years, 1966-73, 9 different experiments under unirrigated condition and 4 experiments under irrigated condition were carried out on hybrid jowar. The average yield rate, under unirrigated condition, of all these experiments (for standard treatment) was 2437 kgs./hectare and under irrigation it was 2079 kgs./hectare, less than dry. But the variation around this mean was quite large. It varied from 1377 kgs. in one experiment in 1970-71 to 5823 kgs. in another in 1969-70 (under dry condition) and from 496 kgs. in one experiment in 1971-72 to 4694 kgs. in another



in 1969-70 (under irrigation). The coefficient of variation was 70.74 per cent (under dry) and 77.29 per cent (under irrigation). The average yield of hybrid rabi jowar for the three years 1968-69 to 1970-71 in Aurangabad zone estimated by the Statistician was 1617 kgs. per hectare and the yield ranged between 1296 kgs. to 1893 kgs./hectare.

At Mohol experiment station in the seven years, 1968-69 to 1972-73, only four experiments were carried out on hybrid rabi jowar under dry condition. The average yield rate of all these experiments was 2228 kgs./hectare. But the variation round this mean was large. It varied from 1486 kgs. in one experiment in 1970-71 to 2981 kgs. in another in 1969-70. The coefficient of variation was 32.58 per cent. The average yield of hybrid jowar for four years, 1968-69 to 1971-72, in Poona zone estimated by the Statistician was 2091 kgs./hectare and the yield ranged between 1810 to 2434 kgs./hectare. These data are tabulated in Table 4.2.8. This suggests that the Statistician's estimated yield rate of hybrid rabi jowar in different zones cannot be considered as over estimates judged by these performance standard in the experiment stations in the zones.

Similarly, it may be useful to compare the Statistician's estimates with the average yield rate recorded in fertiliser and varietal trials (FVT) in cultivators' fields, conducted by the Statistician over six years, 1966-67 to 1971-72. The relevant data are presented in the above Table

**Table 4.2.8 : Estimated Average Yield Rates of Hybrid Rabi Jowar from Different Sources**

Sr. No.	Zone	District/ Research Station	Divisionwise estimated yield by the Statistician			Yield at research station			Districtwise yield under F.V.T.		
			Average (4)	Minimum (5)	Maximum (6)	Average (7)	Minimum (8)	Maximum (9)	Average (10)	Minimum (11)	Maximum (12)
1.	Bombay	-	-	-	-	-	-	-	-	-	-
2.	Nasik	Dhulia	1732	1466	1915	-	-	-	<u>943</u>	<u>770</u>	<u>1110</u>
3.	Poona	Poona	2091	1810	2434	-	-	-	<u>1835</u>	<u>1650</u>	<u>2020</u>
		Poona	-	-	-	-	-	-	816	450	1330
		Ahmednagar	-	-	-	-	-	-	<u>2050</u>	<u>1690</u>	<u>2610</u>
		Mohol	-	-	-	2228	1486	2981	-	-	-
4.	Kolhapur	Sangli	-	-	-	-	-	-	706	680	750
5.	Aurangabad	-	1617	1296	1898	-	-	-	-	-	-
		Parbhani	-	-	-	<u>2079</u>	<u>196</u>	<u>4694</u>	<u>1120</u>	<u>910</u>	<u>1450</u>
		Parbhani	-	-	-	<u>2437</u>	<u>1377</u>	<u>5823</u>	<u>773</u>	<u>560</u>	<u>1250</u>
		Aurangabad	-	-	-	-	-	-	<u>1810</u>	<u>1480</u>	<u>2130</u>
		Aurangabad	-	-	-	-	-	-	920	470	1490
		Nanded	-	-	-	-	-	-	<u>1410</u>	<u>1180</u>	<u>1570</u>
Osmanabad	-	-	-	-	-	-	<u>1916</u>	<u>1690</u>	<u>2150</u>		
6.	Amravati	-	-	-	-	-	-	-	-	-	
7.	Nagpur	Bhandara	-	-	-	-	-	-	622	520	830
State			1948	1676	2285	-	-	-	-	-	-

(Underlined figures indicate the yield under irrigation.)

4.2.8, in columns 10 to 12. The data show that the average yield of hybrid rabi jowar recorded in FVTs in each zone, under dry condition, was about 50 per cent less than the yield rate estimated by the Statistician in those zones, but yield rate recorded in FVTs under irrigation in each zone was somewhat comparable to the yield rate estimated by the Statistician in those zones, excepting in Nasik division and Parbhani district in Aurangabad zone. This clearly indicates that the yield estimates by the Statistician relate to irrigated hybrid rabi jowar.

The third set of data with which we propose to compare the Statistician's estimates, are the data collected by us in one village in Aurangabad district. We made a purposive selection of one village, Kharpudi, in Aurangabad district, a district which accounts for about 34 per cent of the total area under rabi jowar in Aurangabad zone. The village was considered by the agricultural officers concerned as one of the developed village with a well developed hybrid programme. We selected at random 20 cultivators growing hybrid rabi jowar in 1974-75 and collected from them information about their area and production of hybrid jowar for that year and the previous three years. From this survey data it was found that the average yield of hybrid jowar in the village in 1974-75 was 762 kgs./hectare under dry condition and 1600 kgs./hectare under irrigation. The highest average yield of hybrid jowar of these 20 cultivators were recorded as 860 kgs.

under dry and 1800 kgs./hectare under irrigation, in the year 1971-72. The Statistician's estimates of the average yield of hybrid rabi jowar in Aurangabad district are given below side by side our estimate for the particular village surveyed.

Year	Yield rate (kgs./hectare)		
	Statistician's estimate	Village surveyed	
		Dry	Irrigated
1968-69	1835	N.A.	N.A.
1969-70	1862	N.A.	N.A.
1970-71	1297	N.A.	N.A.
1971-72	N.A.	860	1800
1972-73	N.A.	762	1500
1973-74	N.A.	755	1550
1974-75	N.A.	762	1600

The village was purposely chosen as a developed village particularly in terms of hybrid rabi jowar, one might expect the performance of yield rate in this village to be better than the average and not poorer than the average for the district. There are no common years for which yield data for both the sources are available; yet one finds that these data are not at all comparable under unirrigated condition. Estimated yield rate by the Statistician is about two times more than the yield obtained by farmers under dry condition. However, one finds that the data are comparable under irrigated condition.

The preceding discussion shows that the yield estimates of the Statistician relate to irrigated hybrid rabi jowar and there is no strong direct evidence to suspect serious over-estimation of these yield rates. The officially estimated area under hybrid rabi jowar is so small that it does not appear to be over-estimated.

If the farmers had obtained such higher yield from hybrid jowar under either irrigated or unirrigated condition in the rabi season, why was the adoption of this variety of seed as tardy and poor as shown above? The answer to this question is sought in what follows.

As we have seen, the average yield of hybrid rabi jowar, as estimated by the Statistician, was much higher than the yield rate of local jowar. The estimated yield rate of hybrid jowar, for the State as a whole, ranged from 1676 kgs./hectare to 2285 kgs./hectare during the period 1968-69 to 1971-72, but the highest yield rate of local jowar during the previous years was recorded 538 kgs./hectare in 1960-61 for the State as a whole and 1082 kgs./hectare under irrigated condition in the same year. The same picture emerges for the individual crop zones of the State. The Statistician's estimates show that the average yield of local jowar was almost always lower than the average yield of hybrid jowar in each of these zones as can be seen from the Table 4.2.6.

It may not, however, be considered surprising or very impressive that the average estimated yield rate of hybrid

rabi jowar was much higher than that of local rabi jowar. After all, hybrid jowar, unlike local jowar is grown in well-manured and fertilized fields. Comparison of yield rates on hybrid and local jowar plots made by the Statistician or the comparison of the yield rates for our sample of 20 farmers in a village of Aurangabad district is subject to this limitation. The same difficulty arises with the yield data of hybrid and local jowar available from the agronomic experiments in the agricultural research stations of the State, because the rate of fertilizer (N, P, K) input was generally higher in experiments with hybrid than with local jowar.

The only set of data that serves our purpose relate to the Fertilizer and Varietal Trials (FVT) conducted by the Department of Agriculture on the farmers' fields during the period from 1966-67 to 1971-72. The treatments for these trials, with local and hybrid seed, were almost similar. The summary of the results in the different districts is given in Table 4.2.9. It appears that while the mean yield rates of hybrid rabi jowar were higher than those of local jowar in all the districts, the difference was rather small (in case of Poona the average yield rate for local jowar was higher than for hybrid). A statistical test of significance for the two means - a 't' test - showed that the means were not significantly different in all the districts, both under irrigated and unirrigated conditions. It means that the yield performance of hybrid in experiments on farmers fields were not

**Table 4.2.9 : Average Yield of Irrigated Rabi Jowar under Fertilizer and Varietal Trials on Cultivator's Fields in Different Districts of Maharashtra, 1966-67 to 1971-72 (with 67 kgs. Nitrogen and 44 kgs. Phosphoric Acid)**

Sr. No.	District	(Yield kgs./hectare)							
		Average yield of hybrid	Standard deviation	Coefficient of variation	Average yield of Local jowar	Standard deviation	Coefficient of variation	'F' value	't' value
1.	Parbhani	1120 (4)	223	19.91	927 (4)	74	7.98	9.11	1.42
2.	Poona	1835 (2)	185	10.08	1850 (2)	80	4.32	5.34	0.07
3.	Ahmednagar	2050 (3)	401	19.56	1346 (3)	194	14.41	4.31	2.24
4.	Aurangabad	1810 (3)	265	14.64	1520 (3)	180	11.84	2.18	1.28
5.	Nanded	1410 (3)	167	11.84	1236 (3)	267	21.60	1.00	1.05
6.	Osmanabad	1916 (3)	187	9.75	1560 (3)	178	11.41	1.10	1.95
7.	Dhulia	943 (3)	139	14.74	736 (3)	80	10.86	3.00	1.84

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 5.91**
Between centres	3009518	6	501586	Coefficient of variation = 44.38 %
Within centres	1017066	12	84755	Within centres = 18.24 %
Total	4026584	18	223699	Total = 29.65 %

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 10.50**
Between centres	2204065	6	367344	Coefficient of variation = 46.50 %
Within centres	419517	12	34959	Within centres = 14.35 %
Total	2623582	18	145754	Total = 29.24 %

**Table 4.2.9A : Average Yield of Dry Rabi Jowar under Fertilizer and Varietal Trials on Cultivator's Fields in Different Districts of Maharashtra, 1966-67 to 1971-72 (with 44 kgs. Nitrogen and 22 kgs. Phosphoric Acid)**

(Yield kgs./hectare)

Sr. District No.	Average yield of hybrid	Standard deviation	Coefficient of variation	Average yield of local jowar	Standard deviation	Coefficient of variation	'F' value	't' value
1. Parbhani	773 (6)	242	31.30	735 (6)	203	21.61	1.41	0.27
2. Poona	816 (5)	311	38.11	826 (5)	215	26.06	2.09	0.05
3. Aurangabad	920 (3)	425	46.19	993 (3)	224	22.55	3.61	0.21
4. Sangli	706 (3)	31	4.39	710 (2)	320	45.07	-	-
5. Bhandara	622 (5)	148	23.79	796 (3)	151	18.96	2.07	1.61

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 0.31
Between centres	126601	4	31650	Coefficient of variation = 22.84 %
Within centres	1207673	12	100639	Within centres = 40.69 %
Total	1334274	16	83392	Total = 36.97 %

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 0.50
Between centres	137570	4	34392	Coefficient of variation = 22.56 %
Within centres	749655	11	68150	Within centres = 31.82 %
Total	887225	15	59148	Total = 29.63 %



uniformly superior to that of local rabi jowar.

Now it is necessary to examine not only the difference between the mean yield rates of hybrid and local jowar, but also the available evidence about the fluctuations in the yield rates from region to region. Three sets of data are available to us for the purpose: (a) The Statistician's estimates of yields for hybrid and local jowar in different districts during the four years since 1968-69, (b) the results of the F.V. Trials on hybrid and local varieties in different districts, (c) the results of agronomic experiments on hybrid and local varieties in the different experiment stations in the State. We will now examine these data one by one.

The Statistician's estimates of average yield rates of the two varieties are available for four years, 1968-69 to 1971-72, for five districts (data are given in Table 4.2.10). An 'F' test for the difference between the variances of the two varieties was not significant for four of the five districts. However it was significant when the data for the five districts were considered together, showing variance of hybrid jowar to be significantly larger. The coefficient of variation of the yield rate of hybrid jowar was smaller than that of local in two of the five districts and greater in the three districts. But the coefficient of variation with aggregate data for hybrid was slightly higher (18.63 per cent) than that for local jowar (17.59 per cent). Thus, over all it appeared that not only the absolute variance of the yield rate

**Table 4.2.10 : Per Hectare Estimated Yield of Rabi Jowar in Different Districts by the Statistician, Department of Agriculture, Maharashtra, 1968-69 to 1971-72**

Sr. District No.	(Yield kgs./hectare)						
	Average yield of Hybrid	Standard deviation	Coefficient of variation	Average yield of Local Jowar	Standard deviation	Coefficient of variation	F value
1. Dhulia	1861	92	4.94	1091	123	11.27	1.78
2. Poona	2104	101	4.80	1480	231	15.60	5.35
3. Sholapur	2237	419	18.73	1244	77	6.18	29.38**
4. Aurangabad	1664	260	15.62	1050	90	8.57	8.20
5. Bhir	1716	300	17.48	1156	166	14.35	3.26

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 2.02
Between centres	836456	4	209114	Coefficient of variation Between centres = 23.65 % Within centres = 16.66 % Total = 18.63 %
Within centres	1242212	12	103517	
Total	2078668	16	129916	

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 3.09
Between centres	363789	4	90947	Coefficient of variation Between centres = 25.10 % Within centres = 14.34 % Total = 17.59 %
Within centres	352954	12	29412	
Total	716743	16	44796	

of hybrid jowar was higher than that of local jowar, but its percentage variation around its mean was also higher than that of local jowar.

The second set of data relate to F.V. Trials on the farmers' fields, conducted over six years from 1966-67 to 1971-72, in seven districts (with irrigation) and five districts (with dry condition). Data are given in Table 4.2.9. Here again the 'F' test showed the variances of the yield rates of hybrid and local jowar to be not significantly different in any district. Test of significance with pooled data showed similar results under both irrigated and unirrigated conditions. The comparison of the coefficients of variation, however, showed a different picture: in five out of seven districts (irrigated) and in four out of five districts (unirrigated) the coefficient of variation was higher for hybrid rabi jowar. Taking all the data together, the coefficient of variation of hybrid (irrigated) was as large as or slightly larger than that of local jowar (29.65 per cent and 29.24 per cent respectively), while under unirrigated condition, coefficient of variation of hybrid was larger (36.97 per cent) than that of local jowar (28.65 per cent). Thus both Statistician's survey and F.V. Trials showed more fluctuations of hybrid jowar yield than the year of local jowar.

The experimental data from only two agricultural research stations (unirrigated) and from only one station

(irrigated) were available (Table 4.2.11). An 'F' test, in both the conditions was significant showing variance of hybrid jowar to be significantly larger. At Parbhani research station the coefficient of variation of hybrid was more than local jowar (for irrigation 77.29 per cent of hybrid and 35.83 per cent of local and for dry 70.74 per cent of hybrid and 52.50 per cent of local). At Mohol research station coefficient of variation of yield of local jowar was more (51.51 per cent) than the hybrid (32.58 per cent).

The examination of the three sets of data for year to year variation in the yield rates of hybrid and local jowar gives an almost unequivocal answer. In the first place the variance of yield rate of hybrid jowar was not lower than that of local jowar, and when the district data were taken together, the variance of hybrid jowar rate turned out to be significantly higher in case of Statistician's estimates. Secondly, the coefficient of variation of the yield rates of the two varieties showed that in most cases the coefficient was larger for hybrid than for local jowar. One is, therefore, led to the conclusion that on the basis of available statistical evidence, hybrid has not been able to show consistently lesser year to year fluctuation in yield rate than local jowar.

Since the seasonal fluctuation in yield rate of hybrid rabi jowar is almost as large as, or larger than of local jowar, it is natural that cultivators would be reluctant to

**Table 4.2.11 : Average Yield of Irrigated Rabi Jowar at Parbhani Research Station, Maharashtra (With Standard Cultural Practices)**

(Yield kgs./hectare)								
Sr. No.	Research Station	Average Yield of Hybrid	Standard deviation	Coefficient of variation	Average Yield of Local Jowar	Standard deviation	Coefficient of variation	'F' Value
1.	Parbhani	2079 (4)	1607	77.29	2143 (9)	768	35.83	5.72*

**Table 4.2.11-A : Average Yield of Dry Rabi Jowar at Parbhani and Mohol Research Stations, Maharashtra (With Standard Cultural Practices)**

(Yield kgs./hectare)								
Sr. No.	Research Station	Average Yield of Hybrid	Standard deviation	Coefficient of variation	Average Yield of Local Jowar	Standard deviation	Coefficient of variation	'F' Value
1.	Parbhani	2437 (9)	1724	70.74	960 (19)	504	52.50	12.48*
2.	Mohol	2228 (4)	726	32.58	658 (24)	339	51.51	5.85*

Note : Figures in brackets indicate number of observations on which average is based.

\* shows significant at 5 per cent level.

put in the much larger cost that production of hybrid jowar entails. The high variation in yield rate of hybrid between regions, subject to same treatment aggravates the problem. Given the estimated mean yield and coefficient of variation in yield between years as well as the estimated cost of production of hybrid jowar, in case of the F.V.Ts. we find that there is an 8 per cent (under irrigation) probability that a cultivator will not be able to recover his cost of production during a year. Similarly if we consider the coefficient of variation between districts, it appears that in about 35 per cent of the districts the cultivators may not be able to recover the cost of production of hybrid jowar. It is not, therefore, surprising that cultivators by and large reluctant to use hybrid jowar seed in the rabi season even under irrigated condition.

This high variability in its turn would lead to a lesser use of fertilizers and insecticides than would have been otherwise justified and consequently to lower yield. The average input of fertilizers by the 20 sample farmers in our surveyed village was low, by recommended standards 33 per cent under irrigation and 29 per cent under dry condition. Similarly the application of insecticides and pesticides was also inadequate. The reasons for inadequate application of insecticides and pesticides are the same as those discussed under kharif jowar.

One more reason given by the farmers under study is as follows :

Hybrid rabi jowar is a short duration crop of 120 days. Its panicle (earhead) emerges between 45 and 52 days after sowing. When the crop is sown early in the month of September, as per the recommendation of the extension department, the period of emergence of the panicle comes some time between October 15 and 25. This being a very hot and dry period, flowers on the panicle get scorched which ultimately causes poor grain setting. Thereafter watching and protecting the crop from attack by birds becomes more laborious and expensive as there is no other crop in the vicinity during this period for the birds to feed on and hence damage is comparatively more.

Our survey of 20 farmers in one village shows that the average net income of a farmer from one acre of hybrid jowar was less by about 25 per cent under irrigation and 40 per cent under dry condition than his average net income from one acre of local jowar grown by him. The data are presented in Table 4.2.12.

All the inputs including the home supplied as well as the outputs, in the above Table have been valued at market prices current during the year of survey (1974-75). The net profit (gross value of produce minus estimated value of all inputs) for hybrid and local jowar for the 20 farmers is reproduced below.

**Table 4.2.12 : Per Acre Expenditure on and Receipts from Hybrid and Local Rabi Jowar for a Sample of 20 Farmers in a Village in Aurangabad District, Maharashtra, 1974-75**

Sr. No.	Item/Group	Hybrid Jowar						(in Rs.)	
		Irrigated		Unirrigated				Over all dry	
				Large		Medium			
		Rs.	%	Rs.	%	Rs.	%	Rs.	%
1.	Preparatory tillage	61.00	12.51	54.20	17.09	42.12	13.89	46.15	14.99
2.	Farm-Yard manure	46.50	9.54	36.00	11.36	39.00	12.86	38.00	12.35
3.	Fertilizers	139.58	28.63	75.43	23.79	59.48	19.62	64.79	21.05
4.	Seed	22.00	4.52	22.00	6.94	22.00	7.26	22.00	7.15
5.	After-care	77.80	15.96	53.40	16.85	60.27	19.88	57.98	18.84
6.	Irrigation	11.00	2.26	-	-	-	-	-	-
7.	Plant-protection	104.00	21.33	62.40	19.68	68.80	22.69	66.66	21.65
8.	Harvesting	25.60	5.25	13.60	4.29	11.52	3.80	12.21	3.97
9.	Total Expenditure	487.48	100.00	317.03	100.00	303.19	100.00	307.99	100.00
	Yield Grain-quintals	6.40		3.40		2.88		3.05	
	Fodder "	12.80		6.80		5.76		6.10	
	Value - Grain	896.00		476.00		403.20		427.00	
	Fodder	153.60		81.60		69.12		73.20	
	Total	1049.60		557.60		472.32		500.20	
	Profit/Loss	562.12		240.57		169.13		192.41	

(continued)



Table 4.2.12 : (continued)

Local Jowar

(in Rs.)

Sr. No.	Item/Group	Local Jowar						Over all Dry	
		Irrigated		Unirrigated				Rs.	%
		Rs.	%	Large		Medium			
Rs.	%	Rs.	%	Rs.	%	Rs.	%		
1.	Preparatory tillage	62.60	16.02	53.70	25.76	52.55	24.42	52.93	24.86
2.	Farm-Yard Manure	57.00	14.59	39.00	18.71	45.00	20.92	43.00	20.20
3.	Fertilizers	117.35	30.04	25.37	12.17	34.10	15.85	31.19	14.65
4.	Seed	8.40	2.15	7.70	3.69	8.25	3.83	8.06	3.78
5.	After Care	64.50	16.52	50.90	24.41	49.85	23.17	50.20	23.58
6.	Irrigation	13.00	3.33	-	-	-	-	-	-
7.	Plant-Protection	43.20	11.06	19.20	9.22	14.40	6.69	16.00	7.51
8.	Harvesting	24.58	6.29	12.60	6.04	11.00	5.12	11.53	5.42
9.	Total Expenditure	390.63	100.00	208.47	100.00	215.15	100.00	212.91	100.00
	Grain - Quintals	6.12		3.12		2.73		2.86	
	Fodder - "	18.36		9.36		8.19		8.58	
	Value - Grain	918.00		468.00		409.50		429.00	
	Fodder	220.32		112.32		98.28		102.96	
	Total	1138.32		580.32		507.78		531.96	
	Profit/Loss	+747.69		+371.85		+292.63		+319.05	

	H.Y.V. Rs./acre	Local Rs./acre
1. Irrigated farms :		
a) Irrigated Jowar	562.00	748.00
2) Unirrigated farms :		
a) Large	240.00	372.00
b) Medium	169.00	293.00
All	192.00	319.00

It is clear from the above that hybrid jowar yielded less under both irrigated and unirrigated conditions. In both the conditions labour input per acre of hybrid was not higher than per acre of local jowar. This is the average picture; out of 20 farmers surveyed, about 10 showed some net profit while others a net loss. This being the situation, it is not surprising that not many farmers cared to grow hybrid rabi jowar in the village (about 5 per cent of the total rabi jowar area was under hybrid jowar in the village in 1974-75) and of course in the State.

Indeed, it was surprising that in spite of the poor performance of hybrid jowar in the village as large an area was under hybrid as reported. What is more, most of the irrigated, large and medium farmers in our sample had grown hybrid to a greater or lesser extent on the four consecutive years ending 1974-75. This was not consistent with the loss of hybrid and needed some explanation. On enquiry it was found that certified seed producers from Jalna--a well known

town for hybrid seed production and about 2 miles away from the village surveyed--took the land on annual contract basis (unrecorded lease) for hybrid seed production, a highly profitable business. Naturally, as noted earlier in case of kharif jowar, they felt obligated to grow hybrid jowar for commercial purposes so also it was necessary for them to grow commercial hybrid jowar to keep the seed plots free from cross pollinization by adjusting the sowing time. (Our cost return as well as area estimate do not involve seed growing area.) On further inquiry it was also noticed that for the last three or four years, personnel from Gram Sevak Training Centre, Jalna, were conducting demonstrations on cultivator's fields to show a better performance of hybrid rabi jowar over local jowar, as an extension activity.

Despite such a poor performance of commercial hybrid rabi jowar in the villages, the area under the crop continued in the village for the reasons stated above. Naturally where such special conditions did not prevail, the area under hybrid rabi jowar fluctuated from year to year and generally declined.

This long review of the performance of hybrid rabi jowar in Maharashtra during the years since its introduction in 1966-67 shows that it has not been able to make any contribution to break the prolonged stagnancy in the production of rabi jowar in the State.

### Conclusion

The survey of the performance of jowar in Maharashtra shows overall stagnancy in production, area and yield rate of the crop since 1956-57, though year to year fluctuations in these were very much in evidence. The major potential source of increase in production was expected to be the new hybrid seed introduced since 1966. In the rabi season it cannot be grown without irrigation. But very little, about 8 per cent, of the total cropped area as well as area under rabi jowar is irrigated, which puts a limit to the possibility of hybrid in this season. In kharif season it appears not more than 5 or 6 per cent of the jowar land had come under hybrid, and the trend was declining. Yield rates were on an average higher than for local jowar. But the fluctuation in yields from year to year and from district to district in the same year was almost as high in case of hybrid as of local jowar. This was a major obstacle to acceptance of this more expensive variety by the cultivators. Moreover, though the variety was supposed to grow under unirrigated conditions, the requirements for spraying insecticides - a prophylactic measure for this crop - makes a demand for water beyond all reasonable possibility for the vast mass of peasantry in the dry agricultural region of Maharashtra. The net result is hybrid gave an income no higher than local jowar, on an average, and therefore no incentive to producers to adopt it. That producers do respond to reasonable incentives is indicated by the switch over from kharif jowar to bajra in Nasik and Kolhapur zones, where this

was possible, because hybrid bajra was successful (at least until 1972-73 when a soil-borne disease changed the situation), while hybrid jowar was not. The whole experience with hybrid jowar in the State shows little gain for the community at large, except for the certified seed-growing farmers. It is equally clear that increase in jowar production can come only from greater irrigation and higher yielding seed. But irrigation in this State is extremely limited and can grow only at a small pace. And, in any event, jowar has to compete with presently more profitable crops like sugarcane, wheat, etc., for irrigated land. Ultimately, the burden will be on seed development. The new seed for this dry region must have two basic qualities: (a) it should give a reasonably higher yield, which should not be very susceptible to weather fluctuations, and (b) it should be resistant to diseases and pests rather than depend upon spraying insecticides and pesticides. If varieties with these two basic characteristics and with high responsiveness to increased plant nutrients can also be developed for irrigated conditions, then jowar can begin competing with other crops in irrigated lands. It is quite interesting to note that these are the considerations that guided plant-breeders and agronomists of the State in their approach to research and extension in the long period before 1965. It is clear from all this that no crash programme can put the jowar economy of Maharashtra on a growth path. Only sustained development of new varieties with the above characteristics can restore the train on rails and move it at a slow but steady rate.

### 4.3 Bajra

Bajra is the next important foodgrain after jowar, grown in Maharashtra. It accounts for about 9 per cent of the total area under crops (average of five years ending 1972-73), about 14 per cent of the total area under foodgrains and about 10 per cent of the total production of foodgrains in the State. Bajra is mainly grown in four agro-climatic zones of the State, viz., Nasik, Poona, Aurangabad and Kolhapur. The performance of bajra production in the State, therefore, depends significantly on the performance of bajra production in these agro-climatic zones. We will examine the performance of bajra in the State as well as in these four agro-climatic zones for the period 1956-57 to 1972-73; for which data on acreage, production etc. are available. The plan of the exercise is similar to that of jowar.

#### Trend of Bajra Production

During the 17 years since 1956-57 production of bajra in Maharashtra registered a considerable increase, particularly during the four years, 1967-68 to 1970-71. Table 4.3.1 shows that the total annual production fluctuated between 0.36 and 0.78 million tonnes, excluding the years of very low production (1971-72 and 1972-73). If one takes all the 17 years into account the annual compound growth rate of production comes to -1.42 per cent (Table 4.3.1A). This decline, however, is due to the inclusion of the two years

**Table 4.3.1 : Production of Bajra in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

(Production in '00 tonnes)

Sr. No.	Year	Nasik	Poona	Kolha- pur	Auran- gabad	Amra- vati	Nagpur	Maha- rashtra
1.	1956-57	1912 89.43	1207 90.28	708 125.98	538 85.53	133 66.50	2 11.76	4500 92.15
2.	1957-58	2163 101.17	1601 119.74	675 120.11	657 104.45	61 30.50	1 5.88	5158 105.63
3.	1958-59	1798 84.10	1456 108.90	823 146.44	521 82.83	84 42.00	7 41.17	4689 96.03
4.	1959-60	1792 83.82	1582 118.32	814 144.84	713 113.35	57 28.50	4 23.53	4962 101.62
5.	1960-61	2138 100.00	1337 100.00	562 100.00	629 100.00	200 100.00	17 100.00	4883 100.00
6.	1961-62	1969 92.09	992 74.19	581 103.38	742 117.96	30 15.00	3 17.64	4317 88.41
7.	1962-63	2254 105.42	1736 129.84	676 120.28	815 129.57	49 24.50	4 23.53	5534 113.33
8.	1963-64	1987 92.94	1363 101.94	649 115.48	643 102.22	62 31.00	6 35.29	4710 96.46
9.	1964-65	2163 101.17	1210 90.50	537 95.55	802 127.50	63 31.50	5 29.41	4780 97.89
10.	1965-66	1462 68.38	1191 89.08	424 <sup>a</sup> 75.44	577 91.73	42 21.00	2 11.76	3698 75.73
11.	1966-67	1646 76.99	1162 86.91	753 133.98	732 116.37	56 28.00	2 11.76	4351 89.10
12.	1967-68	2240 104.77	1386 103.66	571 101.60	922 146.58	111 55.50	1 5.88	5231 107.12
13.	1968-69	2744 128.34	1702 127.30	576 102.49	1309 208.11	54 27.00	2 11.76	6387 130.80
14.	1969-70	2551 119.32	2164 161.85	711 126.51	1590 252.78	119 59.50	5 29.41	7140 146.22
15.	1970-71	3127 146.26	2130 159.31	546 97.15	1929 306.67	82 41.00	3 17.64	7817 160.08
16.	1971-72	980 45.84	696 52.05	465 82.74	221 35.13	43 21.50	1 5.88	2406 49.27
17.	1972-73	934 43.68	649 48.54	124 22.06	253 40.22	80 40.00	2 11.76	2042 41.82

**Table 4.3.1A : Annual Compound Growth Rates of Production of Bajra in Maharashtra, 1956-57 to 1972-73**

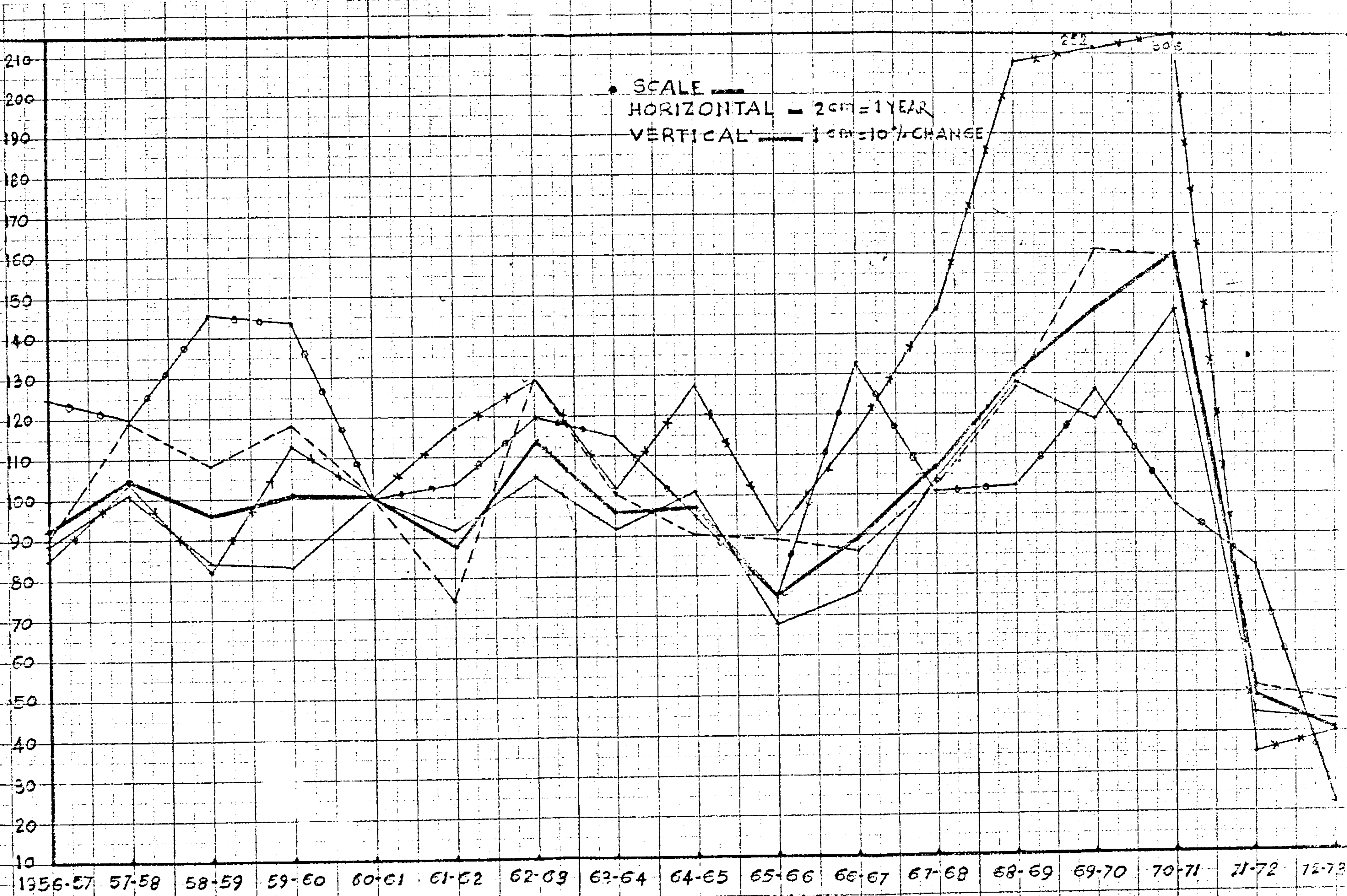
Sr. No.	Period	(Per cent)				
		Maha-rashtra	Nasik	Poona	Kolha-pur	Auran-gabad
1.	1956-57 to 1972-73	-1.42 (0.22)	-1.40 (0.04)	-1.42 (0.04)	-3.74* (0.32)	+0.30 (0.00)
2.	1956-57 to 1970-71	+2.40 (0.55)	+2.10 (0.21)	+2.10 (0.15)	-1.14 (0.12)	+7.40* (0.65)
3.	1956-57 to 1964-65	+0.20 (0.01)	+1.30 (0.15)	-0.96 (0.02)	-3.19 (0.33)	+4.20* (0.49)
4.	1964-65 to 1972-73	-5.21 (0.09)	-4.87 (0.09)	-3.99 (0.12)	-9.54 (0.26)	-8.00 (0.09)
5.	1964-65 to 1970-71	+12.00* (0.78)	+10.60* (0.62)	+12.40* (0.85)	+0.90@ (0.01)	+20.60* (0.84)

Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.3.1.





• PRODUCTION OF BAJRA IN  
 MAHARASHTRA AND ITS AGRO-  
 CLIMATIC ZONES  
 1956-57 TO 1972-73

- NASIK —————
- POONA —————
- KOLHAPUR ————
- AURANGABAD ———
- STATE —————

of very low production towards the end of the period. Excluding these two years, we find the annual compound growth rate to be +2.4 per cent which, though statistically insignificant, indicates an increasing trend in bajra production. A significant difference is seen in growth rates during the pre- and post-hybrid seed periods. The annual growth rate from 1956-57 to 1964-65 was +0.20 per cent while for the later period, 1964-65 to 1970-71 (excluding the years of low production) it was +12.0 per cent (statistically significant), showing an upward trend in bajra production.

The increase in production of bajra during the last half of the 1960s or more appropriately during the years 1964-65 to 1970-71, has been due to increase in both acreage under bajra as well as its yield per hectare. Excepting the years 1971-73, the total area under bajra fluctuated between 1.6 and 2.1 million hectares (Table 4.3.2). The annual compound growth rate for the 17 years, excluding the years 1971-73, was +1.20 per cent (statistically insignificant), (Table 4.3.2A). During the pre-hybrid period upto 1964-65, there was a declining trend of area under bajra (growth rate -1.00 per cent). During the subsequent period, the area under the crop registered an increasing trend (growth rate +2.30 per cent excluding the years 1971-73). This increase in acreage under bajra during the years 1964-65 to 1970-71 calls for explanation and we shall turn to it when we examine the trend in bajra acreage in the different agro-climatic zones of the State.

