CHAPTER VIII
SUMMARY CONCLUSIONS AND SUGGESTIONS

Introduction

Andhra Pradesh is one of the major rice growing states in India. During 1986-87, rice output stood at 65.9 lakh tonnes with an average productivity level of 1905 kg/ha. The record production was during 1988-89 (105.6 lakh tonnes) and the highest yield (2571 kg/ha) was also obtained in that year. In the base year (1956-57), the production was 33.8 lakh tonnes and the yield was 1154 kg/ha. Hectarage rose to 4.11 million hectares in 1988-89 from 2.92 million hectares in 1956-57.

The Telangana region produced 15.8 lakh tonnes in 1986-87 and had an yield of 1742 kg per hectare. The highest rice production (26.3 lakh tonnes) in the region was recorded during 1983-84 and the maximum yield (2018 kg/ha) was obtained during 1981-82. The production and the productivity figures in the base year (1956-57) were 6.5 lakh tonnes and 727 kg per ha. respectively.

It is often mentioned that increase in rice production and productivity is also associated with increase in instability leading to "peaks and troughs" in the production and productivity curves both at the state and at the regional level. While higher production and yield are essential and indeed has to be constantly improved upon with the availability of new technology and techniques, it is equally important to reduce instability in our efforts to achieve a reasonable and desired growth rate in yield and output in the context of ever growing population and diminishing land base.

In the present study, an attempt has been made to study the growth trends in area, output and yield of rice, ascertain factors influencing growth and instability, determine the relative contribution of the various factors to production and yield and identify ways and means to improve rice output and yield in the six selected districts of Telangana region viz., Nalgonda, Karimnagar, Nizamabad, Khammam, Medak and Mahaboobnagar. These districts together accounted for 77.70 percent of the regional rice acreage and produced 78.98 percent of the regional rice output in 1990-91. The Telangana region, that year, had 35.00 percent of the state's rice acreage and accounted for 35.16 percent of the state's rice output.

Specifically, the objectives of the study were to:

1. Examine the growth rates of area, production and yield of rice in the six selected districts covering the period 1956-57 to 1986-87;

1. Rice area in the state increased to 4.21 million hectares in 1989-90
2. Highest rice production in the Telangana region was 33.9 lakh tonnes in 1990-91
3. Highest rice yield in the Telangana region was 2403 kg/ha in 1990-91
(iii) ascertain the factors causing/influencing growth and instability in rice;

(iv) identify major constraints limiting rice output;

(v) indicate research, extension and development strategies that would enable higher production coupled with reasonable degree of stability; and,

(v) suggest ways and means to increase rice output.

The total period was divided into two phases viz., period I (1956-57 to 1966-67) and period II (1967-68 to 1986-87).

Research Methodology:

Districtwise growth rates for area, production and yield of rice were obtained by employing the Semi-log form. Compound rates of growth were calculated for area, production and yield of rice phasewise. To test whether \( r \) differs significantly from zero, the Student's t-test was employed. To test the change in the variability of area, production and yield, F-ratios were calculated. The relative contribution of different components to the growth rate of rice crop was calculated by the Decomposition Function which had four components, viz., yield, area, interaction and covariance. The extent of instability in rice output was calculated by employing the statistical function of coefficient of variation (CV).

The explanatory variables originally considered were: (i) area irrigated through canals, tanks, tube wells, other wells and other sources; (ii) rainfall during the South-West monsoon; (iii) rainfall during June, July, August and September; (iv) coverage under high yielding varieties; (v) proportion of net irrigated area to gross cropped area; (vi) nitrogenous fertiliser consumption; and, (vii) liquid formulation (insecticides). The explanatory variables posed multicollinearity problems amongst themselves despite the high explanatory power of R-square. To obviate this problem, only the rainfall during the months of June, July, August and September, nitrogen consumption, net irrigated area and liquid formulation were considered. Production and yield of rice were regressed against these variables by means of multiple regressions.

Results and Discussion:

Trends in Rice Production

**Area:** Increase in growth rate of area was noted in Nalgonda, Karimnagar, Medak and Nizamabad in Phase II over Phase I. In contrast, area growth rate markedly declined in Khammam and Mahaboobnagar.

