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PRICE POLICY WITH SPECIFIC REFERENCE TO MAJOR IRRIGATION PROJECTS

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This paper examines the price policy in specific relation to major irrigation projects. Part I provides background information on major irrigation projects. Part II presents two special challenges posed by major irrigation projects. Parts III and IV examine the possible economic incentives which might be provided to confront the two challenges. The first has reference to price policy concerning water rates, the second to price policy concerning product prices.

The paper is cast broadly in terms of India's major irrigation projects. More specifically, however, it is illustrated in terms of Mysore State's largest irrigation project, the Tungabhadra. The Tungabhadra Irrigation Project's (TBP's) command area of 9.7 lakh acres rests in north Mysore between Munirabad-Hospet and Raichur. It has been receiving irrigation water since the completion of dam construction in 1953.

I

INTRODUCTION

Major irrigation projects have been a major instrument to the increased levels of agricultural production realized in India during recent years. About 17 million hectares of land in India presently benefit from major and medium irrigation projects.[1] The outlay on major and medium irrigation projects during India's Fourth Five-Year Plan is Rs. 935.8 crores (3.8 per cent of the total Plan outlay).[2] In Mysore State, over 25 per cent of the Fourth Plan outlay is on major and medium irrigation.[3] These facts highlight the importance of major irrigation schemes in India's present and planned development.

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1. Fourth Five-Year Plan, 1969-74, Planning Commission, Government of India, New Delhi, 1970, p. 247.
2. *ibid*, pp. 52 and 252.
3. Computed from Fourth Five-Year Plan (1969-74) (Policy and Programme), Planning Department, Government of Mysore, Bangalore, 1970, p. 71.

Many of the world's major irrigation schemes have been introduced as "protective" projects.[4] Indeed, this is generally true for India[5] and for the TBP in particular.[6] Most of these projects are located in former drought-prone areas. The projects are designed so as to spread the benefits of irrigation over as wide an area, and hence to as many people as possible.

In each major irrigation project, "localization" patterns are developed. These localization patterns indicate which blocks of land are to receive water at which levels of intensity. For instance, in the TBP, provision is made for three major types of localization: "perennial" which involves one cusec of water being supplied to 50 acres for 11 months per year (for sugarcane or double cropped paddy), "wet" which involves one cusec of water per 50 acres for 5 to 6 months per year (for paddy), and "light" which involves one cusec of water per 150 to 160 acres for 5 to 6 months per year (for such crops as bajra, cotton, groundnut, jowar, maize, navene, safflower, and wheat).[7] The vast majority (over 85 per cent)[8] of land in the TBP is localized for "light" irrigation. The presence of a large proportion of "light" irrigation is, of course, conducive to spreading widely the benefits of irrigation.

II

SPECIAL CHALLENGES, MAJOR IRRIGATION PROJECTS

No development project, including major irrigation projects, is immune to problems.[9] Some problems in irrigation projects are rather widespread, others are project-specific.[10] Two rather widespread problems are treated in this paper: (*i*) the preference of farmers to grow crops other than those permitted by localization regulations, *i.e.*, the existence of "unauthorized" cultivation, and (*ii*) the lack of adequate water control and management, particularly as this lacuna contributes to the wastage of irrigation water.

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4. "The Scope of Water Resources Development Needed to Meet the Anticipated Food Requirements of the Developing Countries of the Region, 1970-90" (Agenda Item 5), (E/CN. 11/WRD/Conf. 9/L. 3), prepared by the ECAFE Secretariat in collaboration with the FAO/UN for the ECAFE Regional Conference on Water Resources Development, Ninth Session, 28 September—5 October, 1970, Bangkok, 26 June, 1970, p. 26.

5. Nasim Ansari : Economics of Irrigation Rates (A Study in Punjab and Uttar Pradesh), Asia Publishing House, Bombay, 1968, pp. 25-28.

6. Jayakumar Anagol, "Problems of Tungabhadra Project Ayacut Development in Raichur District," in Tungabhadra, A Citadel of Hope, Edited by Narasing Rao Madarkal, Department of Information and Tourism, Government of Mysore, Bangalore, January, 1968, p. 16.

7. Balagopalan, "Bellary—Bounty of Tungabhadra," in Tungabhadra Project, Achievements and Aspirations, 1970, Edited by Narasing Rao Madarkal, Government Press, Bangalore, 1970, p. 69.

8. Computed from Madarkal (Ed.) : Tungabhadra, A Citadel of Hope, *op. cit.*, pp. 100, 104 and 106.

9. This is one of the most fundamental points in Albert O. Hirschman's provoking book, Development Projects Observed, The Brookings Institution, Washington, D.C., U.S.A., 1967.

10. For a summary statement of the most important problems confronting the TBP, see S. Bisaliah and Donald C. Taylor : An Economic Analysis of Major Irrigated Crops in the Tungabhadra Irrigation Project, (UAS Res. Series), University of Agricultural Sciences, Bangalore, p. 1 (in press).

The Programme Evaluation Organisation (PEO) of India's Planning Commission drew attention to these two problems in their 1965 summary evaluation of eight major irrigation projects in India.[11]

"Unauthorized" Cultivation

The problem of "unauthorized" cultivation in the TBP is frequently mentioned in the literature.[12] The most common "unauthorized" cultivation involves paddy being raised on land localized for "light" irrigation and, to a lesser extent, on land which is intended to receive no irrigation water at all.

Why farmers prefer to raise paddy rather than "light" irrigated crops is not fully understood. Frequently mentioned reasons include the possibility of paddy being more profitable; requiring less management, particularly with respect to irrigation; involving fewer marketing problems; and being more familiar to farmers as an irrigated crop.