**Table 4.3.2 : Area under Bajra in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

(Area in '00 hectares)								
Sr. No.	Year	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1956-57	5773 105.50	6388 125.13	3119 110.05	3012 114.52	279 103.33	3 13.04	18574 113.71
2.	1957-58	5887 107.58	5956 116.67	3059 107.94	2948 112.09	275 101.85	6 26.08	18131 111.00
3.	1958-59	5759 105.24	5914 115.85	3021 106.60	3028 115.13	269 99.63	19 82.61	18010 110.26
4.	1959-60	5415 98.96	5821 114.02	2966 104.66	2895 110.07	255 94.44	17 73.91	17369 106.33
5.	1960-61	5472 100.00	5105 100.00	2834 100.00	2630 100.00	270 100.00	23 100.00	16334 100.00
6.	1961-62	5533 101.11	5260 103.03	2895 102.15	2885 109.69	255 94.44	29 126.08	16857 103.20
7.	1962-63	5642 103.10	5559 108.89	2784 98.23	2553 97.07	261 96.66	25 108.69	16824 103.00
8.	1963-64	5567 101.73	5746 112.55	2829 99.82	2616 99.47	259 95.92	21 91.30	17038 104.31
9.	1964-65	5758 105.22	5907 115.71	2804 98.94	2634 100.15	262 97.03	21 91.30	17386 106.44
10.	1965-66	6016 109.94	6055 118.61	2756 97.25	3171 120.57	248 91.85	14 60.86	18260 111.79
11.	1966-67	6698 122.40	6822 133.63	2892 102.04	3486 132.55	287 106.29	10 43.47	20195 123.64
12.	1967-68	6885 125.82	6619 129.66	2916 102.89	3521 133.87	295 109.25	14 60.86	20250 123.97
13.	1968-69	6596 120.54	6571 128.72	2942 103.81	3874 147.30	347 128.52	14 60.86	20344 124.55
14.	1969-70	6385 116.68	7039 137.88	2983 105.26	4440 168.82	365 135.18	16 69.56	21228 129.96
15.	1970-71	6215 113.58	6262 122.66	2242* 79.11	4352 165.47	373 138.15	15 65.21	19459 119.13
16.	1971-72	4275 78.12	2848 55.78	2412 85.11	1540 58.55	387 143.33	17 73.91	11478 70.27
17.	1972-73	5518 100.84	2657 52.04	726 25.61	3459 131.52	408 151.11	14 60.86	12782 78.25

**Table 4.3.2A : Annual Compound Growth Rates of Area under Bajra in Maharashtra, 1956-57 to 1972-73**

(Per cent)						
Sr. No.	Period	Maha-rashtra	Masik	Poona	Kolha-pur	Auran-gabad
1.	1956-57 to 1972-73	-0.69 (0.00)	+0.10 (0.00)	-2.10 (0.15)	-3.58* (0.29)	+0.90 (0.03)
2.	1956-57 to 1970-71	+1.20 (0.41)	+1.30* (0.38)	+1.10 (0.25)	-0.32 (0.02)	+2.70* (0.39)@ (Except 1971-72)
3.	1956-57 to 1964-65	-1.00 (0.27)	-0.32 (0.05)	-1.05 (0.21)	-1.40* (0.57)	-2.03* (0.74)
4.	1964-65 to 1972-73	-4.30 (0.30)	-2.32 (0.19)	-8.86* (0.44)	-9.95 (0.40)	-0.67 (0.00)
5.	1964-65 to 1970-71	+2.30 (0.25)	+1.20 (0.13)	+1.60 (0.23)	+1.40 (0.52)	+5.10* (0.60) (Except 1971-72)

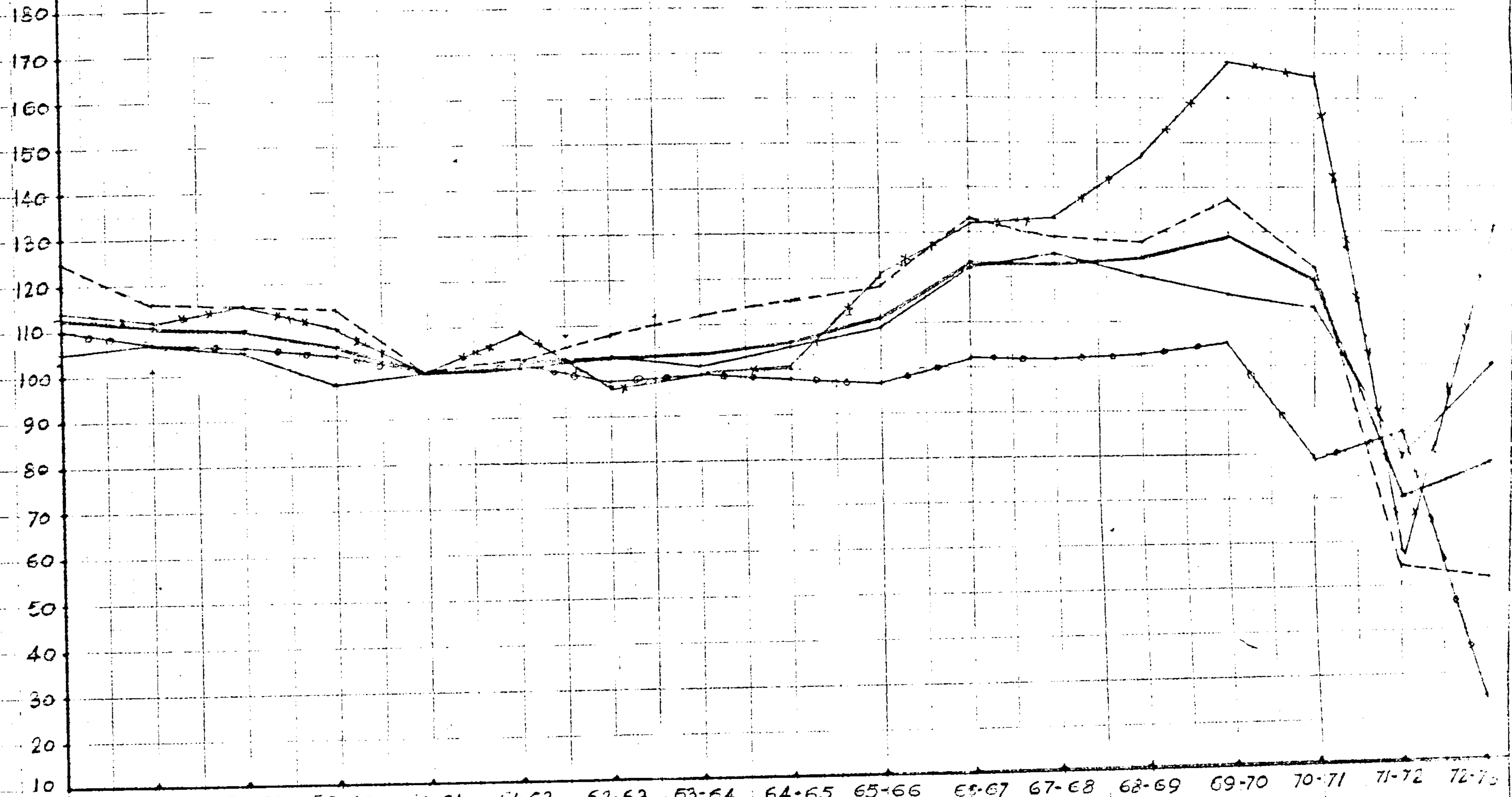
Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.3.2.



• SCALE —  
HORIZONTAL — 200=1 YEAR  
VERTICAL — 100=10% CHANGE



• AREA UNDER SUGARCANE IN MAHARASHTRA AND ITS AGRICULTURAL CLIMATIC ZONES 1956-57 TO 1972-73

- NATICK —————
- POONA —————
- KOLHAPUR ————••
- AURANGABAD ————\*•
- STATE —————

Like the acreage, yield per hectare of bajra also shows a mild increasing trend during these two decades (Table 4.3.3). Of course, the annual compound growth rate for the entire period is -0.60 per cent, but this is mainly due to very low yield in the last two years, 1971-73 (Table 4.3.3A). Excluding these two years we find the rate has increased over the entire period (growth rate +1.70 per cent). During the period 1964-65 to 1970-71 growth rate was +8.10 per cent, but statistically insignificant.

On the whole, we find increasing trend in production, area and yield of bajra in the State during the last two decades. Since the introduction of hybrid seed and particularly during the years 1964-65 to 1970-71, an increasing trend in area, production and yield of bajra is the significant development noticed. The reasons for severe decline in production, area and yield of bajra during the years 1971-73 could be the result of drought conditions, but this alone is not sufficient to explain the sharp decline in area and production both. While the deficient rains must have contributed to the decline there has to be something, that was experienced by the cultivators which must have contributed to decline in area and production, the soil borne disease 'Downy Mildew'. This might be an equally important contributory factor for the decline. This has to be borne in mind when we examine the performance of hybrid bajra in detail.

Out of the four agro-climatic zones in which bajra is

**Table 4.3.3 : Per Hectare Yield Rate of Bajra in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

		(Yield kgs./hectare)						
Sr. No.	Year	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1956-57	331 84.87	188 72.03	226 114.72	178 74.48	476 64.32	666 90.12	242 81.21
2.	1957-58	367 94.10	269 103.06	220 111.67	222 92.88	221 29.86	166 22.46	284 95.30
3.	1958-59	312 80.00	246 94.25	272 138.07	172 71.97	312 42.16	368 49.80	260 87.24
4.	1959-60	330 84.61	271 103.83	274 139.09	246 102.93	223 30.13	235 31.80	285 95.64
5.	1960-61	390 100.00	261 100.00	197 100.00	239 100.00	740 100.00	739 100.00	298 100.00
6.	1961-62	355 91.02	188 72.03	201 102.03	257 107.53	117 15.81	103 13.94	255 85.57
7.	1962-63	399 102.31	312 119.54	242 122.84	318 133.05	187 25.87	160 21.65	328 110.07
8.	1963-64	356 91.28	236 90.42	229 116.24	245 102.51	239 32.30	285 38.56	276 92.62
9.	1964-65	375 96.15	204 78.16	192 97.46	304 127.20	240 32.43	238 32.20	275 92.28
10.	1965-66	242 62.05	196 75.09	154* 78.17	182 76.15	169 22.84	142 19.21	202 67.78
11.	1966-67	245 62.82	170 65.13	260 131.98	209 87.45	195 26.35	200 27.06	230 77.18
12.	1967-68	369 94.61	208 79.69	195 98.98	261 109.20	376 50.81	71 9.61	272 91.27
13.	1968-69	416 106.67	259 99.23	196 99.46	338 141.42	156 21.08	143 19.35	314 105.37
14.	1969-70	399 102.31	307 117.62	238 120.81	358 149.79	326 44.05	312 42.22	336 112.75
15.	1970-71	503 128.97	340 130.26	244 123.86	443 185.35	220 29.73	200 27.06	402 134.90
16.	1971-72	229 58.72	244 93.49	193 97.97	144 60.25	111 15.00	59 7.98	210 70.47
17.	1972-73	169 43.33	244 93.49	171 86.80	73 30.54	196 26.48	143 19.35	160 53.69

**Table 4.3.3A : Annual Compound Growth Rates of Yield Rates of Bajra in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	(Per cent)				
		Maha-rashtra	Nasik	Poona	Kolha-pur	Auranga-bad
1.	1956-57 to 1972-73	-0.60 (0.02)	-1.42 (0.07)	+0.70 (0.03)	-1.17 (0.13)	-0.45 (0.00)
2.	1956-57 to 1970-71	+1.70 (0.24)	+1.10 (0.06)	-	-0.21 <sup>⊗</sup> (0.00)	+4.20 <sup>*</sup> (0.46)
3.	1956-57 to 1964-65	+1.30 (0.39)	+1.60 (0.27)	-1.28 (0.04)	-1.76 (0.13)	+6.40 <sup>*</sup> (0.66)
4.	1964-65 to 1972-73	-1.19 (0.01)	-2.99 (0.05)	+5.40 (0.42)	+0.50 (0.00)	-7.34 (0.14)
5.	1964-65 to 1970-71	+8.10 (0.35)	+9.00 (0.45)	-	+3.00 (0.22)	+11.20 (0.53)

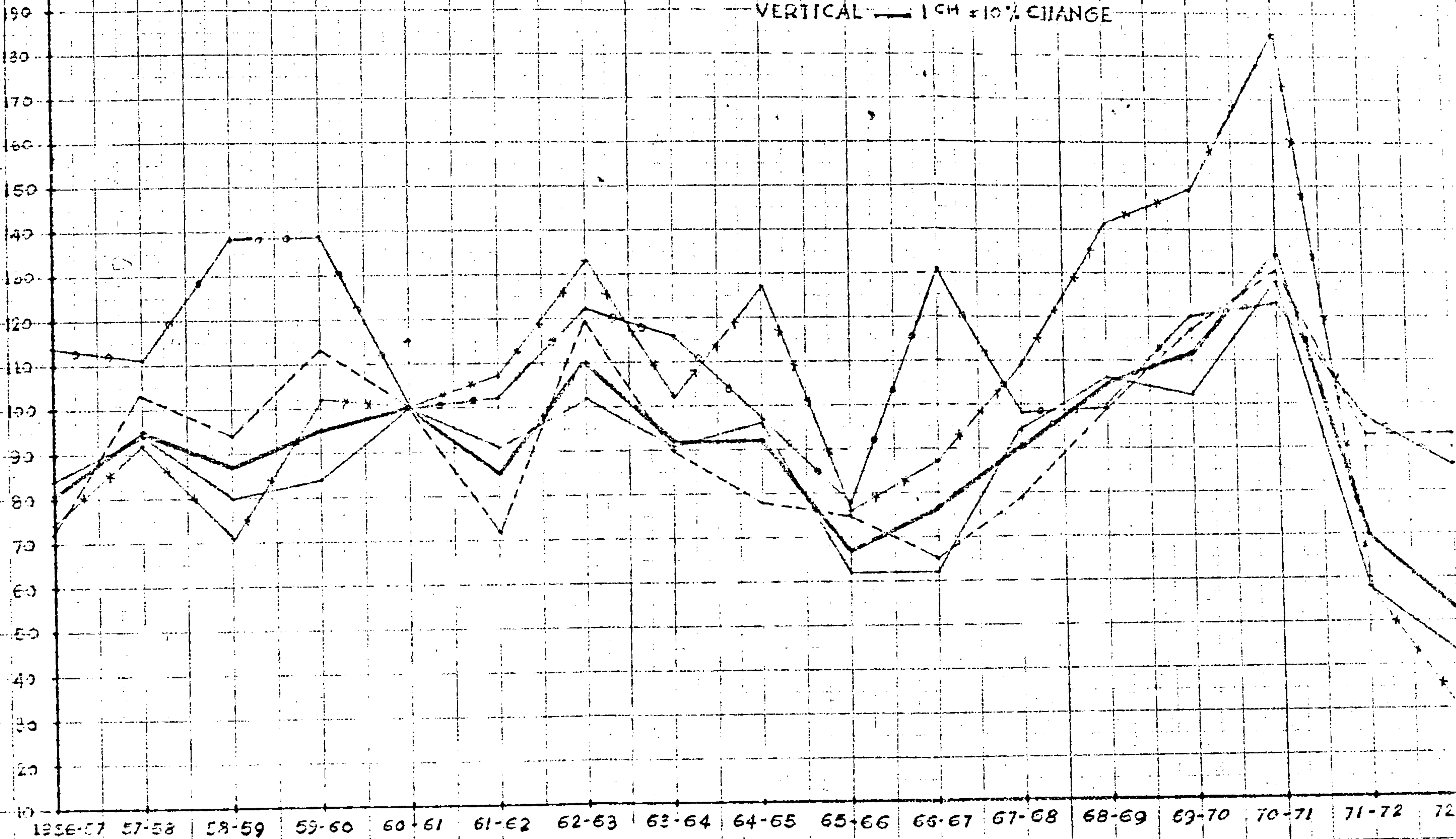
Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

⊗ The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.3.3.



• SCALE —  
 HORIZONTAL — 2 CM = 1 YEAR  
 VERTICAL — 1 CM = 10% CHANGE



• YIELD OF BAJRA IN MAHARASHTRA AND ITS AGRICULTURAL CLIMATIC ZONES 1956-57 TO 1972-73

- NASIK ————
- POONA ————
- KOLHAPUR ————
- AURANGABAD ————
- STATE ————

grown, Nasik and Poona zones account for about 65 per cent of the total area, Aurangabad for about 19 per cent, Kolhapur about 14 per cent, Amravati and Nagpur zones account for the remaining. During the entire period, both Nasik and Poona Zones have shown increasing trend in production (for both, the growth rate was +2.10 per cent excluding the years 1971-73), in the yield rate (growth rate for Nasik was +1.10 per cent and for Poona +0.70 per cent) as well as in area under the crop (for Nasik +1.30 per cent, for Poona +1.10 per cent).

The trend was not very different in these two zones during the later half of this period - the years of hybrid bajra seed. The total production in the years 1964-65 to 1970-71 had increased significantly both in Nasik and Poona zones, (growth rate of production in Nasik was +10.60 per cent and Poona +12.40 per cent). This high growth rate of production was essentially the result of the low magnitude in the earlier years, i.e., 1965-66 and 1966-67. This can be brought out by comparing the two periods, pre-HYV and post-HYV. An increasing trend is observable in the post-HYV period in both the zones. This increasing trend in production is also observable with regard to area and yield rate in the years 1964-65 to 1970-71 in these two zones. Area in Nasik showed a rate of growth of +1.20 per cent and in Poona +1.60 per cent. Yield rate in Nasik showed a growth rate of +9.00 per cent and in Poona it was +5.40 per cent. While the growth rates of area are statistically not significant, increase in

area still had a contribution to make to higher production. Thus the two zones accounting for the bulk of production of and area under bajra in the State showed increasing trend on all fronts in the period 1964-65 to 1970-71.

What has been said in respect of the Nasik and Poona zones is largely true in respect of Aurangabad zone and only partially so in Kolhapur zone. Production of bajra in Aurangabad showed a significant increasing trend over the entire period (growth rate +7.40 per cent, excluding the years 1971-73), but Kolhapur showed a declining growth rate of -1.14 per cent, though this was statistically insignificant. During the same period, area under bajra in Aurangabad zone has shown significantly increasing trend (growth rate +2.70 per cent) as did yield per hectare (growth rate +4.20 per cent). But in Kolhapur both area and yield rate showed mild declining trend (growth rate of area was -0.32 per cent and yield rate -0.21 per cent).

During the period 1964-65 to 1970-71, the production of bajra in Aurangabad zone increased significantly (growth rate 20.60 per cent), while in Kolhapur it increased slightly (growth rate +0.90 per cent). In the same period, area under bajra and yield rate per hectare in Aurangabad increased significantly by +5.10 per cent and +11.20 per cent, while in Kolhapur area increased by +1.40 per cent and yield rate by +3.00 per cent.

In the light of the increase in production, area and

rate of yield of bajra since 1964-65, two factors, viz., irrigation and the new hybrid seeds, come into prominence. Of the two factors mentioned, irrigation may be dismissed as a factor of not much relevance in Maharashtra, since no more than 2.5 per cent of the total area under bajra in the State is irrigated as per official statistics.

The more important development since 1964-65 has been the hybrid bajra seed. We shall examine only the available data on extension of use of the hybrid bajra seed. Data on application of fertilizer to bajra are not separately available.

While extension of hybrid bajra seed began in 1966-67, data about estimated area under hybrid bajra are available from 1968-69. Table 4.3.4 presents the estimates of the percentage of the total area under bajra growing the hybrid variety, provided by the Zilla Parishad and estimates by the Statistician.

The Table shows that according to the estimate of the Zilla Parishads area under hybrid bajra increased from 11 per cent in 1968-69 to 23 per cent in 1970-71 of the total bajra area. In the later two years, 1971-73, the area was estimated at 16 and 18 per cent respectively. The Statistician's sample survey showed that the Zilla Parishad's reported area was to an extent an over-estimate. According to the Statistician's estimate the area under hybrid bajra increased from 8 per cent to 18 per cent from the year 1968-69 to 1970-71. For the later two years, 1971-73, it was put at 10 per cent and 14

**Table 4.3.4 : Percentage of Bajra Area under Hybrid Variety as Estimated by (a) The Zilla Parishads and (b) The Statistician to the Department of Agriculture, Maharashtra, 1968-69 to 1972-73**

Sr. No.	Zone	1968-69		1969-70		1970-71		1971-72		1972-73	
		As per Z.P.s.	As per Statistician	As per Z.P.s.	As per Statistician	As per Z.P.s.	As per Statistician	As per Z.P.s.	As per Statistician	As per Z.P.s.	As per Statistician
1.	Kasik	20.24	15.75	16.97	14.22	25.16	20.88	24.23	17.65	24.65	17.18
2.	Poona	4.72	3.39	10.06	8.45	20.89	18.12	9.80	8.28	4.11	2.85
3.	Kolhapur	1.86	1.14	3.21	2.52	3.00	2.43	3.81	2.38	2.86	1.87
4.	Aurangabad	16.06	9.36	18.71	14.38	33.51	25.39	19.85	9.37	24.98	21.99
5.	State	11.41	8.15	12.76	10.44	22.60	18.46	15.63	10.38	18.42	14.07

per cent respectively. Leaving aside the difference in Zilla Parishads reported area and Statistician's estimates, it is quite clear that the area under hybrid bajra continuously increased during the earlier three years. This is reflected in the zonal figures also.

Nasik zone, the important one for bajra, had about 21 per cent, the highest, area under hybrid bajra in 1970-71. It declined to 18 per cent and 17 per cent in the years 1971-73 respectively. In Poona zone, the percentage of area under hybrid bajra after reaching 18 per cent in 1970-71, had drastically been reduced in the subsequent two years. Aurangabad zone had reported about 25 per cent area under hybrid bajra in 1970-71, thereafter in 1971-72 it declined drastically to about 9 per cent and then increased to about 22 per cent in 1972-73.

Now it is clear that the area under hybrid bajra in the State as well as in different zones increased steadily during the years 1968-69 to 1970-71, thereafter it showed a declining trend. This decline in area during the years 1971-73 may be attributed to either drought or soil borne fungus disease 'Downy Mildew' or both.

Use of hybrid bajra seed, though not on larger area, was expected to make a sizable impact on production resulting from increased average per hectare yield, specially in view of the much higher per hectare yield of hybrid bajra over the local variety. Such expectation of sizable increase in

production was mainly based on the Statistician's area and yield estimates based on crop-cutting experiments. Attention, therefore, needs to be turned to the examination of the data on yield rate of hybrid bajra as well as of total production.

The Statistician conducted random sample crop-cutting experiments to estimate the yield rate of hybrid bajra during the five years since 1968-69. These data for each of the year and zones are given in Table 4.3.5. The data show that, by and large, the yield rate of hybrid bajra was quite high compared to the local bajra in vogue in the State. The yield rate of hybrid bajra during the first three years, 1968-69 to 1970-71, varied between 1300 and 1500 kgs. per hectare and in the subsequent two years, 1971-73, it declined to 1200 and 700 kgs. per hectare. This was about three to four and a half times as high as the average yield of bajra in the State during the 12 years preceding 1968-69 (267 kgs./hectare). The same phenomenon was also recorded for the various bajra zones, as will be seen from the Table. It is to be noted, here, that the yield of hybrid bajra particularly in the year 1972-73 declined to about half the yield recorded in the earlier three years, 1968-70.

With such high rate of yield it is not surprising that the estimated total production of hybrid bajra in the State (estimated by multiplying the estimated area by the estimated yield rate) came to account for a much higher proportion of total bajra production than the area under hybrid as a

**Table 4.3.5 : Average Yield of Bajra and Hybrid Bajra in Maharashtra, 1956-57 to 1972-73**

(Yield kgs./hectare)

Sr. No.	Year	Nasik		Poona		Kolhapur		Aurangabad		Maharashtra	
		Bajra	Hybrid Bajra	Bajra	Hybrid Bajra	Bajra	Hybrid Bajra	Bajra	Hybrid Bajra	Bajra	Hybrid Bajra
1.	1956-57		331		188		226		178		242
2.	1957-58		367		269		220		222		284
3.	1958-59		312		246		272		172		260
4.	1959-60		330		271		274		246		285
5.	1960-61		390		261		197		239		298
6.	1961-62		355		188		201		257		255
7.	1962-63		399		312		242		318		328
8.	1963-64		356		236		229		245		276
9.	1964-65		375		204		192		304		275
10.	1965-66		242		196		154		182		202
11.	1966-67		245		170		260		209		230
12.	1967-68		369		208		195		261		272
Average			339		229		222		236		267
13.	1968-69	416	1479.6	259	1014.1	196	1014.1	338	1036.1	314	1310.5
14.	1969-70	399	1633.4	307	1560.1	238	1560.1	358	1202.5	336	1487.1
15.	1970-71	503	1691.6	340	1710.4	244	828.6	443	942.8	402	1454.0
16.	1971-72	229	1271.1	244	1512.7	193	667.1	144	714.5	210	1185.9
17.	1972-73	169	1043.7	244	1270.4	171	856.5	73	311.8	160	742.3
Average		343	1423.8	279	1413.5	208	985.3	271	841.5	284	1235.9



percentage of total bajra area warranted. These percentages, zonewise, are given in Table 4.3.6. The Table shows that during the earlier three years, 1968-70, production of hybrid bajra increased from 34 per cent to 67 per cent of the total production of bajra, while in the subsequent two years, 1971-72 and 1972-73, it was 62 and 65 per cent respectively. We have seen that the area under hybrid bajra during these two periods was not more than 19 per cent and 14 per cent of the total bajra area. However, the total estimated production of hybrid bajra, since 1970-71 onwards and particularly for the years 1971-72 and 1972-73, appears too 'good' to be true in many zones/districts. For example, in Nasik zone, in 1972-73, hybrid bajra production formed 105.99 per cent of the total bajra production of the zone; in the Poona zone, in 1970-71, hybrid bajra production formed 91.13 per cent of total production of bajra; in Aurangabad zone in 1972-73 hybrid production formed 93.74 per cent of the total production of bajra. Similar figures for the individual districts (not presented here) showed many such instances, during the years 1971-72 and 1972-73, where the estimated yield rate of local bajra was negative or comparatively very less in one or other years.

Indeed, if one compared the estimated yield rate of local bajra in the State and in different zones during the years 1970-73 and particularly in years 1971-72 and 1972-73, (after deducting the estimated area and production of hybrid from the officially estimated total area and production of

**Table 4.3.6 : Estimated Total Production of Hybrid Bajra as a Percentage of the Total Production of All Bajra in Maharashtra, 1968-69 to 1972-73**

Sr. No.	Zone	1968-69	1969-70	1970-71	1971-72	1972-73
1.	Nasik	56.01	58.15	70.23	97.87	105.99
2.	Poona	13.29	42.89	91.13	51.27	14.85
3.	Kolhapur	5.91	16.52	8.28	8.24	9.41
4.	Aurangabad	28.71	48.29	54.02	46.69	93.74
	State	34.02	46.17	66.83	62.29	65.38

bajra) then one finds that they are, by and large, much lower than the yield rates of local bajra in the State and same zones during the 12 years before the introduction of hybrid seed (Table 4.3.7). For example, the calculated yield of local bajra in the State for the years 1971-73 comes to 88 kgs. and 64 kgs. per hectare. In Aurangabad zone for the same years it comes to 84 kgs. and 5 kgs. per hectare. In Poona zone in the year 1970-71 it is 36 kgs. only, and in Nasik zone it is 5 kgs. in 1971-72 and negative in the year 1972-73. It is very difficult to swallow this as an acceptable proposition. Is it really possible to believe that in spite of the above noted yields the cultivator will continue to take local bajra without flinching his eyes?

Such inconsistencies, therefore, raise the whole question of the reliability of the available data on hybrid bajra during the period 1970-71 to 1972-73, particularly so in the

**Table 4.3.7 : Estimated Average Yield of Local Bajra in Maharashtra, 1968-69 to 1972-73**

Sr. No.	Year	(Yield kgs./hectare)				
		Nasik	Poona	Kolhapur	Aurangabad	Maharashtra
1.	1968-69	217	232	186	265	225
2.	1969-70	194	191	204	216	202
3.	1970-71	189	36	228	273	163
4.	1971-72	5	129	181	84	88
5.	1972-73	-12	214	157	5	64

years 1971-72 and 1972-73. We do not have any reason to suspect the data on hybrid bajra during the earlier period, and particularly in the years 1968-69 and 1969-70 since the calculated yield of local bajra in the State and in different zones is comparable to the yield rates of local bajra in the State (refer Table 4.3.7) and different zones during the 12 years previous to the year 1968-69. There is every reason, therefore, to suspect that the error might lie in the estimation of production of hybrid bajra for the years 1970-73.

The estimated yield rates of local bajra during the years 1968-69 and 1969-70 (225 kgs. and 202 kgs. per hectare) are fairly comparable to the yield rates of bajra during the 12 years before the introduction of high yielding varieties seed. However, even these yield rates are, also, comparatively on the lower side as compared to the average of previous 12 years (267 kgs. per hectare) and can be comparable only to the yield rate for the year 1965-66 (202 kgs./hectare), a drought year.

The estimated yield rates of local bajra during the years 1970-71 to 1972-73 are much lower than the average of the previous 12 years. This creates doubt about the reliability of the Statistician's production estimates of hybrid bajra during the years 1968-69 to 1972-73.

The above discussion suggests that the Statistician's estimates of hybrid bajra production, particularly during the years 1971-72 and 1972-73, are likely to be over-estimates. As noted in the case of jowar, production estimates of the Statistician are based on the estimates of area under hybrid variety and its yield rates (multiplying the estimated area by the estimated yield rate). Area estimates are based on by choosing a stratified random sample of villages (the strata based on the area estimates of Zilla Parishad on the basis of seed distribution) and then making a complete count of the fields growing the crop in the sample village during the year. Yield estimates are based on crop-cutting estimates on two plots selected at random from the enumerated hybrid bajra growing plots in every sample village. Now to question the estimated production of hybrid bajra is to question the estimated area under hybrid and/or the estimated yield rate. We, however, propose to examine the data relating to yield rate of hybrid bajra in (i) the different agricultural experiment stations in the State, (ii) the trials conducted on farmers' fields and (iii) the sample farmers in a selected village in Marathwada zone of the State, surveyed by us.

Experiments on hybrid bajra have been conducted in various agricultural experiment stations in the State since 1966-67. The experiments have been for different types of treatments, namely, seed rate, spacing, application of N, P, K; time of sowing, etc. We have collected the results of all the experiments on hybrid bajra in all the experiment stations in the State. For the purpose of analysis we have noted experiment results relating to the following standard treatments for all the different experiments in each of the seven years since 1966-67. The standard treatment referred to is as follows :

1. Time of sowing	Earliest possible in June/July
2. Seed rate	2.5 kgs./hectare
3. Spacing between rows	45 cms.
4. Farmyard manure	12 cartloads/hectare
5. Fertilizers :	
Nitrogen	50 kgs./hectare
Phosphorous	37 kgs./hectare
Potash	25 kgs./hectare
6. Plant Protection	As and when required.

The agricultural experiment stations at Parbhani, Vaijapur (Aurangabad district) in Aurangabad zone and Niphad in Nasik zone are the important stations for research on bajra in the State. During the seven years, 1966-73, five or six different experiments were carried out on hybrid bajra in each of these stations. At Vaijapur research station, the average yield rate of all the experiments (for standard

treatment) was 1077 kgs./hectare. But the variation around this mean was quite large, it varied from 632 kgs. in one experiment in 1968-69 to 1509 kgs. in another in the same year. The coefficient of variation was 26.46 per cent. At Parbhani research station, the average yield rate of all the experiments was 1482 kgs. per hectare, which varied from 738 kgs. in 1970-71 to 2805 kgs. in 1969-70. The coefficient of variation was 47.57 per cent. These were the only experiment stations in Aurangabad zone. The average yield of hybrid bajra for the five years, 1968-69 to 1972-73, in Aurangabad zone estimated by the Statistician was 841 kgs./hectare and the yield ranged between 312 and 1202 kgs./hectare. For the first two years, 1968-69 and 1969-70, the yield estimated was 1036 kgs. and 1202 kgs. per hectare and in the later three years it declined from 942 kgs. to 312 kgs. per hectare. The comparison of the data from the research stations in the other zones with the Statistician's estimates gives more or less similar results. These are tabulated in Table 4.3.8. This suggests that the Statistician's estimated yield rates of hybrid bajra in different zones cannot be considered as over-estimates when judged by the performance standard in the experiment stations in the zones.

Similarly, we will compare the Statistician's estimates with the average yield rates recorded in Fertilizer and Varietal Trials (F.V.Ts.) in cultivators' fields, conducted over seven years, 1966-67 to 1972-73. The relevant data are

**Table 4.3.8 : Estimated Average Yield Rates of Hybrid Bajra from Different Sources**

(Yield kgs./hectare)

Sr. No.	Zone	District/ Research Station	Zonewise estimated yield by the Statistician			Yield at Research Stations			Districtwise yield of F.V.T.s		
			Average (4)	Minimum (5)	Maximum (6)	Average (7)	Minimum (8)	Maximum (9)	Average (10)	Minimum (11)	Maximum (12)
1.	Nasik	-	1423	1043	1691	-	-	-	-	-	-
		Niphad	-	-	-	777	426	1280	-	-	-
		Nasik	-	-	-	-	-	-	1308	1050	1700
		Dhulia	-	-	-	1699	1038	2439	-	-	-
2.	Poona	-	1413	1014	1710	-	-	-	-	-	-
		Poona	-	-	-	-	-	-	942	600	1500
		Ahmednagar	-	-	-	-	-	-	1270	1020	1590
3.	Kolhapur	-	985	667	1560	-	-	-	-	-	-
		Karad	-	-	-	796	209	1614	-	-	-
		Satara	-	-	-	-	-	-	565	460	740
4.	Aurangabad	-	841	312	1202	-	-	-	-	-	-
		Parbhani	-	-	-	1482	738	2805	-	-	-
		Vaijapur	-	-	-	1077	632	1509	-	-	-
		Aurangabad	-	-	-	-	-	-	923	670	1070
		Bhir	-	-	-	-	-	-	1413	460	2210
	State	-	1235	742	1487	-	-	-	-	-	-

presented in the above Table 4.3.8, in columns 10 to 12. The data show that the average yield of hybrid bajra recorded in the FVTs in each zone did not differ much than the yield rates estimated by the Statistician in those zones, except in Satara district of Kolhapur zone, Poona district of Poona zone and Ehir district in Aurangabad zone. Here again there is no clear evidence, except in Kolhapur zone, to suspect over-estimation of the yield rate by the Statistician in the Sample survey.

The third set of data with which we propose to compare the Statistician's estimates are the data collected by us in one village in Aurangabad district of Marathwada division. We made a purposive selection of one village, Aghur, in Aurangabad district which accounts for 60 per cent of the total area under bajra in the Aurangabad zone. This village was considered as one of the developed village with a well developed hybrid programme. We selected at random 20 cultivators growing hybrid bajra in 1974-75 and collected from them information about their area and production of hybrid bajra, for that year and the previous three years. The Statistician's estimates of the average yield of hybrid bajra in Aurangabad district are given below side by side our estimation for the particular village surveyed.

Comparing the data for the two years 1971-73 for which yield data from both sources are available, one finds the two fairly comparable. Therefore, one can say that the yield



rate data provided by the Statistician are not over-estimated.

Year	Yield rate kgs./hectare	
	Statistician's estimate	Village surveyed
1968-69	998	N.A.
1969-70	1187	N.A.
1970-71	842	N.A.
1971-72	807	695
1972-73	326	397
1973-74	N.A.	552
1974-75	N.A.	535

Since there is no evidence to suspect over-estimation of yield rates of hybrid bajra by the Statistician, it follows that his estimation of area under hybrid bajra in the years 1970-73 and particularly 1971-72 and 1972-73 might be the source of error. In our earlier discussion we have seen that the calculated yield rates of local bajra in the State as well as in different zones are much less during the years 1970-73 and particularly in the years 1971-72 and 1972-73 than the average yield rate of local bajra in the State as well as in different zones during the 12 years before the introduction of hybrid variety seed. Similar was not the case for the years 1968-69 and 1969-70 when the calculated yield of local bajra was comparable with the average yield rate of local bajra in the State as well as in different zones during the period before the introduction of hybrid bajra seed. However, independent source of estimation of area

under hybrid bajra in the State are not easily available. The only sample survey data from which relevant information may be obtained is the enquiry into the cost of production of crops conducted in the State in 1972-73, by the Directorate of Economics and Statistics of the Union Ministry of Agriculture. This was conducted on a properly stratified random sample of farms in the State as a whole, covering 400 farmers. In the year 1972-73 the percentage of area under hybrid bajra to the total area under bajra was as small as 4.68 per cent. This is in sharp contrast to the proportion of area under hybrid bajra estimated by the Statistician for the whole State; 14.07 per cent in 1972-73. This is a clear evidence of over-estimation of area under hybrid bajra by the Statistician during the year 1972-73.

We may, therefore, assume that the area under hybrid bajra did not exceed more than 5 per cent of the total bajra area even in the earlier two years, 1968-70. With the given yield rates of hybrid bajra, as we do not consider these yield rates to be over-estimated, and 5 per cent area under it, we have calculated total production of hybrid bajra for the years 1968-70. We have, further, estimated and compared yield rates of local bajra in the State for these two years. It is seen that these are fairly comparable to the yield rates of local bajra in the State for the 12 years previous to the introduction of hybrid bajra. This indicates that even during the years 1968-70 the area under hybrid bajra may not have

been more than 5 per cent of the total bajra area in the State and definitely not as high as estimated by the Statistician (8.15 per cent and 10.44 per cent). In the other years, 1970-73, the area under hybrid bajra can be considered to be less than 5 per cent of the total bajra area in the State and surely not as high as 10 to 18 per cent.

We have seen that there is no reason to suspect the estimated average yield rate of hybrid bajra in the State to be over-estimate. We have also seen that the yield rates for the years 1968-69 and 1969-70 have been at least four and a half times higher than the estimated yield rate of local bajra in the years before the introduction of hybrid seed in the State. During the years 1970-71 to 1972-73, the yield rates of hybrid bajra have declined, though still 2 to 3 times higher than the average yield rate of local bajra. The reason for such decline in yield rate may be attributed to the drought conditions prevailing in the State in the years 1971-72 and 1972-73, but the same cannot be said to be true for the years 1973-74 and 1974-75, when the yield rates of hybrid bajra, as noted in our sample survey, were much lower as compared to the years 1968-70. The decline in yield rates in the years 1971-73, therefore, are likely to have been caused by a soil borne fungus disease 'Downy Mildew', which affected the crop seriously in the later years, than the drought conditions prevailing during the above years.

It was expected that hybrid bajra, being a shorter

duration crop than local bajra, the year to year fluctuation in its yield would be less than in case of local bajra. In view of this, it is necessary to examine the available evidence about the fluctuation in the yield rates of the two varieties from year to year, as well as from region to region. Three sets of data are available to us for the purpose: (a) the Statistician's estimates of yields of hybrid and local bajra in different districts, (b) the results of the F.V. trials on hybrid and local varieties in different districts, and (c) the results of agronomic experiments in the different experiment stations in the State. We now proceed to examine these data one by one.

The Statistician's estimates of average yield rates of the two varieties are available for five years, 1968-69 to 1972-73, for 12 districts (Table 4.3.9). The 'F' test for the difference between the variance of the two varieties was not significant for any district; however, it was significant when the data for all the 12 districts were pooled, showing variance of hybrid bajra to be significantly larger. The coefficient of variation of the yield rate of hybrid bajra was little less than that of local in 10 of the 12 districts. Coefficient of variation with pooled data for hybrid bajra was slightly lower (40.19 per cent) than for local bajra (42.62 per cent). Thus overall it appeared that while the absolute variance of the yield rate of hybrid bajra was slightly lower than that of local bajra, its percentage

**Table 4.3.9 : Per Hectare Estimated Yield Rates of Hybrid and Local Bajra in Different Districts by the Statistician, Department of Agriculture, 1968-69 to 1972-73**

Sr. District No.	(Yield kgs./hectare)						
	Average yield of Hybrid	Standard deviation	Coefficient of variation	Average yield of Local Bajra	Standard deviation	Coefficient of variation	'F' value
1. Nasik	1539	277	17.99	909	188	20.68	2.15
2. Dhulia	1484	278	18.73	726	143	19.69	3.76
3. Jalgaon	1180	140	11.86	668	83	12.42	2.85
4. Ahmednagar	1489	315	21.15	885	186	21.01	2.85
5. Poona	1648	413	25.06	1036	311	30.01	1.76
6. Sholapur	940	91	9.68	512	44	8.59	4.29
7. Satara	1151	272	23.63	728	190	26.09	2.03
8. Sangli	807	470	58.24	474	278	58.64	2.86
9. Aurangabad	832	286	34.37	502	188	37.45	2.30
10. Parbhani	774	271	35.01	478	184	38.49	2.15
11. Bhir	865	451	52.13	522	307	58.81	2.16
12. Osmanabad	856	330	38.55	515	203	39.41	2.63

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 3.99*
Between centres	5729911	11	520901	Coefficient of variation Between centres = 63.78 % Within centres = 31.80 % Total = 40.19 %
Within centres	5865203	45	130337	
Total	11595114	56	207055	

**Analysis of variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 3.26*
Between centres	1993929	11	181266	Coefficient of variation Between centres = 64.15 % Within centres = 35.54 % Total = 42.62 %
Within centres	2499856	45	55552	
Total	4493785	56	80246	

variation around its mean was quite high and, only, slightly lower than that of local bajra.

The second set of data relate to F.V. Trials on the farmers' fields conducted over seven years, from 1966-67 to 1972-73 (Table 4.3.10), in seven districts. The 'F' test showed the variances of the yield rates of hybrid and local bajra to be not significantly different in any district. But test of significance with pooled data showed the variance of hybrid bajra was significantly higher (as was the case with the Statistician's survey). The comparison of the coefficients of variation, however, showed a different picture; in three out of the five districts the coefficient of variation was higher for hybrid bajra, and also with pooled data the coefficient of variation of hybrid was as large as or that of local bajra (41.92 per cent and 41.50 per cent respectively). Thus, while the Statistician's survey showed somewhat lower fluctuations of hybrid bajra yield, F.V.T. data did not reveal any significant difference.

The data from the different agricultural research stations of the State was more, but rather difficult to handle for our purpose. Test of significance for the difference in the variances of the yield rates of the two varieties could be carried out for only two research stations, and F value was not significant at any station (Table 4.3.11). However, even pooling the data for all the 10 stations the 'F' test turned out to be insignificant, showing no significant

**Table 4.3.10 : Per Hectare Yield of Bajra under Fertilizer and Varietal Trials on Cultivator's Fields in Different Districts of Maharashtra, 1966-67 to 1972-73 (with 45 kgs. Nitrogen and 34 kgs. Phosphoric Acid per Hectare)**

(Yield kgs./hectare)

Sr. District No.	Average yield of hybrid	Standard deviation	Coefficient of variation	Average yield of Local bajra	Standard deviation	Coefficient of variation	'F' value	't' value
1. Nasik	1308 (6)	237	18.11	986 (6)	116	11.76	4.162	2.75*
2. Dhulia	-	-	-	603 (3)	59	9.78	-	-
3. Poona	942 (5)	332	35.24	586 (6)	149	25.42	5.145	2.15
4. Ahmednagar	1270 (5)	209	16.45	718 (6)	356	49.58	2.795	2.80*
5. Aurangabad	923 (3)	180	19.50	705 (6)	102	14.46	3.879	2.05
6. Bhir	1413 (3)	723	51.16	-	-	-	-	-
7. Satara	565 (4)	109	19.29	370 (3)	139	37.56	1.845	1.77

Note: Figures in brackets indicate number of observations on which average is based.