**Production:** With the exception of Nalgonda, growth rate of production declined in all the districts during Phase II. The decline was marked in Mahaboobnagar.
Yield: The growth rate of yield in Phase II showed considerable decline in Karimnagar, Medak, Mahaboobnagar and Nizamabad. Nalgonda and Khammam only registered an increase.

Growth rates of production and yield declined in Phase II for the region as a whole.

Growth rates for production were the lowest in the overall period (1956-57 to 1986-87) in case of Karimnagar, Khammam, Medak and Nizamabad. Nalgonda had the highest rate of growth for the overall period.

Compared to Phase I, a decline in the growth rate of yield was noted in Karimnagar, Medak, Mahaboobnagar and Nizamabad during the overall phase.

Growth rate of area during the overall period declined in Khammam and was negative in Medak and Mahaboobnagar. Nalgonda had the highest rate of growth.

In the Telangana region, the growth rates of area and output declined in the overall period (as compared to phase II). Yield growth rate was more or less similar.

Reasons for the differential performance differ from district to district though some are common. Inadequate irrigation facility and soil problem are the major factors. Management of inputs became the consequent issue.

Decomposition of Changes in Production between Two Phases:

Production increased during Phase II, being the highest in Nalgonda and least in Medak. Yield contribution was the major factor in case of Medak and Mahaboobnagar. In case of Karimnagar and Nizamabad also, yield contribution was a major factor though area changes also influenced production increase. Production increase in Nalgonda was due to a more or less equal contribution through yield and area.

For the region as a whole, yield change was a major element for the higher average production in Phase II. Changes in area had a slight influence.

Instability in Rice Production

The co-efficient of variation (CV) was the yardstick for ascertaining the degree of stability. Co-efficient of variation was relatively higher in Phase II for production and yield in all the districts. CV did not differ much for yield in Mahaboobnagar. Instability was marginally high in Phase I in Karimnagar and Nizamabad.

The CV for production was moderate in both phases and low to moderate for area in all districts. Instability in area was markedly more in Phase II for Medak and Nizamabad than in Phase I.
Percentage change of area was high in Medak, Nizamabad, Mahaboobnagar and Karimnagar; medium in Khammam; and low in Nalgonda.

With the exception of Medak and Mahaboobnagar, the percentage change of production was moderate in all the districts. When the percentage change of area and production was considered, Medak and Mahaboobnagar came in one group; Karimnagar and Nizamabad in another group; and Khammam and Nalgonda formed the third group.

In case of yield, the percentage change was negative in Karimnagar and Nizamabad; high in Nalgonda; marginal in Mahaboobnagar; and low for Khammam and Medak.

For the region as a whole, the percentage change was high for area, moderate for output and low for yield.

Indiscriminate area increase, relatively low base yield and differences in input management and consequently variations in effectiveness are reasons for the differential behaviour.

Besides common factors that induce fluctuations or instability, there are those that bring about instability in the course of management of inputs. The influence of seven selected variables was studied through regression analysis. However, the effect of some of the explanatory variables got subsumed in others. As a result, rainfall during the months of June, July, August and September, nitrogen consumption and use of liquid formulation were the considered variables in the regression analysis of production.

The influence of nitrogen on production increase was significant in all the districts excepting Khammam. The exception can be attributed to input management in relation to water regime and timing of application. There are also tribal dominated areas where fertiliser use is low. The influence of rainfall distribution pattern was limited to Khammam, Medak, and Mahaboobnagar. In assured irrigated areas, rainfall distribution pattern would not have a significant effect on production. However, in areas solely dependent on unreliable sources of water supply, any timely rains (in relation to crop growth) would largely influence production in a positive manner.

For the region as a whole, nitrogen consumption turned out to be significant besides early rainfall.

In a subsequent analysis, the importance of net irrigated area became highly relevant followed by nitrogen consumption in Nalgonda, Mahaboobnagar and Karimnagar. The results call for a greater emphasis on the judicious management of this costly fertiliser input rather than quantity per se.
In the regression analysis with yield, net irrigated area turned out to be significant. The result again suggests that in attempts to increase production through yield, the timing and method of application are more relevant than the quantity \textit{perse}. The soil factor should receive attention. Blanket recommendation should give place to need based application.