A decision by the TBP project management during the early 1960's also undoubtedly contributed to the problem of "unauthorized" paddy in the TBP. Because the development of the ayacut had been relatively slow, the decision was taken to allow cultivators to grow paddy on one-third of the land localized for "light" irrigation.[13] The immediate effect of this decision was as desired, *viz.*, to raise the levels of production in the project. Late in 1967, sufficient land was developed and the water-use concessions were withdrawn. By then, however, the habit of raising paddy was so well established that farmers have since been reluctant to raise "light" irrigated crops on all blocks localized for "light" irrigation.

The major actions taken by the TBP management to counteract "unauthorized" cultivation have been in the form of financial penalties and "educational persuasion." Neither approach has been fully effective, however. Financial penalties have not always been rigidly assessed. Even

11. Evaluation of Major Irrigation Projects : Some Case Studies, PEO Publication No. 50, Programme Evaluation Organisation, Planning Commission, Government of India, New Delhi, 1965, pp. 13 and 14. Donald A. Williams also highlights the need for reducing wasteful irrigation practices in his Water Use and Development in India in the 1970's (Staff Document, Vol. V of a Series), The Ford Foundation, New Delhi, August 1, 1970, p. 23.

12. See Anagol, *op. cit.*, pp. 9 and 10; H. R. Arakeri (Chairman) : Report of the Expert Committee on the Development of Light Irrigation on the Left Bank of the Tungabhadra Project, 1965, for Department of Agriculture, Government of Mysore, Farmers' Forum Printing Press, Bangalore, 1968, pp. 11 and 17; Balagopalan, *op. cit.*, p. 72; S. K. Birardar, "Note on Key Achievements of the Tungabhadra Project and the Problems Currently Facing the Development Activities," December, 1969, p. 6 (typescript); N. G. Joshi, "Major Irrigation Projects—Problems in Orderly Development with Particular Reference to the Tungabhadra Project," Paper presented at the Conference on Economic Development and Social Change in Mysore State, sponsored by the Department of Economics, Karnatak University, Dharwar, May 1970, p. 3 (cyclostyled); Mohammed Rahmathulla, "The Development of Tungabhadra Project Region—Retrospective, Contemporary, and Prospective," in Tungabhadra Project, Achievements and Aspirations, *op cit.*, p. 12; and Symposium on Efficiency of Water Distribution and Use on the Land, Publication No. 84, Central Board of Irrigation and Power, New Delhi, August, 1967, p. 98. Detailed tables on the extent of "unauthorized" cultivation in the TBP are found in Evaluation of Major Irrigation Projects : Some Case Studies, *op. cit.*, pp. 94-97.

13. Anagol, *op. cit.*, pp. 9-10.

when they have, difficulties in achieving collection of the fees have been often presented themselves.[14] The fact that the penalty system has been largely ineffective has almost totally undercut efforts aimed at "educational persuasion."

Several other approaches have been advanced as possible counter-measures against "unauthorized" cultivation.

(1) The PEO[15] has suggested the construction of separate water courses for "wet" and "light" irrigated blocks. This approach offers important possibilities for new projects whose water distribution networks and localization patterns are yet to be designed. The PEO's approach has limited feasibility, however, for a project which is already well established.

(2) Joshi[16] suggests the possibility of a "Water Management Committee" for each major distributary in an irrigation network. The basic purpose of the committees would be to manage the distribution of water made available to their respective distributaries. The committees would be comprised of both officials and farmers. Farmers located along the entire lengths of the distributaries would be represented so as to ensure consideration of potentially conflicting points of view among users.[17]

(3) In this paper, special emphasis is given to a third means of counteracting "unauthorized" cultivation. This alternative involves price policies aimed at providing economic incentives to farmers which will encourage the growing of crops consistent with stated localization regulations."[18]

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14. Rahmathulla, *op. cit.*, p. 12. Joshi (*op. cit.*, pp. 3-4) attributes part of the reason for difficulties in effectively implementing the penalty system to spilt-administration, *i.e.*, to the fact that one department is entrusted with assessing penalties, whereas another is entrusted with collecting penalties.

15. Evaluation of Major Irrigation Projects : Some Case Studies, *op. cit.*, p. 105.

16. Joshi, *op. cit.*, p. 4. The basic presupposition for his suggestion is that social forces are a more important instrument of achieving desired patterns of water use than is compulsion through penalty systems. For an interesting and meaningful account of some of these social forces, see Gekee Wickham : "Sociological Aspects of Irrigation," unpublished M.Sc., thesis, Department of Rural Sociology, University of the Philippines College of Agriculture, Los Banos, The Philippines, September, 1970. The Regional Pilot Project for Soil and Water Management in the TBP is currently experimenting with the "water-user" organization concept.

17. A recent ECAFE Regional Conference on Water Resources Development emphasized the role of locally based water-users organizations, especially in developing countries in which are often found many small farmers accustomed to carrying on life and work quite independently from other people, even those who may live only a few miles away. They indicate the likely slow gestation period for such organizations to become fully effective, but the important pay-off once a certain maturity in their mode of operation is reached. Taiwan offers an illustration in which water-user organizations have come to play an important role in minimizing conflicts in water distribution. ["Achievements of Goals through Efficiency in Water Resources Project Management and Use of Water" (Agenda Item 6), (E/CN.11/WRD/Conf. 9/L. 4), prepared by the ECAFE Secretariat in collaboration with the FAO/UN for the ECAFE Regional Conference on Water Resources Development, Ninth Session, 28 September—5 October, 1970, Bangkok, 22 July 1970, pp. 13-14].

18. This paper presupposes that present localization regulations are not subject to change. The presupposition is made to limit the scope of discussion. Though changes in localization regulations are likely to be met with opposition, this alternative deserves consideration as well. In fact, a good deal of literature on the TBP implicitly or explicitly emphasizes the need for considering possible changes in localization regulations. For example, see Arakeri: *op cit.*, p. 20; Balagopalan, *op. cit.*, p. 77; Evaluation of Major Irrigation Projects : Some Case Studies, *op. cit.*, p. 111; Joshi, *op. cit.*, p. 3; Project Work Plan : Regional Pilot Project for Soil and Water Management, Bellary, Mysore State, co-sponsored by Government of India, Mysore State Department of Agriculture and US/AID, April, 1969, p. 43; and Rahmathulla, *op. cit.*, p. 16.