\* Shows significance at 5 per cent level.

#### Analysis of Variance of Pooled Data - HYV

	s.s.	d.f.	Mean s.s.	F = 2.58
Between centres	1940262	5	388052	Coefficient of variation = 58.16 %
Within centres	2707006	18	150389	Within centres = 36.13 %
Total	4647268	23	202055	Total = 41.92 %

#### Analysis of variance of Pooled Data - Local

	s.s.	d.f.	Mean s.s.	F = 2.52
Between Centres	686281	5	137256	Coefficient of variation = 55.63 %
Within centres	760942	14	54353	Within centres = 35.03 %
Total	1447223	19	76169	Total = 41.50 %

**Table 4.3.11 : Per Hectare Average Yield of Bajra Recorded in Different Experiment Stations in Maharashtra by Adopting Standard Cultural Practices**

Sr. No.	Research Station	(Yield kgs./hectare)						
		Average yield of Hybrid	Standard deviation	Coefficient of variation	Average yield of Local Bajra	Standard deviation	Coefficient of variation	'F' value
1.	Niphad	777 (6)	283	36.42	734 (24)	478	65.12	2.47
2.	Dhulia	1699 (7)	434	25.54	840 (3)	156	18.57	6.04
3.	Karad	796 (4)	520	65.32	-	-	-	-
4.	Parbhani	1432 (5)	705	47.57	-	-	-	-
5.	Vaijapur	1077 (5)	285	26.46	-	-	-	-
6.	Poona	-	-	-	677 (8)	399	58.93	-
7.	Chas	-	-	-	512 (6)	251	49.02	-
8.	Kopergaon	-	-	-	1498 (4)	444	29.63	-
9.	Jaur	-	-	-	540 (5)	173	32.03	-
10.	Sholapur	-	-	-	382 (3)	179	46.85	-

Note: Figures in brackets indicate number of observations on which average is based.

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean ss.	F = 2.10
Between centres	2546160	4	636540	Coefficient of variation
Within centres	3923367	13	301797	Between centres = 64.06 %
Total	6469527	17	380560	Within centres = 44.13 %
				Total = 49.59 %

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 3.34*
Between centres	3342784	6	557130	Coefficient of variation
Within centres	6331071	38	166607	Between centres = 98.93 %
Total	9673855	44	219860	Within centres = 54.11 %
				Total = 62.20 %



difference in the yield variances of hybrid and local bajra. A comparison of the coefficient of variation of these two varieties showed that in Niphad coefficient of variation of hybrid was lower while at Dhulia it was more than that of local bajra. The coefficient of variation with the pooled data of all the 10 stations showed hybrid with lesser variation in yield rate (49.59 per cent) than that of local bajra (62.20 per cent).

On the basis of the available statistical evidence, one is led to the conclusion that, hybrid bajra has not been able to show consistently lesser year to year or district to district fluctuation in yield rate than local bajra.

In the ultimate analysis, the cultivator is bound to think in terms of the probable net income. To the extent additional net income, net of additional costs, is not only significant but also certain or near certain, he would not hesitate incurring the additional cost on cultivation. The problem, therefore, seems to be that of his faith in realising additional net income by going in for hybrid bajra and considering the variations in yield rates there does not seem to be any reason why he should not lay faith in the traditional variety. Thus, the probability of getting additional net income may be considered to give us somewhat better ground to explain the decline in area and production of hybrid bajra. For the purpose we will consider the estimated mean yield and coefficient of variation in yield between years as well as the

estimated cost of production of hybrid bajra in case of the F.V.Ts and experimental stations. We find that there is a 50 per cent probability that a cultivator will not be able to recover his cost of production during a year. Similarly, if we consider the coefficient of variation between districts (centres) it appears that in about 50 per cent of the districts (centres) the cultivators may not be able to recover the cost of production of hybrid bajra. It is not, therefore, surprising that cultivators, by and large, were reluctant to use hybrid bajra seed.

Hybrid bajra is at least one and a half times as expensive to grow as local bajra on account of the high cost of hybrid bajra seed, of increased use of fertilizers and of insecticides which are more or less a must for a profitable crop. If the yield variation is anything like 50 per cent, then it is obvious that the farmer would be reluctant to risk the much larger cost that production of hybrid bajra required. Of course, the situation would be different if the average yield rate of hybrid bajra, at the same level of input, were much larger. Then even this high rate of uncertainty attached to the average yield rate may not dissuade the cultivator from growing hybrid bajra. This is what is noticed till 1970. The high variability in yield rate of hybrid bajra till 1970 did not appear to adversely affect the net income of a farmer as the yield rate of hybrid bajra was very much higher (about two and a half times) than that of local bajra on cultivators'

fields. Since the year 1970 onwards, when the crop was affected by a soil borne disease, the yield rate of hybrid bajra declined, though the yield happened to be still more than that of local bajra. Under the changed situation, it is clear that the farmers are likely to run the risk, to a much greater extent, of incurring a loss in the process.

The high variability in its turn would lead to a lesser use of fertilizers and insecticides. The average input of N fertilizer by the farmers surveyed by us was much less, <sup>barely</sup> largely 20 per cent (4 kg N out of 20 kgs. per acre recommended) as compared to recommended standards. This, of course, does not mean that the yield rate was low mainly because the fertilizer application was low. The important reason for this, as noted earlier, may be the emergence of soil borne fungus disease 'Downy Mildew'. This disease has, since 1970-71 onwards, proved the greatest deterrant to extension of hybrid bajra. It has also been noted that during the last 2-3 years the disease has affected the local bajra to a significant extent. The real point, however, is that there is no known control measure for this disease, once it appeared. Steady eradication of affected plants from the field and three years rotation of crops have been suggested as preventive measures besides the use of resistant varieties.

Our survey of the 20 farmers in one village shows that average net income of a farmer from one acre of hybrid bajra was not higher than his average net income from one acre of

local bajra grown by him. The data are presented in Table 4.3.12. All the inputs, including the home supplied, as well as outputs, in the above Table have been valued at market prices current during the year of survey (1974-75). The net profit by hybrid and local bajra for the 20 farmers is reported below :

	<u>HYV</u>	<u>Local</u>
1. Irrigated farms :		
(a) Irrigated Bajra	258	308
(b) Unirrigated Bajra	137	144
2. Unirrigated farms :		
Large	155	191
Medium	162	158
Small	69	105
All	129	151

It is clear from the above Table that hybrid bajra showed no improvement over the local variety. This becomes even more important when one notes that the labour input per acre of hybrid was not higher than per acre of local bajra (Rs. 99.76 for hybrid and Rs. 92.05 for local). All the increase in yield of hybrid bajra has gone to meet the extra cost of the material inputs leaving nothing to the cultivator. Naturally, this is the average picture. About a half of the farmers surveyed showed some net profit while the other half showed a net loss. Such being the situation it is not surprising that not many farmers cared to grow hybrid bajra in the village and, of course, in the State.

Table 4.3.12 : Per Acre Expenditure on and Receipts from Hybrid and Local Bajra for a Sample of 20 Farmers in a Village in Aurangabad District, Maharashtra, 1974-75

(in Rs.)													
Sr. No.	Item/Group	Irrigated Group				Unirrigated Group					Over all Dry Bajra		
		Irrigated Bajra		Dry Bajra		Large		Medium		Small		Rs.	%
		Rs.	%	Rs.	%	Rs.	%	Rs.	%	Rs.	%		
<u>Hybrid Bajra</u>													
1.	Preparatory tillage	60.37	17.85	60.44	33.48	59.50	23.27	54.82	28.46	41.80	21.30	54.14	26.25
2.	Application of F.Y.M.	31.62	9.35	17.25	9.56	26.16	10.23	11.68	6.06	30.80	15.69	21.47	10.41
3.	Application of Fertilizers	95.44	28.22	19.56	10.84	39.52	15.46	10.74	5.57	18.80	9.58	22.15	10.74
4.	Seed and Sowing	17.75	5.25	17.75	9.83	18.75	7.33	18.89	9.82	18.45	9.41	18.46	8.95
5.	After care	30.75	9.09	33.75	18.70	36.00	14.08	28.21	14.64	26.60	13.55	31.14	15.10
6.	Irrigation	14.21	4.23	-	-	-	-	-	-	-	-	-	-
7.	Plant Protection	64.75	19.15	19.00	10.53	60.00	23.47	54.43	28.26	44.20	22.52	44.41	21.53
8.	Harvesting and Thrashing	23.25	6.86	12.75	7.06	15.75	6.16	13.85	7.19	15.60	7.95	14.48	7.02
9.	Total Expenditure	338.14	100.00	180.50	100.00	255.68	100.00	192.62	100.00	196.25	100.00	206.25	100.00
	Yield in quintals: Grain	3.87		2.06		2.67		2.30		1.57		2.14	
	Fodder	11.61		6.18		8.01		6.90		7.65		7.17	
	Value of Yield : Grain	503.10		267.80		347.10		299.00		204.10		278.20	
	Fodder	92.88		49.44		64.08		55.20		61.20		57.36	
	Total	595.98		317.24		411.18		354.20		265.30		335.56	
	Profit	257.84		136.74		155.50		161.58		69.05		129.31	
<u>Local Bajra</u>													
1.	Preparatory tillage	60.44	26.75	48.25	41.15	62.31	41.95	54.71	36.30	45.95	39.91	52.80	39.73
2.	Application of F.Y.M.	48.87	21.63	21.25	18.12	20.25	13.63	27.18	18.04	16.10	13.98	21.19	15.94
3.	Application of Fertilizers	37.19	16.46	-	-	15.28	10.29	13.09	8.69	7.99	6.94	9.09	6.84
4.	Seed and Sowing	10.06	4.45	10.50	8.96	11.70	7.88	10.07	6.68	10.00	8.68	10.57	7.95
5.	After care	33.00	14.62	28.25	24.09	27.00	18.18	35.36	23.46	27.30	23.72	29.48	22.18
6.	Irrigation	16.24	7.19	-	-	-	-	-	-	-	-	-	-
7.	Plant Protection	-	-	-	-	-	-	-	-	-	-	-	-
8.	Harvesting and Thrashing	20.12	8.90	9.00	7.68	12.00	8.07	10.28	6.83	7.80	6.77	9.77	7.36
9.	Total expenditure	225.92	100.00	117.25	100.00	148.54	100.00	150.69	100.00	115.14	100.00	132.90	100.00
	Yield in quintals : Grain	3.14		1.54		2.00		1.82		1.30		1.67	
	Fodder	7.85		3.85		5.00		4.55		3.25		4.17	
	Value of Yield : Grain	471.00		231.00		300.00		273.00		195.00		250.50	
	Fodder	62.80		30.80		40.00		36.40		26.00		33.36	
	Total	533.80		261.80		340.00		309.40		221.00		283.86	
	Profit	307.88		144.55		191.46		158.71		105.86		150.96	

Of course, this is a picture when the yield of hybrid bajra had declined due to soil borne disease. Prior to this i.e. 1969-70, the yield of hybrid bajra was much higher (about 6 quintals per acre of hybrid bajra against 3 quintals per acre of local bajra) on cultivators fields. Considering these yield rates and recommended cultural practices, we have calculated the net profit from both hybrid and local bajra. The net profit from hybrid bajra worked out to Rs. 221 per acre as against Rs. 143 per acre of local bajra. With the reported results of about 55 per cent larger net income per acre it was quite in order that larger number of cultivators took up hybrid bajra cultivation.

The whole exercise can be summarized as below :

The area under bajra in the State increased continuously from 1.8 million to 2.1 million hectares in a matter of four years, 1965-66 to 1969-70. This increase in area was also accompanied by a steady increase in yield per hectare during the same period. It increased from a low of 202 kgs. in 1965-66 to 402 kgs. in 1970-71. This significant rise was due to the adoption of hybrid bajra seed by increasing number of farmers since 1966 to 1970. The average yield rate of hybrid bajra, during this period, was much higher on cultivators' fields than that of local bajra. A sharp decline in the production, area and yield rate of bajra in the State was noticed since the year 1970-71 onwards. This was partly due to the drought conditions prevailing during the years 1971-73,

the more serious development being the widespread affectation of bajra crop, beginning with the hybrid variety, by a soil borne fungus disease 'Downy Mildew'.

#### 4.4 Rice

Rice is one of the important foodgrains grown in Maharashtra. It accounts for about 7 per cent of the total area under crops (average for five years ending 1972-73) and about 11 per cent of the total area under foodgrains and a little over 24 per cent of the total production of foodgrains in the State. The purpose of this exercise is to examine the performance of Rice during the period 1956-57 to 1972-73, the last year for which data on acreage, production etc. are available. The plan of the study is similar to that of jowar and bajra.

During the 17 years, since 1956-57, total production of rice in the State fluctuated between 1.1 and 1.6 million tonnes, excluding the years of very low production (1965-66 and 1972-73). If one takes all the 17 years into account (Table 4.4.1) the annual compound growth rate of production comes to -0.60 per cent (Table 4.4.1A). This decline, however, is due to inclusion of the two years of very low production (1965-66 and 1972-73). Excluding these two years, we find that the annual compound growth rate to be only +0.70 per cent which is statistically insignificant and indicates a very low increasing trend in rice production. The annual growth rate from 1956-57 to 1964-65 i.e. pre-high yielding varieties period, was +2.30 per cent, statistically significant, while for the later period i.e. post-HYV seed period, from 1964-65 to 1971-72 (excluding the years 1965-66 and 1972-73)



**Table 4.4.1 : Production of Rice in Maharashtra and Its Agro-Climatic Zones,  
1956-57 to 1972-73**

		(Production in '00 tonnes)							
Sr. No.	Year	Bombay	Nasik	Poona	Kolha- pur	Auran- gabad	Amra- vati	Nagpur	Maha- rashtra
1.	1956-57	4802 92.11	484 95.84	636 88.09	1237 72.64	326 55.16	218 132.12	4399 93.59	12102 88.99
2.	1957-58	5385 103.30	403 79.80	463 64.13	1360 79.86	332 56.17	199 120.60	3829 81.47	11971 88.03
3.	1958-59	6280 120.47	531 105.15	551 76.31	1237 72.64	255 43.15	154 93.33	4693 99.51	13701 100.75
4.	1959-60	4868 93.38	501 99.21	694 96.12	1477 86.73	501 84.77	116 70.30	4612 98.13	12769 93.90
5.	1960-61	5213 100.00	505 100.00	722 100.00	1703 100.00	591 100.00	165 100.00	4700 100.00	13599 100.00
6.	1961-62	5861 112.43	596 118.02	874 121.05	1722 101.11	464 78.51	114 69.09	5407 115.04	15038 110.58
7.	1962-63	5256 100.82	499 98.81	794 109.97	1714 100.64	588 99.49	146 88.48	3622 77.06	12619 92.79
8.	1963-64	6102 117.05	616 121.98	795 110.11	1449 85.08	623 105.41	136 82.42	5051 107.47	14772 108.62
9.	1964-65	5917 113.50	604 119.60	676 93.63	1393 81.79	694 117.43	226 136.97	4979 105.94	14489 106.54

(continued)

Table 4.4.1 : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
10.	1965-66	4408* 84.56	252 49.90	335 46.40	822 48.27	353 59.73	123 74.54	2526 <sup>o</sup> 53.74	8819 64.85
11.	1966-67	4388 84.17	366 72.47	437 60.52	1596 93.72	263 44.50	80 48.48	3349 71.25	10479 77.05
12.	1967-68	6593 126.47	537 106.33	559 77.42	1264 74.22	352 59.56	138 83.63	4632 98.55	14075 103.50
13.	1968-69	5376 103.13	415 82.18	572 79.22	1226 71.99	422 71.40	172 104.24	5000 106.38	13183 96.94
14.	1969-70	5295 101.57	340 67.33	442 61.23	1336 78.45	422 71.40	168 101.81	5670 99.36	13673 100.54
15.	1970-71	6873 131.84	551 109.11	464 64.26	1617 94.95	436 73.77	181 109.70	6339 134.87	16461 121.04
16.	1971-72	5707 109.48	404 80.00	484 67.03	1547 90.84	222 37.56	173 104.84	5156 109.70	13693 100.69
17.	1972-73	3917 75.14	137 27.13	119 16.48	773 45.39	40 6.77	73 44.24	2399 51.04	7458 54.84

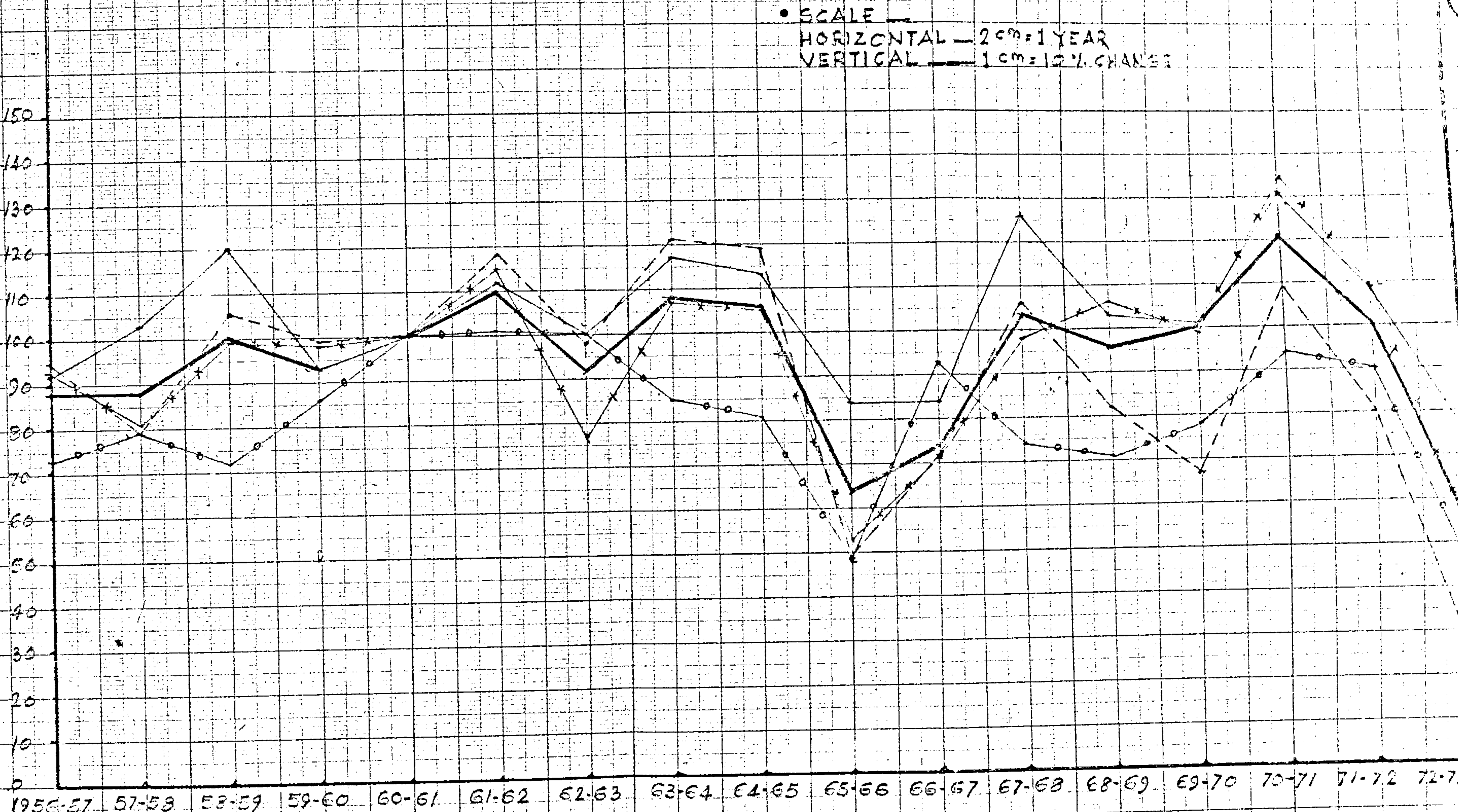
**Table 4.4.1A : Annual Compound Growth Rates of Production of Rice in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Bombay	Nasik	Poona	Kolha-pur	Nagpur
1.	1956-57 to 1972-73	-0.60 (0.02)	-0.12 (0.00)	-3.49* (0.23)	-4.94* (0.30)	-1.09 (0.06)	-0.23 (0.00)
@2.	1956-57 to 1971-72 (Except 1965-66)	+0.70 (0.09)	@+1.10 (0.25)	-1.09 (0.10)	-2.12 (0.20)	+0.20 (0.01)	@+2.00* (0.47)
3.	1956-57 to 1964-65	+2.30* (0.43)	+1.70 (0.22)	+3.70* (0.56)	+4.80 (0.42)	+2.40 (0.24)	+1.60 (0.11)
4.	1964-65 to 1972-73	-0.74 (0.00)	-0.35 (0.00)	-6.67 (0.16)	-9.45 (0.28)	-0.62 (0.06)	+1.20 (0.01)
5.	1964-65 to 1971-72 (Except 1965-66)	+3.20 (0.32)	@+1.10 (0.01)	-2.30 (0.06)	-3.01 (0.20)	+2.30 (0.21)	+3.50 (0.55)

Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods in case of the individual zones are shown by \* in Table 4.4.1.



• PRODUCTION OF RICE IN MAHARASHTRA AND ITS AGRO-CLIMATIC ZONES 1956-57 TO 1972-73

- BOMBAY —————
- NASIK —————
- KOLHAPUR — o o —
- NAGPUR — x x —
- STATE —————

it was +3.20 per cent, statistically insignificant. The non-drought years of the post-HYV period show an upward trend. This upward trend in production is mainly because of the higher production in the year 1970-71. If we compute the growth rate of production excluding the year 1970-71, it comes to +0.58 per cent only.

During the entire period under study, the total area under rice fluctuated between 1.2 and 1.3 million hectares (Table 4.4.2). The annual compound growth rate for the 17 years, excluding 1972-73, was +0.50 per cent, statistically significant (Table 4.4.2A). During the pre-HYV seed period upto 1964-65, the area increased by 1.4 per cent. During the subsequent period, the area under the crop was almost stagnant (growth rate +1.0 per cent excluding 1972-73). On the whole, the area under rice in both the periods has not shown any significant upward or downward trend and practically remained stagnant.

Like acreage, yield per hectare of rice also shows no significant trend during these two decades (Table 4.4.3). Of course, the annual compound growth rate for the entire period was -1.03 per cent, but this is mainly due to the unfavourable conditions in the years 1965-66 and 1972-73 (Table 4.4.3A). Excluding these two years we find the yield rate to be virtually unchanged over the entire period (growth rate +0.20 per cent). During the period of HYV seed (excluding drought years) the growth rate was +3.10 per cent but



**Table 4.4.2 : Area under Rice in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

(Area in '00 hectares)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1956-57	4162 100.48	731 99.45	653 90.82	1213 88.80	671 83.87	222 77.35	4474 87.16	12126 91.99
2.	1957-58	4195 101.28	776 105.57	676 94.02	1237 90.55	748 93.50	244 85.02	4578 89.18	12454 94.48
3.	1958-59	4220 101.88	761 103.53	699 97.21	1262 92.38	760 95.00	248 86.41	4659 90.76	12609 95.65
4.	1959-60	4135 99.83	731 99.45	722 100.41	1343 98.31	739 92.37	261 90.94	4815 93.80	12746 96.69
5.	1960-61	4142 100.00	735 100.00	719 100.00	1366 100.00	800 100.00	287 100.00	5133 100.00	13182 100.00
6.	1961-62	4151 100.22	748 101.77	732 101.80	1409 103.15	861 107.62	295 102.78	4957 96.57	13153 99.78
7.	1962-63	4163 100.51	733 99.73	740 102.92	1470 107.61	887 110.87	338 117.77	5065 98.67	13396 101.62
8.	1963-64	4163 100.51	722 98.23	742 103.19	1490 109.08	926 115.75	378 131.70	5106 99.47	13527 102.61
9.	1964-65	4176 100.82	723 98.36	732 101.80	1444 105.71	1010 126.25	321 111.85	5233 101.95	13639 103.46

(continued)

Table 4.4.2 : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
10.	1965-66	4160 100.43	716 97.41	707 98.33	1395 102.12	1021 127.62	318 110.80	4774 93.00	13091* 99.31
11.	1966-67	4177 100.84	718 97.68	707 98.33	1450 106.15	939 117.37	356 124.04	5204 101.38	13551 102.80
12.	1967-68	4141 99.97	630 85.71	646 89.84	1403 102.71	875 109.37	364 126.83	5254 102.35	13313 100.99
13.	1968-69	4156 100.33	600 81.63	600 83.45	1364 99.85	844 105.50	342 119.16	5375 104.71	13281 100.75
14.	1969-70	4114 99.32	585 79.59	614 85.39	1318 96.48	852 106.50	348 121.25	5413 105.45	13244 100.47
15.	1970-71	4172 100.72	648 88.16	579* 80.53	1360 99.56	861 107.62	323 112.54	5483 106.81	13426 101.85
16.	1971-72	4221 101.91	597 81.22	569* 79.14	1337 97.87	774 96.75	335 116.72	5507 107.28	13340 101.19
17.	1972-73	4042 97.58	639 86.94	479 66.62	1262 92.38	811 101.37	338 118.11	5277 102.80	12848 97.47

**Table 4.4.2A : Annual Compound Growth Rates of Area under Rice in Maharashtra, 1956-57 to 1972-73**

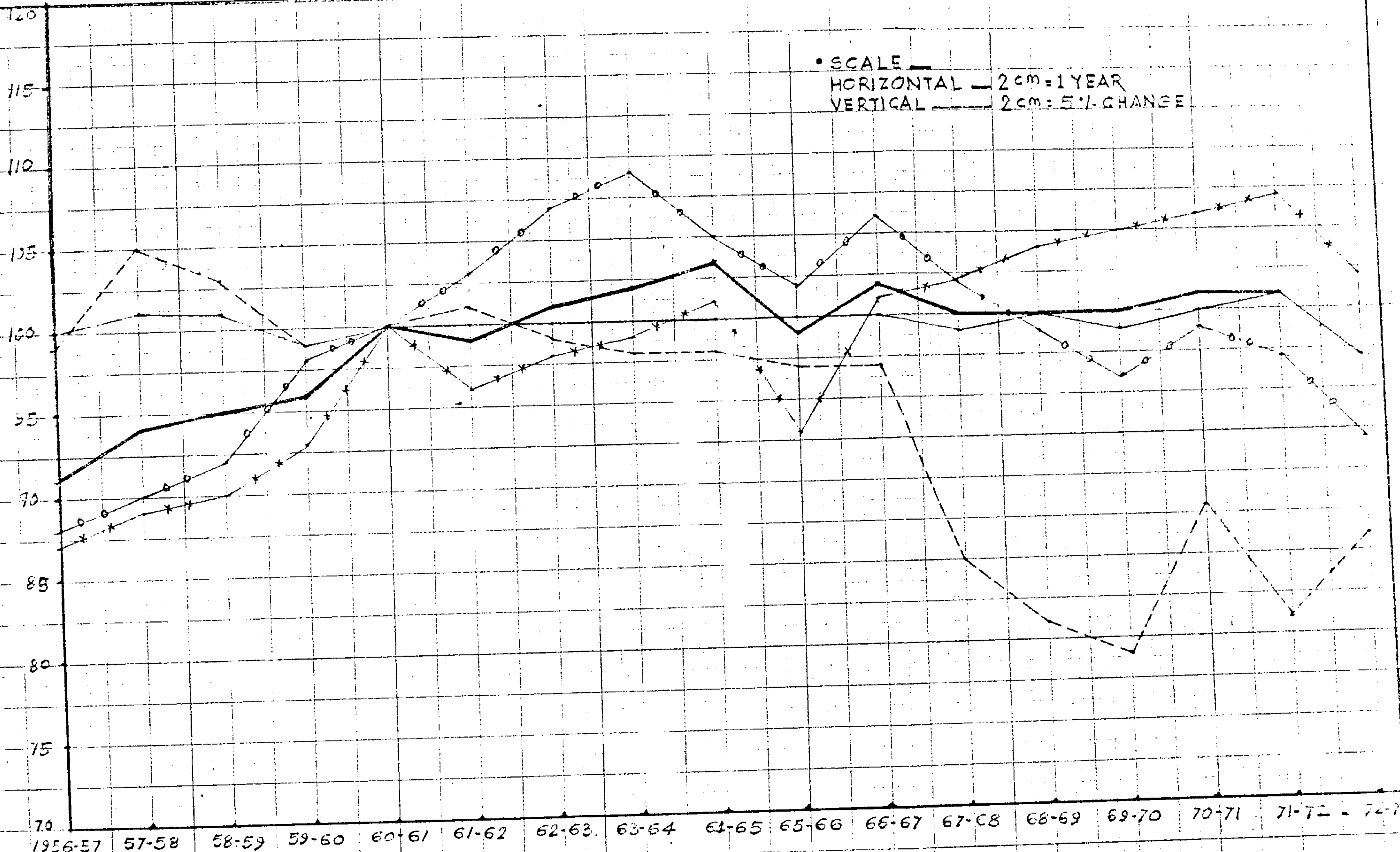
Sr. No.	Period	Maha-rashtra	Bombay	Nasik	Poona	Kolha-pur	Nagpur
1.	1956-57 to 1972-73	+0.30* (0.46)	-0.07 (0.04)	-1.60* (0.96)	-1.67* (0.49)	+0.20 (0.05)	+1.10* (0.55)
2.	1956-57 to 1971-72	+0.50* (0.28)	0.00 (0.00)	-	@-0.67 (0.15)	+0.50 (0.17)	-
3.	1956-57 to 1964-65	+1.40* (0.44)	-0.05 (0.00)	-0.69* (0.61)	+1.40* (0.69)	+2.70* (0.76)	+1.90* (0.68)
4.	1964-65 to 1972-73	-0.32 (0.05)	-0.18 (0.08)	-2.17* (0.44)	-4.55* (0.86)	-1.37* (0.75)	+1.00 (0.22)
@5.	1964-65 to 1971-72	+1.00* (0.72)	0.00 (0.00)	-	-4.10 (0.90)	-0.87 (0.31)	-

Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods are shown by \* in Table 4.4.2.





• AREA UNDER RICE IN MAHRASHTRA AND ITS AGRO CLIMATIC ZONES 1956-57 TO 1972-73

- BOMBAY ———
- NASIK ———
- KOLHAPUR —○—
- NAGPUR —x—
- STATE ———

**Table 4.4.3 : Per Hectare Yield Rate of Rice in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

		(Yield kgs./hectare)							
Sr. No.	Year	Bombay	Nasik	Poona	Kolha- pur	Auran- gabad	Amra- vati	Nagpur	Maha- rashtra
1.	1956-57	1153 91.58	662 96.50	973 96.91	1019 81.78	485 62.15	981 170.90	933 107.31	998 96.61
2.	1957-58	1283 101.91	519 75.66	684 68.13	1099 88.20	443 60.02	815 141.98	836 91.26	961 93.03
3.	1958-59	1488 118.19	697 101.60	788 78.49	980 78.65	335 45.39	620 108.01	1007 109.93	1086 105.13
4.	1959-60	1177 93.49	685 99.85	961 95.72	1099 88.20	677 91.73	444 77.35	957 104.47	1001 96.90
5.	1960-61	1259 100.00	686 100.00	1004 100.00	1246 100.00	738 100.00	574 100.00	916 100.00	1033 100.00
6.	1961-62	1412 112.15	797 116.18	1193 118.82	1222 98.07	538 72.90	386 67.25	1090 118.99	1142 110.55
7.	1962-63	1262 100.24	680 99.12	1072 106.77	1167 93.66	662 89.70	431 75.09	715 78.05	942 91.19
8.	1963-64	1466 116.44	852 124.20	1071 106.67	1174 94.22	672 91.05	359 62.54	988 107.86	1113 107.74
9.	1964-65	1417 112.55	836 121.86	923 91.93	964 77.37	687 93.09	704 122.64	952 103.93	1061 102.71

(continued)

Table 4.4.3 : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolha- pur	Auran- gabad	Amra- vati	Nagpur	Maha- rashtra
10.	1965-66	1059 84.11	352 51.31	473 47.11	588 47.19	345 46.75	386 67.24	529 57.75	670 64.86
11.	1966-67	1050* 83.40	509 74.20	618* 61.55	1101 88.36	280 37.94	224 39.02	643* 70.19	773 74.83
12.	1967-68	1592 126.69	853 124.34	865 86.15	901 72.31	402 54.47	379 66.03	881 96.17	1055 102.13
13.	1968-69	1294 102.80	692 100.87	953 94.92	899 72.15	500 67.75	503 87.63	930 101.53	993 96.13
14.	1969-70	1287 102.22	581 84.70	720 71.71	1014 81.38	495 67.07	483 84.14	1047 114.30	1032 99.90
15.	1970-71	1647 130.82	850 123.91	801 79.78	1189 95.42	506 68.56	560 97.56	1156 126.20	1226 118.68
16.	1971-72	1352 107.39	677 98.69	851 84.76	1157 92.86	287 38.89	516 89.89	936 102.18	1026 99.32
17.	1972-73	969 79.96	214 31.19	248 24.70	613 49.20	49 6.64	229 39.89	455 49.67	580 56.15

**Table 4.4.3A : Annual Compound Growth Rates of Yield Per Hectare of Rice in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Bombay	Nasik	Poona	Kolha-pur	Nagpur
1.	1956-57 to 1972-73	-1.03 (0.07)	-0.05 (0.00)	-1.91 (0.07)	-3.15 (0.18)	-1.42 (0.11)	-1.14 (0.05)
2.	1956-57 to 1971-72 (Except 1965-66)	+0.20 (0.00)	@+1.10 (0.25)	+0.60 (0.02)	@-0.23 (0.01)	-0.23 (0.01)	@+0.90 (0.13)
3.	1956-57 to 1964-65	+1.00 (0.17)	+1.80 (0.26)	+4.20* (0.57)	+3.30 (0.27)	+0.80 (0.04)	+0.30 (0.00)
4.	1964-65 to 1972-73	-0.39 (0.00)	-0.16 (0.00)	-4.63 (0.07)	-4.52 (0.09)	+0.80 (0.01)	+0.20 (0.00)
5.	1964-65 to 1971-72 (Except 1965-66)	+3.10 (0.29)	@+0.70 (0.02)	+0.50 (0.00)	+1.60 (0.05)	+3.50 (0.52)	+2.40 (0.35)

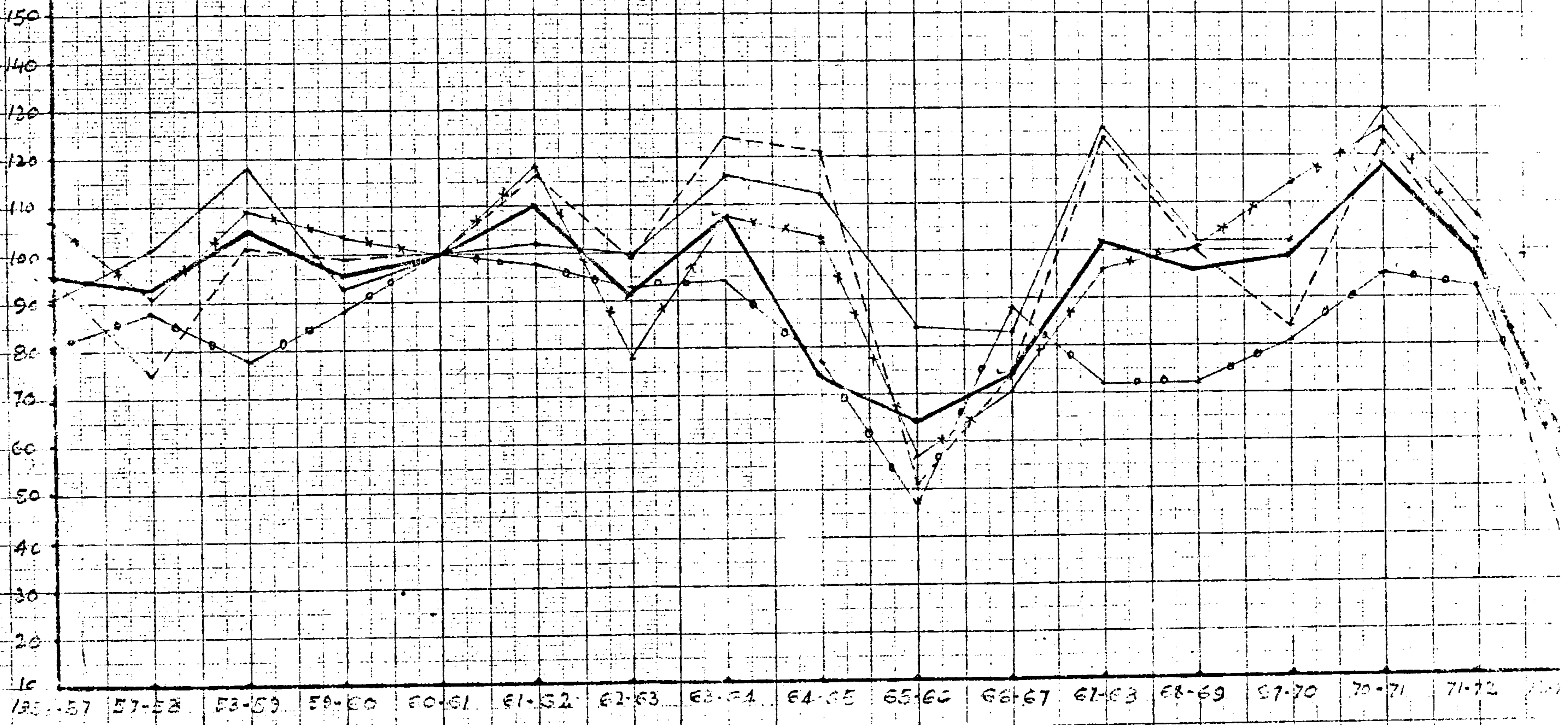
Note : Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods are shown by \* in Table 4.4.3.



• SCALE —  
 HORIZONTAL — 2cm = 1 YEAR  
 VERTICAL — 1cm = 10% CHANGE



• YIELD OF RICE IN MAHARASHTRA AND ITS AGRO CLIMATIC ZONES

1956-57 TO 1972-73

- NASHIK — — — — —
- BOMBAY — — — — —
- KOLHAPUR — — — — —
- NAGPUR — — — — —
- STATE — — — — —

statistically insignificant, and indicates small upward trend in yield rate. This increase is mainly because of the low yield in the year 1966-67 due to normal seasonal fluctuations. If we exclude the year 1966-67, the growth rate comes to +1.4 per cent only.

On the whole, therefore, we do not see any encouraging upward trend in production, area and yield of rice in the State during the last two decades, in spite of the introduction of high-yielding varieties seed.

Rice is mainly grown in three agro-climatic zones of the State, viz., Bombay, Nagpur and Kolhapur, of which Bombay and Nagpur account for about 72 per cent of the total area and Kolhapur about 10 per cent. Of the remaining 18 per cent, about 15 per cent is equally divided between Poona, Nasik and Aurangabad zones and about 3 per cent is in Amravati zone. During the entire period both Bombay and Nagpur zones have shown mild increasing trend in production (growth rate for Bombay was +1.10 per cent and for Nagpur +2.0 per cent, excluding the years of low production i.e. 1965-66, 1966-67 and 1972-73), in yield rate (for Bombay +1.10 per cent and Nagpur +0.90 per cent); and almost stagnancy in area under the crop (for Bombay '0' per cent and for Nagpur +1.10 per cent).