The Telangana region generally has the disadvantage of having less productive soils. Added to this, is the problem of salinity and/or alkalinity and zinc deficiency. Inadequate irrigation facility and dependence on undependable sources of irrigation have imposed additional stress. Under this impact, the efficiency of applied nitrogen is reduced. Weather and climate induced factors pose problems of another kind and of varying magnitude. These natural and soil related constraints are impediments to high production increase unless these are carefully managed. There are also the socio-economic problems and administrative bottlenecks that indirectly influence farmers efforts to step up output. These problems are experienced by the farmers in almost all the districts of Telangana to varying degree.

The controllable factors included varietal composition and cultural aspects. Despite limitations, it is still possible to realise the existing varietal potential.

The present study and the yield gap analysis indicate the potential for increasing yield to the extent of 5 to 6 tonnes per hectare as against the existing level of 1.5 to 3.5 tonnes of hectare. Such yields to be obtained in the context of soil sustainability factor, varietal potential, economic viability, and ecological balance call for a sound land and water management, adoption of an integrated approach to nutrient and pest management, recourse to timely and effective ameliorative methods and adoption of suitable post- harvest technology. Maximisation of yields in favourable environment and yield optimisation in less favourable situations should result in higher rice production with stability.

Conclusions :

The introduction of high yield potential varieties and adoption of the new seed - fertiliser technology since the mid - sixties led to significant changes in the production of rice and wheat in the country. These two crops registered high increase in yield and output. The increase in yield and production, however, varied from country to country, from region to region within a country and within a region from district to district.

Yields (rice) of the order of more than 4 tonnes per hectare are reported from a few countries in South East Asia, South Asia and Europe. The national average was 1.47 tonnes per hectare. Punjab, Tamil Nadu and Haryana had yield of 3329, 2727 and 2457 kg/ha. respectively. Andhra Pradesh recorded an yield of 1905 kg/ha. Within Andhra Pradesh, the Telangana region had a productivity level of
1742 kg/ha. (1986-87). Considerable variation exists indicating the scope for yield improvement.

The objective of this study was to analyse the growth performance of rice in the six selected districts of Telangana region of Andhra Pradesh viz., Nalgonda, Karimnagar, Khammam, Medak, Mahaboobnagar and Nizamabad with a view to capture the spatial pattern of changes during the period 1956-57 to 1986-87 in two phases i.e., 1956-57 to 1966-67 and 1967-68 to 1986-87. An attempt was also made to ascertain factors influencing instability in output and yield of rice, identify constraints to higher production and suggest ways to increase rice yield and output in these selected districts.

This part of the thesis contains a summary of the salient conclusions.

Nalgonda witnessed a steady growth. The district had a positive growth rate taking advantage of the irrigation potential. Rice production can be considerably increased through higher doses of nitrogen application (both organic and inorganic) and better management. The district should benefit greatly through an integrated nutrient supply approach. In the follow up process, higher cropping intensity and diversification of cropping pattern should receive attention. Given the irrigation potential, existing infrastructure and the farmers resourceful nature this district has high potential to increase not only rice production but also to diversify its agricultural pattern. This district is in a "take off" stage for greater production and agricultural prosperity.

A decline in the growth rates of area and production was noted in Khammam. Yield growth rate, however, increased. A third of the rice area in this district is rainfed. There are also tribal dominated pockets where crop management standard is of a low order in their traditional "jhumming" practice. In the black cotton soil, root growth is restricted. Rice yields are also low in the upland rice area. Rice cultivation should be intensified in areas served by Srisamsagar Project and Kakatiya Canal system with better input management. In the upland areas, emphasis should be on a remunerative cropping pattern centered around more remunerative crop (perhaps other than rice) or if situation permits around early maturing varieties of rice. A combination of organo-inorganic forms of fertilisers would be useful. In tribal areas of some of the states in North-East India, alternatives to "jhumming" form of cultivation have been successfully adopted. These should be tested and adopted after necessary modifications to suit the local needs.