Wastage of Irrigation Water

As mentioned above, one of the common problems identified by the PEO in their evaluation of major irrigation projects in India, including the TBP, is the carelessness of farmers, particularly those in the upper reaches, to let water run to waste.[19]

The most frequently suggested means of reducing water wastage involve advocating physical measures, *e.g.*, patrolling watercourses to identify breaches, repairing breaches, careful observation to ensure that fields are not over-flooded. This paper places particular emphasis on creating economic incentives so that farmers will have stronger motivation to undertake physical measures such as these.

III

PRICE POLICY CONCERNING WATER RATES

Price policy concerning water rates is considered from two standpoints: the level of the overall water rate structure and the relative levels of water charges for different crops.

The Level of the Water Rate Structure

Most major irrigation projects appear to be heavily subsidized. This conclusion arises irrespective of whether the water rates charged to farmers are compared with (*i*) the costs of providing the water or (*ii*) the benefits derived by farmers in using the water.[20] To illustrate, the PEO estimates

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19. The quantities of water wasted in the TBP have not been systematically assessed. Bhattacharya and Srivastava, (Experimental and Empirical Studies on Water Requirements of Principal Crops of Uttar Pradesh," Symposium on Efficiency of Water Distribution and Use of Land, *op. cit.*, pp. 35-36) however, have compared "actual" with "required" levels of water used by farmers in a number of irrigation divisions in Uttar Pradesh. They found that the actual levels of water use on wheat and sugarcane "invariably" exceeded the required levels by 30 per cent to 40 per cent, with the result that yields were actually reduced by 10 per cent to 20 per cent. They estimated the economic loss from such wasteful practices in the Uttar Pradesh for 1957-58 at Rs. 40 crores (nearly one-sixth of the total production). This economic loss did not take into account water-logging and the common consequent problems of salt accumulation.

20. Colin Clark ("Charges for Water," The Economics of Irrigation, Second Edition, Pergamon Press, Oxford, 1970, Chapter 6) arrives at this as a general conclusion throughout the world. Many of his examples are based on India's experiences. I. D. Carruthers (Irrigation Development Planning, Aspects of Pakistan Experience, Agrarian Development Studies Report No. 2, Department of Economics, Wye College, University of London, Ashford, Kent, 1968, p. 64) indicates that, for the Lower Indus Region, the returns to additional water are in excess of Rs. 25 per acre-foot, whereas costs are from Rs. 2 to Rs. 7 per acre-foot. Ansari (*op. cit.*, p. 29) argues that irrigation schemes in India have not been remunerative. Baljit Singh and Shridhar Misra's (Benefit-Cost Analysis of the Sarda Canal System, Asia Publishing House, New York, 1965, pp. 56 and 139) benefit-cost analysis of the Sarda canal system reveals that the irrigation rates are based on neither the costs nor the benefits of the particular canal concerned and further, that even if no allowance is made for depreciation, the canal has run at a heavy loss to the State. A contrary finding is reported by G. Parthasarathy (Economics of Irrigation and Water-Rate under Cauvery Mettur Project, Agricultural Economics Research Centre, University of Madras, Madras, 1961, p. 80) for the Cauvery Mettur Project. He indicates that the Government expected cultivators to contribute to the whole cost of the project, at certain specified rates of interest, and that when the costs of operating the project increased, water rates were automatically increased.

Rs. 49.57 as the annual equivalent cost per acre for constructing the TBP.[21] Yet, the per acre rates charged for "perennial," "wet," and "light" irrigation are only Rs. 32, Rs. 16, and Rs. 8, respectively.

Historically in India, two contradictory positions have been taken with respect to the levels at which water rates are fixed. The Planning Commission, on the one hand, has emphasized the need for raising rates so as to augment irrigation revenues.[22] "Certain academic and even certain official and semi-official circles," on the other hand, have argued that the level of irrigation charges should be kept low,[23] even if this implies that full irrigation costs may not necessarily be recouped.

Three possible arguments for assessing charges on investments at levels inadequate to cover costs and the validity of each to major irrigation schemes are first examined.[24]

(1) If the benefits of an investment are spread over a wide range of people, with some people realizing direct benefits and others only indirect benefits, the full recoupment of costs may be unrealistic. Vagueness on precisely who the indirect benefactors are and/or what the extent of their actual benefit is reinforces difficulties in recouping costs. Under such circumstances, it is infeasible to assess charges against the indirect benefactors and unfair to expect the direct benefactors to bear the full burden of the project costs.

With major irrigation projects, this argument would appear to have limited validity only. The immediate and principal benefactors are the ayacutors themselves. The quantum of direct benefit which they derive can be roughly measured in terms of their enhanced net income from raising crops under irrigated rather than under rain-fed conditions. While indirect benefits arise from expanded business opportunities for agro-industrialists within ayacut areas and from larger quantities of lower priced (than otherwise would have obtained) food available to urban consumers, these benefits are difficult to measure and their realization is usually not immediate.

The PEO (Evaluation of Major Irrigation Projects: Some Case Studies, *op. cit.*, pp. 7, 69, 118, 119, 182, 199, 200, 216, 230 and 240) shows the annual equivalent cost per acre for constructing eight of India's major irrigation projects. These costs vary from Rs. 16·77 for the Hirakad Project to Rs. 49·57 for the TBP. They also show the schedules of water rates for different projects. With one minor exception ("perennial" irrigation in the Gangapur Project), the levels of water rates charged are less than the annual equivalent costs of construction. The differences are substantial, with many instances, for example, of rates being one-fifth or less than the costs. The facts that (*i*) project costs are allocated on the basis of total ultimate command areas rather than on acres presently developed and (*ii*) difficulties are often encountered in collecting the full irrigation fees assessed imply, in reality, even greater gaps between costs and returns than this analysis indicates.