During the later years of this period, the years of HYV seed, total production of rice, since 1964-65 onwards, (excluding the years of very low production i.e. 1965-66,

1966-67 and 1972-73), has increased by 1.10 per cent in Bombay zone. In the same period production in Nagpur zone recorded an increase of 3.50 per cent. Area in Bombay zone remained unchanged while in Nagpur it increased by 1.00 per cent. Yield rate in Bombay showed a growth rate of +0.70 per cent, in Nagpur it was +2.40 per cent (both statistically insignificant). Thus Bombay zone has shown almost stagnancy in production, area and yield rate of rice while Nagpur zone has shown a small, though statistically insignificant, upward trend in all respects.

Production in Kolhapur zone during the entire period (excluding the years of very low production 1965-66 and 1972-73) was almost stagnant (growth rate +0.20 per cent). In the same period area under the crop and yield rate also remained mostly unchanged (growth rate of area +0.50 per cent and yield -0.23 per cent). In the later half of the period - 1964-65 onwards - production and yield rate recorded an increase of 2.30 per cent and 3.50 per cent (excluding the years 1965-66 and 1972-73), while area declined by -0.87 per cent (all statistically insignificant).

However, the two rice growing zones in Western Maharashtra, Nasik and Poona, showed a different trend in the later half of the period. During these years 1964-65 onwards, production in both the zones declined (growth rate for Nasik was -2.34 per cent and Poona -3.01 per cent, excluding the years 1965-66 and 1972-73), the same was the case with the

area under the crop (growth rate in Nasik was -2.17 per cent and in Poona -4.10 per cent); while yield rate remained mostly stagnant (growth rate for Nasik +0.50 per cent and Poona +1.60 per cent). The statistically insignificant decline in area under rice in Nasik and Poona zones does not seem to have effected the total rice area of the State adversely.

In the light of the above performance in production, area and rate of yield of rice in the State during the last decade and a half, it is necessary to enquire into the performance of the factors that are considered to be important to the increase in the yield rate and production, namely, extension of irrigation and use of the new high-yielding varieties of rice, IR-8 and TN-1, and chemical fertilizers.

Of the factors mentioned above, irrigation may be dismissed as a factor of non-relevance in Bombay zone, since no more than 1.7 per cent of the total area under rice in the zone is irrigated. The Nagpur zone has mainly tank irrigation sufficient only for the late varieties of kharif rice. The area under irrigated rice in the zone is about 45 per cent of the total area under rice and it remained unchanged since 1960-61 onwards. In the State, as a whole, the area under irrigated rice remained almost unchanged (about 22 per cent of the total rice area) since 1960-61 onwards (Tables 4.4.4 and 4.4.4A). As the area under



irrigated rice is almost stagnant since 1960-61, we will not consider it as a factor of relevance.

Table 4.4.4 : Area under Irrigated Rice in Maharashtra, 1956-57 to 1971-72

(Area in '00 hectares)			
Sr. No.	Year	Gross irrigated cropped area	Total area under Rice Area under irrigated Rice
1.	1956-57	10802	12126
2.	1957-58	10842	12454
3.	1958-59	11023	12609
4.	1959-60	11717	12746
5.	1960-61	12182	13182
6.	1961-62	12336	13153
7.	1962-63	12782	13396
8.	1963-64	13130	13527
9.	1964-65	13639	13639
10.	1965-66	13880	13091
11.	1966-67	14133	13551
12.	1967-68	14762	13313
13.	1968-69	15568	13281
14.	1969-70	16232	13244
15.	1970-71	15703	13426
16.	1971-72	16216	13340

Bombay zone and to a large extent Nagpur zone are mono-crop areas growing rice. Bombay zone, where annual average rainfall is much higher (2200 to 2400 mm), and Nagpur zone, under tank irrigation which is sufficient only for the late varieties of kharif rice, are the major rice growing areas of the State. In other zones of the State, i.e.,

**Table 4.4.4A : Area under Irrigated Rice in Maharashtra and Its Agro-Climatic Zones, 1960-61 to 1970-71**

(Area in '00 hectares)

Sr. No.	Year	Bombay	Masik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1960-61	59 1.42	98 13.33	78 10.84	145 10.61	74 9.25	1 0.34	2268 44.18	2723 20.65
2.	1961-62	63 1.51	96 12.83	85 11.61	150 10.64	76 8.82	1 0.33	2189 44.15	2660 20.22
3.	1962-63	62 1.48	81 11.05	72 9.72	157 10.68	93 10.48	2 0.59	2340 46.19	2807 20.95
4.	1963-64	63 1.51	70 9.69	65 8.76	159 10.67	78 8.42	2 0.52	2393 46.86	2830 20.92
5.	1964-65	75 1.79	81 11.20	54 7.37	162 11.21	86 8.51	1 0.31	2413 46.11	2872 21.05
6.	1965-66	70 1.68	100 13.96	66 9.33	177 12.68	78 7.63	6 1.88	1989 41.66	2486 18.99
7.	1966-67	76 1.81	129 17.96	73 10.32	205 14.13	81 8.62	8 2.24	2325 44.67	2897 21.37
8.	1967-68	70 1.69	140 22.22	72 11.14	199 14.18	102 11.65	8 2.19	2407 45.81	2998 22.51
9.	1968-69	68 1.63	141 23.50	96 16.00	216 15.83	97 11.49	6 1.75	2451 45.60	3075 23.15
10.	1969-70	70 1.70	158 27.00	63 10.26	241 18.28	104 12.20	7 2.01	2494 46.07	3137 23.68
11.	1970-71	50 1.19	166 25.61	75 12.95	215 15.80	137 15.91	8 2.47	2487 45.35	2923 21.77
12.	1971-72	51 1.20	182 30.48	66 11.59	271 20.26	71 9.17	8 2.38	2447 44.43	3096 23.20

(Figures on line 2 are percentages to the total rice area.)

Kolhapur, Poona and Nasik, rice is mostly grown in the areas where annual rainfall is comparatively adequate than the respective zone.

Bombay, Nagpur and Kolhapur are the major rice growing zones of the State. Bombay zone covers about 31 per cent of the total rice area of the State. During the last 12 years, 1960-61 to 1970-71, gross irrigated area in different districts of the zone remained almost unchanged. Similarly area under irrigated rice has not increased beyond 1.5 per cent of the total rice area of the zone. Rice is almost wholly grown during the kharif season. Cultivation of rice in rabi season is not possible in this zone because of inadequate irrigation facilities.

Nagpur zone accounts for about 41 per cent of the total rice area of the State. Chanda and Bhandara are the major rice growing districts. Gross irrigated area, during the last 12 years, in these districts remained almost unchanged. About 96 per cent of the gross irrigated area is under rice in both these districts and there is no change in it during the last 12 years. Tank irrigation is the main source (more than 75 per cent area irrigated by this source) of irrigation and it is supplemental and sufficient only for the late varieties of kharif rice. To grow rice in rabi season is out of question in this major rice growing zone because of lack of irrigation facilities.

Kolhapur zone covers about 10 per cent of the total

rice area of the State. About 16 per cent of the total rice area in the zone is under irrigation. During the last 12 years in Satara, Sangli and Kolhapur districts of the zone the linear increase/decrease per annum in gross irrigated area in respective districts was -1.89, 13.33 and 14.98 hundred hectares. Area under irrigated rice in the same period increased by a linear rate of 2.88, 3.90 and 4.22 hundred hectares, while area under sugarcane, a perennially irrigated crop, increased by a linear rate of 4.09, 8.70 and 10.37 hundred hectares per annum. It shows that in Sangli and Kolhapur districts the major portion of the increased irrigation has been diverted to sugarcane crop.

Amravati zone accounts for about 3 per cent of the total rice area of the State. Out of this area only about 2 per cent is under irrigation.

Aurangabad zone and Poona zone each accounts for about 5 per cent of the total rice area of the State. During the last 12 years area under irrigated rice did not exceed 10 to 12 per cent of the total rice area of the respective zones.

Nasik zone covers about 5 per cent of the total rice area of the State. Area under irrigated rice is about 25 per cent of the total rice area of the zone. In Nasik, Dhulia and Jalgaon districts of the zone, the gross irrigated area, during the last 12 years, increased at a linear rate of 53.37, 44.15 and 62.67 hundred hectares per annum while area under irrigated rice increased at a linear rate of 1.43,

3.03 and 4.77 hundred hectares per annum only.

It can be pointed out from the foregoing that the rice in Maharashtra is grown, especially, during the kharif season and the major irrigated rice growing areas have irrigation facilities only for late varieties grown during the season. Area under irrigated rice is very small and has not markedly increased (linear rate 47.93 hundred hectares) during the last 12 years in spite of an increase in gross irrigated area (linear rate 400.84 hundred hectares) of the State. During the same period area under wheat and sugarcane has increased at a linear rate of 156.06 and 62.31 hundred hectares per annum. This suggests that the increased irrigation has been mainly diverted to crops like wheat, sugarcane etc. and rice remained mostly unaffected.

Under the prevailing conditions area under rice can only be increased if either net cropped area or perennial irrigation is increased in the State. During the last decade the net cropped area remained unchanged while there is a small increase in irrigation. The increased irrigation has been mostly used for wheat and sugarcane crops and rice remained unchanged. Therefore, under the existing circumstances, the production of rice can only be increased by adopting new technology and high-yielding varieties of rice.

The more relevant development during the last decade has been the high-yielding varieties of rice, which was to use significant quantities of fertilizers to give more yield.

As noted in earlier crops, separate cropwise data on application of fertilisers are not available, we shall examine only the available data on extension of use of the HYV seed.

While the extension of HYV seed began in 1965-66, data about estimated area under HYV rice are available from 1968-69. Table 4.4.5 presents the estimate of the percentage of the total area under rice growing the HY variety, provided by the Zilla Parishads and estimated by the Statistician, side by side. The Table shows that according to the estimate of the Zilla Parishads the highest spread of HYV rice was in 1971-72 when about 16 per cent of the total rice area had come under these varieties. In the other four years till 1972-73 it increased from 9 to 15 per cent. The Statistician's sample survey showed that Zilla Parishad's estimates were somewhat over-estimates; the highest percentage was put at about 14 per cent and in the earlier years it increased from 6 to 13 per cent.

The Statistician's estimates show that the area under HYV rice has never been very large in the past. This is reflected in the zonal figures as well. Of the two important zones of rice, Bombay had about 26 per cent, the highest area under HYV rice in 1971-72. It fluctuated between 14 and 25 per cent in the subsequent four years. The Nagpur zone had about 8 per cent, the highest, area under HYV rice in 1971-72 and it varied between 2 and 7.5 per cent in the next four years. Kolhapur zone had reported about 14 per cent, the

**Table 4.4.5 : Percentage of Rice Area under High Yielding Variety as Estimated by (a) The Zilla Parishads and (b) The Statistician, Department of Agriculture, 1968-69 to 1972-73**

Sr. No.	Zone	1968-69		1969-70		1970-71		1971-72		1972-73	
		As per Z.P.s	As per Statistician	As per Z.P.s	As per Statistician	As per Z.P.s	As per Statistician	As per Z.P.s	As per Statistician	As per Z.P.s	As per Statistician
1.	Bombay	18.16	13.77	24.59	17.83	25.87	21.67	28.70	25.87	28.49	24.66
2.	Nasik	9.32	7.41	8.94	5.90	8.32	4.98	11.70	6.06	3.85	2.35
3.	Poona	11.58	3.58	17.40	11.76	14.26	8.38	17.24	12.11	22.94	16.63
4.	Kolhapur	8.88	6.37	11.57	8.25	15.13	11.48	16.26	13.60	16.61	13.70
5.	Nagpur	3.29	1.99	8.55	4.67	10.06	5.50	10.16	7.97	8.69	7.50
	State	8.87	6.26	13.48	9.07	14.70	10.74	16.16	13.62	15.21	12.92

highest, area under HYV seed in 1971-72 and 1972-73 and in the earlier three years it varied between 6 and 11 per cent of the total rice area. In terms of the Statistician's estimate, therefore, the extension of HYV seed of rice had not been very encouraging.

The Statistician had conducted a random sample crop-cutting experiments to estimate the yield rate of HYV rice during the five years since 1968-69. These data for each of the years and zones are given in Table 4.4.6. The data show that the yield rates of HYV rice were quite high compared to the traditional performance of local rice in the State. The average yield rate of HYV rice over the five years, 1968-73, was estimated at 2568 kgs. per hectare. This was about 2-1/2 times as high as the average yield of rice in the State during the 12 years preceding 1968-69 (986 kgs./hectare). The same phenomenon was recorded for the various rice zones, as will be seen from the Table.

With such high rate of yield it is not surprising that the estimated total production of HYV rice in the State came to account for a much higher proportion of the total rice production than the HYV rice area of the total rice area. These percentages, zonewise, are given in Table 4.4.7.

The Table shows that during these five years production of HYV rice accounted for between 18 and 37 per cent of the total production of rice, while, as we have seen, even in the best year the area under HYV rice was not more than 14 per cent of the total area.



**Table 4.4.6 : Average Yield Rates of Rice and High Yielding Rice in Maharashtra, 1956-57 to 1972-73**

		(Yield kgs./hectare)											
Sr. No.	Year	Bombay		Nasik		Poona		Kolhapur		Nagpur		Maharashtra	
		Rice	HYV Rice	Rice	HYV Rice	Rice	HYV Rice	Rice	HYV Rice	Rice	HYV Rice	Rice	HYV Rice
1.	1956-57	1153		662		973		1019		983		998	
2.	1957-58	1283		519		684		1099		836		961	
3.	1958-59	1488		697		788		980		1007		1086	
4.	1959-60	1177		685		961		1099		957		1001	
5.	1960-61	1259		686		1004		1246		916		1033	
6.	1961-62	1412		797		1193		1222		1090		1142	
7.	1962-63	1262		680		1072		1167		715		942	
8.	1963-64	1466		852		1071		1174		988		1113	
9.	1964-65	1417		836		923		964		952		1061	
10.	1965-66	1059		352		473		588		529		670	
11.	1966-67	1050		509		618		1101		643		773	
12.	1967-68	1592		853		865		901		881		1055	
Average		1301		677		885		1046		875		986	
13.	1968-69	1294	2832.0	692	2832.0	953	2677.9	899	2828.1	930	2815.5	993	2829.8
14.	1969-70	1287	2974.0	581	1736.0	720	2134.9	1014	2361.1	1047	2644.0	1032	2776.9
15.	1970-71	1647	2875.0	850	2384.0	801	2884.5	1189	2583.5	1156	3158.2	1226	2891.6
16.	1971-72	1352	2755.0	677	2142.0	851	2867.5	1157	2635.2	936	2590.8	1026	2695.7
17.	1972-73	969	1705.0	214	636.0	248	879.0	613	1716.0	455	1655.0	580	1644.9
Average		1310	2628.0	603	1946.0	714	2288.7	974	2424.8	905	2572.7	971	2567.8

**Table 4.4.7 : Estimated Total Production of High Yielding Variety Rice as a Percentage of the Total Production of All Rice in Maharashtra, 1968-69 to 1972-73**

Sr. No.	Zone	1968-69	1969-70	1970-71	1971-72	1972-73
1.	Bombay	30.15	41.21	37.82	52.72	43.38
2.	Nasik	38.19	17.64	13.97	19.20	7.00
3.	Poona	11.96	41.80	39.36	50.15	42.28
4.	Kolhapur	20.05	19.23	24.95	30.97	38.39
5.	Nagpur	6.03	11.79	15.03	22.06	27.32
	State	17.86	24.42	25.34	35.79	36.62

Now, if one compares the estimated yield rates of local rice in different zones during these five years (after deducting the estimated area and production of HYV rice from the officially estimated total area and production of rice) then one finds that they are, by and large, lower than the average yield rates of local rice in the same zones during the 12 years before the introduction of high-yielding varieties seed (Table 4.4.8).

This raises the question of the reliability of the available HYV rice data. If the yield rate of local varieties of rice during the years since 1968-69 appears to be low, the source of error may be either in the estimated total production of rice during these years in the State, or in the Statistician's estimate of production of rice. As noted earlier, it is not easy to question the estimation of rice

**Table 4.4.8 : Estimated Average Yield of Local Rice in Maharashtra, 1968-69 to 1972-73**

Sr. No.	Year	(Yield kgs./hectare)				
		Bombay	Nasik	Kolhapur	Nagpur	Maharashtra
1.	1968-69	1047	471	767	891	869
2.	1969-70	920	508	892	969	858
3.	1970-71	1307	769	1008	1039	1025
4.	1971-72	862	582	924	792	763
5.	1972-73	728	204	437	357	422

production by the Government, as there has been no change in the method of estimating production over the last 15 years or so.

To question the estimated production of HYV rice is to question the estimated area under HYV seed and/or the estimated yield rate. We, therefore, propose to examine the data relating to the yield rate of HYV rice in (i) the different agricultural experiment stations in the State, (ii) the trials conducted on farmers' fields, and (iii) the sample farmers in a selected village in the Marathwada zone of the State surveyed by us. This may help us to judge the reliability of the Statistician's estimated yield rate of HYV rice.

Experiments on high-yielding varieties of rice have been conducted in various agricultural experiment stations

in the State since 1966-67. The experiments have been for different types of treatments, seed rate, spacing, application of N, P and K etc. We have collected the results of all the experiments on HYV rice in all the experiment stations in the State. For purpose of analysis, we have noted results of experiments relating to the following standard treatments from all the different experiments in each of the seven years since 1966-67. The standard treatment referred to is as follows :

- |                                         |                               |
|-----------------------------------------|-------------------------------|
| 1. Time of sowing                       | 15th June to 15th July        |
| 2. Seed rate/No. of seedlings per bunch | 50 kgs./hectare/2-4 seedlings |
| 3. Spacing between rows and plants      | 9" x 6"                       |
| 4. Farmyard Manure                      | 25 cartloads/hectare          |
| 5. Fertilizers :                        |                               |
| Nitrogen                                | 80-100 kgs./hectare           |
| Phosphorous                             | 40 kgs./hectare               |
| 6. Plant Protection                     | As and when required.         |

The agricultural experiment station at Karjat (District Kolaba) is the oldest and most important station for research on rice in the State. During the seven years, 1966-73, 13 different experiments were carried out on HYV rice in this station. The average yield rate of all these experiments (for the standard treatments) was 4334 kgs. per hectare. The variation around this mean was quite large. It varied from 2687 kgs. in one experiment in 1966-67 to 5640 kgs. in another in 1970-71. The coefficient of variation was 24.73 per cent.

The average yield of HYV rice for the five years, 1968-69 to 1972-73, in Bombay zone estimated by the Statistician was 2628 kgs./hectare and yield ranged between 1705 and 2974 kgs. per hectare.

The agricultural research station, Sakoli (District Bhandara) is also an important station for research in rice in the State. During the seven years, 9 different experiments were carried out on HYV rice in this station. The average yield rate of all these experiments (for the standard treatments) was 2705 kgs. per hectare. It varied from 1710 kgs. in one experiment in 1970-71 to 5446 kgs. in another in 1969-70. The coefficient of variation was 41.66 per cent. The average yield of HYV rice for the five years, 1968-69 to 1972-73, in Nagpur zone estimated by the Statistician was 2572 kgs./hectare and the yield ranged between 1655 to 3158 kgs./hectare.

The comparison of the data from the research stations in other zones with the Statistician's estimates for the zones give similar results. These are tabulated in Table 4.4.9. This suggests that the Statistician's estimated yield rate of HYV rice in different zones cannot be considered as over-estimates judged by their performance standard in the experimental stations in the zones.

Similarly, it may be useful to compare the Statistician's estimates with the average yield rate recorded in Fertilizer and Varietal Trials in cultivators' fields over

**Table 4.4.9 : Estimated Average Yield Rates of High Yielding Variety of Rice from Different Sources**

		(Yield kgs./hectare)									
Sr. No.	Zone	District/ Research Station	Zonewise estimated yield by the Statistician			Yield at Research Stations			Districtwise yield of F.V.T.s		
			Average (4)	Minimum (5)	Maximum (6)	Average (7)	Minimum (8)	Maximum (9)	Average (10)	Minimum (11)	Maximum (12)
1.	Bombay		2628	1705	2974	-	-	-	-	-	-
		Karjat	-	-	-	4334	2687	5640	-	-	-
		Ratnagiri	-	-	-	3518	2148	4636	2426	1900	3010
		Dapoli	-	-	-	3991	3184	5726	-	-	-
		Kolaba	-	-	-	-	-	-	3176	2370	3660
		Thana	-	-	-	-	-	-	2743	2130	3550
2.	Nasik		1946	636	2832	-	-	-	-	-	-
3.	Poona		2288	879	2884	-	-	-	-	-	-
		Vadgaon	-	-	-	3776	3225	4327	-	-	-
4.	Kolhapur		2424	1716	2828	-	-	-	-	-	-
		Kolhapur	-	-	-	-	-	-	3290	2680	3660
5.	Nagpur		2572	1655	3158	-	-	-	-	-	-
		Sakoli	-	-	-	2705	1710	5446	-	-	-
		Sindewai	-	-	-	3220	1524	4916	-	-	-
		Bandara	-	-	-	-	-	-	2706	2680	2730
		Chandrapur	-	-	-	-	-	-	2120	1770	2410
	State		2567	1644	2891	-	-	-	-	-	-

seven years, 1966-67 to 1972-73. The relevant data are presented in the above Table 4.4.9 in columns 10 to 12. The data show that the average yield of HYV rice recorded in the FVTs in each zone was fairly comparable to the estimated yield of the Statistician. There is, again, no evidence to suspect over-estimation of the yield rate by the Statistician in the sample survey.

The third set of data with which we propose to compare the Statistician's estimates are the data collected by us in one village in Osmanabad District of Aurangabad zone. We made a purposive selection of one village, Malumra, in Osmanabad district, which accounts for about 38 per cent of the total area under rice in the zone. This is one of the most developed village with considerable lift irrigation, sugarcane crop, co-operative poultry farms and a well developed hybrid programme. We selected a random sample of 20 cultivators growing HYV rice in 1974-75 and collected from them information about their area and production of HYV rice for that year and the previous three years. The Statistician's estimates of the average yield of HYV rice in the State (data for the district and the zone are not available) are given below (overleaf) side by side our estimates for the particular village surveyed.

It is true that it is not proper to compare the data relating to one particular village, that too in a district and zone which is not a major rice growing tract, with the

Year	Yield rate kgs./hectare		
	Statistician's estimate	Village surveyed	
		Irrigated	Dry
1968-69	2829	N.A.	N.A.
1969-70	2776	N.A.	N.A.
1970-71	2891	N.A.	N.A.
1971-72	2695	2250	885
1972-73	1644	1325	300
1973-74	N.A.	1740	1080
1974-75	N.A.	1870	1180

average of sample data from the State as a whole. However, in view of the fact that this village was purposely chosen as an important rice growing one (about 20 per cent of the total foodgrain area was under rice) and particularly in terms of high-yielding varieties, one might expect the performance of yield rate in this village to be better than the average and not poorer than the average for the State. Comparing the data for the two years, 1971-73, for which yield data from both sources are available, one finds the yield rates relating to irrigated HYV rice in our survey are 20 to 25 per cent less than the yield estimates of the Statistician. However, the Statistician's yield estimates cannot be said as gross over-estimates. Of course it is true that the yield rates estimated by us under rainfed condition are at much lower side. It is mainly because the annual rainfall of the village surveyed is much less (900 mm per year) as compared to the



major rice growing zones (Bombay zone 2200 to 2400 mm. and Nagpur zone 1300 mm. per year).

Now we shall refer to the sample survey data collected by the Institute of Agricultural Research Statistics, New Delhi, in the year 1970-71.<sup>1</sup> Data relating to the yield rate of high-yielding varieties of rice were collected on a properly stratified random sample of farms in Nagpur district, covering 31 farms. Average yield of high-yielding varieties of rice in the year 1970-71 was estimated to be 25.39 quintals per hectare. This is fairly comparable (only about 5 per cent lower) with the yield rate of HYV rice estimated by the Statistician in the same year in Nagpur district (26.7 quintals per hectare).

Additional support can be obtained by referring to the survey data collected by the Agro-Economic Research Unit of the Gokhale Institute of Politics and Economics, Poona, in the year 1968-69.<sup>2</sup> The yield rate data of two high-yielding varieties of rice, TN-1 and IR-8, were collected from 60 farmers in four villages in Bhandara district of the State. The average yield rate of TN-1 rice was 15.3 quintals/hectare and it varied between 10.3 quintals and 23.07 quintals per

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1 Das, M.N., Raheja, S.K. et al. 'Sample Surveys for Assessment of High-Yielding Varieties Programme', Annual Report 1970-71, Vol. I. Institute of Agricultural Research Statistics, New Delhi, 1973.

2 Joglekar, M.V. 'Study of the High-Yielding Varieties Programme, Bhandara District (Maharashtra State), HYV Paddy (Kharif 1968-69)'. Gokhale Institute of Politics and Economics, Poona, (Agro-Economics Research Unit), December, 1969.

hectare while that of IR-8 it was 10.27 quintals/hectare and varied from 5.1 quintals to 15.40 quintals per hectare. During the same year, 1968-69, the Statistician had estimated the average yield of HYV rice in Bhandara district to be 20.39 quintals per hectare. Considering the high variability in yield rates of HYV rice, it will be fair to say that the Statistician's yield estimate for Bhandara district is not over-estimate.

All the above evidences examined by us indicate that the yield estimates of high-yielding varieties of rice by the Statistician for different years are fair enough and cannot be considered as over estimates.

Since the preceding discussion shows that there is no evidence to suspect serious over-estimation of yield rates by the Statistician, it follows that his estimation of area under HYV rice in different years might be the source of error. However, independent source of estimation of area under HYV rice in the State is not easily available to prove the over-estimation of area under HYV rice.

This long review of the performance of HYV rice in Maharashtra during the year since its introduction in 1965-66 shows that it has been able to make precious little contribution to break the prolonged stagnancy in the production of rice in the State. The officially estimated yield rate of HYV rice does not appear to be over-estimated, but the estimate of area under these varieties appear to be somewhat over-estimated.

So far we have checked and compared the estimated yield rates of HYV rice with the yield rates recorded under different surveys. We have seen that the estimated yield rates of HYV rice by the Statistician are more by about 5 per cent (as per IARS, Delhi, survey) and 20 to 25 per cent (as per our village survey and G.I.P.E., Poona). However, looking to the variation in yield rates of HYV rice, we will not consider these estimated yield rates by the Statistician to be over-estimated. Once we accept that the estimated yield rates of HYV rice are fair enough and not over-estimated then we have to say that the estimated area under these varieties during the different years has to be over-estimated. Similarly we have noted earlier that the estimated yield rates of local rice particularly during the period, 1968-69 to 1972-73, are lower than the average yield rate of rice during the 12 years previous to the introduction of HYV rice. Now let us consider the yield rate of local rice during the years 1968-69 to 1972-73 to be the same as that before the introduction of HYV rice and calculate the area under HYV rice. Accordingly area under HYV rice does not exceed more than 3 per cent in 1968-69, 7 per cent in 1970-71, 5 per cent in 1971-72 and 1 per cent in 1972-73 of the total rice area in the State during the respective years.

We have noted earlier that the estimated yield rates of HYV rice by the Statistician are about 5 to 25 per cent more than the yield rates estimated in other surveys. Even

if we consider 20 per cent less in yield rates of HYV rice and estimate the area under the variety, it does not exceed 5 per cent in the year 1968-69 and 1969-70, 8 per cent in the year 1970-71, 6 per cent in 1971-72 and 2 per cent in the year 1972-73. It shows that the area under HYV rice did not exceed that estimated by us for different years and definitely was not as high as estimated by the Statistician for the period of the study, i.e., 1968-69 to 1972-73.

It is seen from the data (Tables 4.4.1 and 4.4.3) that the production and yield rate of rice in the year 1970-71 was higher as compared to the production and yield rates during the last 17 years. Now if we consider the yield rate of local rice even in this year, 1970-71, to be on par with the average yield rate of 12 years (986 kgs./hectare) before the introduction of HYV seed and calculate the area under HYV rice, it does not exceed the area estimated by the Statistician (10.14 per cent). This shows that in any one of the five years under study the area under HYV rice was, generally, never more than around 10 per cent of the total rice area in the State.

We have seen that average yield rate of HYV rice is more than that of local varieties of rice. Now let us examine the fluctuations in yield rates of the two varieties from year to year, as well as from region to region. Three sets of data are available for this purpose: (1) the Statistician's estimates of yields of HYV and local rice, (2) the results

of Fertilizer and Varietal Trials, and (3) the results of agronomic experiments. We will examine these data one by one.

The Statistician's estimates of average yield rates of the two varieties are available for five years, 1968-69 to 1972-73, for 12 districts (Table 4.4.10). An 'F' test for the difference between the variances of the two varieties was not significant for any district. However, it was significant when the data for all the 12 districts were pooled, showing variance of HYV rice to be significantly larger. The coefficient of variation of the yield rate of HYV rice was not markedly different than of local rice in any of the 12 districts. Similar was the result when the data were pooled (coefficient of variation of HYV rice 28.98 per cent and local 28.09 per cent). Thus, overall it appeared that there was no difference either in absolute variance or the percentage variation around the means of both high-yielding and local varieties.

The second set of data relate to F.V. Trials on the farmers' fields, conducted over seven years, 1966-67 to 1972-73, in six districts. Here again the 'F' test showed the variance of the yield rates of HYV rice and local rice not to be significantly different in 5 of the 6 districts (Table 4.4.11). Test of significance with pooled data also showed the variance of HYV rice not significantly higher. The comparison of the coefficients of variation showed in half of the districts the coefficient of variation was higher

**Table 4.4.10 : Average Yield Rates of Rice Estimated by the Statistician, Department of Agriculture, in Different Districts, 1966-67 to 1972-73**

Sr. No.	District	(Yield kgs./hectare)						'F' value
		Average yield of HYV Rice	Standard deviation	Coefficient of variation	Average yield of Local Rice	Standard deviation	Coefficient of variation	
1.	Thana	2757	706	25.60	1673	411	24.56	2.93
2.	Kolaba	2488	335	13.46	1643	232	14.12	2.08
3.	Ratnagiri	2568	344	13.39	1559	170	10.96	4.06
4.	Nasik	1896	681	35.91	1273	461	36.21	2.18
5.	Dhulia	2317	450	19.42	1546	253	16.36	3.16
6.	Satara	2259	551	24.39	1494	382	25.56	2.08
7.	Sangli	2132	822	38.55	1323	515	38.92	2.54
8.	Kolhapur	2570	323	12.56	1605	221	13.76	2.13
9.	Poona	2288	755	32.99	1393	466	33.45	2.61
10.	Nagpur	1909	827	43.32	1225	461	37.63	3.22
11.	Bandhara	2179	395	18.12	1541	297	19.27	1.77
12.	Chandrapur	3026	584	19.29	1979	375	18.94	2.41

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 1.23
Between centres	6121055	11	556459	Coefficient of variation = 31.51 %
Within centres	20763254	46	451375	Within centres = 28.34 %
Total	26884309	57	471654	Total = 28.98 %

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 1.19
Between centres	2312298	11	210208	Coefficient of variation = 30.13 %
Within centres	8119101	46	176502	Within centres = 27.63 %
Total	10431399	57	183007	Total = 28.09 %

**Table 4.4.11 : Average Yield of Rice under Fertilizer and Varietal Trials on Cultivators' Fields in Different Districts, 1966-67 to 1972-73 (With 50 kgs. Nitrogen and 25 kgs. Phosphoric Acid Per Hectare)**

Sr. District No.	(Yield of rice kgs./hectare)							
	Average yield of HYV Rice	Standard deviation	Coefficient of variation	Average yield of Local Rice	Standard deviation	Coefficient of variation	'F' Value	't' Value
1. Kolaba	3176 (3)	574	18.07	3246 (6)	387	11.92	3.30	0.19
2. Ratnagiri	2446 (3)	453	18.52	2228 (6)	336	15.08	2.27	0.71
3. Thana	2743 (3)	596	21.72	2201 (6)	419	19.03	2.52	1.39
4. Bhandara	2706 (3)	21	0.77	2600 (6)	272	10.46	140.37**	0.59
5. Kolhapur	3290 (3)	435	13.22	2705 (6)	598	22.10	1.51	1.33
6. Chandrapur	2120 (3)	265	12.50	1875 (6)	291	15.52	1.03	1.08

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 2.01
Between centres	2892951	5	578590	Coefficient of variation = 27.66 %
Within centres	3447671	12	287306	Within centres = 19.51 %
Total	6340622	17	372978	Total = 22.24 %

**Analysis of Variance of Pooled Data-Local**

	s.s.	d.f.	Mean s.s.	F = 4.57**
Between centres	3766461	5	753292	Coefficient of variation = 34.55 %
Within centres	2142304	13	164792	Within centres = 16.16 %
Total	5908765	18	328264	Total = 22.81 %

for HYV rice. When the data were pooled the coefficient of variation of HYV rice was as large as that of local rice (22.24 per cent and 22.81 per cent respectively). Thus both the Statistician's survey and F.V. Trials data did not reveal any significant difference in the yield fluctuations of both high-yielding and local varieties of rice.

In case of the data from different agricultural research stations, test of significance of the difference in variances of the yield rates of the two varieties could be carried out for only four research stations (Table 4.4.12). For three stations the 'F' value was statistically significant, showing larger variance of HYV rice yield rate. Pooling the data for all the stations, the 'F' test showed the variance of HYV rice to be significantly higher. Similarly, a comparison of the coefficient of variation of these two varieties showed that in Vadgaon it was smaller for HYV rice, whereas in other stations it was larger. The coefficient of variation with the pooled data showed high-yielding variety with slightly larger variation in yield rate than local variety (coefficient of variation for HYV rice 25.86 per cent and for local 26.53 per cent).

The examination of the three sets of data for year to year/region to region variation in the yield rates of high-yielding and local varieties of rice showed that the variance of yield rate of HYV rice was not lower than that of local varieties of rice.



**Table 4.4.12 : Average Yield of High Yielding and Local Variety of Rice at Different Research Stations in Maharashtra (With Standard Cultural Practices)**

Sr. Research No. Station	(Yield kgs./hectare)						
	Average yield of HYV Rice	Standard deviation	Coefficient of variation	Average yield of Local Rice	Standard deviation	Coefficient of variation	'F' Value
1. Karjat	4334 (13)	1072	24.73	2577 (29)	616	23.90	3.16**
2. Ratnagiri	3578 (6)	987	28.05	2643 (16)	421	15.92	6.17**
3. Dapoli	3991 (12)	704	17.63	-	-	-	-
4. Sakoli	2705 (9)	1127	41.66	-	-	-	-
5. Vadgaon	3776 (2)	551	14.59	2713 (14)	464	17.10	2.61
6. Igatpuri	-	-	-	2249 (16)	773	34.37	-
7. Radhanagari	-	-	-	1478 (9)	568	38.43	-
8. Sindewai	3220 (2)	1696	52.67	2874 (16)	1019	35.45	5.18**

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 2.79**
Between centres	12300107	5	2460021	Between centres = 40.91 %
Within centres	15870409	18	881689	Within centres = 24.50 %
Total	28170516	23	1224805	Total = 28.86 %

**Analysis of Variance of Pooled Data-Local**

	s.s.	d.f.	Mean s.s.	F = 4.85**
Between centres	7695133	5	1539026	Between centres = 50.69 %
Within centres	17120810	54	317052	Within centres = 23.01 %
Total	24815943	59	420609	Total = 26.53 %

We have noted, earlier, that the average yield of HYV rice of the 20 sample farmers in our surveyed village was smaller than the average yield estimated by the Statistician for the State. The average input of fertilizers used by these farmers was also low, by recommended standard 36 per cent of it. This of course does not mean that the yield rate was low mainly because the fertilizer application was low. Another reason for this may be the negligence of the farmers towards the application of insecticides and pesticides, as the new varieties are more susceptible to the attack of insects and pests.

Some more reasons for low yield of HYV rice are noted by us during our survey of one village are as follows :

1. Seedlings of HYV rice have to be transplanted 20 to 25 days after sowing seed in the nursery. If transplanting for whatever reasons is delayed, the panicles (earheads) emerge earlier than the stipulated time and that results in poor yield.
2. Rice is wholly grown as a kharif crop in the State. As the crop season coincides with monsoon, when the sunshine hours are less due to the cloud cover, it adversely affects the process of photosynthesis and causes lower yield.
3. High-yielding varieties of rice cannot thrive well in standing water as it obstructs the proper aeration of the roots. This lack of proper root aeration causes stunted plant growth and early emergence and ripening of earheads,

ultimately causing poor yield. On the other hand, such standing water does not prove an obstacle for the local varieties. Of course this is a view of the agricultural scientists working at Tuljapur paddy research station in Osmanabad district.

Our survey of the 20 farmers in one village shows that the average net income of a farmer from one acre of HYV rice was no higher than his average net income from one acre of local rice grown by him. The data are presented in Table 4.4.13.

All the inputs including the home supplied as well as the outputs, in the above Table have been valued at market prices current during the year of survey (1974-75). The average net profit for HYV and local rice for the 20 farmers is reproduced below:

	<u>HYV</u>	<u>Local</u>
1. Irrigated Farms :		
(a) Irrigated rice	741	766
2. Unirrigated Farms :		
(a) Large	440	430
(b) Medium	392	459
(c) Small	329	384
All	402	432

It is clear from the above that HYV rice yielded somewhat less profit per acre than the local under both irrigated and unirrigated conditions. This is mainly because of the less price for these varieties in the market. The high-yielding

**Table 4.4.13 : Per Acre Expenditure on and Receipts from High Yielding and Local Rice for a Sample of 20 Farmers in a Village in Osmanabad District, Maharashtra, 1974-75**

Sr. No.	Item/Group	High Yielding Rice								(in Rs.)	
		Irrigated Group				Unirrigated Group				Overall Dry Rice	
		Large		Medium		Small					
		Rs.	%	Rs.	%	Rs.	%	Rs.	%	Rs.	%
1.	Preparatory tillage	69.78	13.16	63.95	15.74	53.12	11.96	59.50	16.95	58.85	14.71
2.	Farmyard manure	59.37	11.20	39.00	9.60	54.37	12.25	55.00	15.71	49.45	12.36
3.	Fertilizers	124.53	23.49	85.80	21.12	97.87	22.05	62.83	17.95	82.16	20.53
4.	Seed	86.00	16.22	64.00	15.75	65.00	14.64	66.66	19.04	65.22	16.30
5.	After care	71.21	13.43	62.70	15.43	70.12	15.79	53.00	15.13	61.94	15.48
6.	Irrigation	15.36	2.90	-	-	-	-	-	-	-	-
7.	Plant Protection	59.00	13.04	60.80	14.98	74.00	16.67	29.33	8.37	54.70	13.67
8.	Harvesting and Thrashing	34.75	6.56	30.00	7.38	29.50	6.64	24.00	6.85	27.83	6.95
9.	Total Expenditure	530.00	100.00	406.25	100.00	443.98	100.00	350.32	100.00	400.15	100.00
	Yield in quintals	7.48		4.98		4.92		4.00		4.72	
	Value of Rice in Rs.	1271.60		846.60		836.40		680.00		802.40	
	Profit	741.60		440.35		392.42		329.68		402.25	

(continued)

Table 4.4.13 : (continued)

		Local Rice									
Sr. No.	Item/Group	Irrigated Group		Unirrigated Group						Overall Dry Rice	
				Large		Medium		Small			
		Rs.	%	Rs.	%	Rs.	%	Rs.	%	Rs.	%
1.	Preparatory tillage	60.25	12.60	52.05	19.34	51.12	18.42	53.00	24.28	52.05	20.38
2.	Farmyard manure	48.75	10.19	24.00	8.92	31.87	11.49	35.00	16.04	30.29	11.86
3.	Fertilizers	116.91	24.45	66.81	24.83	70.20	25.30	23.50	10.77	53.50	20.94
4.	Seed	64.75	13.54	48.00	17.84	48.75	17.57	45.00	20.62	47.25	18.50
5.	After care	71.53	14.96	50.25	18.67	52.00	18.75	42.75	19.59	48.33	18.92
6.	Irrigation	16.64	3.48	-	-	-	-	-	-	-	-
7.	Plant Protection	60.00	12.55	6.40	2.38	-	-	-	-	2.66	1.04
8.	Harvesting and Thrashing	39.37	8.23	21.60	8.02	23.50	8.47	19.00	8.70	21.36	8.36
9.	Total Expenditure	478.20	100.00	269.11	100.00	277.44	100.00	218.25	100.00	255.44	100.00
	Yield in quintals	6.55		3.68		3.88		3.17		3.62	
	Value of Rice in Rs.	1244.50		699.20		737.20		602.30		687.80	
	Profit	766.30		430.09		459.76		384.05		432.36	

varieties of rice are comparatively coarser than the local varieties and hence lower price for it in market (Rs. 170 per quintal as against Rs. 190 per quintal of local varieties). This becomes even more important when one notes that the labour input per acre of HYV rice was not higher than that for the local rice (HYV Rs. 175 and local Rs. 171). This is the average picture, about 10 of the 20 farmers surveyed showed some net profit while others a net loss. This being the situation, it is not surprising that not many farmers cared to grow HYV rice in the village and in the State.