A lower growth rate for both yield and production of rice was witnessed in phase II in Medak, Mahaboobnagar, Karimnagar and Nizamabad. The first two districts are drought prone and the average annual rainfall is in borderline in relation to rice requirement. Perhaps it is advantageous to limit rice cultivation in the favourable areas in the districts and concentrate efforts to optimise production at such locations. High yielding and early duration varieties of rice

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are preferable. In the remaining areas, the situation warrants a consideration to switch over to other more remunerative crops, profitable cropping pattern and an effective input management strategy. These approaches have to be simultaneous. In case of Nizamabad (with better irrigation facility) emphasis has to be on input management and adoption of effective ameliorative methods for the existing problem of zinc deficiency. Better management of irrigation infrastructure is desirable. In Karimnagar, increasing irrigation frequency coupled with appropriate changes in input management (especially nitrogen) should increase the output of rice. Here again, early duration varieties of rice with high yield potential should be preferred.

Higher yields are possible only under higher levels of inputs especially nitrogen. The efficiency at higher nitrogen levels (to be economical) is dependent on availability of assured irrigation. In the present study, Nalgonda is the only district that had greatly benefitted through the seed-cum-fertiliser technology followed by Khammam to some extent. Provision for assured irrigation to the extent possible and development of irrigation infrastructure in the districts should lead to higher rice output.

Considering the extent of loss of this nutrient (nitrogen) even under good management and under normal circumstances and the absence of a clear positive relation between nitrogen dosage and yield increment (indicated in this present study), fertiliser recommendations relating to this vital input should be more specific, based on plant requirement, soil fertility status, soil type, stage of requirement, water regime etc. Fertiliser use efficiency is crucial especially as one operates at low and medium levels of production.

An increase up to 30 to 40 percent in yield can be realised by providing adequate irrigation as against an estimated increase by 5 to 20 percent through the use of various inputs. Irrigation also ensures stability. Available water sources (surface and ground water) in the different selected districts should be explored and judiciously exploited to increase rice output through higher input efficiency.

Districts with higher percentage of area under irrigation recorded relatively higher yields. Those without irrigation infrastructure, or devoid of assured irrigation or those dependent on undependable sources of irrigation and unable to adopt the new technology in full recorded lower yields and production. Nalgonda on the one hand and Medak and Mahaboobnagar on the other hand constitute examples. Prospects and possibilities for increasing rice output in the former district are high. In case of latter two districts, a more suitable cropping pattern with emphasis on a more remunerative crop is preferable. Rice cultivation can be restricted to relatively favourable areas with assured irrigation facility. Optimisation of rice yields is called for in such situations. Ensuring adequate irrigation in favourable areas assumes greater relevance and importance than area expansion which leads to diffused distribution of available water.
The percentage of net irrigated area to net sown area in Telangana region was 21.7 during 1980-81. While further expansion would have occurred during the subsequent period, judicious exploitation of groundwater source (as a complement to surface water) is vital and indeed necessary as timeliness of agricultural operations is crucial for higher production. This would also minimise the adverse effect of delayed monsoon or its failure.

One of the components in the seed-cum-fertiliser technology is the variety. The importance of this component was not brought out in the present analysis perhaps due to its effect being subsumed in others. In a situation where there is greater attention on testing of introduction and release, it would seem that the presently available new varieties are at best marginally better than the traditional varieties. This suggests a need for an independent approach to the development of new varieties based on problems associated and constraints specific to the location. The Regional Stations should reorientate its perspectives and objectives and draw up specific programmes keeping in view soil-water-plant relationship. With the development and cultivation of superior rice varieties, production can be increased. Further, suitable cropping pattern can be determined and adopted simultaneously taking advantage of the integrated nutrient supply system and integrated pest management approach. This would ensure higher production with positive growth rate and stability.

The present focus on new varieties should not distract our attention from some of the better suited traditional types (otherwise well adapted) under cultivation for a long period. With such varieties, changes in management practices should lead to increased production ensuring stability and minimising other problems.

Periodic introduction of new varieties, the possible implications in terms of changes in the components of the package of new technology and the prevailing time lag in the adoption of the effective components of changing technology can lead to variability in production and cause instability. While time lag has to be reduced for rapid progress and to minimise variations in output, it is desirable that, to the extent possible, frequent changes in variety picture and components of technology are avoided. Farm technology to be adopted is to be fine tuned to the existing situation.