21. Evaluation of Major Irrigation Projects : Some Case Studies, *op. cit.*, p. 7.

22. Ansari : *op. cit.*, p. 5 and V. T. Krishnamachari, as quoted in A. H. Hanson : Public Enterprise and Economic Development, London, 1959, p. 310.

23. Ansari : *op. cit.*, p. 6; Criteria for Fixation of Water Rates and Selection of Irrigation Projects, National Council of Applied Economic Research, Asia Publishing House, Bombay, 1959; and the Report of the Foodgrains Enquiry Committee, Government of India, 1957.

24. Part of the following discussion is based on ideas gained from Ansari : *op. cit.*, pp. 5-12, 328 and 329; Carruthers: *op. cit.*, pp. 63 and 65; and Joshi, *op. cit.*, p. 4.

(2) A second possible argument has pertinence to "decreasing cost" industries in which indivisible costs are high relative to variable costs. Long run marginal costs are so limited, relative to long run average costs, that the two never coincide. Under such circumstances, if social welfare is to be maximized and prices are based on marginal costs, losses will inevitably result.

In principle, these circumstances would appear to have a certain validity in major irrigation projects, for initial construction costs are relatively high compared to operating costs. This issue has not been subjected to extensive empirical study in India. Ansari does examine it with respect to irrigation in the Punjab and Uttar Pradesh, however, and concludes that this argument is too weak to represent adequate justification for heavy subsidization of irrigation projects.[25]

(3) A third and perhaps the most common argument for keeping water rates low is built upon the fact that irrigation potentials frequently are underutilized. If rates are raised, the argument runs, farmers will be even less motivated to exploit the full irrigation potential. This argument may have a certain limited validity during the initial "transition" stages of an irrigation project. But even then, the obstacles to fuller utilization of the irrigation potential may more importantly be due to such factors as inadequate availability of water to farmers' fields, inadequate research on locally adapted irrigated crops and cropping patterns, inadequate knowledge on techniques and improper equipment for levelling and shaping land, inadequate dissemination of information, inadequate quantities and inaccessibility to farmers of improved inputs and credit, and deficiencies in the systems for marketing the products which farmers raise.

Apart from these potential obstacles, also, is the question of how responsive farmers are to differing levels of water rates. One of Ansari's principal findings is that over a considerable range of rates around existing levels in Punjab and Uttar Pradesh, the demand for irrigation is inelastic.[26] This, of course, implies that water rates could be raised without adversely affecting the level of water utilization.

The evidence, therefore, suggests that the third argument may have only limited validity to irrigation projects.

Having raised and found less than fully satisfactory these possible arguments for assessing uneconomically low water rates, three arguments are now advanced in favour of higher water rates.

(1) Assessing higher water rates would make it possible to augment much needed financial resources to the Government.

(2) Assessing higher water rates would contribute to realizing the concept of "social justice." Those farmers within reach of water from irri-

25. Ansari : *op. cit.*, pp. 8, 328-329.
26. Ansari : *ibid.*, p. 342.

gation projects are indeed a specially privileged group. Their income-earning and overall welfare potential are greatly enhanced because their fortuitous location brings them access to irrigation water. It seems reasonable, therefore, that they bear a major part of the cost incurred in providing the irrigation. Certainly the alternative of those elsewhere in rural India bearing the burden of these costs, through general taxation, is unfair and indeed laden with potential political chaos, particularly in a rural India which is becoming more politically conscious and articulate.

(3) Assessing higher water rates and charging them on a volumetric basis[27] would provide economic incentives for less wastage of irrigation water. The argument is that as a result of such policies, farmers will perceive irrigation water as a more precious resource and they, therefore, will be more judicious in their use of it. Literature on the behaviour of farmers with respect to irrigation in South Asia supports the implication of this argument.[28]

Relative Levels of Water Charges for Different Crops

The basic presupposition for this section is that water rates can be manipulated so as to influence the crops that farmers prefer to produce.[29] To illustrate, if the Government wants to encourage the production of a crop A relative to that of a crop B, it can provide economic incentive for achieving the desired adjustment by shifting the relative irrigation charges in favour of A.

Circumstances in the TBP are now examined to determine if the present irrigation rates charged for different categories of crops may possibly be related

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27. The possibility of volumetric charges for water in major irrigation projects is controversial. While most would agree that, in principle, such a price policy would lead to less water wastage (*e.g.*, Ansari : *op. cit.*, pp. 109 and 344; B. S. Swan, "Economic Utilization of Water for Irrigation," Symposium on Management of Irrigation Waters, Publication No. 92, Central Board of Irrigation and Power, New Delhi, May, 1969, pp. 76-77 ; Symposium on Efficiency of Water Distribution and Use of Land, *op. cit.*, pp. 95-96) and a more economic allocation of irrigation water to alternative crops (*e.g.*, Ansari : *op. cit.*, p. 108; The Project Work Plan : Regional Pilot Project for Soil and Water Management, Bellary, Mysore State, *op. cit.*, p. 29), they would not agree on the feasibility of implementing such a policy. For a discussion of contrary points of view, see Ansari (*op. cit.*, pp. 108, 113 and 344), Carruthers (*op. cit.*, p. 65), and Parthasarathy (*op. cit.*, pp. 113-114). The author would argue that the potential pay-off from volumetric pricing of water is sufficiently great that the system ought to be implemented in India on a trial basis. This point of view is supported by Ansari (*op. cit.*, p. 113) and is the basis for one aspect of the work currently underway in the Regional Pilot Project for Soil and Water Management in the TBP.