Now it will not be surprising to note that the area under these varieties in the village declined from about 17 per cent in 1971-72 to about 8 per cent of the total rice area in the year 1974-75. Even the existing 8 per cent area under HYV rice was not quite consistent with the poor profitability. On enquiry it was found that these producers had necessary supply of fertilizers, insecticides at regulated price from the Zilla Parishad, and they divert these inputs to the crops like sugarcane, vegetables etc.

Our village survey data show that under irrigated condition per acre yield of HYV rice and total cost incurred on it was about 14 per cent and 11 per cent more than the local rice, while under unirrigated condition per acre yield and cost incurred on it was about 30 per cent and 57 per cent more than the local rice. Under both the conditions per quintal price of HYV rice was about 11 per cent less than

that of local rice. As noted earlier the low price was mainly because of its coarser character. If this price difference would have not been there, the net income from HYV rice under both the conditions would have been about 16 per cent more than that of local rice.

Now we will refer the survey data collected in a IADP district (Bhandara) in Maharashtra by the Agro-Economic Research Unit of the Gokhale Institute of Politics and Economics, Poona, in the year 1968-69 and see the net profit earned by the sample cultivators cultivating IR-8 Paddy and local medium variety paddy. The choice of the medium variety for comparison is based wholly on the procurement price being the same for both. The average production per acre was valued at the monopoly procurement price (Rs. 62.00 per quintal for both the varieties), prescribed by the Government of Maharashtra for the year 1968-69. We will reproduce the data.

Size of cultivated holding (Acres)	Surplus over cost	
	Medium Local Paddy	IR-8 Paddy
0 - 5.00	139.26	222.96
5.01 - 10.00	225.23	152.13
10.01 - 15.00	117.60	67.58
15.01 - 20.00	182.35	295.76
20.01 - 30.00	115.09	59.71
30.01 - 40.00	264.03	23.94
More than 40 acres	210.59	111.21

Even by considering equal price for both the local and IR-8 Paddy (in open market price for IR-8 will always be less as it is a coarse or bold variety), profit from IR-8 Paddy is less (Rs. 50 to Rs. 240 per acre) in 5 out of 7 size groups.

Let us refer to other survey data from a major rice growing district of the State collected by the Agro-Economic Research Unit of the Gokhale Institute of Politics and Economics, Poona, in the year 1966-67.<sup>3</sup> (The name of the district is not disclosed in the report.) The information was collected from a sample of 117 cultivators cultivating TN-1 Paddy and 192 cultivators cultivating local paddy in four selected villages in the district. Cost of cultivation of TN-1 Paddy and local paddy was calculated to be Rs. 194 and Rs. 126 per acre. Average yield of TN-1 and local paddy was estimated to be 476 kgs. and 585 kgs. per acre. Now we will value the average production of both the varieties at Rs. 62 per quintal (the monopoly procurement prices prescribed by the State Government for the year 1968-69). The value of TN-1 and local paddy comes to Rs. 295 and Rs. 363 per acre. The net profit from the cultivation of TN-1 and local paddy is thus calculated to be Rs. 101 and Rs. 237 per acre respectively. This shows that the cost of production of TN-1 paddy

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3 Muranjan, S.W. 'Study of the High Yielding Varieties Programme in a District in Maharashtra (Paddy 1966-67)'. Gokhale Institute of Politics and Economics, Poona, Mimeograph Series No. 4.



is more by Rs. 68 per acre than local paddy while its yield and net profit per acre is less by 109 kgs. and Rs. 136 respectively. With this performance of HYV paddy in Maharashtra, it is not surprising to see that it has been largely rejected by the farmers in the State.

Such rejection of HYV rice during kharif is not something very peculiar to Maharashtra but has been observed in other States also. We have already referred to the studies (in Chapter II) of Robert W. Herdt, P. S. George and V. V. Choukidar and G. Parthasarathy and D. S. Prasad where it has been pointed out that the progress of HYV paddy is slackening in kharif season than rabi one. The reasons given are (a) lower product prices and (b) lower yields of HYV paddy in kharif than the local varieties.

Under the prevailing conditions in Maharashtra, where rice is mainly grown during kharif season, the prospects of HYV rice do not seem to be very encouraging unless some technological improvements take place in these varieties.

To make the new high-yielding varieties of rice popular among the cultivators an attempt has to be made to introduce such varieties which are comparatively less coarser in character, can thrive well in the existing climatic conditions, are more stable in their yield rates, and are resistant to insects and pests.

In short, we find almost stagnancy in production, area and yield rate of rice in the State during the last two

decades. The spread of high-yielding variety seed of rice fluctuated between 6 and 13 per cent of the total rice area during the period 1968-69 to 1972-73. Average yield of HYV rice has been somewhat more on farmers' fields than of local varieties of rice. Wide fluctuations in yield rate, high cost of cultivation and comparatively low price in the market because of the coarse character of the new seed are the major obstacles to the acceptance of high-yielding variety rice by the cultivators.

#### 4.5 Wheat

Wheat accounts for about 5 per cent of the total area under crops (average of 5 years ending 1972-73) and about 7 per cent of the total area under foodgrains, and a little over 8 per cent of the total production of foodgrains in the State. We will, now, examine the performance of wheat in the State during the period 1956-57 to 1972-73, the last year for which data on acreage, production etc. are available.

The total production of wheat in the State has fluctuated between 0.30 and 0.51 million tonnes during the 17 years under review (excluding the years 1965-66 and 1972-73, the years of exceptionally low production) (Table 4.5.1). If one takes all the 17 years into account, the annual compound growth rate of production comes to +0.20 per cent (Table 4.5.1A). However, the very small increase is due to the inclusion of two years of very low production (1965-66 and 1972-73) on account of unfavourable climatic conditions. Excluding those two years we find the annual compound growth rate to be +2.30 per cent which though statistically insignificant, indicates an increasing trend in wheat production. We find a significant difference in growth rates during the pre- and post-high yielding varieties periods. The annual growth rate from 1956-57 to 1964-65 was +2.50 per cent, statistically insignificant, while for the later period, 1964-65 to 1972-73 (excluding the years 1965-66 and 1972-73) it was +4.60 per cent, statistically significant.

**Table 4.5.1 : Production of Wheat in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

(Production in '00 tonnes)

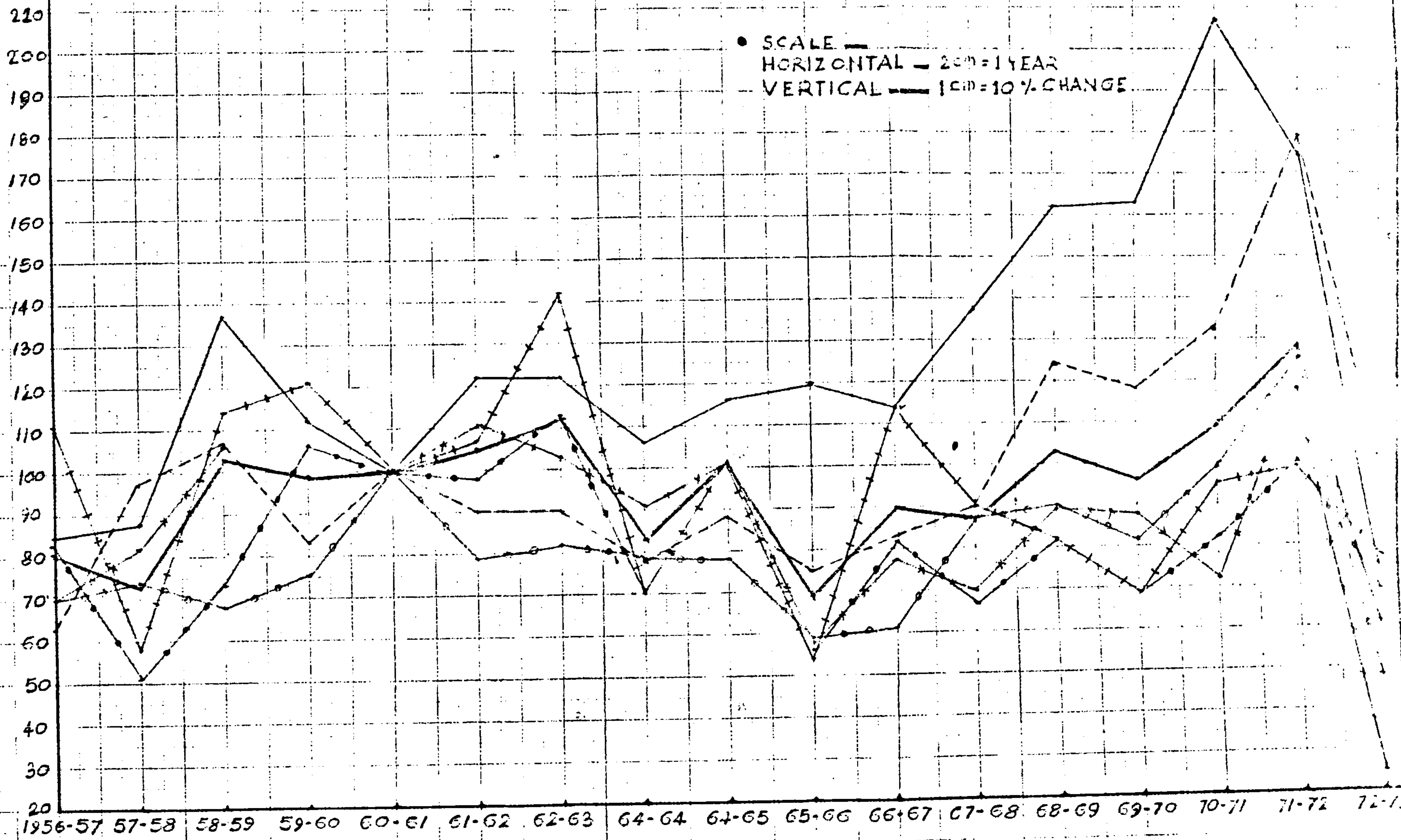
Sr. No.	Year	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1956-57	583 85.10	278 63.18	164 70.68	790 70.47	715 111.19	740 83.24	3270 81.55
2.	1957-58	604 88.17	429 97.50	172 74.14	922 82.25	376 58.47	462 51.97	2965 73.94
3.	1958-59	942 137.52	473 107.50	160 68.96	1198 106.87	734 114.15	654 73.56	4161 103.76
4.	1959-60	771 112.55	369 83.86	176 75.86	931 83.05	783 121.77	943 106.07	3973 99.07
5.	1960-61	685 100.00	440 100.00	232 100.00	1121 100.00	643 100.00	889 100.00	4010 100.00
6.	1961-62	837 122.18	399 90.68	184 79.31	1236 110.25	689 107.15	878 98.76	4223 105.31
7.	1962-63	842 122.92	400 90.90	192 82.76	1158 103.30	917 142.61	1011 113.72	4520 112.72
8.	1963-64	729 106.42	346 78.63	183 78.88	1029 91.79	451 70.14	628 70.64	3366 83.94
9.	1964-65	795 116.06	388 88.18	183 78.88	1142 101.87	653 101.55	915 102.92	4076 101.64
10.	1965-66	825 120.44	331 75.23	137 59.05	652 58.16	349 54.27	504 56.69	2798 69.77
11.	1966-67	781 114.01	368 83.64	142 61.21	868 77.43	735 114.31	730 82.11	3624 90.37
12.	1967-68	941 137.37	396 90.00	200 86.21	793 70.74	587 91.29	598 67.26	3515 87.66
13.	1968-69	1110 162.04	546 124.09	210 90.51	1002 89.38	529 82.27	734 82.56	4131 103.01
14.	1969-70	1117 163.06	521 118.41	191 82.33	989 88.22	444 69.05	616 69.29	3878 96.71
15.	1970-71	1418 207.00	583 132.50	231 99.57	808 72.08	615 95.64	729 82.00	4384 109.32
16.	1971-72	1192 174.01	791 179.77	291 125.43	1328 118.46	642 99.84	890 100.11	5134 128.03
17.	1972-73	519 75.77	445 101.13	112 48.27	290 25.87	501 77.91	618 69.52	2485 61.97

**Table 4.5.1A : Annual Compound Growth Rates of Production of Wheat in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Nasik	Poona	Kolha-pur	Auran-gabad	Amra-vati	Nagpur
1.	1956-57 to 1972-73	+0.20 (0.00)	-2.50* (0.23)	+2.90* (0.34)	+0.60 (0.01)	-2.50 (0.13)	-1.19 (0.05)	-0.23 (0.00)
2.	1956-57 to 1971-72	-	+4.30* (0.69)	+3.40* (0.38)	+1.90 (0.22)	-0.16 (0.00)	-	-
3.	1956-57 to 1971-72 (Except 1965-66)	+2.30 (0.05)	-	-	-	0.00 (0.00)	-	-
4.	1956-57 to 1964-65	+2.50 (0.22)	+2.80 (0.22)	+0.70 (0.01)	+1.70 (0.18)	+3.40 (0.37)	+0.80 (0.01)	+4.30 (0.21)
5.	1964-65 to 1972-73	+0.60 (0.00)	+1.30 (0.01)	+7.50* (0.50)	+2.10 (0.18)	-5.29 (0.11)	+0.20 (0.00)	+0.20 (0.00)
6.	1964-65 to 1971-72	-	+8.40* (0.82)	-	+8.40* (0.65)	+3.30 (0.12)	-	-
7.	1964-65 to 1971-72 (Except 1965-66)	+4.60* (0.72)	-	-	-	-	-	-

Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.



• PRODUCTION OF WHEAT IN MAHARASHTRA  
 AND ITS AGRO-CLIMATIC ZONES  
 1956-57 TO 1972-73

- NASIK ———
- POONA ———
- KOLHAPUR ———
- AJRANGABAD ———
- AMRAYATI ———
- NAGPUR ———

The area under wheat, excepting a year of very severe drought (1972-73), fluctuated between 0.82 and 1.0 million hectares (Table 4.5.2). The annual compound growth rate of area for the 17 years, excluding 1972-73, was -0.30 per cent, statistically insignificant (Table 4.5.2A). During the pre-high yielding varieties period, upto 1964-65, there was a mild declining trend (growth rate was -0.23 per cent) in area. During the subsequent period, the area under the crop registered an increasing trend (growth rate +1.30 per cent excluding 1972-73).

During these two decades, yield per hectare of wheat shows a mild increasing trend. The annual compound growth rate for the entire period is +0.90 per cent (Table 4.5.3 and Table 4.5.3A). This small increase in yield rate is mainly due to low yields in the years 1965-66 and 1972-73. Excluding these two years we find the growth rate to be +1.60 per cent, which is statistically significant, over the entire period. During the period of high-yielding variety of seed (excluding drought years) growth rate was +2.90 per cent, statistically significant.

On the whole, therefore, we find an increasing trend in production and yield of wheat in the State during the last two decades. Since the introduction of high-yielding varieties seed, a slow but sure increase in area under wheat has also been a significant development.

Except Bombay, wheat is grown in all the six agro-

**Table 4.5.2 : Area under wheat in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

		(Area in '00 hectares)						
Sr. No.	Year	Nasik	Poona	Kolha- pur	Auran- gabad	Amra- vati	Nagpur	Maha- rashtra
1.	1956-57	1861 115.52	1035 109.75	291 95.41	2643 101.50	1528 85.36	1978 84.93	9336 97.43
2.	1957-58	1665 103.35	942 99.89	295 96.72	2548 97.85	1482 82.79	1771 76.04	8703 90.82
3.	1958-59	1791 111.17	950 100.74	219 71.80	2592 99.54	1363 76.14	1647 70.72	8562 89.35
4.	1959-60	1762 109.37	954 101.16	303 99.34	2674 102.68	1754 97.98	2168 93.08	9615 100.34
5.	1960-61	1611 100.00	943 100.00	305 100.00	2604 100.00	1790 100.00	2329 100.00	9582 100.00
6.	1961-62	1533 95.16	856 90.77	317 103.93	2719 104.41	1586 88.60	2064 88.62	9075 94.70
7.	1962-63	1509 93.67	814 86.32	298 97.70	2691 103.34	1593 88.99	1894 81.32	8799 91.83
8.	1963-64	1497 92.92	791 83.88	309 101.31	2696 103.53	1635 91.34	1979 84.97	8907 92.95
9.	1964-65	1572 97.58	826 87.59	300 98.36	2708 103.99	1532 85.58	1926 82.70	8864 92.50
10.	1965-66	1669 103.60	777 82.39	264 86.56	2513 96.50	1298 72.51	1800 77.28	8321 86.84
11.	1966-67	1600 99.32	797 84.52	313 102.62	2491 95.66	1411 78.82	1784 76.60	8396 87.62
12.	1967-68	1587 98.51	842 89.28	290 95.08	2414 92.70	1276 71.28	1788 76.77	8197 85.54
13.	1968-69	1670 103.66	894 94.80	294 96.39	2455 94.28	1328 74.19	1753 75.26	8394 87.60
14.	1969-70	1659 102.97	1102 116.86	309 101.31	2454 94.24	1255 70.11	1697 72.86	8476 88.46
15.	1970-71	1751 108.69	969 102.75	335 109.83	2503 96.12	1293 72.23	1701 73.03	8552 89.25
16.	1971-72	1765 109.56	1260 133.61	361 118.36	3371 129.45	1455 81.28	1796 77.11	10008 104.44
17.	1972-73	1186 73.62	688 72.96	225 73.77	1768 67.89	1346 75.19	1693 72.69	6906 72.07



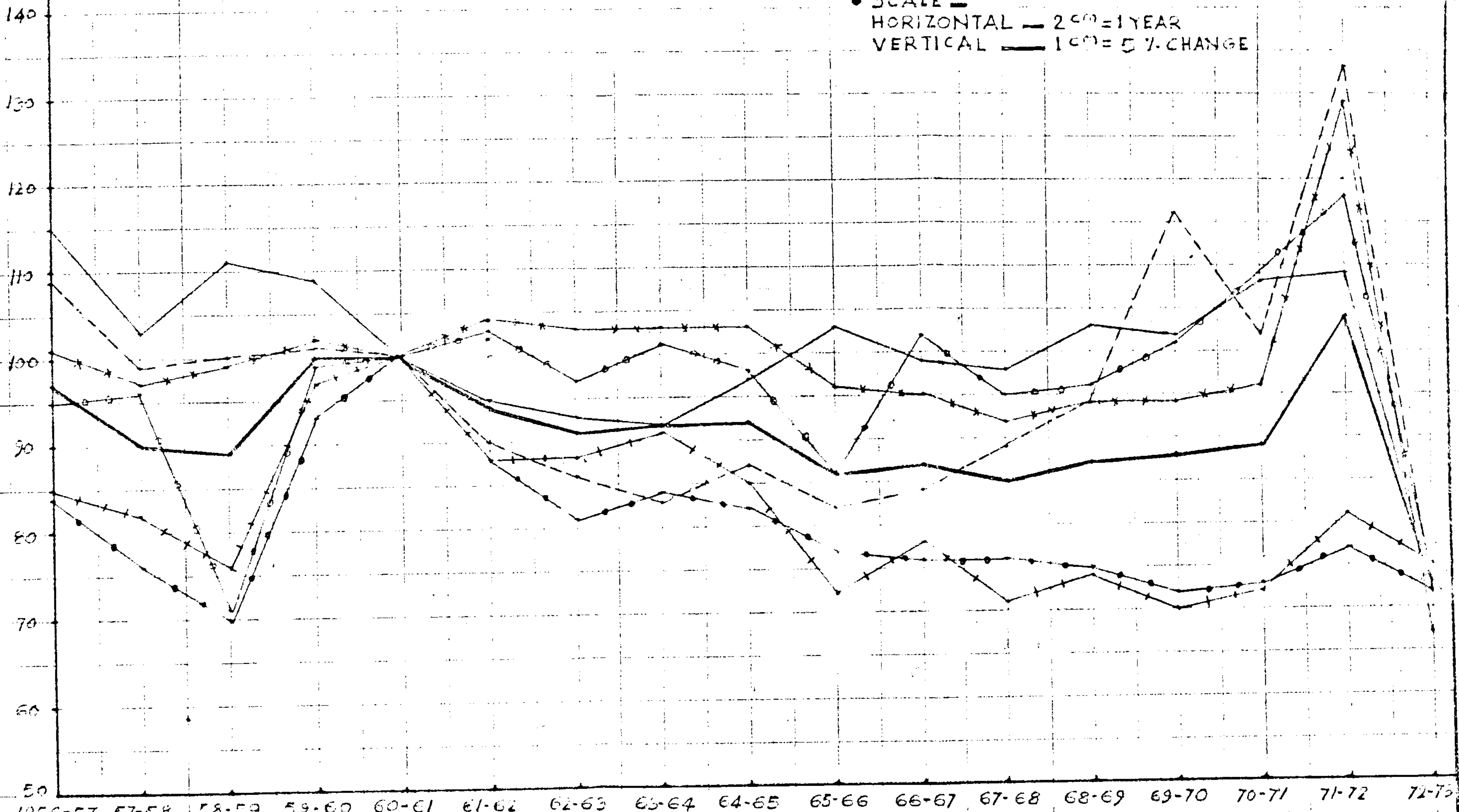
**Table 4.5.2A : Annual Compound Growth Rates of Area under Wheat in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Nasik	Poona	Kolhapur	Auran-gabad	Amra-vati	Nagpur
1.	1956-57 to 1972-73	-0.74 (0.19)	-0.76 (0.14)	-0.16 (0.00)	+0.30 (0.02)	-0.67* (0.72)	+0.30 (0.02)	-0.96* (0.25)
2.	1956-57 to 1971-72	-0.30 (0.05)	-0.14 (0.01)	+0.40 (0.02)	+1.10 (0.23)	+0.10 (0.00)	-	-
3.	1956-57 to 1964-65	-0.23 (0.02)	-2.41* (0.73)	-3.01* (0.84)	+1.50 (0.13)	+0.60 (0.12)	+0.90 (0.07)	+0.70 (0.04)
4.	1964-65 to 1972-73	-0.62 (0.17)	-1.21 (0.07)	+2.30 (0.11)	0.00 (0.00)	-1.35 (0.05)	-0.60 (0.05)	-1.12 (0.34)
5.	1964-65 to 1971-72	+1.30 (0.19)	+1.40* (0.59)	+5.70* (0.76)	+3.00* (0.51)	+1.70 (0.14)	-	-

Note : Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significant at 5 per cent level.

• SCALE —  
HORIZONTAL — 2 CM = 1 YEAR  
VERTICAL — 1 CM = 5 % CHANGE



• AREA UNDER WHEAT IN MAHARASHTRA AND ITS AGRO-CLIMATIC ZONES, 1956-57 TO 1972-73

- NASIK —————
- POONA —————
- KOLHAPUR —————
- AURANGABAD —————
- AMRAVATI —————
- NAGPUR —————
- STATE —————

**Table 4.5.3 : Per Hectare Yield Rate of Wheat in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**  
(Yield kgs./hectare)

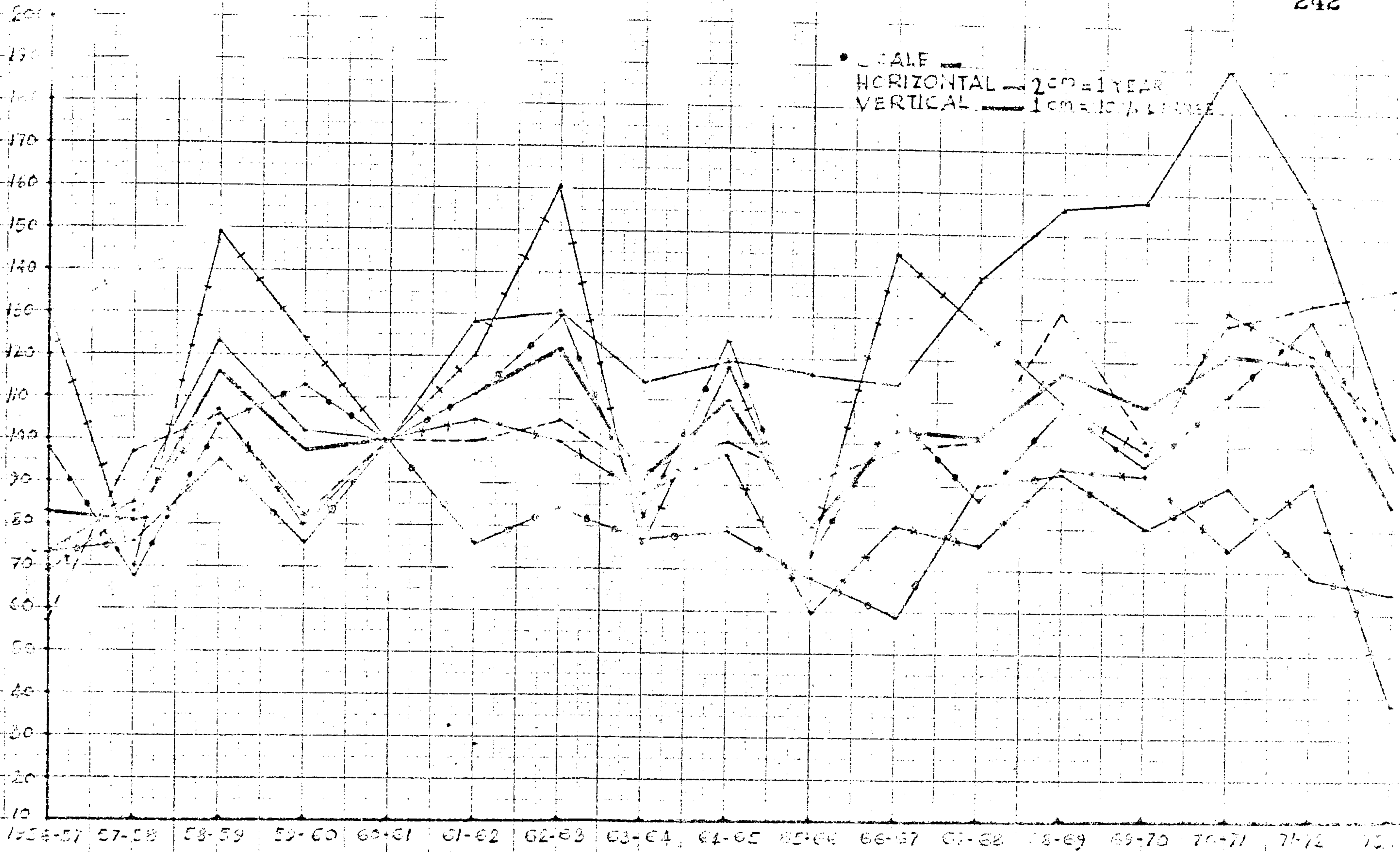
Sr. No.	Year	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1956-57	313 73.65	268 57.51	563 73.79	298 69.30	467 130.00	374 98.16	350 83.73
2.	1957-58	362 85.18	455 97.64	583 76.41	361 83.95	253 70.47	260 68.24	340 81.34
3.	1958-59	526 123.76	497 106.65	730 95.67	462 107.44	538 149.86	397 104.20	485 116.02
4.	1959-60	437 102.82	386 82.83	581 76.14	348 80.93	446 124.23	434 113.91	413 98.80
5.	1960-61	425 100.00	466 100.00	763 100.00	430 100.00	359 100.00	381 100.00	418 100.00
6.	1961-62	546 128.47	466 100.00	580 76.01	454 105.58	434 120.89	425 111.55	465 111.24
7.	1962-63	558 131.29	491 105.36	644 84.40	430 100.00	575 160.17	534 140.15	513 122.73
8.	1963-64	486 114.35	437 93.78	591 77.46	381 88.60	276 76.88	317 83.20	383 91.63
9.	1964-65	506 119.06	470 100.58	609 79.82	421 97.91	426 118.66	475 124.67	460 110.04
10.	1965-66	494 116.23	426 91.42	519 68.02	259 60.23	269 74.93	280 73.49	336 80.38
11.	1966-67	488 114.82	461 98.93	454 59.50	348 80.93	521 145.12	409 107.34	433 103.59
12.	1967-68	593 139.53	471 101.07	689 90.30	328 76.28	460 128.13	334 87.66	428 102.39
13.	1968-69	665 156.47	611 131.11	714 93.58	408 94.88	398 110.86	419 109.97	492 117.70
14.	1969-70	673 158.35	473 101.50	618 80.99	403 93.72	354 98.60	363 95.27	458 109.57
15.	1970-71	810 190.59	602 129.18	690 90.43	323 75.11	476 132.59	429 112.59	513 122.73
16.	1971-72	675 158.82	628 134.76	529 69.33	394 91.63	441 122.84	496 130.18	503 120.33
17.	1972-73	438 103.05	647 138.84	498 65.26	164 38.14	372 103.62	365 95.80	360 86.12

**Table 4.5.3A : Annual Compound Growth Rates of Yield Per Hectare of Wheat in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Nasik	Poona	Kolha-pur	Auran-gabad	Amra-vati	Nagpur
1.	1956-57 to 1972-73	+0.90 (0.10)	+3.40* (0.49)	+3.00* (0.55)	-0.51 (0.03)	-1.83 (0.13)	+0.10 (0.00)	+0.70 (0.03)
2.	1956-57 to 1971-72	-	+4.50* (0.74)	-	-	-0.28 (0.01)	-	-
3.	1956-57 to 1971-72 (Except 1965-66)	+1.60* (0.39)	-	-	+0.20 (0.01)	-	-	-
4.	1956-57 to 1964-65	+2.80 (0.27)	+5.40* (0.52)	+3.90 (0.29)	+0.20 (0.00)	+2.80 (0.27)	0.00 (0.00)	+3.60 (0.20)
5.	1964-65 to 1972-73	+1.00 (0.03)	+2.50 (0.11)	+5.10* (0.68)	-0.58 (0.01)	-3.99 (0.14)	+0.80 (0.01)	+1.40 (0.04)
6.	1964-65 to 1971-72	-	+6.90* (0.79)	-	-	+9.30 (0.04)	-	-
7.	1964-65 to 1971-72 (Except 1965-66)	+2.90* (0.81)	-	-	+0.30 (0.00)	-	-	-

Note : Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significant at 5 per cent level



• YIELD OF WHEAT IN MAHARASHTRA  
 AND ITS AGRO-CLIMATIC ZONES  
 1956-57 TO 1972-73

- NASHIK — — — — —
- PURNA — — — — —
- JALGAON — — — — —
- AMRAVATI — — — — —
- SOLAPUR — — — — —

climatic zones of the State, of which Aurangabad and Nagpur zones account for about 50 per cent of the total area; Nasik zone for about 19 per cent, Amravati, Poona and Kolhapur zones for about 16, 11 and 4 per cent respectively. During the entire period, both Aurangabad and Nagpur zones have shown stagnancy in production (for Aurangabad the growth rate comes to '0' excluding 1965-66 and 1972-73, and for Nagpur +0.20 per cent excluding only 1965-66); in yield rate (for Aurangabad -0.28 per cent and for Nagpur +0.70 per cent); as well as in area under the crop (for Aurangabad +0.10 per cent excluding 1972-73 and for Nagpur -0.96 per cent).

The trend was somewhat different in these two zones during the later half of this period, the years of high-yielding varieties seed. Total production in the years since 1964-65 remained stagnant in Nagpur zone (growth rate +0.40 per cent excluding 1967-68 and +0.20 per cent including it). In Aurangabad zone production recorded an increase of 3.30 per cent per year (excluding the year 1972-73), and if the later years' production is compared with that during the pre-1964-65 period, production shows no upward trend. During the above period, since 1964-65, area in Aurangabad showed a rate of growth of +1.70 per cent and in Nagpur of -1.12 per cent, both small and insignificant. Yield rate in Aurangabad showed a growth rate of +9.30 per cent (excluding 1972-73); in Nagpur it was +1.40 per cent both statistically insignificant.



Thus, among the two zones accounting for the bulk of the production of and area under wheat in the State, Aurangabad showed an upward trend in all fronts in the years since 1965-66 while Nagpur showed near-stagnancy. However, the two wheat growing zones in Western Maharashtra, Nasik and Poona showed a different trend in the later half of the period. Production of wheat in both Nasik and Poona, during the entire period showed a significant increase (growth rate in Nasik was +4.30 per cent excluding 1972-73 and in Poona +2.90 per cent including 1972-73 and +3.40 per cent excluding it). During the same period area under wheat in both the zones remained stagnant (growth rate of area in Nasik was -0.14 per cent and in Poona +0.40 per cent), while yield rate during the above period, in both the zones showed significant increase (growth rate of yield in Nasik was +4.50 per cent excluding 1972-73 and in Poona +3.00 per cent).

During the later half of the period, since 1964-65 onwards, both Nasik and Poona zones have shown significant increase in production (growth rate in Nasik +8.40 per cent excluding 1972-73, and in Poona +7.50 per cent); in yield rate (growth rate for Nasik +6.90 per cent, and in Poona +5.10 per cent); as well as in area under the crop (for Nasik +1.40 per cent, for Poona +5.70 per cent).

The significant increasing trend in the area under wheat in Nasik and Poona zones during the period 1964-65 to 1972-73, seem to largely account for the slight increasing

trend in the total wheat area in the State, noted earlier. The reason for this increase in area appears to be the diversion of some land from under rabi jowar to wheat during the later part of the 1960s as already explained in detail in the section on Rabi Jowar.

In the light of the above discussion regarding production, area and rate of yield of wheat, particularly during the later part of the 1960s, it is necessary to enquire into the performance of the factors that are considered to be crucial to the increase in yield rate and production, namely, extension of irrigation and use of new high-yielding varieties and chemical fertilizers.

Of the two factors mentioned above, irrigation cannot be dismissed as a factor of no relevance in the State, as was done in case of jowar, bajra and rice, since more than 27 per cent of the total area under wheat in the State is irrigated as per official statistics (Table 4.5.4). Area under irrigated wheat in the State, during the earlier part of the 1960s, 1960-61 to 1964-65, was about 16 per cent of the total wheat area, while in the later period, 1965-66 to 1971-72, it increased to 28 per cent. Among the different wheat growing zones Nasik and Nagpur recorded almost 100 per cent increase in the area under irrigated wheat during the period 1965-66 to 1971-72, while Poona, Aurangabad and Amravati showed an increase of about 13, 64 and 213 per cent respectively (Table 4.5.4A). This is an important



**Table 4.5.4 : Area under Irrigated Wheat in Maharashtra, 1956-57 to 1971-72**

Sr. No.	Year	(Area in '00 hectares)		
		Gross irrigated cropped area	Total area under wheat	Area under irrigated wheat
1.	1956-57	10802	9336	1392
2.	1957-58	10842	8703	1328
3.	1958-59	11023	8562	1383
4.	1959-60	11717	9615	1466
5.	1960-61	12182	9582	1385
6.	1961-62	12336	9075	1418
7.	1962-63	12782	8799	1413
8.	1963-64	13130	8907	1437
9.	1964-65	13639	8864	1577
10.	1965-66	13880	8321	2050
11.	1966-67	14133	8396	2110
12.	1967-68	14762	8197	2215
13.	1968-69	15568	8394	2359
14.	1969-70	16232	8476	2630
15.	1970-71	15703	8552	2753
16.	1971-72	16216	10008	2979

development and is to be borne in mind when we discuss the performance of area and yield rate of high-yielding varieties of wheat.

The more relevant development during the above period has been the high-yielding varieties of wheat which was to use significant quantities of chemical fertilizers to give improved yield. As noted earlier, separate cropwise data

**Table 4.5.4A : Area under Irrigated Wheat in Maharashtra and Its Agro-Climatic Zones, 1960-61 to 1971-72**

Sr. No.	Year	(Area in '00 hectares)						Maharashtra State
		Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	
1.	1960-61	374 23.21	387 41.03	200 65.57	312 11.98	69 3.85	43 1.84	1385 14.45
2.	1961-62	406 26.48	374 43.69	202 63.72	319 11.73	66 4.16	51 2.47	1418 15.62
3.	1962-63	432 28.62	361 44.34	198 66.44	309 11.48	64 4.01	49 2.58	1413 16.05
4.	1963-64	410 27.38	376 47.53	203 65.69	334 12.38	64 3.91	50 2.52	1437 16.43
5.	1964-65	475 30.21	385 46.61	204 68.00	364 13.44	81 5.28	68 3.53	1577 17.79
6.	1965-66	770 46.13	416 53.53	185 70.07	417 16.59	194 14.94	68 3.77	2050 24.63
7.	1966-67	788 49.25	371 46.54	218 69.64	467 18.74	178 12.61	88 4.93	2110 25.13
8.	1967-68	807 50.85	452 53.68	206 71.03	491 20.33	184 14.42	75 4.19	2215 27.02
9.	1968-69	905 54.19	456 51.00	214 72.78	508 20.69	173 13.02	103 5.87	2359 28.10
10.	1969-70	1068 64.37	516 46.82	203 65.69	584 23.79	144 11.47	115 6.77	2630 31.92
11.	1970-71	1226 73.01	629 64.91	212 63.29	378 15.10	165 12.76	143 8.40	2753 32.19
12.	1971-72	1156 65.49	650 51.58	251 69.52	548 16.25	189 12.98	185 10.30	2979 29.76

(Figures on Line 2 are percentages to total wheat area.)

on application of fertilizers are not available, we shall examine only the available data on extension of use of the new high-yielding varieties of wheat.

High-yielding varieties of seed, particularly the Mexican varieties and its derivatives, were made available to the farmers in the State from 1965-66 onwards. It was felt at that time that these varieties can be more fruitfully used by the farmers under irrigated condition to facilitate the use of significant doses of fertilizers.

While extension of HYV seed began in 1965-66, data about estimated area under HYV wheat are available from 1968-69. Table 4.5.5 presents the estimate of the percentage of the total area under wheat growing high-yielding varieties, provided by the Zilla Parishads and estimated by the Statistician, Department of Agriculture, side by side. The Table shows that according to the estimate of the Zilla Parishads the proportion of total wheat area under HYV increased steadily from 11.11 per cent in 1968-69 to 24.34 per cent in 1971-72. The Statistician's sample survey showed a similar increasing trend over the four years, but of a lower order. It increased from 9.74 per cent in 1968-69 to 18.32 per cent in 1971-72. Thus, the Zilla Parishads' estimate of area turn out to be over-estimates.

The Statistician's estimates show that the area under HYV wheat has never been very large, but there has been a steady increasing tendency in the area under the crop. This

**Table 4.5.5 : Percentage of Wheat Area under High Yielding Variety as Estimated by (a) The Zilla Parishads and (b) The Statistician, Department of Agriculture, 1968-69 to 1971-72**

Sr. No.	Zone	1968-69		1969-70		1970-71		1971-72	
		As per Z.P.s	As per Statistician	As per Z.P.s	As per Statistician	As per Z.P.s	As per Statistician	As per Z.P.s	As per Statistician
1.	Nasik	34.39	34.04	39.14	33.78	41.68	31.93	48.93	36.76
2.	Poona	9.33	5.53	14.26	13.66	23.93	22.28	26.16	23.16
3.	Kolhapur	17.53	11.27	25.19	20.00	21.44	17.38	24.15	14.84
4.	Aurangabad	7.09	5.00	12.95	7.36	19.18	13.77	23.40	14.82
5.	Amravati	2.69	2.31	6.95	6.70	11.18	9.51	16.24	15.14
6.	Nagpur	0.79	0.76	2.64	2.18	4.18	3.96	7.29	6.62
	State	11.11	9.74	15.74	12.68	20.22	16.00	24.34	18.32

is reflected in the zonal figures as well. All except the Kolhapur zone recorded a steady increase in the proportion of total wheat area under HYV. Kolhapur zone alone records some decline in the middle. The highest rate of adoption is recorded in Nasik zone, where it had been above 34 per cent since 1968-69. The lowest rate of adoption was in Nagpur, 6 per cent only.