Saline and/or alkaline soils occur in all the selected districts in varying degrees. Medak and Mahaboobnagar did not witness any increase in growth rate in phase II. This situation is a cause for concern and calls for efforts to adopt ameliorative methods or introduce suitable varieties to increase output at such stress locations. Proper management of soil would increase production besides preventing soil degradation.

Zinc deficiency is widespread in most districts. Zinc sulphate application or adoption of ameliorative method, it is observed, has not led to the expected rice output increase. Perhaps, there has also been a wastage in the costly input
Rice production in Telangana region presents a mixed picture. Growth rate production declined in phase II and further declined in the overall period. Yield growth rate declined in phase II but marginally increased during the overall period but still lower than that witnessed during phase I. Area growth rate was higher in phase II (than in phase I) but declined in the overall period but still slightly higher than that recorded during phase I. Spread of new varieties to less fertile and marginal lands resulted in a thin spread of costly inputs (wide diffusion) leading to production decline. Widespread zinc deficiency is prevalent in several districts and there is also the problem of salinity and alkalinity patches in the region. The emerging situation calls for a careful and effective utilization of nitrogenous fertiliser taking into consideration the nutrient deficiency picture and soil problem. The latter calls for an immediate solution before fertiliser use efficiency can be exploited. Rice cultivation to be economical and remunerative in the Telangana region should, hence, take into consideration soil related problems and need for better water management and input use. Cultivation of superior and quality rices in favoured situations for export market and diversion of less fertile lands to more remunerative crops in an overall cropping pattern best suited to specific areas is an alternative that warrants immediate consideration. Through such a diversified approach, the overall economy of the region can be substantially improved ushering in a new era of prosperity.

Growth has often been associated with instability. Increase in instability could occur when growth comes about as a result of area expansion and increased use of chemical inputs. Under such situations, improvement in skill and adoption of timely corrective measures should increase stability.

The emerging need is for formulating a combined strategy to maximise/optimise rice production in the different situations by adopting appropriate technology and efficient use of inputs to realise the varietal potential without endangering soil productivity status.

The present strategy to increase rice output is exclusively technology based. To sustain such a technology and enable it to succeed, appropriate policy measures have to be taken and suitable methods adopted.

In the context of available technology and the existing potential for higher production the role of extension agencies has assumed importance. Their emphasis should be more on imparting knowledge, technology, skills etc., rather than on supply of inputs and related aspects.

In the developing agricultural scenario, basic research, strategic research, adaptive research, applied research and maintenance research all have relevance. However, "adaptive research" relating to fine adjustment of technol-
ogy to suit the needs of a particular environment has priority. Maintenance research that goes to sustain the progress has next priority. Both types of research have to be carefully planned, carried out in a methodical way and monitored periodically. The Agricultural Universities have a vital role to play in the transformation process. The other types of research activities would have their own priorities depending on the existing situation and emerging scenario.

The situation calls for an inter-disciplinary approach and inter-institutional (both Central and State) collaboration for mutual benefit and in the interests of the State. At the farm level, "group effort" has merit with institutional assistance wherever essential. The research institutions should forge close linkages with Departmental, Developmental and Extension Agencies to facilitate a two way communication channel and for rapid transfer of knowledge, technology and techniques to the ultimate users.

Research institutions and staff should develop capability to critically analyse different situations, consider the potential, weigh different alternatives and consequently develop location specific technology keeping in view the socio-economic aspect and long term sustainability.

Suggestions

Past trends in rice production and yield, developing pattern and future needs call for a more practical approach to tap the full potential of all the resources without disturbing the ecological balance. New approaches are required in the field of research, extension, application of technology and institutional and infrastructural development.

Research in rice is a continuous process. The time factor (lag phase) in the adoption of technology still continues to be long resulting in a prolonged gestation phase. This period must be minimised.

A technology that promotes higher yield in one environment need not necessarily lead to an increase in another set of situation. Every technology should be fine tuned to suit the local set of conditions. Accordingly, research infrastructure and manpower development should have the capacity and capability to analyse the different situations in different districts, consider the existing potential and develop location specific alternative approaches suited to the needs of the farming community and economical level of operations. Both high yielding varieties and traditional varieties should find their position, depending on the local situation and their suitability.