28. Talwani ("Efficiency of Water Distribution and Use on the Land," Symposium on Efficiency of Water Distribution and Use on Land, *op. cit.*, p. 79) of the Water Resources Development Training Center, University of Roorkee indicates that when water supplies are ample, irrigation efficiencies are low. Carruthers (*op. cit.*, p. 35) reports that when water in the Lower Indus Basin is desperately required, farmers patrol the water courses from canal to field, even at night, closing leaks and preventing stealing; when the need for water is less intense, farmers are no longer vigilant and wastage results. Singh and Misra (*op. cit.*, p. 138) report that farmers on the Sarda Canal system repair and maintain water channels only during years when water supplies are short.

29. The PEO (Evaluation of Major Irrigation Projects: Some Case Studies, *op. cit.*, pp. 71-73) and Singh and Misra (*op. cit.*, p. 141) provide a basis for this presupposition. They examine the ratio of the per acre irrigation rate to the per acre return for each crop under irrigation. Considerable variations in the ratios for different crops were found. These variations were then examined in relation to present *versus* desired cropping patterns. In certain instances, they found that the ratios were lower for crops preferred by farmers but not by the project management, and vice versa. The implications of these findings on probable cropping pattern adjustments were then examined.

to "unauthorized" cultivation. It will be recalled that the primary form of "unauthorized" cultivation in the TBP is the preference of farmers to grow paddy, rather than "light" irrigated crops.

Table I provides data on the relative "profitability" of 13 different crop/variety/season situations during 1969-70 in the TBP.[30] Five "profit" criteria are examined, *viz.*, net income per acre, net income per acre per day, gross income per rupee cost, net income per acre-foot of irrigation water, and quintals of foodgrain per acre-foot of irrigation water. The average levels of income (quintals of foodgrain) reported by different farmers and the rank order for each crop/variety/season situation are first indicated in the table. At the bottom of the table, these data are summarized for paddy, on the one hand, and the "light" irrigated crops, on the other.[31]

The first three "profit" criteria shown in the table reflect the decision-making perspective of individual farmers, *i.e.*, these "profit" criteria represent three important dimensions of the economics which face individual farmers as they decide which crops to grow. The fourth and fifth "profit" criteria, on the other hand, more closely approximate the decision-making perspective of the project management. For the project as a whole, water is the most limiting resource. The project management, therefore, is interested to maximize outturn with respect to water. This outturn may be viewed in either monetary or physical terms. Hence, attention is paid to both net income and the quantity of produce generated per acre-foot of water.

The data in Table I bring into sharp focus one of the important bases for a conflict in preferred cropping patterns between individual farmers in the TBP and the project management of the TBP.

(1) From the standpoint of individual farmers, groundnut and cotton are quite competitive with paddy. But compared to the other "light" irrigated crops, and indeed to the "light" irrigated crops as a whole, paddy is considerably more profitable. Note, for example, that the net incomes (*i*) per acre and (*ii*) per acre per day for paddy are over 45 per cent greater than those for the "light" irrigated crops as a group.

(2) From the standpoint of the project management, the net income per acre-foot of water from groundnut and cotton is again favourable and that from bajra is unfavourable. But the profitability of jowar, maize, and wheat is generally higher than that of paddy, with the result that the "light" irrigated crops as a group generate more than twice as much income per acre-foot of water as does paddy. The quantity of foodgrains produced per acre-

30. This table is based on data reported in Bisaliah and Taylor, *op. cit.*, p. 19 (typescript). These data take no account of important variations in production efficiencies from one region to another within the overall TBP command area. The referenced report places under detailed consideration such micro-variations within the command area.

31. Much of the ensuing discussion is based on these group-summary data. This simplified approach facilitates the development of the most fundamental arguments in the paper. It does not imply, however, that the recommended product price policies should be implemented with respect to the "light" irrigated crops as a group; such policies obviously need to be considered on a crop-by-crop basis.

TABLE I—FIVE MEASURES OF "PROFITABILITY" FOR SELECTED CROPS (VARIETIES/SEASONS), TUNGABHADRA IRRIGATION PROJECT: 1969-1970[1]

	Net income (Rs./acre)		Net income/ day[2] (Rs./acre)		Gross income/ rupee cost		Net income/ acre-foot water (Rs.)[3]		Foodgrain/ acre-foot water (quintal)[3]	
	Average	Rank	Average	Rank	Average	Rank	Average	Rank	Average	Rank
Groundnut TMV2(summer)	1,010	1	8·38	1	2·91	1	505	1	N.A.	N.A.
Paddy GEB24 (*kharif*) ..	886	2	6·70	2	2·73	2	148	6	2·0[4]	9
Paddy Jaya (summer) ..	654	3	5·90	3	2·08	4	109	8	2·4[4]	6
Cotton Hampi (*kharif/rabi*) ..	644	4	3·84	7	2·53	3	322	2	N.A.	N.A.
Paddy HR35 (*kharif*) ..	575	5	4·08	6	2·06	5	96	10	1·9[4]	10
Paddy IR8 (*kharif*) ..	529	6	4·20	5	1·85	8	88	11	2·3[4]	7
Groundnut TMV2 (*kharif*) ..	482	7	3·75	8	1·92	7	241	3	N.A.	N.A.
Paddy IR8 (summer) ..	478	8	4·21	4	1·76	9	80	12	2·3[4]	7
Jowar CSH1 (summer) ..	337	9	3·18	9	1·71	10	169	4	6·2	2
Maize Deccan (*kharif*) ..	317	10	3·05	10	1·69	11	159	5	6·5	1
Jowar M35-1 (*rabi*)	289	11	2·23	11	2·00	6	145	7	3·5	3
Wheat Mexican (*rabi*) ..	199	12	1·91	12	1·49	12	100	9	3·5	3
Bajra BH1 (*kharif*/summer)	125	13	1·29	13	1·38	13	63	13	3·3	5
Average[5] Paddy	624	4·8	5·02	4·0	2·10	5·6	104	9·4	2·2	7·8
"Light" irrigated crops ..	425	8·4	3·45	10·0	1·95	7·9	213	5·4	4·6	2·8

1. "Net income" is defined as the surplus of gross income over and above all costs of production except (*i*) the rental cost-equivalent of land, including cesses, (*ii*) interest on capital, and (*iii*) expenditures on crop watching and marketing.