The Statistician had conducted random sample crop-cutting experiments to estimate the yield rates of HYV wheat during the four years since 1968-69. These data for each of the years and zones are given in Table 4.5.6. The data show that by and large the yield rates of HYV wheat were quite high compared to the traditional performance of local wheat in the State. The average yield rate of HYV wheat over the four years 1968-72 was estimated at 1883 kgs. per hectare. This was about four times as high as the average yield of wheat (418 kgs./hectare) and two times that of irrigated wheat (938 kgs./hectare) in the State during the 12 years preceding 1968-69. The same phenomenon was also recorded for the various wheat zones as will be seen from the Table 4.5.6.

With such high rate of yield, it is not surprising that the estimated total production of HYV wheat in the State came to account for a much higher proportion of the total wheat production than the area under HYV wheat. These percentages, zonewise, are given in Table 4.5.7. The Table shows that during these four years production of HYV wheat

**Table 4.5.6 : Average Yield of Wheat and of High Yielding Variety of Wheat in Maharashtra, 1956-57 to 1971-72**

		(Yield kgs./hectare)													
Sr. No.	Year	Nasik		Poona		Kolhapur		Aurangabad		Amravati		Nagpur		Maharashtra	
		Wheat	HYV	Wheat	HYV	Wheat	HYV	Wheat	HYV	Wheat	HYV	Wheat	HYV	Wheat	HYV
1.	1956-57	313		268		563		298		467		374		350	
2.	1957-58	362		455		583		361		253		260		340	
3.	1958-59	526		497		730		462		538		397		485	
4.	1959-60	437		386		581		348		446		434		413	
5.	1960-61	425		466		763		430		359		381		418	
6.	1961-62	546		466		580		454		434		425		465	
7.	1962-63	558		491		644		430		575		534		513	
8.	1963-64	486		437		591		381		276		317		383	
9.	1964-65	506		470		609		421		426		475		460	
10.	1965-66	494		426		519		259		269		280		336	
11.	1966-67	488		461		454		348		521		409		433	
12.	1967-68	593		471		689		328		460		334		428	
Average		478		441		609		377		419		385		418	
13.	1968-69	665	1871.4	611	1630.7	714	1630.7	408	1212.8	399	1417.5	419	1419.5	492	1723.7
14.	1969-70	673	2199.3	473	1804.1	618	1804.1	403	1420.6	354	1381.8	363	1381.8	458	1898.1
15.	1970-71	810	2104.6	602	1988.7	690	1844.4	323	1521.7	476	1738.2	429	1536.1	513	1867.5
16.	1971-72	675	2209.4	628	2336.6	529	1754.0	394	1813.3	441	1974.0	496	1583.2	503	2039.4
Average		706	2096.1	578	1940.0	638	1758.3	382	1492.1	417	1628.3	426	1480.1	491	1883.3

**Table 4.5.7 : Estimated Total Production of High-Yielding Variety Wheat as Percentage of the Total Production of All Wheat in Maharashtra, 1968-69 to 1971-72**

Sr. No.	Zone	1968-69	1969-70	1970-71	1971-72
1.	Nasik	95.84	110.34	82.98	120.28
2.	Poona	14.76	52.15	73.66	86.23
3.	Kolhapur	25.73	58.40	46.50	32.29
4.	Aurangabad	14.85	25.95	64.91	68.24
5.	Amravati	8.25	26.20	34.76	67.77
6.	Nagpur	2.60	8.31	14.20	21.16
	State	34.13	52.60	58.29	72.84

accounted for between 34 and 73 per cent of the total production of wheat, while, as we have seen, even in the best year the area under HYV wheat was not more than 18 per cent of the total area. The zonal figures in some years seem to have pierced the ceiling; in Nasik zone in 1969-70 and 1971-72, HYV wheat production formed 110.34 per cent and 120.28 per cent of the total wheat production of that zone, in Poona, Aurangabad and in Amravati zones in the year 1971-72, HYV wheat production formed 86.23, 68.24 and 67.77 per cent of the total production of wheat in the respective zones. These and similar other figures in the Table are ridiculous. Similar figures for the individual districts, in 11 out of 22 districts (not presented here) showed more such instances where the estimated yield rate of local wheat was negative or near zero

during one or other of these four years.

If one compared the estimated yield rate of local wheat in different zones during these four years (after deducting the estimated area and production of HYV wheat from the officially estimated total area and production of total wheat) then one finds that they are, by and large, much lower than the yield rates of local wheat in the same zones during the 12 years before the introduction of high yielding varieties seed. This is rather difficult to accept (Table 4.5.8).

Table 4.5.8 : Estimated Average Yield of Local Wheat in Maharashtra, 1968-69 to 1971-72

Sr. No.	Year	(Yield kgs./hectare)						
		Hasik Poona	Kolha-pur	Auran-gabad	Amra-vati	Nagpur	Maha-rashtra	
1.	1968-69	42	551	597	365	374	410	358
2.	1969-70	-106	262	321	322	279	340	248
3.	1970-71	202	203	446	131	342	382	254
4.	1971-72	-216	112	640	146	167	418	170

This raises the whole question of the reliability of the available data. If the yield rate of local variety of wheat during the years since 1968-69 appears too low to be believed, the source of error may lie either in the estimated total production of wheat during these years in the State, or in the Statistician's estimate of production of HYV wheat. Now it is not easy to question the estimation of wheat



production by the State Government, which has been carried out in a given manner by a specified agency for many years now. In any case there is no apparent reason why the State Government's estimate of wheat production should be biased in the years since 1968-69.

To question the estimated production of HYV wheat is to question the estimated area under HYV seed and/or the estimated yield rate. We, however, propose to examine the data relating to the yield rate of high-yielding varieties of wheat in (i) the different agricultural experiment stations in the State, (ii) the trials conducted on farmers' fields and (iii) the sample farmers in a selected village in the Marathwada zone of the State surveyed by us. This might help us form a judgement about the reliability of the Statistician's estimated yield rate of HYV wheat.

Experiments on high-yielding varieties of wheat have been conducted in various agricultural experiment stations in the State since 1966-67. The experiments have been for different types of treatments, namely, seed rate, spacing, application of N, P and K, etc. We have collected the results of all the experiments on HYV wheat in all the experiment stations in the State. For the purpose of analysis we have noted experiment results relating to the following standard treatments for all the different experiments in each of the years since 1965-66. The standard treatment referred to is as follows :

<u>Treatment</u>	<u>Irrigated</u>	<u>Unirrigated</u>
1. Sowing time	15th October to 15th November	15th October to 15th November
2. Seed rate	80-100 kgs./hectare	70-75 kgs./hectare
3. Spacing between rows	22-25 cms.	22-25 cms.
4. Farmyard manure	35-40 cartloads/ hectare	25 cartloads/ hectare
5. Fertilizers :		
Nitrogen	100-125 kgs./hectare	50-75 kgs./hectare
Phosphorus	50-75 kgs./hectare	40-50 kgs./hectare
Potash	50-75 kgs./hectare	40-50 kgs./hectare
6. Plant Protection	As and when required	As and when required

The agricultural experiment station at Kiphad (District Nasik) is the most important station for research in wheat in the State. During the eight years, 1965-73, the experiments were conducted both under irrigated and unirrigated conditions. Under irrigated condition five different experiments were conducted on HYV wheat in this station. The average yield rate of all these experiments (for standard treatments) was 1380 kgs. per hectare. It varied from 977 kgs. in one experiment in 1967-68 to 1987 kgs. in another in 1966-67. The coefficient of variation was 29.20 per cent. Under dry condition eight experiments were conducted. The average yield rate of all these experiments was 533 kgs. per hectare and it varied between 290 kgs. and 1009 kgs. per hectare. The coefficient of variation was 44.09 per cent.

The average yield of HYV wheat for the four years,

1968-69 to 1971-72, in Nasik zone estimated by the Statistician was 2096 kgs./hectare and the yield ranged between 1871 and 2209 kgs./hectare.

The agricultural research station at Badnapur (District Aurangabad) is another important station for research on wheat in the State. During the 7-8 years only 3 different experiments were conducted on HYV wheat. All these experiments were carried out under irrigated condition. The average yield rate of all these experiments was 1185 kgs. per hectare and it varied from 848 kgs. in one experiment in 1967-68 to 1438 kgs. in another in 1969-70. The coefficient of variation was 29.95 per cent. This was the only experiment station in Aurangabad zone for wheat. The average yield of HYV wheat for the four years in Aurangabad zone estimated by the Statistician was 1492 kgs./hectare and it ranged between 1212 and 1813 kgs./hectare.

The comparison of the data from the research stations in the other zones tabulated in Table 4.5.9.

Similarly, it may be useful to compare the Statistician's estimates with the average yield rates recorded in Fertilizer and Varietal Trials (FVT) in cultivators' fields, over the 7 years, 1966-67 to 1972-73. The relevant data are presented in the above Table 4.5.9 in columns 10 to 12. The data show that the average yield of HYV wheat, under irrigated condition, recorded in the FVTs in each zone was slightly lower than the yield rate estimated by the Statistician in those zones.

**Table 4.5.9 : Estimated Average Yield Rates of High Yielding Variety Wheat from Different Sources**

		(Yield kgs./hectare)									
Sr. No.	Zone	District/ Research Station	Zonewise estimated yield by Statistician			Yield at Research Stations			Districtwise yield of F.V.T.s		
			Aver- age (4)	Mini- mum (5)	Maxi- mum (6)	Aver- age (7)	Mini- mum (8)	Maxi- mum (9)	Aver- age (10)	Mini- mum (11)	Maxi- mum (12)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1.	Nasik	-	2096	1871	2209	-	-	-	-	-	-
		Niphad	-	-	-	533	290	1009	-	-	-
		Dhulia Jalgaon	-	-	-	<u>1380</u>	<u>977</u>	<u>1987</u>	<u>1783</u> <u>2080</u>	<u>1500</u> <u>1860</u>	<u>1990</u> <u>2300</u>
2.	Poona	1940	1630	2336	-	-	-	-	-	-	
3.	Kolhapur	1758	1630	1844	-	-	-	-	-	-	
4.	Aurangabad	-	1492	1212	1813	-	-	-	-	-	-
		Badnapur	-	-	-	<u>1185</u>	<u>848</u>	<u>1438</u>	-	-	-
		Ehir Aurangabad	-	-	-	-	-	-	993 <u>1199</u>	930 <u>956</u>	1040 <u>1595</u>
5.	Amravati	-	1628	1381	1974	-	-	-	-	-	-
		Washim	-	-	-	671	539	815	-	-	-
		Akola	-	-	-	-	-	-	580	540	610
		Buldhana	-	-	-	-	-	-	730	640	800
		Amravati Yeotmal	-	-	-	-	-	-	<u>1312</u> <u>776</u>	<u>970</u> <u>540</u>	<u>1672</u> <u>1120</u>
6.	Nagpur	-	1480	1381	1583	-	-	-	-	-	-
		Nagpur	-	-	-	851	257	1312	786	650	900
		Tharsa Wardha	-	-	-	<u>1895</u> <u>921</u>	<u>1253</u> <u>741</u>	<u>2633</u> <u>1102</u>	- 420	- 350	- 480
State			1883	1723	2039	-	-	-	-	-	-

Note : Underlined figures indicate yield of irrigated wheat.

The third set of data with which we propose to compare the Statistician's estimates, are the data collected by us in one village in Aurangabad district. We made a purposive selection of one village, Selgaon, in Aurangabad district, which accounts for 32 per cent of the total area under wheat in Aurangabad zone. We selected at random 20 cultivators growing HYV wheat in 1974-75, and collected from them information about their area and production of wheat for that year and the previous three years. The Statistician's estimates of the average yield of HYV wheat in Aurangabad district are given below side by side our estimate for the particular village surveyed.

Year	Yield rate kgs./hectare		
	Statistician's estimate	Village surveyed	
		Irrigated	Unirrigated
1968-69	1128	N.A.	N.A.
1969-70	1170	N.A.	N.A.
1970-71	1274	N.A.	N.A.
1971-72	1874	1885	742
1972-73	N.A.	1760	610
1973-74	N.A.	2155	760
1974-75	N.A.	2140	812

Comparing the data for the year 1971-72, for which yield data from both the sources are available, one finds the yield rate under irrigated condition in our survey is fully comparable to the estimated yield rate by the

Statistician. Therefore, one can say that the yield rate data for the years 1963-69 to 1970-71 provided by the Statistician are not over-estimated and these yield rates are related to the irrigated high-yielding varieties of wheat.

Additional support can be deduced by referring to the sample survey data collected by the Institute of Agricultural Research Statistics, New Delhi, in the year 1970-71.<sup>1</sup> The data relating to the yield rate of high-yielding varieties of wheat were collected on a properly stratified random sample of farms in the State as a whole, covering 970 farms. In the year 1970-71, average yield of high-yielding varieties of wheat was estimated to be 17.1 quintals per hectare and it varied between 15.5 quintals and 18.9 quintals per hectare. This is fairly comparable to the yield rate of high-yielding varieties of wheat estimated by the Statistician in the same year (18.6 quintals/hectare). This and other evidences examined by us indicates that the yield estimates of high-yielding varieties of wheat by the Statistician for different years are fair enough and cannot be considered as over-estimates.

The comparison of the yield data relating to HYV wheat from the three different sources bring out the following.

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1 Das, M.N., Raheja, S.K. et al. 'Sample Surveys for Assessment of High Yielding Varieties Programme' Annual Report 1970-71, Volume I. Institute of Agricultural Research Statistics, New Delhi, 1973.

(i) There is a very wide disparity noticed between the performance of HYV seed under irrigated and unirrigated conditions. The yield rate is seen to be two to four times higher under irrigation than under unirrigated condition, from all the three sources of data. Incidentally, it is interesting to note that there were more experiments and varietal trials on farmers' fields reported under unirrigated than under irrigated condition. In some districts the experiments/trials related only to unirrigated wheat. This is very curious, especially because it was generally presumed that HYV wheat seed was likely to be profitable only under irrigated condition.

(ii) The Statistician's yield estimates are comparable to the yield estimates under irrigated condition only in all the three sources of data cited above. This, in our judgement is clear evidence that not only do the Statistician's yield estimates relate to irrigated HYV wheat, but HYV wheat in Maharashtra was grown by farmers only under irrigated condition. This is in keeping with the general expectation. The point is also of importance in examining the estimate of area under HYV wheat in the State.

(iii) While the Statistician's estimate of yield of HYV wheat is more in line with the yield rates on irrigated wheat farms from the other sources, most of the <sup>line</sup> line the Statistician's average yield rate turns out to be on the higher side (except in case of our village survey). This may

not unreasonably, lead one to suspect a slight over-estimation of HYV wheat yield by the Statistician - by about 5 to 10 per cent. This suspicion may be strengthened by the difference in the yield estimate of the Statistician and that from the sample survey conducted by the IAAS, New Delhi.

If we accept the last mentioned suspicion as valid, then we may revise our estimated yield rate of local wheat for the four years for which the Statistician's data are available. If we now presume the actual average yield of HYV wheat in each of the four years, 1968-72, to be 10 per cent less than that estimated by the Statistician, then the estimate of the yield rate of local wheat will be as follows:

<u>Year</u>	<u>Yield rate</u> kgs./hectare
1968-69	377
1969-70	275
1970-71	290
1971-72	216

We find that these yield rates of local wheat are much lower than the yield rates of local wheat in the State during the 12 years before the introduction of high yielding varieties seed (418 kgs./hectare). This suggests that the error likely to lie in the area estimation of HYV wheat.

Since the preceding discussion shows that there is no very strong direct evidence to suspect serious gross over-estimation of yield rates by the Statistician, it follows that his estimation of area under high-yielding varieties in



different years might be the chief source of error. However, independent source of estimation of area under these varieties in the State are not easily available.

However, the point may be little clearly made by referring to area under HYV wheat in Amravati zone. We have noted earlier, the estimated yield rate of HYV wheat by the Statistician was related to irrigated lands only. Official statistics show that in the year 1971-72 area under irrigated wheat, in Amravati zone, was only 18900 hectares, i.e., 12.98 per cent of the total wheat area, whereas area estimated by the Statistician under HYV wheat in the same year was 22028 hectares, i.e., 15.14 per cent of the total wheat area for that year. Considering the yield rate of irrigated wheat, there is some reason to doubt the Statistician's estimate of area under HYV wheat and, therefore, it may not be very unfair to suggest that the above referred estimates of area by the Statistician are likely to be over-estimates.

However, this is not the case with other zones where area under irrigated wheat was larger than the area under HYV wheat. During the four years, 1968-72, the area under irrigated wheat in Nasik, Poona and Kolhapur zones varied between 54 per cent and 68 per cent of the total wheat area, while the maximum area under HYV wheat in Nasik was 37 per cent (1971-72), in Poona 23 per cent (1971-72) and in Kolhapur 20 per cent of the total wheat area. In Aurangabad zone, area under irrigated wheat varied from 15 to 24 per

cent while maximum area under HYV wheat was 14 per cent only (1971-72). Similar was the case of Nagpur zone where area under irrigated wheat varied between 6 and 10 per cent and that of HYV wheat between 0.76 per cent and 6 per cent. This suggests that even the entire area under irrigated wheat was not covered by the new seed.

The statistical data show that the area under high-yielding variety wheat in Maharashtra during the four years, 1968-72, steadily increased from 35 per cent in 1968-69 to 62 per cent in 1971-72 of the total irrigated area under wheat. In Punjab, where wheat is an important crop and mostly grown under irrigated condition, area under HYV wheat increased from 35 per cent in 1967-68 to 72 per cent of the total wheat area in the year 1971-72.<sup>2</sup> This suggests that, even in the State like Punjab, adoption of the new variety seed was not 100 per cent. Among the different reasons, undesirable physical character and comparatively low price than that of local wheat might be one of the reason for non-adoption of these varieties on entire irrigated land.

The present statistics show that the area under irrigated wheat in Maharashtra never exceeded more than 32 per cent of the total wheat area in any one of the last 12 years. Under the circumstances it will not be unfair to say that the area under HYV wheat in Maharashtra is not likely to exceed

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2 The Economic Adviser to Government of Punjab, 'Statistical Hand Book, Punjab', 1970-71 and 1972-73.

more than 32 per cent of the total wheat area in near future.

We have so far argued that the estimated yield rates of HYV wheat are not over-estimated but the error lies in the estimation of area under the new varieties during the four years, 1968-72, under study. Now considering the area under HYV wheat to be 4 to 6 per cent of the total wheat area in different years in the State, we have estimated the yield rates of local varieties of wheat. Such estimated yield rates appear to be fairly comparable to the average yield rate of wheat during the 12 years previous to the introduction of HYV seed. This suggests that, if we consider the estimated yield rates of HYV wheat by the Statistician are correct, then the area under HYV wheat might not have exceeded more than about 6 to 7 per cent of the total wheat area in the State.

We have noted earlier that the estimated yield rates of HYV wheat appear to be higher by about 5 to 10 per cent. Even if we consider the estimated yield rates of HYV wheat to be lower by 10 per cent and estimate the area under it, it does not exceed more than about 7 per cent of the total wheat area. This indicates that the area under HYV wheat in the State during the years 1968-69 to 1971-72 may not be much higher than 7 per cent of the total wheat area and definitely not as high as estimated by the Statistician (10 per cent in 1968-69 to 18 per cent in 1971-72).

This long review of the performance of high-yielding

varieties of wheat in Maharashtra from the year of its introduction, 1965-66, shows that it has been able to stimulate to increase the wheat production in the State. The officially estimated yield rate of HYV wheat is related to irrigated condition and does not appear to be an over-estimate, but estimate of area under these varieties appears to be over-estimate.

We have noted earlier that the average yield rate of HYV wheat is more than that of local varieties. Now let us examine the available evidence about the fluctuation in yield rates of the two varieties from year to year, as well as from region to region. Three sets of data are available to us for this purpose: (a) The Statistician's estimates of yields of high-yielding and local wheat in different districts during the four years since 1968-69, (b) the results of the Fertilizer and Varietal trials on farmers' fields, and (c) the results of agronomic experiments in the different experiment stations in the State.

The Statistician's estimates of average yield rates of the two varieties are available for four years, 1968-69 to 1971-72, for 22 districts (Table 4.5.10). An 'F' test for the difference between the variances of the two varieties was not significant for 18 of the 22 districts; however, it was significant when the data for the 22 districts were pooled, showing variance of HYV wheat to be significantly larger. The coefficient of variation of the yield rate of

**Table 4.5.10 : Average Yield of Wheat Estimated by the Statistician, Department of Agriculture, in Different Districts, 1968-69 to 1971-72**

Sr. No.	District	(Yield kgs./hectare)						
		Average yield of HYV	Standard deviation	Coefficient of variation	Average yield of Local Wheat	Standard deviation	Coefficient of variation	'F' value
1.	Nasik	2183	159	7.28	1458	148	10.15	1.13
2.	Dhulia	2290	190	8.29	1500	57	3.81	10.95*
3.	Jalgaon	1827	228	12.47	1255	239	19.04	1.09
4.	Ahmednagar	2142	208	9.71	1527	178	11.65	1.36
5.	Poona	1969	248	12.59	1380	182	13.18	1.85
6.	Sholapur	1733	102	5.88	1159	63	5.43	2.62
7.	Satara	1599	259	16.19	1083	177	16.34	2.14
8.	Sangli	1536	227	14.77	1130	64	5.66	12.76*
9.	Kolhapur	1847	172	9.31	1263	132	10.45	1.69
10.	Aurangabad	1361	300	22.04	876	118	13.47	6.50*
11.	Parbhani	1627	326	20.03	901	115	12.76	8.10*
12.	Bhir	1472	72	4.89	911	57	6.27	1.57
13.	Nanded	1388	39	2.80	892	32	3.58	1.48
14.	Osmanabad	1625	218	13.41	1017	156	15.33	1.94
15.	Buldhana	1792	178	9.93	1135	73	6.43	5.93
16.	Akola	1587	358	22.55	910	165	18.13	4.73
17.	Amravati	1709	278	16.26	1130	157	13.89	3.10
18.	Yeotmal	1450	160	11.03	876	76	8.67	4.47
19.	Wardha	1539	212	13.77	965	93	9.63	5.20
20.	Nagpur	1585	207	13.05	1062	150	14.12	1.90
21.	Bhandara	1074	80	7.44	704	68	9.65	1.39
22.	Chandrapur	1337	129	9.64	877	74	8.43	3.07

(continued)

Table 4.5.10 : (continued)

## Analysis of Variance of Pooled Data - HYV

	s.s.	d.f.	Mean s.s.	F = 5.70***
Between centres	7291128	21	347196	Coefficient of variation
Within centres	4015088	66	60834	Between centres = 35.31 %
Total	11306216	87	129956	Within centres = 14.80 %
				Total = 21.58 %

## Analysis of Variance of Pooled Data--Local

	s.s.	d.f.	Mean s.s.	F = 9.42***
Between centres	4371212	21	208152	Coefficient of variation
Within centres	1457668	66	22085	Between centres = 41.79 %
Total	5828880	87	66998	Within centres = 13.65 %
				Total = 23.73 %

high-yielding wheat was smaller than that of local in half of the 22 districts. The coefficient of variation with pooled data for high-yielding wheat was slightly lower (21.58 per cent) than that for local wheat (23.73 per cent). Thus, overall it appeared that the uncertainty associated with year to year fluctuation in yield rate was not higher in case of HYV wheat than for local wheat, and was possibly slightly lower.

The second set of data relate to Fertilizer and Varietal Trials on farmers' fields, conducted over six years, 1966-67 to 1971-72, in six districts under unirrigated condition with both HYV and local wheat and in five districts in irrigated condition with HYV wheat only. Therefore, under irrigated condition comparison between high-yielding and local varieties is not possible.

Under unirrigated condition, the 'F' test showed the variances of the yield rates of HYV and local wheat not to be significantly different in any district. Similar was the result when the data were pooled (Table 4.5.11A). The comparison of the coefficient of variation showed that in 4 out of 5 districts the coefficient of variation was lower for high-yielding wheat, but with pooled data the coefficient of variation of HYV wheat was as large as that of local wheat (30.81 per cent for HYV and 30.50 per cent for local).

The coefficient of variation of yield rates of high-yielding variety wheat was slightly lower under irrigation

**Table 4.5.11A : Average Yield of Unirrigated Wheat, under Fertilizer and Varietal Trials on Cultivators' Fields in Different Districts, 1966-67 to 1971-72 (With 44.8 kgs. Nitrogen and 22.4 kgs. Phosphoric Acid Per hectare)**

Sr. District No.	(Yield kgs./hectare)							
	Average yield of HYV	Standard deviation	Coefficient of variation	Average yield of Local Wheat	Standard deviation	Coefficient of variation	'F' Value	't' Value
1. Akola	580 (3)	29	5.00	621 (6)	61	9.82	3.49	0.97
2. Nagpur	796 (3)	103	13.10	858 (6)	107	12.47	1.17	0.86
3. Wardha	420 (3)	54	12.85	420 (6)	59	14.04	1.03	-
4. Buldhana	730 (3)	67	9.17	713 (6)	113	15.84	2.29	0.21
5. Amravati	776 (3)	249	32.08	746 (6)	256	34.31	1.18	0.15
6. Bhir	993 (3)	46	4.63	-	-	-	-	-

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 5.55***
Between centres	574551	5	114910	Coefficient of variation Between centres = 47.47 % Within centres = 20.16 % Total = 30.81 %
Within centres	248403	12	20700	
Total	822954	17	48409	

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 6.96***
Between centres	647148	4	161787	Coefficient of variation Between centres = 59.82 % Within centres = 22.61 % Total = 30.50 %
Within centres	580440	25	23217	
Total	1227588	29	42330	



(29.62 per cent) than that of unirrigated condition (30.81 per cent) (Table 4.5.11B).

**Table 4.5.11B : Average Yield of Irrigated Wheat under Fertilizer and Varietal Trials on Cultivators' Fields in Different Districts, 1966-67 to 1971-72 (With 60 kgs. Nitrogen and 30 kgs. Phosphoric Acid Per Hectare)**

Sr. No.	District	(Yield kgs./hectare)		
		Average yield	Standard deviation	Coefficient of variation
1.	Buldhana	1312 (3)	287	21.87
2.	Aurangabad	1199 (3)	282	23.51
3.	Jalgaon	2080 (2)	220	10.57
4.	Dhulia	1783 (3)	207	11.60
5.	Yeotmal	1130 (2)	160	14.15

Note : Figures in brackets are number of observations on which average is based.

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 4.09**	Coefficient of variation
Between centres	1561687	4	390421		Between centres = 42.08 %
Within centres	762689	8	95336		Within centres = 20.80 %
Total	2324376	12	193698		Total = 29.62 %

The third set of data relate to agronomic experiments conducted on different research stations in the State. Test of significance for the difference in the variances of the yield rates of two varieties could be carried out for only three research stations under unirrigated condition and two research stations under irrigated condition (Tables 4.5.12A and 4.5.12B). Pooling the data, both for unirrigated and irrigated separately, the 'F' test did not show the variance of high-yielding wheat to be significantly higher. The coefficient of variation with the pooled data under unirrigated condition showed high-yielding variety with larger variation (41.28 per cent for HYV and 37.33 per cent for local) while under irrigated condition with lesser variation (31.41 per cent for HYV and 38.69 per cent for local) in yield rate than local variety wheat.

After the examination of the three sets of data for variation in the yield rates of high-yielding and local wheat, one is led to the conclusion that, on the basis of the available statistical evidence, high-yielding variety wheat has not been able to show consistently lesser year to year/district to district fluctuation in yield rate than local wheat.

We have noted earlier that the average yield of high-yielding variety wheat on the 20 sample farms in our surveyed village was higher than the Statistician's estimate of the average yield of high-yielding variety in the district (under

**Table 4.5.12A : Average Yield of Unirrigated Wheat at Different Research Stations in Maharashtra (with Standard Cultural Practices)**

Sr. Research No. Station	(Yield kgs./hectare)						
	Average yield of HYV	Standard deviation	Coefficient of variation	Average yield of Local Wheat	Standard deviation	Coefficient of variation	'F' value
1. Niphad	533 (8)	235	44.09	454 (12)	105	23.12	4.54 <sup>a</sup>
2. Washim	671 (3)	113	16.84	659 (16)	176	25.76	2.64
3. Tharasa	921 (2)	180	19.54	-	-	-	-
4. Nagpur	851 (15)	307	36.07	659 (12)	216	32.77	1.99
5. Badnapur	-	-	-	577 (15)	235	40.72	-

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 2.47
Between centres	607352	3	202450	Coefficient of variation = 60.32%
Within centres	1959544	24	81647	Within centres = 38.33%
Total	2566896	27	95070	Total = 41.28%

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 2.66
Between centres	357595	3	119198	Coefficient of variation = 58.27%
Within centres	2282526	51	44755	Within centres = 35.64%
Total	2640121	54	48891	Total = 37.33%

**Table 4.5.12B : Average Yield of Irrigated Wheat at Different Research Stations in Maharashtra (with Standard Cultural Practices)**

Sr. Research No. Station	(Yield kgs./hectare)						
	Average yield of HYV	Standard deviation	Coefficient of variation	Average yield of Local Wheat	Standard deviation	Coefficient of variation	'F' value
1. Niphad	1380 (5)	403	29.20	1534 (5)	156	10.16	6.61*
2. Tharsa	-	-	-	1150 (19)	406	35.30	-
3. Nagpur	1895 (8)	411	21.68	-	-	-	-
4. Badnapur	1185 (3)	660	29.95	2203 (2)	249	21.01	9.64

**Analysis of Variance of Pooled Data - HYV**

	s.s.	d.f.	Mean s.s.	F = 4.03**
Between centres	1454861	2	727430	Coefficient of variation Between centres = 53.27% Within centres = 26.48% Total = 31.41%
Within centres	2345062	13	180389	
Total	3799923	15	253328	

**Analysis of Variance of Pooled Data - Local**

	s.s.	d.f.	Mean s.s.	F = 6.31**
Between centres	2263088	2	1131544	Coefficient of variation Between centres = 81.45% Within centres = 32.42% Total = 38.69%
Within centres	4121109	23	179178	
Total	6384197	25	255367	

irrigation). Our survey of the 20 farmers also shows that the average net income of a farmer from one acre of HYV wheat was higher than his average net income from one acre of local wheat grown by him under irrigated condition, while it was the same as that of local under unirrigated condition. The data are presented in Table 4.5.13.

All the inputs including the home supplied as well as the outputs, in the above Table have been valued at market prices current during the year of survey (1974-75). The net profit for HYV and local wheat for the 20 farmers is reproduced below :

	<u>HYV</u>	<u>Local</u>
1. Irrigated farms	866.72	775.96
2. Unirrigated farms	232.46	240.07

It is clear from the above that high-yielding variety wheat yielded higher profit (about Rs. 90) per acre than local, only under irrigated condition. Under unirrigated condition, HYV wheat showed no improvement over the other. This is an average picture. The labour input per acre of HYV wheat was slightly higher (Rs. 17) than per acre of local wheat under irrigated condition, while under dry condition it was almost the same. Out of 12, 7 farmers under irrigated condition and four out of eight under dry condition showed net profit, while the others showed net loss. This being the situation, it is not surprising that many farmers took interest to grow high-yielding wheat under irrigated condition only in the village and of course in the State.

**Table 4.5.13 : Per Acre Expenditure on and Receipts from High Yielding and Local Varieties of Wheat for a Sample of 20 Farmers in a Village in Aurangabad District, Maharashtra, 1974-75**

(in Rs.)

Sr. No.	Item/Group	HYV Wheat				Local Wheat			
		Irrigated		Unirrigated		Irrigated		Unirrigated	
		Rs.	%	Rs.	%	Rs.	%	Rs.	%
1.	Preparatory tillage	72.00	12.23	63.15	19.73	69.83	15.05	61.34	19.79
2.	Farmyard Manure	87.50	14.87	48.75	15.23	57.50	12.39	45.00	14.52
3.	Fertilizers	210.75	35.81	80.87	25.27	145.32	31.32	72.76	23.48
4.	Seed and Sowing	84.79	14.42	64.37	20.11	74.75	16.10	70.87	22.87
5.	After care	67.83	11.53	46.72	14.60	64.31	13.86	46.59	15.03
6.	Irrigation	22.91	3.89	-	-	21.25	4.58	-	-
7.	Plant Protection	-	-	-	-	-	-	-	-
8.	Harvesting and Thrashing	42.70	7.25	16.18	5.06	31.08	6.70	13.37	4.31
9.	Total Expenditure	588.48	100.00	320.04	100.00	464.04	100.00	309.93	100.00
	Yield in quintals: Grain	8.56		3.25		6.20		2.75	
	Value of grain	1455.20		552.50		1240.00		550.00	
	Profit	866.72		232.46		775.96		240.07	

Indeed it is somewhat surprising that in spite of the good performance of HYV wheat, under irrigated condition in the village, only 60 per cent of the total irrigated wheat area was under these varieties. The main reason for non-adoption of these varieties on the remaining 40 per cent land is noted as the undesirable physical characters, namely, colour and size of grain. The colour of the Mexican varieties is dull yellow and the grain size is shorter as against bright yellow colour and longer grain size of local varieties, which is preferred by the people, and, therefore, the price per quintal of local varieties was more by about Rs. 30 than the price of HYV wheat in the year of survey. However, efforts are being made to remove these drawbacks of high-yielding varieties and it is hoped that more and more area will come under these varieties.

The whole exercise can be summarized as below:

A small increasing trend in production and yield rate of wheat has been noticed in the State during the last two decades. After the introduction of HYV seed, a slow but sure increase in area under wheat is seen. During the later part of the 1960s area under irrigated wheat has been increased to the extent of 28 per cent of the total wheat area in the State. Average yield rate of the new variety was higher than local variety wheat only under irrigated condition. Net income of a farmer from one acre of HYV wheat under irrigated condition was higher than his average net income from local variety. By and large farmers have developed interest in growing the new variety seed under irrigated condition in the State.

CHAPTER V

CONCLUSION



Our survey of the performance of the important cereal crops - Jowar, Bajra, Rice and Wheat - in Maharashtra shows overall stagnancy in production, area and yield rate of these crops, except wheat, during the decade of the 1960's and beyond. A mild increase in area, production and productivity of wheat is noticed, particularly during the later years of the period, 1964-65 onwards. The performance of these cereals, which account for about 78 per cent of the total area under foodgrains and about 82 per cent of the total production of foodgrains in the State, is disturbing in the context of the development and propagation of new hybrid and high-yielding varieties of seeds of these crops since 1965.

The foodgrains production in the State, during the years 1960-61 to 1971-72, (the official statistics was available upto 1971-72 only) has not only failed to register an increase but has actually gone down. The production figures show that the level obtained in 1960-61 was not attained in the next eleven years. The compound growth rate of foodgrains production for the entire period of twelve years is calculated to be -2.30 per cent per annum. This leaves one wondering as to what happened to all the investment in agriculture in the form of increased irrigation facilities, development of high-yielding varieties etc.

It is true that agriculture is sensitive to climatic conditions and one may suspect that the relatively bad years,

particularly the terminal years, 1970-71 and 1971-72, of this period could be responsible for the negative growth rates. But if we delete these two years as well as the poor year 1965-66 and the exceptionally good year 1960-61 the growth rate comes to -0.07 per cent, indicating a virtual stagnancy.

Between the two Censuses of 1961 and 1971 the State population, on the other hand, increased from 39.55 million to 50.41 million at the compound growth rate of 2.40 per cent per annum. The phenomenon of declining production of foodgrains, in the face of apparently substantial investment in agriculture in Maharashtra, is not only puzzling but is indeed staggering.

This stagnancy in production of foodgrains was clearly because there was no noticeable increase in the area under foodgrains or the average yield rate. Till about the end of the 1960's Maharashtra's agricultural production had increased at 3.53 per cent over a decade, and foodgrains at 2.57 per cent. Out of this 0.49 per cent was due to increase in gross cropped area and 2.89 per cent in yield per hectare. In case of foodgrains also area increased at 0.48 per cent and yield rate at 2.03 per cent.

In the next decade and more, since 1960-61, on the other hand, this upward trend has ceased. Net cropped area (NCP) showed a decline of (-)0.16 per cent per year, and if poor years are excluded, there was complete stagnancy. This

showed that there had been no net addition to the area under crops in the State. Apparently the two sources for addition to this, culturable waste land and current fallows, were fast approaching their limits. The gross cropped area (GCA) also showed stagnancy or slight decline with a growth rate of  $-0.12$  per cent per annum. The double cropped area, however, had a positive growth rate of  $0.70$  per cent, which accounts for the smaller percentage decline in GCA than in NCA.

Irrigation is supposed to help increase the gross cropped area. In Maharashtra area under irrigation increased during the 12 years since 1960-61. But its impact on the gross cropped area has been negligible. The main reason for this is that irrigated area accounts for a very small portion of the gross cropped area of the State: it was 6 per cent of GCA in the beginning of the decade and increased to about 9 per cent by the beginning of the 1970's. Therefore, though the increase in irrigated area was in itself significant, it could hardly make a significant impact on gross cropped area. Furthermore, increase in gross cropped area through irrigation can come about if irrigation is available over both the kharif and the rabi seasons. Mere protective irrigation in the kharif season may not have any impact on the trend in GCA. And, finally, the method of reporting multiple cropping also affects the estimate of area "double cropped". If perennial irrigation results in land being put under an

annual crop like sugarcane or banana, it will be counted as cropped once, while if the same land is put under two seasonal crops, it would be counted twice for calculating GCA. As we shall see the bulk of the incremental net irrigated area during the 1960's and later, has been devoted to annual crops like sugarcane. Thus irrigation has been of only marginal significance in increasing gross cropped area. More than 90 per cent of the total cultivated land depends on natural precipitation. And statistics show a declining trend in area under crops in the rabi season, because of the unfavourable weather conditions, and increase of area under crops in the kharif season could not compensate this. (While on an average rabi area declined at the rate of 337 hundred hectares per year, total cropped area declined at the rate of 224 hundred hectares per year.)

The overall declining trend in cropped area in the State was naturally due to the decline in area of the major cereals, rabi and kharif jowar, which together accounts for one-third of total cropped area. The very slight increasing trend in area under bajra and rice, the two other important cereals, and of wheat - a rather unimportant cereal in the State - could not completely upset the general negative trend of total area under cereals.

Increase in the small proportion of irrigated cropped area in the State also did not favour the major cereal crops. The Gross irrigated area (GIA) shows a growth rate of 2.90

per cent per annum or a linear terms an increase of 400.84 hundred hectares per annum. Jowar, with a share of 23 per cent in GIA in the initial period (average of first three years) - the highest area share in GIA of any crop - registered a decline by the end of the period to 18 per cent only (average of last three years). This was because there was no addition to area under irrigated jowar during the period of 12 years. Rice, which ranked second in the initial period (share in GIA 21.97 per cent) comes out first at the end of the period but again with a reduced share of 20 per cent. A substantial increase in share in the increased irrigated area is observed only in case of wheat of all the cereals. It increased from 11.29 per cent in the beginning to 17.38 per cent in the end. The growth rate for the entire period comes to 8.10 per cent per annum. Bajra and other cereals (mainly maize) also show small increases. However, cereals as a whole could hardly maintain their share in the GIA, thanks to the substantial contribution of wheat. All other cereals failed to secure even the same share in the additional irrigated area during these 12 years as they had earlier.

What was the reason for this? As we have seen in this study it was in case of irrigated wheat alone that the new variety of seed had a better payoff, as a result of which wherever more paying irrigated crops like sugarcane were not competing for irrigation or where wheat could come

in the rotational scheme, irrigated wheat was taken up by farmers. The other cereals - jowar, bajra and rice - had a meagre pay off under irrigated conditions, even with their new varieties, and therefore, could not compete with wheat or other irrigated crops. Indeed, irrigated area was put under a cereal crop when growing sugarcane was not possible because of seasonal irrigation facility only, (or any other reason) or as a part of a rotation with sugarcane.