Development of new varieties or identification of new types from the germplasm for region where shifting cultivation (jhumming) is practised by the tribal population as in Khammam should be considered.
Models need to be developed for the forecast of drought and other meteorological changes well in advance to take recourse to suitable alternatives or to minimise the adverse effect.

Application of nitrogen did not result in the expected output increase especially in Khammam, Medak, and Nizamabad. Reasons could be (i) inter-area imbalances (intra-district) in consumption, (ii) imbalanced application, (iii) defects in the time and method of application, (iv) water availability and its management in relation to nitrogen uptake efficiency etc.

In the Northern Telangana zone, under tank and canal irrigated tail end areas, late planting (late August to mid September) of rice (aged seedlings) is common. Due to prevailing low temperature condition during the reproduction stage, yield of the late planted crop is reduced. Two approaches are possible. Early duration varieties can be cultivated. Alternatively, the 'cut off' date for planting of the present mid duration types can be fixed and appropriate cultural practices recommended/adopted for realising the varietal potential. The research staff at Jagtial could play an important role in increasing rice yields.

Development of resistant varieties (for blast, stemborer, hispa) wherever needed and their introduction after evaluation would increase rice production.

Given the present area under high yielding varieties, diffusion process could slow down and further increases in yield might be restricted. While further increase in irrigated area could increase yield, there is a need for a regular flow of 'maintenance' research to sustain what has been achieved.

Importance of net irrigated area had been brought out. In Medak and Mahaboobnagar, irrigation facility is limited. A third of the cultivated area in Khammam is still rainfed. In tank fed areas and well dependent region, source of water charge is through seasonal rain. Conjunctive use of ground and surface water assumes importance. Groundwater sources should be explored and judiciously exploited. Watershed management should have relevance.

July and August rainfall in Khammam, September rainfall in Medak and August rainfall in Mahaboobnagar showed significant impact on rice output. Timeliness of cultural operation is important and water availability at critical stages of crop growth is crucial. In case of monsoon delay or failure, other sources of water supply have to be utilised to stabilise output.

There is a decline in rainfall in recent years in Nizamabad district. There is also the problem of the irrigation system. Silting and lack of distributory mechanism do not allow adequate storage and proper water distribution. Added to this, the capacity of the Nizamssagar has come down. In the available distributories, lateral seepage is common due to the non-lining of the sides. The Pocharam project and the Ramadurga project are not able to serve the areas fully.
These have affected rice output and its stability. Appropriate remedial measures would boost rice output.

Mahaboobnagar and parts of Nalgonda and Medak are in the semi arid zone. Mahaboobnagar is chronically drought prone. Areas with inadequate irrigation or tankfed run the risk of instability in output and lower fertiliser efficiency. While rice can be confined to areas (if necessary) with relatively better assured water supply, development and adoption of suitable cropping pattern is necessary.

Extension of irrigation facility through minor irrigation in areas where there is no assured irrigation facility is a major technological change by itself and hence priority needs to be given for minor irrigation schemes.

Zinc deficiency, as stated earlier, is widespread in the Telangana region. Further, as pointed out elsewhere, zinc sulphate application had not been uniformly effective. The quantity applied is not reflected in yield increase nor does it show any relation to the extent of zinc deficiency in the soil. Proper delineation of deficiency areas and application of correct dosage are important.

*Jhumming* is practised in the tribal dominated areas. Alternatives to this type of cultivation are being adopted in some of the states in North East India. The various methods can be tested and adopted with modification wherever necessary.

Emphasis on extension services by way of imparting the available knowledge, technology, skill, etc., is equally important as provision of inputs. Regular refresher courses for the extension staff is essential.

Extension agencies should be more involved in formulating approaches appropriate to local situations, economic capability of the farmers and human resources.

With population increase and shrinkage in cultivated area, heavy dependence on rice cultivation even in less favourable environment is neither economical nor desirable. Cropping pattern centred around the predominant and economically viable crop of the area should be popularised and encouraged.