2. The numbers of days in this computation are the days from sowing/transplanting to the date of harvest. In other words, no account is taken of the (widely variant) numbers of days required for land preparation. The figures reported, therefore, over-state the net income per acre per day that the land must actually be set aside for growing the crop. The relative magnitudes in the values between and among crops, however, are not thereby subjected to any bias of practical consequence.

3. These are only approximate data. They are obtained by dividing the per acre net incomes and yields for (*i*) the different varieties (seasons) of paddy by 6 and (*ii*) the other crops (varieties/seasons) by 2. The assumption of a 3 : 1 ratio between the quantity of water applied to paddy and that applied to the other crops is based on the respective "duties" for "wet" and "light" irrigated land, in the TBP. See Balagopalan, "Bellary—Bounty of Tungabhadra," in Tungabhadra Project, Achievements and Aspirations, 1970, *op. cit.*, p. 69.

The absolute levels of 6 acre-feet for paddy and 2 acre-feet for the other crops are derived from data reported in Project Work Plan : Regional Pilot Project for Soil and Water Management, Bellary, Mysore State, co-sponsored by Government of India, Mysore State Department of Agriculture, and US/AID, April, 1969, p. 28.

4. "Milled rice" equivalents of paddy ("raw rice") yields are used in this computation ; the conversion factor used is 0·7.

5. These are "simple averages."

N.A. = Not available.

foot of water is greater for every "light" irrigated foodgrain considered than it is for paddy. As with profits, the physical outturn per acre-foot of water for the "light" irrigated crops as a group is more than twice that for paddy.[32]

(3) These findings indicate unambiguously that one important reason for "unauthorized" cultivation in the TBP is economic conflict. The economics presently facing individual farmers in the project are immensely different from the economics facing the project management.

What can be done to reconcile this economic conflict? One possibility would be policy decisions to raise the rate charged for irrigating paddy relative to that for irrigating "light" irrigated crops and to assess the water rates on a volumetric basis. This would shift the economics of crop production for individual farmers against paddy relative to the "light" irrigated crops. As a result, an important economic incentive would be given to farmers to reduce "unauthorized" cultivation.

IV

PRICE POLICY CONCERNING PRODUCT PRICES

In this section, two alternative price policies for farm products are considered. The first involves the possibility of price supports which would shift relative prices. The second involves the possibility of taking measures to stabilize prices.[33] The focus in this section, again, is on paddy *versus* the "light" irrigated crops in the TBP.

The departure point for this section is the relative profitability, as viewed by individual farmers, of raising different crops in the TBP. It will be recalled that during 1969-70 in the TBP, groundnut and cotton were quite competitive with paddy. But compared to the other "light" irrigated crops, and the "light"' irrigated crops as a group, paddy was considerably more profitable.

Relative Prices

One possible way to encourage farmers to show greater preference for raising "light" irrigated crops relative to paddy in future years in the TBP

32. N. P. Patil ("Requirements of Various Crops," *Mysore Vyavasaya Patrike* (Kannada), Vol XLIII, No 10, October, 1968, p. 4) arrives at a similar conclusion for crops raised elsewhere in Mysore State. One of the principal themes in J. Anagol's provoking paper ("A Strategy for Ayacut Development under Major Irrigation Projects," *Economic and Political Weekly*, Vol. IV, No. 26 (Review of Agriculture), June 28, 1969, pp. A-111 to A-118) is based on a presupposition consistent with the finding reported above.

Also, in The Project Work Plan: Regional Pilot Project for Soil and Water Management, Bellary, Mysore State (*op. cit.*, p. 28), water use on the Right Bank Canals in the TBP is examined from the standpoint of costs. The conclusion is that farmers are, in effect, charged Rs. 2·69 per acre-foot of water for irrigating paddy, but well over Rs. 4·00 per acre-foot of water for irrigating "light" irrigated crops. This finding is, of course, analogous to that reported above.

33. While a conceptual distinction exists between "price support" policies and "price stabilization" policies, it is recognized that the distinction often becomes blurred when the policies are implemented.

would be the shifting of relative prices in favour of "light" irrigated crops as compared to paddy. To determine whether such relative price shifts are likely to take place, without the implementation of fresh price policies, a study covering approximately ten years' price behaviour for farm products sold through the three regulated markets in the TBP command area was undertaken.[34] The markets are located at Bellary, Gangavati, and Raichur.

Specific attention was given to studying changes over time in the prices of "light" irrigated crops relative to the prices of paddy. For each regulated market, then, the price ratios[35] of each "light" irrigated crop to paddy were computed.

The most important relationships were analysed through constructing and studying Table II. This table shows the relative changes over time in the price ratios of the "light" irrigated crops to paddy in each of the three regulated markets. Four specific time comparisons are made, three of which involve comparing the 1970[36] price ratios with the price ratios during earlier periods and the fourth of which involves comparing prices during the most recent three to four years with those of the earliest three to four years for which data are available. The first comparisons emphasize immediate past prices in relation to earlier prices, whereas the last involves a longer term comparison. Immediate past prices are examined because (*i*) they refer roughly to the crop year for which data on the relative profitability of crops grown in the TBP are available and, (*ii*) of all prices in a time-series, the most recent may have more predictive power with respect to prices in the near future. The longer term comparison has perhaps greater pertinence to anticipating more distant future price relationships.