This is well illustrated in the case of irrigated area in the Poona Division. In the beginning of the 1960's, the Poona Division contained nearly half of the gross irrigated area in the State. Most of this was under canal irrigation, and the bulk of the canal irrigated land (which is perennially irrigated) was in this Division. Of the total irrigated area, 17.79 per cent was under sugarcane and 58.58 per cent under cereals. During the subsequent 12 years the gross irrigated area in the Division increased by 9.27 per cent. But 65 per cent, or nearly two-thirds of this increased irrigated land was put under sugarcane whereas cereals had only 21.38 per cent of the additional irrigated land. This indicates how perennial irrigation facility was used overwhelmingly for annual crops like sugarcane (and banana in the two Khandesh districts), in preference to seasonal cereal crops. As things stand, it is almost inevitable that the individual cultivator prefer growing sugarcane to any combination of irrigated seasonal crops which taken together

are not as profitable to him with limited land resources, unless State policy in regard to the use of irrigation water is differently designed.

But, whatever the State policy, it is difficult to visualize a substantial increase in irrigated area under cereals in the State in the not-too-distant future. For, not merely is the present irrigated area very small, but the best projection into the future available so far - by the Maharashtra Irrigation Commission (12 per cent) - puts the ultimate potentiality of irrigated area in the State at 32 per cent of all cropped area, provided all the known water sources are fully and most economically utilized. This is a long way apart from the dominance of annual crops in it. The growth of production of seasonal crops now and even in the long run will have to depend upon increased productivity of such crops under unirrigated conditions and extension of offseason irrigation facilities in such areas - as the rice growing tracts where sugarcane may not be a successful competitor. Jowar and bajra have to depend largely on unirrigated farming and increased paddy production on both extension of irrigation in rabi season as also greater productivity in the kharif season.

The review of the performance of the hybrid and high-yielding variety of seeds of the major cereals in the State during the last decade brought out the severe limitations of the varieties extended to the farmers till 1975. Hybrid

jowar was a complete failure on unirrigated fields in the rabi season. In kharif, the unirrigated hybrid jowar gave a higher yield. On an average than local jowar. A still higher yield could be possible with regular and frequent preventing spraying of insecticides, which was well-nigh impossible in the dry regions. The observed high yield was subject to as large fluctuations from year to year. The cost of production being high, the farmers ran high risk of getting not only a lower net return than on local jowar but even of a zero net return. In case of bajra, the observed yield rates for hybrid were very much higher than for local bajra, so much so that the observed unmitigated rate of fluctuation in it from year to year would have been unable to discourage the farmers from adopting it. But a new seed-borne disease - Downey mildew - entered the scene and the result was a sharp decline in area under hybrid bajra. The yield rate of HYV rice was higher, but in the first place this performance was on irrigated lands only, which limited the possibility of its extension in the State. But more important was the fact that the higher observed yield was not so much higher as to be able to sufficiently offset the impact of the lower price that HYV paddy obtained in the market on account of its comparatively inferior "quality". It is only in case of wheat that the HYV seed succeeded in raising yield rates, of course, on irrigated land only. As a result wheat alone could show an increasing trend in production during the period.



The net result of all this is that the new varieties, except for HYV wheat, resulted in an income no higher than from local varieties and therefore failed to provide the necessary incentive to the producers to adopt them. Under the circumstances it is clear that increase in the production of these major cereal crops can come only from the development of seeds and associated cultural practices with the following three basic qualities, if the vast mass of peasantry in Maharashtra is to use it.

(a) The new seed should give a significantly higher yield, with much less fluctuations on account of the weather factor than experienced hitherto. If the fluctuations are to be as large, then the response of these seeds to given levels of plant nutrients would have to be very much larger, so that even a poorer yield can cover the costs most of the years.

(b) The varieties of seeds should, as far as practicable, be resistant to pests and diseases, rather than entail large additional expenditures for preventive measures like insecticides and pesticides.

(c) The quality of the final product should not at least be inferior to the existing local varieties.

These are the lessons of the experience of the last decade in Maharashtra with the new varieties.

At the end, the failure of hybrid/high yielding

varieties of the important cereal crops at the farm level in Maharashtra raises important questions. It raises the question of misallocation and wastage of <sup>Social</sup> ~~soil~~ resources in the face of persistent poor acceptance of the new seed, except wheat, by the farmers. It appears from our investigation that the quantity of the seed of these varieties distributed to the farmers by the Government was much more than the quantity actually used by the cultivators. The seed of these varieties was sold to the farmers at a higher rate, with State subsidy on occasions, and was purchased from the producer farmers at almost the same higher price. At the private level, the bulk of this cost was borne by the farmers and the State expended some valuable resources. The sole beneficiaries were the seed growers. The earnings of the seed growers were, therefore, largely a transfer of income from one category of farmers (and the general tax payers) to another. These are matters that have to be taken into account in studying the social cost-benefit of the high-yielding varieties programme in the State.

APPENDIX I

STATISTICAL ANALYSIS OF DATA  
- KHARIF JOWAR

We have explained earlier, in kharif jowar, that if hybrid jowar yields more than local jowar, it also costs proportionately higher, and a farmer will naturally hesitate to stake a larger expenditure than a smaller one if the chances of a poor crop are as high in case of the former as in case of the latter. Similarly wide variation in the performance of hybrid jowar among regions/districts of the State, if noted, would be another disturbing factor from the point of view of adoption of the crop in different regions. Fluctuations in yield rates of the two varieties, Hybrid and Local, from year to year as well as from region to region have been examined with the help of analysis of variance and coefficients of variation. Three sets of data are available to us for the purpose :

- (a)\* The Statistician's estimates of yields of hybrid and local jowar in different districts;
- (b)\* The results of the F.V. Trials on hybrid and local varieties in different districts; and
- (c)\* The results of agronomic experiments on hybrid and local varieties in different experiment stations in the State.

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\* The data are presented in Tables A<sub>1.2</sub>, A<sub>1.3</sub>, A<sub>1.5</sub>, A<sub>1.6</sub>, A<sub>1.8</sub> and A<sub>1.9</sub>. In the same Tables some steps of analysis of variance have also been recorded.

For each of these data sets the differences between the year to year variances of the two varieties were examined for each centre separately by carrying out F Tests. The results of these tests have been presented in Tables A<sub>1.1</sub>, A<sub>1.4</sub> and A<sub>1.7</sub>.

All the important steps of the analysis of variance have been carried out as follows.

We shall consider first the Statistician's data for hybrid jowar.

Let  $X_{ij}$  represent yield per hectare at the  $i^{\text{th}}$  centre in the  $j^{\text{th}}$  year,  $N_i$  be the number of years for which the observations are available for the  $i^{\text{th}}$  centre and let  $K$  be the number of centres. Let total number of observations be  $N$  so that  $N = \sum_{i=1}^K N_i$ . Then  $\bar{X}$  the grand mean of all the

observations is given by :

$$\frac{\sum_{i=1}^K \sum_{j=1}^{N_i} X_{ij}}{\sum_{i=1}^K N_i}$$

Let the centre mean for the  $i^{\text{th}}$  centre be denoted by  $\bar{X}_i$ .

Then :

$$\bar{X}_i = \frac{\sum_{j=1}^{N_i} X_{ij}}{N_i}$$

The total sum of squares is given by :

$$\sum_{i=1}^K \sum_{j=1}^{N_1} (x_{1j} - \bar{X})^2$$

This total sum of squares can be partitioned as below :

$$\begin{aligned} \sum_{i=1}^K \sum_{j=1}^{N_1} (x_{1j} - \bar{X})^2 &= \sum_{i=1}^K \sum_{j=1}^{N_1} (x_{1j} - \bar{X}_i)^2 \\ &+ \sum_{i=1}^K N_1 (\bar{X}_i - \bar{X})^2 \quad \dots (1) \end{aligned}$$

The total variation described by the sum of squares of all  $N$  cases around the total mean has been broken up into two components each of which is expressive of a type of variation. In the equation (1) above the component

$$\sum_{i=1}^K \sum_{j=1}^{N_1} (x_{1j} - \bar{X}_i)^2$$

represents variation among individuals within centres (within centres sum of squares), and the component

$$\sum_{i=1}^K N_1 (\bar{X}_i - \bar{X})^2$$

represents variation between centre means (between centres sum of squares). Each of these sums of squares is associated with degrees of freedom as shown in the following analysis of variance table (overleaf).

The yield fluctuation between and within centres is examined by comparing the relative variances with the help of an  $F$  test (Mean s.s. between centres divided by Mean s.s. within centres) and by comparing the coefficient of variation.

## Analysis of Variance Table

Source of Variation	Sum of Squares	Degrees of freedom	Mean sum of squares (2)/(3)	F test
(1)	(2)	(3)	(4)	(5)
Within centres	$\sum_{i=1}^K \sum_{j=1}^{N_i} (X_{ij} - \bar{X}_i)^2$	$\sum_{i=1}^K (N_i - 1)$	MBSS	$F = \frac{MBSS}{EWSS}$
Between centres	$\sum_{i=1}^K N_i (\bar{X}_i - \bar{X})^2$	$K - 1$	MBSS	
Total	$\sum_{i=1}^K \sum_{j=1}^N (X_{ij} - \bar{X})^2$	$N - 1$		

Coefficient of variation is defined as :

$$CV = \frac{\sqrt{\text{Mean S.S.}}}{\text{Grand mean}} \times 100$$

Thus we get three coefficients of variation, namely, between, within and total.

Similar procedure is followed for local variety.

Yield fluctuations of hybrid and local variety between and within centres are examined by comparing the relative variances with the help of F tests carried out as follows:

$$\text{Between centres } F = \frac{MBSS (HYV)}{MBSS (Local)}$$

$$\text{Within centres } F = \frac{MWSS (HYV)}{MWSS (Local)}$$

$$\text{Total } F = \frac{MTSS (HYV)}{MTSS (Local)}$$

The first set of data relate to the Statistician's estimates of yields of hybrid and local jowar in different districts during the five years since 1968-69, for 20 districts. In all the districts the number of observations was equal to the number of years i.e. one observation for each year, for which the data are available. Therefore, variation in yield rates within the year cannot be calculated. To find out the variation in yield rates within the centres/districts (from one year to another) and between the centres/district (from one district to another) the available data are pooled. Coefficients of variation within and between centres have been calculated. Fluctuation in yield rates within and between centres is examined by comparing the relative variances with the help of F test. The results of the analysis are given in Tables A<sub>1.2</sub> and A<sub>1.3</sub> for hybrid and local jowar respectively.

Similar method of analysis of variance was used for analysing the yield data obtained from fertilizer and varietal trials on farmers' fields as well as from experiments in research stations.



The second set of data relate to fertilizer and varietal trials on the farmers' fields, conducted over seven years from 1966-67 to 1972-73. In all districts, the number of observations was equal to the number of years, i.e. one observation for each year, for which the data are available. The procedure for analysis of variance is, therefore, the same as explained above. The detailed analysis is given in Tables A<sub>1.5</sub> and A<sub>1.6</sub> for hybrid and local jowar respectively.

The third set of data relates to the results of experiments carried out in the research stations. The data from 10 agricultural research centres were available for hybrid and local jowar. In many cases the number of observations either for hybrid or local jowar was more than the number of years, i.e. there were more than one observation for each year for which the data are available. This facilitated the estimation of variation in yield rates within and between the years. In all, there were six centres each for hybrid and local jowar where the number of observations for each year was more than one. Among these centres, Parbhani, Achalpur and Jalgaon, were common for both hybrid and local jowar. Therefore, we have selected these three centres for our further analysis of variance to find out the yield variation both within and between the years. The results of this analysis are given in Tables A<sub>1.8</sub> and A<sub>1.9</sub>.

After carrying out the analysis of variance for each of these three centres separately, we have pooled the data

for these three centres together and estimated the yield variation both within the years and between the years for hybrid as well as local jowar. These results are presented in Table A<sub>1.10</sub>.

**Table A<sub>1.1</sub> : Average Yield Rates of Kharif Jowar Estimated by the Statistician, Department of Agriculture, in Different Districts, 1966-67 to 1972-73**

Sr. No.	District	(Yield kgs./hectare)						
		Average yield of hybrid jowar	Standard deviation	Coefficient of variation	Average yield of local jowar	Standard deviation	Coefficient of variation	'F' Value
1.	Nasik	1979	494	24.96	798	185	23.18	7.15**
2.	Dhulia	1977	371	18.76	856	137	16.00	7.33**
3.	Jalgaon	1799	124	6.89	754	260	34.48	4.38
4.	Ahmednagar	2006	336	1674	1011	184	18.19	3.33
5.	Poona	1841	327	17.76	966	187	19.35	3.04
6.	Satara	1873	455	24.29	1099	332	30.20	1.87
7.	Sangli	1527	568	37.19	958	374	39.03	2.31
8.	Kolhapur	2341	534	22.81	1338	510	38.11	1.09
9.	Aurangabad	1249	629	50.36	538	342	63.56	3.39
10.	Parbhani	1370	326	23.79	635	238	37.48	1.87
11.	Bhir	1570	433	27.57	707	310	43.84	1.95
12.	Nanded	1617	678	41.92	803	382	47.57	3.15
13.	Osmanabad	1549	635	40.99	757	390	51.51	2.65
14.	Buldhana	1533	286	18.65	674	284	42.13	1.01
15.	Akola	1415	301	21.27	698	199	28.51	2.29
16.	Amravati	1660	326	19.63	747	217	29.04	2.25
17.	Yeotmal	1309	184	14.05	692	146	21.09	1.59
18.	Wardha	1155	273	23.63	614	154	25.08	3.16
19.	Nagpur	1354	232	17.13	736	232	31.52	1.00
20.	Chandrapur	1381	310	22.44	793	256	32.28	1.46

Table A<sub>1.1A</sub> : Statistician's Data Analysis of Variance  
of Pooled Data - HYV

Analysis of Variance of Pooled Data - HYV

	s.s.	d.f.	Mean s.s.	F = 2.07***
Between centres	8744685	19	460246	
Within centres	17519153	79	221761	
Total	26263838	98	267998	

Coefficient of variation

Between centres	= 41.82 %
Within centres	= 28.99 %
Total	= 31.83 %

Analysis of Variance of Pooled Data - Local

	s.s.	d.f.	Mean s.s.	F = 1.74**
Between centres	3346995	19	176157	
Within centres	7963990	79	100810	
Total	11310985	98	115418	

Coefficient of variation

Between centres	= 52.10 %
Within centres	= 39.33 %
Total	= 42.18 %

Comparison of Yield Fluctuations of HYV and Local Jowar :

Between Centres	F = 460246/176157 = 2.61**
Within centres	F = .221761/100810 = 2.19***
Total	F = 267998/115418 = 2.32***

Table A<sub>1.2</sub> : Estimated Yields of Kharif Hybrid Jowar by the Statistician

Sr. No.	District	Yield					Mean	Deviation from Mean					Deviation Square					Σd <sup>2</sup>	n-1	Devia- tion of centre's mean from Grand Mean	Devia- tion Square (21) <sup>2</sup>
		1968- 69	1969- 70	1970- 71	1971- 72	1972- 73		1968- 69	1969- 70	1970- 71	1971- 72	1972- 73	1968- 69	1969- 70	1970- 71	1971- 72	1972- 73				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1.	Nasik	1838	2028	2823	1921	1284	1979	141	49	844	58	695	19881	2401	712336	3364	483025	1221007	4	358	128164
2.	Dhulia	2128	2187	2372	1898	1299	1977	151	210	395	79	678	22801	44100	156025	6241	459684	688851	4	356	126736
3.	Jalgaon	1808	1992	1792	1599	1806	1793	9	193	7	200	7	81	37249	49	40000	49	77428	4	179	32041
4.	Ahmednagar	1687	2290	1655	2390	-	2006	319	284	351	384	-	101761	80656	123201	147456	-	453074	3	385	148225
5.	Poona	1687	2290	1742	2116	1368	1841	154	449	99	275	473	23716	201601	9801	75626	223729	534472	4	220	48400
6.	Satara	2140	2065	2001	2188	973	1873	267	192	128	315	900	71289	36864	16384	99225	810000	1033762	4	252	63504
7.	Sangli	1234	2247	1716	1846	593	1527	293	720	189	319	934	85849	518400	35721	101761	872356	1614087	4	94	8836
8.	Kolhapur	2013	3074	2608	2498	1514	2341	328	733	267	157	827	107584	537289	71289	24649	683929	1424740	4	720	518400
9.	Aurangabad	1897	2055	1131	624	536	1249	648	806	118	625	713	419904	649636	13924	390625	508369	1982458	4	372	138384
10.	Parbhani	1346	1982	1265	1003	1256	1370	24	612	105	367	114	576	374544	11025	134689	12996	533830	4	251	63001
11.	Bhir	2125	2011	1495	1138	1078	1570	555	441	75	432	492	308025	194481	5625	186624	242064	936819	4	51	2601
12.	Nanded	2595	2276	1186	995	1033	1617	978	659	431	622	584	956484	434281	185761	386884	341056	2304466	4	4	16
13.	Osmanabad	2255	2255	1496	648	1092	1549	706	706	53	901	457	498436	498436	2809	811801	20849	2020331	4	72	5184
14.	Buldhana	1918	1804	1142	1391	1410	1533	385	271	391	142	123	148225	73441	152881	20164	15129	409840	4	88	7744
15.	Akola	1680	1759	958	1189	1488	1415	265	344	457	226	73	70225	118336	208849	51076	5329	453815	4	206	42436
16.	Amravati	1780	2065	1147	1867	1441	1660	120	405	513	207	219	14400	164025	263169	42849	47961	532404	4	39	1521
17.	Yeotmal	1181	1344	1029	1543	1450	1309	128	35	280	234	141	16384	1225	78400	54756	19881	170646	4	312	97344
18.	Wardha	1209	1180	643	1461	1280	1155	54	25	512	306	125	2916	625	262144	93636	15625	374946	4	466	217156
19.	Nagpur	1482	1475	977	1629	1209	1354	128	121	377	275	145	16384	14641	142129	75625	21025	269804	4	267	71289
20.	Chandrapur	1291	1720	831	1607	1457	1361	90	339	550	226	76	8100	114921	302500	51076	5776	482373	4	240	57600
Grand Mean							1621											17519153	79	8744685	

## Statistician's Data Analysis of Variance - HYV

	s.s.	d.f.	Mean s.s.
Between centres	8744685	19	460246
Within centres	17519153	79	221761
Total	26263838	98	267998

F = 2.07\*\*

Coefficient of Variation :

Between centres	= 41.82
Within centres	= 28.99
Total	= 31.83



Table A<sub>1.3</sub> : Estimated Yields of Kharif Local Jowar by the Statistician

Sr. No.	District	Yield					Mean	Deviation from Mean					Deviation Square					Σd <sup>2</sup>	n-1	Devia- tion of centre's mean from Grand Mean	Devia- tion Square (21) <sup>2</sup>
		1968- 69	1969- 70	1970- 71	1971- 72	1972- 73		1968- 69	1969- 70	1970- 71	1971- 72	1972- 73	1968- 69	1969- 70	1970- 71	1971- 72	1972- 73				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
1.	Nasik	958	1041	536	667	789	798	160	243	262	131	9	25600	59049	68644	17161	91	170545	4	8	64
2.	Dhulia	1000	835	960	876	608	856	144	21	104	20	248	20736	441	10816	400	61504	93897	4	50	2500
3.	Jalgaon	954	1055	343	574	843	754	200	301	411	180	89	40000	90601	168921	32400	7921	339843	4	52	2704
4.	Ahmednagar	1129	1238	765	911	-	1011	118	227	246	100	-	13924	51529	60516	10000	-	135969	3	205	42025
5.	Poona	1129	1238	765	911	788	966	163	272	201	55	178	26569	73984	40401	3025	31684	175663	4	160	25600
6.	Satara	1369	1036	1462	1116	514	1099	270	63	263	17	584	72900	3969	131769	289	341056	549983	4	293	85849
7.	Sangli	1002	1365	1080	1091	252	958	44	407	122	133	706	1936	165649	14884	17689	498436	698594	4	152	23104
8.	Kolhapur	1162	1737	1859	1497	437	1338	176	399	521	159	901	30976	159201	271441	25281	811801	1298700	4	532	283024
9.	Aurangabad	1012	890	289	300	197	538	474	352	249	238	341	224676	123904	62001	56681	116281	583506	4	268	71824
10.	Parbhani	774	1005	300	543	551	635	139	370	335	92	84	19321	136900	112225	8464	7056	283966	4	171	29241
11.	Bhir	1124	1012	316	589	492	707	417	305	391	118	215	173889	93025	152881	13924	46225	479944	4	99	9801
12.	Nanded	1384	1123	404	605	501	803	581	320	399	198	302	337561	102400	159201	39204	91204	729570	4	3	9
13.	Osmanabad	1164	1280	317	449	577	757	407	523	440	308	180	165649	273529	193600	94864	32400	760042	4	49	2401
14.	Buldhana	1006	954	233	651	526	674	332	280	441	23	148	110224	78400	194481	529	21904	405538	4	172	29584
15.	Akola	919	872	358	699	644	698	221	174	340	1	54	48841	30276	115600	1	2916	197634	4	108	11664
16.	Amravati	1012	949	449	557	768	747	265	202	298	190	21	70225	40804	88804	36100	441	236374	4	59	3481
17.	Yeotmal	761	819	441	824	618	692	69	127	251	132	74	4761	16129	63001	17424	5476	106791	4	114	12996
18.	Wardha	731	709	375	490	767	614	117	95	239	124	153	13689	9025	57121	15376	23409	118620	4	192	36864
19.	Nagpur	935	890	438	467	949	736	199	154	298	269	213	39601	23716	88804	72361	45369	269851	4	70	4900
20.	Chandrapur	1026	894	420	564	1063	793	233	101	373	229	270	54289	10201	139129	52441	72900	328960	4	13	169
Grand Mean							806											7963990	79	3346995	

## Statistician's Data Analysis of Variance - Local

	s.s.	d.f.	Mean s.s.	F = 1.74**
Between centres	3346995	19	176157	Coefficient of Variation Between centres = 52.10 Within centres = 39.33 Total = 42.18
Within centres	7963990	79	100810	
Total	11310985	98	115418	

**Table A<sub>1.4</sub> : Average Yield of Kharif Jowar Under Fertilizer and Varietal Trials on Cultivators' Fields in Different Districts, 1966-67 to 1971-72 (with 52 kgs. Nitrogen and 28 kgs. Phosphoric Acid Per Hectare)**

Sr. District No.	(Yield kgs./hectare)							
	Local Varieties			Hybrid Varieties			SP Value	T Value
	Average yield	Standard deviation	Coefficient of variation	Average yield	Standard deviation	Coefficient of variation		
1. Parbhani	771 (6)	174	22.56	1180 (3)	255	21.61	2.674	2.490**
2. Nanded	1315 (6)	225	17.11	2184 (7)	420	19.23	3.392	4.239***
3. Osmanabad	1023 (6)	302	29.52	1798 (7)	447	24.86	2.124	3.369***
4. Bhir	1188 (6)	126	10.60	1673 (3)	238	14.22	4.482	3.540***
5. Nagpur	2043 (6)	229	11.20	1876 (6)	641	34.16	7.634	0.566
6. Akola	1216 (6)	323	26.56	1755 (6)	609	34.70	3.457	1.820
7. Amravati	1366 (3)	463	33.89	1540 (3)	559	36.29	14.540	0.340
8. Yectmal	1588 (6)	608	38.28	2381 (6)	691	29.02	1.255	2.038
9. Buldhana	-	-	-	2666 (3)	347	13.01	-	-
10. Sangli	1418 (6)	376	26.51	1710 (6)	500	29.23	1.714	1.097
11. Satara	843 (6)	85	10.08	786 (3)	133	16.92	3.078	0.695

Table A<sub>1.4A</sub> : Fertilizer and Varietal Trials Data Analysis  
of Variance of Pooled Data - HYV

Analysis of Variance of Pooled Data - HYV

	s.s.	d.f.	Mean s.s.	F = 3.32**
Between centres	9241075	10	924107	Coefficient of variation
Within centres	11661738	42	277660	Between centres = 53.56 %
Total	20902813	52	401977	Within centres = 29.31 %
				Total = 35.34 %

Analysis of Variance of Pooled Data - Local

	s.s.	d.f.	Mean s.s.	F = 6.61**
Between centres	7374690	9	819410	Coefficient of variation
Within centres	5821294	47	123857	Between centres = 71.14 %
Total	13195984	56	235642	Within centres = 27.67 %
				Total = 38.12 %

Comparison of Yield Fluctuations of HYV and Local Jowar

Between Centres	F = 924107/899410	= 1.13
Within centres	F = 277660/123857	= 2.24
Total	F = 401977/235652	= 1.70



Table A<sub>1.5</sub> : Fertilizer and Varietal Trials of Kharif Hybrid Jowar

Sr. No.	District	Yield						Mean	Deviation from Mean							
		1966-67	1967-68	1968-69	1969-70	1970-71	1971-72		1972-73	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1.	Parbhani	1280	830	1430	-	-	-	-	1180	100	350	250	-	-	-	-
2.	Nanded	1860	2550	1950	3010	2020	1700	2200	2184	324	366	234	826	164	484	16
3.	Nagpur	-	1490	2390	2685	1130	1300	1450	1741	-	251	649	944	611	441	291
4.	Akola	-	1320	1740	2680	1330	1180	1360	1601	-	281	139	1079	271	421	241
5.	Amravati	-	-	1310	2310	1000	-	-	1540	-	-	230	770	540	-	-
6.	Yeotmal	-	2530	1420	3240	1470	2390	2380	2238	-	292	818	1002	768	152	142
7.	Buldhana	-	-	-	3080	2690	2230	-	2666	-	-	-	414	24	436	-
8.	Sangli	-	1810	1110	1780	1940	2440	1110	1698	-	112	588	82	242	742	588
9.	Satara	-	970	730	660	-	-	-	786	-	184	56	126	-	-	-
10.	Osmanabad	1340	1340	1960	2680	2070	1700	1500	1798	458	458	162	882	272	98	298
11.	Bhir	1520	1490	2010	-	-	-	-	1673	153	183	337	-	-	-	-
Grand Mean									1794							

(continued)

Table A<sub>1.5</sub> : (continued)

Sr. No.	District	Deviation Square						$\Sigma d^2$	n-1	Deviation of centre's mean from Grand Mean	Deviation Square (27) <sup>2</sup>	
		1966-67	1967-68	1968-69	1969-70	1970-71	1971-72					1972-73
(1)	(2)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
1.	Parbhani	10000	122500	62500	-	-	-	-	195000	2	614	376996
2.	Nanded	104976	133956	54756	682276	26896	234256	256	1237372	6	390	152100
3.	Hagpur	-	63001	421201	891136	373321	194481	84681	2027821	5	53	2809
4.	Akola	-	78961	19321	1164241	73441	177241	58081	1571286	5	193	32249
5.	Amravati	-	-	52900	592900	291600	-	-	937400	2	254	64516
6.	Yeotmal	-	85264	669124	1004004	589824	23104	20164	2391484	5	444	197136
7.	Buldhana	-	-	-	171396	576	190096	-	362068	2	872	760384
8.	Sangli	-	12544	345744	6724	58564	550564	345744	1319884	5	96	9216
9.	Satara	-	33856	3136	15876	-	-	-	52868	2	1008	1016064
10.	Osmanabad	209764	209764	26244	777924	73984	9604	88804	1396088	6	4	16
11.	Bhir	23409	33489	113569	-	-	-	-	170467	2	121	14641
									11661738	42	9241075	

## Fertilizer and Varietal Trials

## Analysis of Variance - HYV

	s.s.	d.f.	Means.s.
Between centres	9241075	10	924107
Within centres	11661738	42	277660
Total	20902813	52	401977

$$F = 3.32^{**}$$

## Coefficient of Variation

Between centres	= 53.56
Within centres	= 29.31
Total	= 35.34

Table A<sub>1.6</sub> : Fertilizer and Varietal Trials of Kharif Local Jowar

Sr. No.	District	Yield						Mean	Deviation from Mean							
		1966-67	1967-68	1968-69	1969-70	1970-71	1971-72		1972-73	1966-67	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1.	Parbhani	820	860	1020	450	690	790	-	771	321	49	81	89	19	249	-
2.	Nanded	1060	1660	1300	1010	1440	1420	-	1315	305	255	125	345	105	15	-
3.	Nagpur	1830	2380	1930	2130	1740	2250	-	2043	87	303	213	207	337	113	-
4.	Akola	1460	1080	1810	860	1110	980	-	1216	356	106	244	236	136	594	-
5.	Amravati	1430	1900	770	-	-	-	-	1366	64	534	596	-	-	-	-
6.	Yeotmal	2410	1150	2440	940	1420	1170	-	1588	648	168	822	418	438	852	-
7.	Sangli	2160	1340	1100	1110	1620	1180	-	1418	308	202	742	238	78	318	-
8.	Satara	860	830	840	860	690	980	-	843	17	153	17	137	13	3	-
9.	Osmanabad	910	820	1600	800	770	1240	-	1023	223	113	253	203	217	577	-
10.	Bhir	1340	1180	1270	1260	950	1130	-	1188	72	152	238	8	58	82	-
Grand Mean									1272							

(continued)



Table A<sub>1.6</sub> : (continued)

Sr. No.	District	Deviation Square						Σd <sup>2</sup>	n-1	Deviation of centre's mean from Grand Mean	Deviation Square (27) <sup>2</sup>	
		1966-67	1967-68	1968-69	1969-70	1970-71	1971-72					1972-73
(1)	(2)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
1.	Parbhani	103041	2401	6561	7921	361	62001	-	182286	5	501	251001
2.	Handed	93025	65025	15625	119025	11025	225	-	303950	5	43	1849
3.	Nagpur	7569	91809	45369	42849	113569	12769	-	313934	5	771	594441
4.	Akola	126736	11236	59536	55696	18496	352836	-	624536	5	56	3136
5.	Amravati	4096	285156	355216	-	-	-	-	644468	2	94	8836
6.	Yeotmal	419904	28224	675684	174724	191844	725904	-	2216284	5	316	99856
7.	Sangli	94864	40804	550564	56644	6084	101124	-	850084	5	146	21316
8.	Satara	289	23409	289	18769	169	9	-	42934	5	429	184041
9.	Osmanabad	49729	12769	64009	41209	47089	332929	-	547734	5	249	62001
10.	Ehir	5184	23104	56644	64	3364	6724	-	95084	5	84	7056
									5821294	47	7374690	

Fertilizer and Varietal Trials

Analysis of Variance - Local Jowar

	s.s.	d.f.	Mean s.s.
Between centres	7374690	9	819410
Within centres	5821294	47	123857
<b>Total</b>	<b>13195984</b>	<b>56</b>	<b>235642</b>

F = 6.61\*\*

Coefficient of variation

Between centres	= 71.14
Within centres	= 27.67
<b>Total</b>	<b>= 38.12</b>

**Table A<sub>1.7</sub> : Average Experimental Yields of Kharif Jowar from Different Agricultural Research Stations in Maharashtra, 1948-49 to 1972-73**

Sr. No.	Research Station	(Yield kgs./hectare)						
		Average yield of hybrid jowar	Standard deviation	Coefficient of variation	Average yield of local jowar	Standard deviation	Coefficient of variation	F Value
1.	Parbhani	3870 (22)	962	24.85	1586 (13)	808	50.94	1.36
2.	Achalpur	4816 (6)	533	11.06	1488 (27)	548	36.82	1.09
3.	Jalgaon	4297 (8)	642	15.04	1635 (26)	727	44.46	1.16
4.	Nagpur	3334 (3)	1085	32.54	1775 (35)	729	41.07	3.22
5.	Akola	2687 (6)	1094	40.71	1865 (29)	693	37.15	2.89*
6.	Amravati	3491 (4)	524	15.01	1546 (3)	170	10.99	8.46
7.	Yeotmal	3937 (9)	906	23.01	723 (13)	236	32.37	11.00
8.	Buldhana	2751 (3)	920	33.44	-	-	-	-
9.	Kutki	3161 (6)	1304	41.25	-	-	-	-
10.	Dhulia	4212 (5)	1470	34.90	1353 (16)	372	27.49	18.33*
11.	Karad	6233 (2)	1000	15.79	1579 (3)	499	31.66	16.06
12.	Kolhapur	4116 (2)	17	0.41	-	-	-	-
13.	Digras	5146 (4)	370	7.19	1156 (4)	446	38.58	2.18

Note: Figures in brackets indicate the number of observations on which average yield is based.

Table A<sub>1.8</sub> : Centrewise Experimental Results of Kharif Hybrid Jowar

Sr. No.	Year	Yield						Mean	Deviation from Mean					
		1	2	3	4	5	6		1	2	3	4	5	6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
<u>Centre - PARBHANI</u>														
1.	1967-68	3765	2883	3173	-	-	-	3273	492	390	100	-	-	-
2.	1968-69	4884	4219	4332	4556	5023	-	4602	282	383	270	46	421	-
3.	1969-70	4116	4317	4987	5133	5306	5325	4864	748	547	123	269	442	461
4.	1970-71	3020	2990	3260	3253	-	-	3130	110	140	130	123	-	-
5.	1971-72	2210	2377	4120	-	-	-	2902	692	525	1218	-	-	-
Grand Mean								3964						
<u>Centre - ACHALPUR (Dist: Amravati)</u>														
1.	1969-70	4930	4642	-	-	-	-	4786	144	144	-	-	-	-
2.	1970-71	4123	4260	-	-	-	-	4191	68	69	-	-	-	-
3.	1971-72	5541	5402	-	-	-	-	5471	70	69	-	-	-	-
Grand Mean								4816						
<u>Centre - JALGAON</u>														
1.	1969-70	4549	4434	-	-	-	-	4491	58	57	-	-	-	-
2.	1970-71	3981	3908	-	-	-	-	3944	37	36	-	-	-	-
3.	1971-72	3572	3602	-	-	-	-	3587	15	15	-	-	-	-
Grand Mean								4007						

(continued)

Table A<sub>1.8</sub> : (continued)

Sr. No.	Year	Deviation Square						Σd <sup>2</sup>	d.f. n-1	Deviation of centre's mean from Grand Mean	Deviation Square (24) <sup>2</sup>
		1	2	3	4	5	6				
(1)	(2)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
<u>Centre - PARBHANI</u>											
1.	1967-68	242064	152100	10000	-	-	-	404164	2	-691	477481
2.	1968-69	79524	146689	72900	2116	177241	-	478470	4	+638	407044
3.	1969-70	559504	299209	15129	72361	195364	212521	1354088	5	+900	810000
4.	1970-71	12100	19600	16900	15129	-	-	63729	3	-834	695556
5.	1971-72	478864	275625	1483524	-	-	-	2238013	2	-1062	1127844
								4538464	16	14493419	
<u>Centre - ACHALPUR (Dist : Amravati)</u>											
1.	1969-70	20736	20736	-	-	-	-	41472	1	30	900
2.	1970-71	4624	4761	-	-	-	-	9385	1	625	390625
3.	1971-72	4900	4761	-	-	-	-	9661	1	655	429025
								60518	3	1641100	
<u>Centre - JALGAON</u>											
1.	1969-70	3364	3249	-	-	-	-	6613	1	484	234256
2.	1970-71	1369	1296	-	-	-	-	2665	1	63	3969
3.	1971-72	225	225	-	-	-	-	450	1	420	176400
								9728	3	829250	

Analysis of Variance - Parbhani - HYV

	s.s.	d.f.	Mean s.s.	F = 12.78**
Between years	14493419	4	3623354	Coefficient of variation Between years = 48.00 % Within years = 13.44 % Total = 24.59 %
Within years	4538464	16	283654	
Total	19031883	20	951594	

Analysis of Variance - Achalpur - HYV

	s.s.	d.f.	Mean s.s.	F = 40.67**
Between years	1641100	2	820550	Coefficient of variation Between years = 18.81 % Within years = 2.94 % Total = 12.10 %
Within years	60518	3	20172	
Total	1701618	5	340323	

Analysis of Variance - Jalgaon - HYV

	s.s.	d.f.	Mean s.s.	F = 127.89**
Between years	829250	2	414625	Coefficient of variation Between years = 16.07 % Within years = 1.42 % Total = 10.20 %
Within years	9728	3	3242	
Total	838978	5	167795	



Table A<sub>1.9</sub> : Centrewise Experimental Results of Kharif Local Jowar - Pooled Analysis

Sr. No.	Year	Yield						Mean	Deviation from Mean					
		1	2	3	4	5	6		1	2	3	4	5	6
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
<u>Centre - PARBHANI</u>														
1.	1960-61	2950	3662	-	-	-	-	3306	356	356	-	-	-	-
2.	1963-64	1248	1426	-	-	-	-	1337	89	89	-	-	-	-
3.	1964-65	1189	1748	-	-	-	-	1468	279	280	-	-	-	-
Grand Mean								2037						
<u>Centre - AGHALPUR (Dist : Amravati)</u>														
1.	1960-61	1744	1601	-	-	-	-	1672	72	71	-	-	-	-
2.	1961-62	2112	1962	604	625	-	-	1325	787	637	721	700	-	-
3.	1962-63	1632	1313	1671	1506	-	-	1530	102	217	141	24	-	-
4.	1963-64	1652	1467	1642	1452	1795	-	1601	51	134	41	149	194	-
Grand Mean								1518						
<u>Centre - JALGAON</u>														
1.	1948-49	1746	893	856	-	-	-	1165	581	272	309	-	-	-
2.	1949-50	1416	966	968	-	-	-	1116	300	150	148	-	-	-
3.	1950-51	1837	1053	1094	-	-	-	1328	509	275	234	-	-	-
4.	1951-52	981	1498	1497	-	-	-	1325	344	173	172	-	-	-
5.	1952-53	774	757	-	-	-	-	765	9	8	-	-	-	-
6.	1953-54	1782	1740	-	-	-	-	1761	21	21	-	-	-	-
Grand Mean								1241						

(continued)



Table A<sub>1.9</sub> : (continued)

Sr. No.	Year	Deviation Square						Σd <sup>2</sup>	d.f. n-1	Deviation of centre's mean from Grand Mean	Deviation Square (24) <sup>2</sup>
		1	2	3	4	5	6				
(1)	(2)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
<b>Centre - ACHALPUR (Dist : Amravati)</b>											
1.	1960-61	5184	5041	-	-	-	-	10225	1	154	23716
2.	1961-62	619369	405769	519841	490000	-	-	2034979	3	193	37249
3.	1962-63	10404	47089	19881	576	-	-	77950	3	12	144
4.	1963-64	2601	17956	1681	22201	37636	-	82075	4	83	6889
								2205229	11	231449	
<b>Centre - JALGAON</b>											
1.	1948-49	337561	73984	95481	-	-	-	507026	2	76	5776
2.	1949-50	90000	22500	21904	-	-	-	134404	2	125	15625
3.	1950-51	259081	75625	54756	-	-	-	389462	2	87	7569
4.	1951-52	118336	29929	29584	-	-	-	177849	2	84	7056
5.	1952-53	81	64	-	-	-	-	145	1	476	226576
6.	1953-54	441	441	-	-	-	-	882	1	520	270400
								1209768	10	1102030	

Analysis of Variance - Parbhani - Local

	s.s.	d.f.	Mean s.s.	F
Between years	4848244	2	2424122	17.08
Within years	425555	3	141851	
Total	5273799	5	1054759	

Coefficient of variation  
 Between years = 76.43 %  
 Within years = 18.45 %  
 Total = 50.41 %

Analysis of Variance - Achalpur - Local

	s.s.	d.f.	Mean s.s.	F
Between years	231449	3	77149	0.38
Within years	2205229	11	200475	
Total	2436678	14	174048	

Coefficient of variation  
 Between years = 18.37 %  
 Within years = 29.44 %  
 Total = 27.47 %

Analysis of Variance - Jalgaon - Local

	s.s.	d.f.	Mean s.s.	F
Between years	1102030	5	220406	1.82
Within years	1209768	10	120976	
Total	2311798	15	154119	

Coefficient of variation  
 Between years = 37.79 %  
 Within years = 27.96 %  
 Total = 31.66 %

**Table A<sub>1.10</sub> : Experimental Results of Kharif Jowar - Pooled Analysis of Variance**

Centre	Hybrid Jowar				Local Jowar				F Value	
	s.s.	d.f.	Mean s.s.	Coefficient of variation	s.s.	d.f.	Mean s.s.	Coefficient of variation		
<u>Between Years</u>	Parbhani	14493419	4	3623354	48.00	4848244	2	2424122	76.43	1.49
	Achalpur	1641100	2	820550	18.81	231449	3	77149	18.37	10.63*
	Jalgaon	829250	2	414625	16.07	1102030	5	220406	37.79	1.88
	Pooled	16963769	8	2120471	34.94	6181723	10	618172	53.03	3.43*
<u>Within Years</u>	Parbhani	4538464	16	283654	13.44	425555	3	141851	18.45	1.99
	Achalpur	60518	3	20172	2.94	2205229	11	200475	29.44	9.93*
	Jalgaon	9728	3	3242	1.42	1209768	10	120976	27.96	37.31*
	Pooled	4608710	22	209486	11.07	3840552	24	160023	27.00	1.30

**Centrewise Comparison of Yield Fluctuations of HYV and Local Jowar :**

Parbhani : Between <sup>years</sup> centres = F = 3623354/2424122 = 1.49  
 Within centres = F = 283654/141851 = 1.99

Achalpur : Between <sup>years</sup> centres = F = 820550/77149 = 10.63\*\*  
 Within centres = F = 200475/20172 = 9.93\*\*

Jalgaon : Between <sup>years</sup> centres = F = 414625/220406 = 1.88  
 Within centres = F = 120976/3242 = 37.31\*\*

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APPENDIX II

COTTON

Cotton is an important non-foodgrain crop grown in Maharashtra. It accounts for about 14 per cent of the total area under crops (average of five years ending 1972-73) and about 39 per cent of the total area under non-foodgrains. This is the only non-food crop for which a new high yielding variety has been introduced in the State recently. We will, therefore, try to assess the performance of the newly introduced (1971-72 onwards) hybrid variety cotton seed, H-4.