In the years to come, the proven technologies need to be widely adopted and popularised. Being so, the extension staff would have a critical role in the technology transfer process. Technologies developed should reach the targetted group through effective methods of diffusion. A close co-operation between research and extension staff is essential. Outreach programmes such as minikits, national demonstrations, pilot projects, operational research projects, “on farm research” *etc.*, would have to be properly planned and correctly implemented within a time frame followed by an economic analysis.
The present strategy advocates concentration of the available supplies of inputs in potential areas with assured irrigation. While there can be no valid objections to this approach, yet it is bound to result in increasing disparities among the regions. It is, hence important, to simultaneously improve the soil productivity potential of the less favourable areas.

With the present policy of "phasing out" of the subsidy element, cost escalation of the fertilisers is inevitable. Returns to the farmers being an important criterion, improving the natural resource base of the farmers and insulating them from risks are both important. An adoption of "organo-inorganic" combination of fertiliser use would have relevance.

Buffer stock of a minimum number of selected rice varieties (for emergency late seeding) should be retained. This involves "built in risk". A suitable mechanism should be worked out.

Timely supply of inputs, extension and servicing facility, cheap credit, technical assistance and guidance on post harvest processing of the produce, storage, marketing, utilisation of the by-products etc., would improve the economic status of the farmers besides providing inducement for higher output. The establishment of "Krishi Vigyan Kendras" (KVK) in all districts becomes relevant. In this, the Agricultural University, Department of Agriculture, Agricultural Institutions (both central and state) need to play more effective role. Single window operation need to be further strengthened for the flow of timely and adequate credit in rural areas.

There would be higher use of fertilisers in the years to come keeping in view the need for increased rice production. This likely expansion would need investments in infrastructure for storage, transport, marketing etc. Proper coordination among the agencies has to be ensured.

An exclusively technology based growth strategy would not completely succeed. Technology since it acts as a catalyst, by itself (alone) cannot sustain any far reaching development unless it is adequately supported by appropriate policy measures and methods that would enthuse the farmers to adopt such a technology.

The approach to agricultural growth according to Bhatia (1988) "remains target oriented and the reliance for achieving the set targets is entirely on technological factors". While the technology according to him "can only make increased farm production possible, the actual realisation of the potential thrown up by the new technology depends, among other things, upon the motivation of the farmers to put their land to their best use and to make optimal use of modern technology and the inputs associated with it for raising crop yields". The technological thrust should be backed up by appropriate package of appropriate socio-economic policy measures as an exclusively technology based growth strategy is not likely to succeed.
Instability in output is due to risk and uncertainty associated with the production process. Farmers' interest is centred around income maximisation and minimisation of risk. Both can be achieved through adoption of suitable cropping pattern. However, given the complex economic, institutional and environmental milieu, the decision making itself is difficult let alone the follow up action and the likely hazards, uncertainties etc., during the implementation process. Continuous interaction between research institutions, extension agency and the farmers should assist the latter in making correct decisions and in the process of implementation.

In a country like India with considerable diversity, fixation of production targets should be a "bottom-up process". This process should start at district level and taking into consideration the past performance, available resources, existing infrastructure and expected development, etc., production target should be decided and finalised at the state level after mutual discussions. This approach would avoid wastage of scarce resources, ensure optimal utilisation of inputs and enable timely stocking of all inputs in appropriate and vantage points and their timely supply to the farmers. This would also largely reduce the gap between actual crop production figures and planned targets.

Rice production process has followed a bimodal pattern. There is the capital intensive and technologically advanced type. The traditional, labour intensive and low productive type is another. This has resulted in a growing influential sector and a stagnant and marginalised but predominant sector consisting of a large majority of small and marginal farmers. Unless basic infrastructural facilities are made available to the second category of the farming community, they may not be motivated adequately to respond to economic incentives. Even if motivated, they may not be in a position to respond to them.

In the Indian scenario, increased rice output (and stability) is dependent on the efforts and success of the small and marginal farmers. Better infrastructure development, rural electrification, increased literacy level, easy and timely availability of credit, access to market, a broad based and farm oriented administration with package of policies favouring agricultural development, increased farmers' resources, changes in tenancy system (which is difficult) etc., should provide strong impetus for higher production. In the ultimate analysis, all these would mean a multipronged rural oriented development activity besides the involvement of research, development and extension agencies.