1. 1970 *versus* preceding two to three years

Except for Bellary navene, relative prices have shifted in favour of "light" irrigated crops during this period. For the foodgrains, the shift for no crop exceeds 15 per cent, whereas for cotton, safflower, and groundnut, the price relationships have improved between 20 per cent and 35 per cent.

2. 1970 *versus* 1964-65 peaks[37]

34. The time-series analysis presented in this paper is only part of a more comprehensive analysis currently in process.

35. The price ratios are with respect to 24-month moving averages. In the Bellary and Gangavati Regulated Markets, separate data were recorded for different varieties of paddy only during very recent years. The prices used in the Bellary and Gangavati computations, then, are for "all varieties" of paddy. In the Raichur Regulated Market, separate data were recorded since 1959 for *mohta* (coarse) and fine paddy. The prices for fine paddy were used in the ratio computations because larger quantities of fine (compared to *mohta*) paddy were sold through the Raichur Regulated Market during recent years.

36. The period "1970" is represented by the moving averages centred on October, 1969-September, 1970.

37. The ratios for most commodities showed a marked peak during late 1964 and/or during 1965. Minor exceptions are Raichur navene, whose price ratio remained high well into 1966 as well, and Bellary cotton, whose price ratio was highest during 1963-64. Major exceptions are (*i*) the price ratio with respect to Bellary safflower (about 20 per cent higher during both 1961-62 and 1966-67 than during 1964-65) and (*ii*) the price ratio with respect to Gangavati groundnut (about 10 per cent higher during 1966-67 than during 1964-65).

TABLE II—RELATIVE CHANGES OVER TIME IN THE PRICE RATIOS OF "LIGHT" IRRIGATED CROPS TO PADDY: BELLARY (1961-1971), GANGAVATI (1959-1971), AND RAICHUR (1959-1971) REGULATED MARKETS*

	1970 *versus* preceding two to three years**	1970 *versus* 1964-65 peak	1970 *versus* earliest three to four years	Most recent three to four years *versus* earliest three to four years†
Higher (percentage)				
More than 30	B—Cotton B—Safflower G—Groundnut R—Groundnut R—Safflower	B—Safflower	G—Groundnut	
21 — 30	R—Cotton	G—Groundnut	B—Safflower R—Groundnut R—Safflower	
11 — 20	B—Bajra G—Bajra	R—Cotton R—Groundnut	B—Navene	B—Navene
1 — 10	B—Jowar G—Jowar G—Navene R—Bajra R—Jowar R—Navene		G—Bajra R—Cotton R—Jowar R—Wheat	G—Groundnut
No Change	B—Navene		B—Bajra G—Navene R—Bajra R—Navene	B—Safflower G—Bajra R—Cotton R—Jowar R—Safflower R—Wheat
Lower (percentage)				
1 — 10		R—Safflower	B—Cotton B—Jowar	B—Bajra G—Navene R—Bajra R—Groundnut R—Navene
11 — 20		B—Cotton B—Jowar B—Navene G—Bajra G—Jowar G—Navene R—Wheat		B—Cotton B—Jowar
21 — 30		B—Bajra R—Jowar R—Navene		
More than 30		R—Bajra		

* The commodities reported in the various markets are described as follows: bajra and navene— "local", cotton—*Mungari* in Bellary and *Laxmi* in Raichur, groundnut— *Gunguru*, jowar— "red/white" in Bellary and "white" in Gangavati and Raichur, paddy— "fine" or *mohta* in Raichur and "all varieties" in Bellary and Gangavati, and wheat—"red." The three regulated markets are abbreviated in the table as simply "B", "G", and "R."

In each column heading, two time periods are indicated. The comparisons shown in the table are roughly with respect to "simple averages" of the monthly price ratios for the respective time periods indicated. The "simple averages" computed generally represent the relevant price ratios reasonably well. The widely fluctuating price ratios for safflower, cotton, and groundnut, however, made less meaningful the "simple averages" for these commodities.

** Since October 1969, the price ratio of wheat (red) to fine paddy in the Raichur Regulated Market has remained almost constant. During the preceding year, however, the ratio declined by over 15 per cent. This peculiar behaviour made it infeasible to place Raichur wheat in any of the categories shown in the table.

† The marketing of jowar through Gangavati Regulated Market during early years was too irregular to provide the necessary basis for these comparisons.

An almost opposite outcome obtains for this, as compared to the above, time contrast. In this case, except for Bellary safflower, Raichur cotton, and groundnut in Gangavati and Raichur, the price ratios for all commodities have fallen. For a majority of commodities, the drop is between 10 per cent and 20 per cent. For bajra, jowar, and navene in Raichur and bajra in Bellary, the extent of fall is substantially greater.

3. 1970 *versus* earliest three to four years studied

With those two periods as the basis for comparison, the price ratios for jowar and cotton in Bellary have become less favourable, those for bajra in Bellary and Raichur and navene in Gangavati and Raichur have not changed, whereas the ratios for the other crops have increased. The increases are most marked for groundnut and safflower.

4. Most recent three to four years *versus* earliest three to four years studied

Except for Bellary navene and Gangavati groundnut, recent price ratios for the various commodities are about the same or less than they were some 7 to 11 years ago. The largest decreases are for jowar and cotton in Bellary, with smaller decreases for bajra in Bellary and Raichur, for navene in Gangavati and Raichur, and for groundnut in Raichur.

What can be concluded from this analysis ? Certainly, the analysis does not contribute to an unambiguous conclusion that future relative prices are likely to shift in favour of, or against, "light" irrigated crops relative to paddy. Depending on the time periods and specific crops considered, different future price relationships are suggested.

The author's judgment, however, is to place more emphasis on the longer term analysis reflected in para 4. This judgment is based largely on the high degree of price variability for crops in the TBP which manifests itself above and more specifically in the following section. To the extent that price relationships are variable, one would seem ill-advised to place too much emphasis on price relationships which involve data from too short a period of time.