During the 17 years since 1956-57 to 1972-73, total production of cotton remained almost stagnant. Table A<sub>2.1</sub> shows that the total annual production of cotton has fluctuated between 1.0 and 1.6 million bales (one bale = 180 kgs. lint) excluding the years of very poor production. If we take all the 17 years into account the annual compound growth rate of production comes to -1.23 per cent (Table A<sub>2.1A</sub>). Even if we exclude 1959-60, 1961-62 and 1970-71, years of very low production, the growth rate comes to -0.83 per cent, which is also statistically insignificant. If we exclude the year 1960-61, the year of exceptionally high production, along with the above years, the growth rate comes to -0.62 per cent.

This stagnancy in production of cotton during the last 17 years has been mainly due to stagnancy in area under cotton and its yield rate per hectare.

**Table A.2.1 : Production of Cotton in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

Sr. No.	Year	(Production in '00 bales)							
		Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1956-57	-	2404 112.02	210 35.35	164 153.27	2326 53.33	6377 83.47	891 77.95	12372 77.37
2.	1957-58	-	2321 108.15	401 67.50	39 36.44	2933 67.25	6351 83.12	800 70.00	12845 80.33
3.	1958-59	-	1949 90.82	395 66.50	85 79.44	2820 64.66	6390 83.64	735 64.30	12374 77.38
4.	1959-60	-	1183* 55.12	401 67.51	81 75.70	2303 52.81	2020* 26.44	489* 42.78	6477* 40.50
5.	1960-61	-	2146 100.00	594 100.00	107 100.00	4361 100.00	7640 100.00	1143 100.00	15991 100.00
6.	1961-62	-	2310 107.64	572 96.30	99 92.52	2635 60.42	3357* 43.94	602* 52.67	9575* 59.88
7.	1962-63	-	3128 145.76	752 126.60	122 114.02	3118 71.50	5048 66.07	704 61.59	12872 80.49
8.	1963-64	-	2971 138.44	827 139.22	135 126.16	2839 65.10	6565 85.93	1168 102.18	14505 90.71
9.	1964-65	-	2202 102.61	464 78.11	73 68.22	2600 59.62	6295 82.39	1026 89.76	12660 79.17

(continued)

Table A<sub>2.1</sub> : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
10.	1965-66	-	757* 35.27	233 39.22	54 50.46	2775 63.63	4971 65.06	1261 110.32	10051 62.85
11.	1966-67	-	1483 69.10	345 58.08	136 127.10	2639 60.51	5032 65.86	1232 107.78	10867 67.96
12.	1967-68	-	1896 88.35	499 84.00	97 90.65	3406 78.10	6107 79.93	1112 97.29	13117 82.03
13.	1968-69	-	1945 90.63	410 69.02	130 121.49	3793 86.97	6212 81.30	1197 104.72	13687 85.59
14.	1969-70	-	1573 73.30	313 52.69	111 103.74	3208 73.56	5632 73.71	1244 108.83	12081 75.65
15.	1970-71	-	931* 43.38	351 59.09	113 105.61	959 21.99	1845 24.15	543* 47.51	4742* 29.65
16.	1971-72	-	1847 86.06	334 56.22	122 114.02	1582* 36.27	6269 82.05	1337 116.97	11491 71.86
17.	1972-73	-	1378* 64.21	284 47.81	118 110.28	1711* 39.23	5527 72.34	1515 132.54	10533 65.87

Note : Bale = 180 kg. lint.

**Table A<sub>2.1A</sub> : Annual Compound Growth Rates of Production of Cotton in Maharashtra, 1956-57 to 1972-73**

Sr. No.	Period	Maha-rashtra	Nasik	Auran-gabad	Amra-vati	Nagpur
1.	1956-57 to 1972-73	-1.23 (0.00)	-3.10 (0.17)	-3.26* (0.24)	-0.69 (0.01)	+3.50* (0.25)
2.	1956-57 to 1972-73 (except 1970-71)	@-0.83 (0.00)	@-2.60* (0.33)	@+0.50 (0.01)	@-0.78 (0.11)	@+3.80 (0.66)

Note: Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods in case of the individual zones are shown by \* in Table A<sub>2.1</sub>.

During the last 17 years the total area under cotton fluctuated between 2.4 and 2.8 million hectares (Table A<sub>2.2</sub>). The annual compound growth rate for the 17 years was +0.20 per cent (Table A<sub>2.2A</sub>). If we exclude the years 1971-72 and 1972-73, the years of rather sharp decline in area, the growth rate comes to -0.14 per cent. If we exclude only the year 1971-72, the year of very low area under cotton, the annual growth rate comes to +0.5 per cent only. This shows that the area under cotton during the last 17 years remained almost stagnant.

**Table A<sub>2.2</sub> : Area under Cotton in Maharashtra and Its Agro-Climatic Zones,  
1956-57 to 1972-73**

		(Area in '00 hectares)							
Sr. No.	Year	Bombay	Nasik	Poona	Kolha- pur	Auran- gabad	Amra- vati	Nagpur	Maha- rashtra
1.	1956-57	-	3521 123.89	717 144.55	170 186.81	7829 108.90	11661 97.56	2223 90.69	26121 104.39
2.	1957-58	-	2978 104.78	580 116.93	129 141.75	7540 104.88	11796 98.69	2415 98.53	25438 101.66
3.	1958-59	-	3104 109.22	480 96.77	133 146.15	7532 104.77	12040 100.73	2382 97.18	25671 102.60
4.	1959-60	-	2856 100.49	407 82.05	90 98.90	7320 101.82	11908 99.63	2374 95.85	24955 99.73
5.	1960-61	-	2842 100.00	496 100.00	91 100.00	7189 100.00	11952 100.00	2451 100.00	25021 100.00
6.	1961-62	-	3386 119.14	637 128.42	115 126.37	7596 105.66	12476 104.38	2726 111.22	26936 107.65
7.	1962-63	-	3637 127.97	621 125.20	107 117.58	7369 102.50	12305 102.95	2550 104.03	26589 106.26
8.	1963-64	-	4117 144.86	854 172.17	98 107.69	7457 103.72	12740 106.59	2756 112.44	28022 111.99
9.	1964-65	-	4165 146.55	597 120.36	85 93.40	7607 105.81	13023 108.96	2758 112.52	28235 112.84

(continued)



Table A<sub>2.2</sub> : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
10.	1965-66	-	3249 114.32	393 79.23	76 83.51	7737 107.62	12812 107.19	2931 119.58	27198 108.70
11.	1966-67	-	2949 103.76	374 75.40	61 67.03	7239 100.69	12698 106.24	2829 115.42	26150 104.51
12.	1967-68	-	3414 120.12	557 112.29	98 107.69	7271 101.14	12895 107.88	2854 116.44	27089 108.26
13.	1968-69	-	3159 111.15	427 86.08	93 102.19	7663 106.59	12860 107.59	2960 120.76	27162 108.55
14.	1969-70	-	3473 122.20	417 84.07	89 97.80	7906 109.97	13165 110.14	2995 122.19	28045 112.08
15.	1970-71	-	3260 114.70	478 96.37	116 127.47	7690 106.96	13325 111.48	3047 124.31	27916 111.57
16.	1971-72	-	2900 102.04	256 51.61	114 125.27	4612 64.15	13005 108.81	3125 127.50	24012 95.96
17.	1972-73	-	3039 106.93	170 34.27	75 82.41	5826* 81.04	13043 109.12	3157 128.80	25310 101.15

Table A<sub>2.2A</sub>: Annual Compound Growth Rates of Area under Cotton in Maharashtra, 1956-57 to 1972-73

Sr. No.	Period	Maha-rashtra	Nasik	Auran-gabad	Anra-vati	Nagpur
1.	1956-57 to 1972-73	+0.20 (0.02)	+0.09 (0.00)	-1.26 (0.22)	+0.80* (0.50)	+2.10* (0.90)
2.	1956-57 to 1970-71	-0.14 (0.02)	+0.40 (0.05)	+0.10 (0.01)	-	-

Note : Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in the two periods in case of individual zones are shown by \* in Table A<sub>2.2</sub>.

Yield per hectare of cotton during the period under study showed a declining trend (Table A<sub>2.3</sub>). Compound growth rate for the entire period of 17 years comes to -1.35 per cent (Table A<sub>2.3A</sub>). Excluding the years of very low yield rates, 1959-60, 1961-62 and 1970-71, the growth rate comes to -0.94 per cent; both growth rates are statistically insignificant. If we also exclude the year 1960-61, a year of exceptionally high yield rate never again reached during the entire period, the annual growth rate comes to -0.60 per cent only. This indicates that during the entire period yield per hectare of cotton was also almost unchanged or slightly declined.

**Table A<sub>2.3</sub> : Per Hectare Yield Rate of Cotton in Maharashtra and Its Agro-Climatic Zones, 1956-57 to 1972-73**

Sr. No.	Year	(Yield Lint cotton kgs./hectare)							
		Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
1.	1956-57	-	122 90.37	52 24.18	173 81.99	53 48.62	98 85.21	72 86.74	85 73.91
2.	1957-58	-	140 103.70	124 57.67	54 25.59	71 65.13	96 83.48	59 71.08	90 78.26
3.	1958-59	-	113 83.70	148 68.83	115 54.50	67 61.46	95 82.60	55 66.29	86 74.78
4.	1959-60	-	74* 54.81	177 82.32	162 76.77	56 51.37	30* 26.08	37* 44.58	46* 40.00
5.	1960-61	-	135 100.00	215 100.00	211 100.00	109 100.00	115 100.00	83 100.00	115 100.00
6.	1961-62	-	122 90.37	161 74.88	311 147.39	62 56.88	48 41.74	43* 51.80	64* 55.65
7.	1962-63	-	154 114.07	217 100.93	205 97.15	76 69.72	73 63.47	49 59.03	87 75.65
8.	1963-64	-	129 95.55	174 80.93	247 117.06	68 62.38	92 80.00	76 91.56	93 80.86
9.	1964-65	-	95 70.37	139 64.65	154 72.98	61 55.96	87 75.65	66 79.52	80 69.56

(continued)

Table A<sub>2.3</sub> : (continued)

Sr. No.	Year	Bombay	Nasik	Poona	Kolhapur	Aurangabad	Amravati	Nagpur	Maharashtra
10.	1965-66	-	41 30.37	106 49.30	127 60.18	64 58.71	69 60.00	77 92.77	66 57.39
11.	1966-67	-	90 66.66	166 77.21	401 190.04	65 59.63	71 61.74	78 93.97	74 64.35
12.	1967-68	-	99 73.33	161 74.88	178 84.36	59 54.12	85 73.91	70 84.33	87 75.65
13.	1968-69	-	111 82.22	173 80.46	252 119.43	89 81.65	87 75.65	73 87.95	91 79.13
14.	1969-70	-	81 60.00	135 62.79	224 106.16	73 66.97	77 66.95	75 90.36	77 66.96
15.	1970-71	-	51 37.37	132 61.39	175 82.94	22 20.18	25 21.74	32 38.55	31 26.95
16.	1971-72	-	115 85.18	235 109.30	193 91.47	62 56.88	87 75.65	77 92.77	86 74.78
17.	1972-73	-	82 60.74	301 140.00	259 122.74	53 48.62	76 66.08	86 103.61	75 65.22

Table A<sub>2.3A</sub> : Annual Compound Growth Rates of Yield Per Hectare of Cotton (Lint) in Maharashtra, 1956-57 to 1972-73

Sr. No.	Period	Maha-rashtra	Nasik	Auran-gabad	Amra-vati	Nagpur
1.	1956-57 to 1972-73	-1.35 (0.01)	-3.01 (0.19)	-1.85 (0.08)	-1.40 (0.03)	+1.40 (0.01)
2.	1956-57 to 1972-73 (except 1970-71)	@-0.94 (0.07)	@-2.39* (0.39)	-0.16 (0.00)	@-1.51 (0.29)	@+1.60 (0.02)

Note : Figures in brackets are  $r^2$ , upto 2 places after decimal.

\* Shows significance at 5 per cent level.

@ The years excluded in these two periods in case of individual zones are shown by \* in Table A<sub>2.3</sub>.

On the whole, therefore, we find stagnancy in production, area under and yield rate of cotton in the State during the 17 years, 1956-57 to 1972-75.

Cotton is mainly grown in four agro-climatic zones of the State, of which Amravati and Aurangabad zones account for about 75 per cent of the total cotton area, and Nasik and Nagpur zones about 12 per cent each.

During the entire period the annual compound growth rate of production in Amravati zone was -0.69 per cent. Even by excluding the years of low production, 1959-60, 1961-62 and 1970-71, the growth rate was -0.78 per cent.

Area under cotton, during the last 17 years in Amravati zone, has shown a mild but significant increasing trend of 0.80 per cent per annum. For the entire period the yield rate has shown a declining trend (annual compound growth rate was -1.40 per cent). If we exclude the years of very low yield rates, 1959-60, 1961-62 and 1970-71, the growth rate comes to -1.51 per cent. This shows that, during the last 17 years, in Amravati zone, the area under cotton has shown a mild increasing trend while total production and yield per hectare have shown a declining trend.

In Aurangabad zone, during the last 17 years, production of cotton has declined at the annual rate of -3.26 per cent. If we exclude the drought years, 1970-71 to 1972-73, the growth rate comes to +0.50 per cent, showing almost stagnancy in production. During the same period area under cotton declined at the annual rate of -1.26 per cent. If we exclude the years of low area under cotton, 1971-72 and 1972-73, the growth rate comes to only +0.10 per cent; indicating no change in the area under cotton during the last 17 years. The annual compound growth rate of yield rate has shown a declining trend for the entire period (growth rate -1.85 per cent). Even by excluding the year 1970-71, a year of very low yield rate, the growth rate comes to -0.16 per cent. In short in Aurangabad zone, during the last 17 years, we have not seen any significant change in production, area under and yield rate of cotton.

As regards Nagpur zone, production, area and yield rate of cotton have shown an increasing trend during the entire period (growth rate of production +3.80, area +2.10 and yield +1.60 per cent).

In Nasik zone, production and yield rate during the entire period, excluding the years 1959-60, 1965-66 and 1970-71, of low production and yield rate, have significantly declined (growth rate of production - 2.60 per cent and yield rate -2.39 per cent) while area under cotton remained mostly unchanged (growth rate +0.40 per cent excluding the years 1971-73).

On the whole the picture of production, area under and yield rate of cotton in Maharashtra is one of stagnancy over this long period.

In Maharashtra cotton is mainly grown under unirrigated (dry) condition. As per official statistics the area under irrigated cotton is not more than 3 per cent of the total area under cotton (Table A<sub>2.4</sub>). To increase the production and productivity of cotton a new hybrid cotton seed (H-4) was made available to the farmers in the State from 1971-72 onwards. The new seed was first made available by the Government and till now the Government is the only source of its supply. If the State Government has been the only source of supply of H-4 cotton seed to cultivators, this is the only basis on which the area under the variety in the State is being estimated. There is no independent

Table A<sub>2.4</sub> : Area under Irrigated Cotton in Maharashtra, 1956-57 to 1971-72

(Area in '00 hectares)				
Sr. No.	Year	Gross irrigated cropped area in Maharashtra	Total area under cotton	Area under irrigated cotton
1.	1956-57	10802	26121	142
2.	1957-58	10842	25438	198
3.	1958-59	11023	25671	212
4.	1959-60	11717	24955	293
5.	1960-61	12182	25021	359
6.	1961-62	12336	26936	418
7.	1962-63	12782	26589	659
8.	1963-64	13130	28022	723
9.	1964-65	13639	28235	644
10.	1965-66	13880	27198	463
11.	1966-67	14133	26150	434
12.	1967-68	14762	27089	574
13.	1968-69	15568	27162	657
14.	1969-70	16232	28045	663
15.	1970-71	15703	27916	726
16.	1971-72	16216	24012	748

source of estimating the yield rate of H-4 cotton in the State. Unlike in case of the hybrid or HYV cereals for which the Statistician to the Department of Agriculture has been conducting special sample crop-cutting surveys, there has been no special survey for H-4 cotton. Currently, the only available source of information about total production of H-4 cotton in the State from year to year is the data on variety-wise purchase of raw cotton from the farmers by the



Maharashtra State Federation of Co-operative Marketing Societies under the scheme of State monopoly procurement of cotton. This total quantity of raw cotton, described and paid for as H-4 cotton, when divided by the total area under H-4 cotton, gives the average yield per hectare of the variety in the State. The available data relate to the State as a whole; the district/zone-wise data are not made available. We propose to examine the reliability of these estimates in what follows.

Table A<sub>2.5</sub> presents the percentage of the total area under cotton growing the hybrid variety. The Table shows that in the first two or three years, 1971-74, area under H-4 cotton was much insignificant (0.29 per cent and 0.79 per cent) as compared to the later years. There was a sharp spurt in the year 1974-75 when the area under H-4 cotton was about 10 per cent. In the next year, 1975-76, it increased to 12 per cent of the total cotton area in the State. The data show an increasing trend of area under hybrid cotton since 1971-72 onwards.

Table A<sub>2.5</sub> : Percentage of Cotton Area under Hybrid Variety  
Estimated by the Department of Agriculture,  
Maharashtra for the State, 1971-72 to 1975-76

Sr.No.	Year	Area under H-4 Cotton
1.	1971-72	0.29
2.	1972-73	0.79
3.	1973-74	N.A.
4.	1974-75	10.20
5.	1975-76	11.90

Total purchase of H-4 cotton under the scheme of monopoly procurement of cotton formed hardly 2 per cent of total cotton production in the State, as seen from Table A<sub>2.6</sub>.

Table A<sub>2.6</sub> : Procurement of Total Hybrid Cotton as a Percentage to the Total Cotton Procurement in Maharashtra, 1971-72 to 1975-76

Sr.No.	Year	Procurement of H-4 Cotton
1.	1971-72	2.12
2.	1972-73	1.84
3.	1973-74	N.A.
4.	1974-75	25.09
5.	1975-76	29.52

During the last two years, however, this accounted for about 25 to 30 per cent of the total cotton production. If correct, it means that H-4 cotton, occupying only 10 to 12 per cent of the total cotton area accounted for about 25 to 30 per cent of the total cotton production. That means its per hectare yield was much higher than of all other varieties of cotton taken together. This derived per hectare yield estimates are given in Table A<sub>2.7</sub>. (Production and yield rate data for 1973-74 are not available since monopoly procurement of cotton had been suspended this year.) The data show that the average yield rate of hybrid cotton was quite high as compared to the average yield rate of local cotton in the State. The average yield rate of hybrid cotton over the four years 1971-72 to 1975-76, except 1973-74, was calculated to be 298 kgs. lint per hectare. This was more than 3-1/2 times as high as the average yield of cotton in the State

during the 15 years preceding 1971-72 (78 kgs. per hectare) and more than 3 times the average productivity of all cotton during the years 1971-72 to 1975-76.

Table A<sub>2.7</sub> : Average Yield of Cotton and Hybrid Cotton in Maharashtra, 1956-57 to 1975-76

		(Yield Lint kgs./hectare)	
Sr.No.	Year	All Cotton	H-4 Cotton
1.	1956-57	85	-
2.	1957-58	90	-
3.	1958-59	86	-
4.	1959-60	46	-
5.	1960-61	115	-
6.	1961-62	64	-
7.	1962-63	87	-
8.	1963-64	93	-
9.	1964-65	80	-
10.	1965-66	66	-
11.	1966-67	74	-
12.	1967-68	87	-
13.	1968-69	91	-
14.	1969-70	77	-
15.	1970-71	31	-
Average		78	-
16.	1971-72	86	489
17.	1972-73	75	225
18.	1973-74	N.A.	N.A.
19.	1974-75	130	318
20.	1975-76	65	160
Average		89	298

Source : i) All cotton upto 1972-73 from Season and Crop Reports of the State Government.

ii) All cotton for the years 1974-76 and H-4 Cotton, data made available by Director of Agriculture, Maharashtra.

How reliable are these estimates of area and production of H-4 cotton? We have no independent estimates of area under H-4 cotton to compare with the official estimates based on seed distribution. However, we have some way of checking the derived yield rates. The two sources of alternative data are: (i) The results of agronomic experiments in two research stations, Parbhani and Kopergaon, and (ii) a sample survey of H-4 cotton growers carried out by us in a village in Parbhani district.

Since 1971-72 onwards, only two agricultural research stations in the State have conducted experiments on H-4 cotton. The experiments have been for different levels of nitrogen application. For the purpose of our analysis we have noted experiment results relating to 100 kgs. nitrogen per hectare, as a recommended standard dose.

The agricultural research station, Parbhani (Aurangabad zone) is one of the important stations for research on cotton in the State. During the last four years, 1971-75, four different experiments were carried out on H-4 cotton in this station. The average yield rate for all these experiments was 527.9 kgs. lint per hectare. The variation around this mean was quite large: It varied from 327.7 kgs. lint per hectare in one experiment in 1971-72 to 866.3 kgs. in another in the year 1972-73. The coefficient of variation was 38.53 per cent.

The agricultural research station, Kopergaon (Ahmednagar

district, Poona zone) is another research station where in all three experiments on H-4 cotton have been conducted. The average yield rate for all these experiments was 388.4 kgs. lint/hectare and it varied from 337.6 kgs. lint per hectare to 431.2 kgs. lint/hectare. The coefficient of variation was 9.97 per cent.

The experiments on both the research stations were conducted under irrigated conditions. The average yield rate of H-4 cotton at Parbhani was 528 kgs. lint per hectare while at Kopergaon it was 388 kgs. per hectare. On other hand our derived estimate of yield rate of H-4 cotton for the State is the average of both irrigated as well as un-irrigated cotton. This average yield rate of H-4 cotton comes to 298 kgs. per hectare. If we compare the derived yield rates for each of the years since 1971-72 with the averages for the experiment station data, one is led to believe that the derived yield estimates are more in keeping with the irrigated H-4 cotton's performance on the research stations. The suspicion is strengthened when we turn to the yield data from the sample farmers in our surveyed village.

Parbhani is an important cotton growing district. The village, Alegaon, was considered as a developed village with considerable canal irrigation. We selected at random 20 cultivators growing hybrid cotton in 1974-75 and collected from them information about the area under and production of hybrid cotton for that year and the previous

one year. From this survey it was found that the average yield of H-4 cotton in the village in the year 1974-75 was 210 kgs. lint per hectare under irrigated condition and 96 kgs. lint/hectare under unirrigated condition. In the earlier year, 1973-74, average yield of irrigated H-4 cotton was 221 kgs. lint per hectare and 99 kgs. lint of dry cotton.

The calculated yield rates of hybrid cotton for the State are given below, side by side our estimates for a particular village surveyed.

Year	Yield lint kgs./hectare	
	Calculated	Village surveyed
		Irrigated
1971-72	489	N.A. N.A.
1972-73	225	N.A. N.A.
1973-74	N.A.	221 99
1974-75	318	210 96
1975-76	160	N.A. N.A.

Comparing the data from both the sources for the year 1974-75, one finds that the calculated yield rate of H-4 cotton is about 51 per cent (108 kgs./hectare) higher than the estimated yield rate in the village under irrigated condition, and about three times more than the level recorded under dry condition. This suggests two things: (a) the derived estimate of per hectare yield of H-4 cotton is nearer the likely yield rate under irrigated conditions,

and far, far above dry cotton; (b) even if one considers only irrigated cotton the derived estimates appear gross over-estimates.

The first point to check, therefore, is the total irrigated area under cotton in the State in these 4/5 years. Official statistics show that the total irrigated cotton area was never more than 3 per cent of the total cotton area in the State during the 18 years under review. On the other hand, the proportion of estimated areas under H-4 in the State during the two years 1974-75 and 1975-76 were 10 and 12 per cents respectively. If this area estimate is true, then it means the derived yield estimates simply cannot relate to irrigated H-4 cotton only, and are, therefore, serious over-estimates. Since the yield rate estimates are derived from the total procurement of what was described as H-4 cotton, that procurement figure consequently becomes suspect.

While independent estimates of area under H-4 cotton are not available, there are reasons to think that the estimated area figures are not serious over-estimates. It is true that the total irrigated area under cotton is only a fraction of the total area under H-4 cotton. But there is reason to believe that farmers had put not only irrigated but also unirrigated land under H-4 cotton. In the sample survey of 20 H-4 cultivators in a village in Parbhani district, we estimated the average net income from growing

H-4 and local varieties under irrigated and unirrigated conditions. The data are presented in Table A<sub>2.8</sub>. They are summarized below :

	Net income from (in Rs.)	
	H-4 cotton	Local Cotton
1. Irrigated farms	1223.29	976.83
2. Unirrigated farms		
i) Large	277.02	182.36
ii) Medium	292.11	165.88
iii) All	281.32	177.77

It is clear from the above data that H-4 cotton yielded Rs. 246 and Rs. 103 more per acre under irrigated and unirrigated conditions respectively, compared to local cotton. This is reason why farmers would like to take up H-4 cotton under dry as well as irrigated condition. In fact, this is the reason why in our surveyed village the area under H-4 cotton had increased by 8 per cent in a single year. It is worth noting that in view of the very high cost of H-4 cotton seed (Rs. 100 per kg.), no farmer, who does not want to use it would buy it.

The suspicion is thus heavily loaded against the total procurement figure of H-4 cotton. In fact, because H-4 cotton was paid a higher price (Rs. 400/quintal) than any other variety of cotton, it is quite plausible that some none H-4 cotton was wrongly classified as H-4 cotton and paid for at that rate.

We may attempt a more reasonable estimate of the



Table A<sub>2.8</sub> : Per Acre Expenditure on and Receipts from Hybrid and Local Cotton for a Sample of 20 Farmers in a Village in Parbhani District, Maharashtra, 1974-75

Sr. No.	Item/Group	Hybrid Cotton						(in Rs.)	
		Irrigated		Unirrigated				Overall Dry	
				Large		Medium			
		Rs.	%	Rs.	%	Rs.	%	Rs.	%
1.	Preparatory tillage	71.08	7.89	62.71	11.30	51.81	9.54	58.75	10.67
2.	Farmyard manure	64.16	7.12	54.64	9.84	30.00	5.52	45.68	8.29
3.	Fertilizers	285.37	31.67	136.32	24.56	149.77	27.57	141.21	25.64
4.	Seed	75.00	8.33	75.00	13.51	75.00	13.81	75.00	13.62
5.	After care	125.19	13.89	83.03	14.96	73.31	13.50	79.50	14.44
6.	Irrigation	18.89	2.10	-	-	-	-	-	-
7.	Plant Protection	205.33	22.79	117.71	21.21	136.00	25.04	124.36	22.58
8.	Harvesting (Picking)	55.89	6.21	25.57	4.62	27.25	5.02	26.18	4.76
9.	Total Expenditure	900.91	100.00	554.98	100.00	543.14	100.00	550.68	100.00
	Yield of seed cotton quintal/acre	5.59		2.56		2.57		2.56	
	Value	2124.20		832.00		835.25		832.00	
	Profit	1223.29		277.02		292.11		281.32	

(continued)

Table A<sub>2.8</sub> : (continued)

Sr. No.	Item/Group	Local Cotton							
		Irrigated		Unirrigated				Overall Dry	
				Large		Medium			
		Rs.	%	Rs.	%	Rs.	%	Rs.	%
1.	Preparatory tillage	72.56	10.37	64.36	26.25	51.25	18.87	59.59	23.39
2.	Farmyard manure	60.78	8.69	24.64	10.05	43.12	15.87	31.36	12.31
3.	Fertilizers	204.50	29.23	66.72	27.22	49.13	18.09	60.29	23.67
4.	Seed	15.00	2.14	20.00	8.16	20.00	7.36	20.00	7.85
5.	After care	119.22	17.04	43.14	17.60	50.37	18.55	45.77	17.97
6.	Irrigation	21.11	3.02	-	-	-	-	-	-
7.	Plant Protection	159.11	22.74	9.14	3.73	32.00	11.78	17.45	6.85
8.	Harvesting (Picking)	47.39	6.77	17.14	6.99	25.75	9.48	20.27	7.96
9.	Total Expenditure	699.67	100.00	245.14	100.00	271.62	100.00	254.73	100.00
	Yield of seed cotton quintal/acre	4.79		1.71		1.75		1.73	
	Value	1676.50		427.50		437.50		432.50	
	Profit	976.83		182.36		165.88		177.77	

total production of H-4 cotton in the State during the two years 1974-76, on the basis of the official estimate of area and our survey estimate of yield rates. We may assume that about 4 per cent of the total area under cotton was irrigated, and all of it was under H-4 cotton in these two years. (Actually cropwise irrigated area figures are not available after 1972-73, and since till that date the highest percentage of irrigated cotton area was 3 per cent, we make an optimistic assumption of 4 per cent.) The remained of the 10 to 12 per cent H-4 area is assumed to be unirrigated. Again, assuming the per hectare yield of irrigated H-4 cotton to be 210 kgs. and 221 kgs. and of unirrigated H-4 cotton to be 99 kgs. and 96 kgs. for the two years respectively (the same as in our village survey), we estimate the total production of H-4 cotton.

Estimation of Total Production of H-4 Cotton

Year	Area under irrigated H-4 cotton (hectares)	Area under dry H-4 cotton (hectares)	Production of irrigated H-4 cotton (bales)	Production of dry H-4 cotton (bales)	Total Production of H-4 cotton (bales)
1974-75	100660	155940	117436	85767	203203
1975-76	95420	188580	117154	100576	217730

Thus the estimated production of H-4 cotton for the years 1974-75 and 1975-76, is about 124 per cent and 16 per

cent <sup>lower</sup> ~~more~~ than the actual quantity of H-4 cotton purchased in the respective years. (454200 bales in 1974-75 and 252700 bales in 1975-76.) We have, now, deducted the area and estimated production of H-4 cotton from the total area and production of all cotton and calculated the yield rate of local cotton varieties for the years 1974-75 and 1975-76 respectively. Average yield rate of all local cotton varieties together comes to 127 kgs. and 54 kgs. lint per hectare for the years 1974-75 and 1975-76 respectively. The calculated yield rate of all cotton (except H-4) for the year 1974-75 (127 kgs.), seems to be higher as compared to the yield rates in the earlier 12 years (highest 96 kgs. in 1972-73), but is not inconsistent when compared to the yield rates of other cotton varieties during the same year. The exercise only suggests that the procured quantity of H-4 cotton for the years 1974-76 is not in excess of production. However, if we compare our estimated yield rate of all cotton varieties together (except H-4) for the year 1974-75 with the average yield rates of cotton from Aurangabad and Amravati zones (major cotton growing zones) as well as for the State during the last 17 years (1956-57 to 1972-73), it seems to be over-estimated (average for the State 80 kgs. per hectare).

**Table A<sub>2.9</sub> : Staple and Varietywise Production of Cotton in Maharashtra, 1960-61 to 1975-76**

(Production '000 bales of 180 kgs. lint each)

Sr. No.	Year	Superior long			Long	Superior Medium	Medium	Short	Other	Total	
		Deviraj 170-CO-2 Varlaxmi	H-4	Andrews MCU-5							Total
1.	1960-61	45.0 2.80	-	-	45.0 2.80	336.0 20.86	1034.0 64.17	3.00 0.18	153.0 9.49	40.0 2.50	1612.0 100.00
2.	1961-62	52.0 5.69	-	-	52.0 5.69	206.0 22.56	123.0 13.47	476.0 52.13	45.0 4.95	11.0 1.20	913.0 100.00
3.	1962-63	53.0 4.22	-	-	53.0 4.22	289.0 23.03	119.0 9.48	640.0 51.00	106.0 8.45	48.0 3.82	1255.0 100.00
4.	1963-64	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
5.	1964-65	41.7 3.38	-	-	41.7 3.38	396.7 32.19	515.8 41.85	3.1 0.25	91.6 7.43	183.6 14.90	1232.5 100.00
6.	1965-66	35.9 3.71	-	1.5 0.15	37.6 3.88	482.4 49.82	355.4 36.72	43.8 4.52	49.0 5.06	-	968.2 100.00
7.	1966-67	35.5 3.32	-	0.2 0.02	35.7 3.34	595.0 55.62	318.0 29.73	59.0 5.51	62.0 5.80	-	1069.7 100.00
8.	1967-68	35.6 2.53	-	-	35.6 2.53	734.0 52.10	521.6 37.03	66.5 4.72	50.8 3.62	-	1408.5 100.00
9.	1968-69	59.0 4.37	-	-	59.0 4.37	821.6 60.87	432.0 32.01	7.7 0.57	29.4 2.18	-	1349.7 100.00

(continued)

Table A<sub>2.9</sub> : (continued)

Sr. No.	Year	Superior Long			Long	Superior Medium	Medium	Short	Other	Total	
		Deviraj 170-00-2 Varlaxmi	H-4	Andrews							Total
10.	1969-70	76.9 6.46	-	-	76.9 6.46	695.9 58.46	345.8 29.06	7.9 0.66	63.8 5.36	-	1190.3 100.00
11.	1970-71	29.6 6.14	-	-	29.6 6.14	310.7 64.50	117.1 24.31	7.7 1.60	16.6 3.45	-	481.7 100.00
12.	1971-72	39.1 4.26	19.4 2.12	72.3 7.88	130.4 14.26	507.2 55.30	258.9 28.23	3.8 0.43	16.4 1.79	-	917.1 100.00
13.	1972-73	-	25.1 1.84	102.5 7.53	127.6 9.37	567.3 41.68	637.1 46.81	-	-	29.1 2.14	1361.1 100.00
14.	1973-74	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
15.	1974-75	1.5 0.08	454.2 25.09	39.9 2.21	495.6 27.38	814.2 44.98	480.7 26.58	-	-	19.4 1.07	1809.9 100.00
16.	1975-76	43.5 5.08	252.7 29.52	12.4 1.45	308.6 36.05	381.5 44.57	161.0 18.81	-	-	4.9 0.57	856.0 100.00

Source : 1) Secretary, The East India Cotton Association Ltd. "Bombay Cotton Annual".  
Cotton Exchange, Marwarí Bazar, Bombay-2.

ii) Data supplied by Directorate of Agriculture, Maharashtra Government.

**Table A<sub>2.10</sub> : Staple and Varietywise Area under Cotton in Maharashtra, 1960-61 to 1975-76**

(Area in '000 hectares)

Sr. No.	Year	Superior long			Long	Superior Medium	Medium	Short	Other	Total	
		Deviraj 170-00-2 Varlaxmi	H-4	Andrews MCU-5							Total
1.	1960-61	71.0 1.14	-	-	71.0 1.14	1422.0 22.83	3876.0 62.23	11.0 0.18	654.0 10.50	194.0 3.12	6228.0 100.00
2.	1961-62	92.0 1.46	-	-	92.0 1.46	1832.0 28.97	1065.0 16.86	2935.0 46.46	290.0 4.59	104.0 1.66	6318.0 100.00
3.	1962-63	116.0 1.70	-	-	116.0 1.70	1891.0 27.77	755.0 11.08	3004.0 44.12	685.0 10.06	359.0 5.27	6810.0 100.00
4.	1963-64	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
5.	1964-65	76.2 2.76	-	-	76.2 2.76	859.6 31.16	1218.4 44.16	5.2 0.19	239.5 8.68	360.1 13.05	2759.0 100.00
6.	1965-66	62.5 2.47	-	5.7 0.22	68.2 2.69	1097.1 43.32	1067.9 42.17	110.1 4.35	189.1 7.47	-	2532.4 100.00
7.	1966-67	46.7 1.80	-	0.5 0.01	47.2 1.81	1451.5 55.83	847.0 32.58	61.1 2.35	193.1 7.43	-	2597.9 100.00
8.	1967-68	41.6 1.43	-	-	41.6 1.43	1626.1 55.96	995.0 34.23	72.8 2.50	170.8 5.88	-	2906.3 100.00
9.	1968-69	58.7 2.20	-	-	58.7 2.20	1522.0 57.03	899.6 33.71	12.3 0.46	176.3 6.60	-	2668.9 100.00

(continued)

Table A2.10 : (continued)

Sr. No.	Year	Superior long			Long	Superior Medium	Medium	Short	Other	Total	
		Deviraj 170-CO-2 Varlakmi	H-4	Andrews MCU-5							Total
10.	1969-70	60.7 2.20	-	-	60.7 2.20	1574.1 57.02	930.5 33.72	12.7 0.46	182.3 6.60	-	2760.3 100.00
11.	1970-71	61.9 2.20	-	-	61.9 2.20	1612.4 57.35	967.2 34.40	11.5 0.41	158.6 5.64	-	2811.6 100.00
12.	1971-72	44.1 1.85	7.0 0.29	54.5 2.29	105.6 4.44	1372.1 57.70	795.0 33.43	3.3 0.14	102.1 4.29	-	2378.1 100.00
13.	1972-73	-	20.2 0.79	110.0 4.33	130.2 5.12	1368.3 53.86	856.0 33.69	-	-	186.1 7.33	2540.6 100.00
14.	1973-74	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
15.	1974-75	0.5 0.02	256.6 10.20	68.0 2.70	325.1 12.92	1251.1 49.72	873.1 34.69	-	-	67.2 2.67	2516.5 100.00
16.	1975-76	29.5 1.24	284.0 11.90	38.0 1.59	351.5 14.73	1210.0 50.72	697.0 29.31	-	-	125.0 5.24	2385.5 100.00



Table A<sub>2.11</sub> : Staple and Varietywise Yield Rate of Cotton in Maharashtra, 1960-61 to 1975-76

(Yield in Lint kgs./hectare)

Sr. No.	Year	Deviraj 170-CO-2 Varlaxmi	H-4	Andrews MCU-5	Total	Long	Superior Medium	Medium	Short	Other	Total
1.	1960-61	114	-	-	114	43	48	49	42	37	47
2.	1961-62	102	-	-	102	20	21	29	28	19	26
3.	1962-63	82	-	-	82	27	28	39	28	24	33
4.	1963-64	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
5.	1964-65	100	-	-	100	83	76	108	68	92	81
6.	1965-66	105	-	60	101	79	60	72	47	-	69
7.	1966-67	138	-	72	138	74	68	174	58	-	74
8.	1967-68	158	-	-	158	81	94	165	54	-	87
9.	1968-69	180	-	-	180	97	86	120	30	-	91
10.	1969-70	227	-	-	227	80	67	111	63	-	78
11.	1970-71	87	-	-	87	35	22	131	19	-	31
12.	1971-72	159	489	240	222	67	59	240	28	-	69
13.	1972-73	-	225	167	177	75	134	-	-	28	96
14.	1973-74	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
15.	1974-75	540	318	106	275	117	99	-	-	51	130
16.	1975-76	267	160	57	159	57	41	-	-	7	65

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