If prime emphasis is given to the longer term price perspective, there is no reason to believe that future price relationships in the TBP are likely to favour "light" irrigated crops relative to paddy, unless fresh price policies are evolved. Even if attention is also devoted to the shorter term perspective, except for cotton, groundnut, and safflower, the prospect of future price relationships which provide adequate economic incentive for farmers to find "light" irrigated crops more profitable than paddy is remote.

Thus, we conclude that if the present localization pattern in the TBP is taken as fixed, the Government would be well advised to consider shifting the relative prices of "light" irrigated crops, particularly the foodgrains, up relative to the prices of paddy.[38]

38. Difficulties in implementing the area-specific price policies implied in this and the following recommendation are recognized by the author. Nevertheless, without the type of price policies advocated in this paper, it appears extremely doubtful that farmers in the TBP will have the necessary incentive to substantially reduce "unauthorized" cultivation.

The Stability of Prices

In formulating price expectations for making decisions, farmers consider not only average expected prices but also the likelihood that the expected prices will obtain. Other things remaining equal, farmers usually prefer to grow crops whose prices are relatively stable.

This section analyses price data for the same crops as in the preceding section. The specific focus here, however, is on the relative stability of prices of paddy compared to prices of the "light" irrigated crops. Consideration is given to whether or not fresh policies to stabilize the prices of "light" irrigated crops would likely provide needed additional economic incentive to farmers for raising such crops.

The statistic used to quantify the relative stability in the prices of the various crops is the coefficient of variation.[39] The coefficient of variation represents the standard deviation of a distribution as a percentage of the mean of the distribution. Being independent of units, coefficients of variation for different distributions (in this case, price time-series for different commodities and for different periods of time) lend themselves to comparison one with another.

Table III reports the results of the computations for determining the coefficients of variation.[40] The means and standard deviations are shown to enable an understanding of the factors responsible for differences between and among the different coefficients of variation. The standard deviations also represent a quantification, in absolute terms, of the dispersions in the various sets of price data.

The computations in Table III are done for the pre-December 1964 period separate from the post-January 1966 period because the price series for most crops showed a marked break during 1965. Calendar year 1965 (plus a few months in 1964 for some crops) represented a breaking point in the sense that (*i*) during this period prices rose rapidly, presumably because of food shortages resulting from the drought and psychological repercussions from the Indo-Pakistan war, and (*ii*) the absolute variations in the prices for most commodities were more following than before it (note that the standard deviations for a majority of commodities are substantially higher during the late period).

For the purpose of this paper, the two most important relationships indicated in Table III are the following :

(1) For the combined early and late period, with only one exception (*viz.*, Gangavati jowar), the prices of paddy have been more stable than the prices of any other "light" irrigated crop. We would argue that this is one

39. See R. G. D. Allen: Statistics for Economists, Hutchinson University Library, London, 1964 (13th Impression), p. 90.

40. The raw data used in these computations are the monthly "average" and "modal" prices reported in the regulated markets.

TABLE III—MEASURES OF PRICE STABILITY, PRE-DECEMBER 1964 (EARLY) AND POST-JANUARY 1966 (LATE), SELECTED COMMODITIES : BELLARY (1961-1971), GANGAVATI (1959-1971) AND RAICHUR (1959-1971) REGULATED MARKETS

	Mean (Rs./qt)		Standard deviation (Rs./qt)		Coefficient of variation					
	Early	Late	Early	Late	Early		Late		Early-cum-late	
					CV	R†	CV	R†	CV*	R†
Bellary										
Paddy (all varieties)	41·07	77·42	39·6	69·0	0·96	1	0·89	2	0·93	1
Navene (local) ..	33·04	67·72	36·8	66·6	1·11	3	0·98	4	1·05	2
Bajra (local) ..	40·04	68·05	62·6	55·7	1·56	5	0·82	1	1·19	3
Safflower ..	52·61	104·26	54·8	144·7	1·03	2	1·39	5	1·21	4
Jowar (red/white)..	46·09	78·10	72·7	71·7	1·58	6	0·92	3	1·25	5
Cotton (*Mungari*)	110·51	166·79	156·4	262·8	1·42	4	1·58	6	1·50	6
Gangavati										
Jowar (white) ..	42·88	85·15	44·4	49·0	1·04	1	0·58	1	0·81	1
Paddy (all varieties)	38·92	73·34	42·4	76·1	1·09	2	1·04	4	1·07	2
Bajra (local) ..	37·09	66·12	46·6	68·0	1·26	3	1·03	3	1·15	3
Groundnut (*Gunguru*)	64·68	135·43	84·1	183·8	1·30	4	1·36	5	1·33	4
Navene (local) ..	31·24	60·53	51·5	61·3	1·65	5	1·01	2	1·81	5
Raichur										
Paddy (fine) ..	40·47	77·84	42·8	76·3	1·06	2	0·98	5	1·02	1
Paddy (*mohta*) ..	34·86	65·18	37·2	73·5	1·07	3	1·13	6	1·10	2
Cotton (*Laxmi*) ..	104·10	185·86	73·4	279·4	0·71	1	1·50	8	1·11	3
Bajra (local) ..	39·45	68·32	56·4	59·5	1·43	6	0·87	2	1·15	4
Navene (local) ..	34·64	65·30	51·2	58·4	1·48	7	0·89	3	1·19	5
Wheat (red) ..	61·12	126·30	102·2	115·4	1·67	8	0·91	4	1·29	6
Jowar (white) ..	43·31	79·94	81·2	58·9	1·87	9	0·74	1	1·31	7
Groundnut (*Gunguru*)	67·70	127·07	88·9	178·1	1·31	5	1·40	7	1·36	8
Safflower ..	55·04	112·14	68·0	196·1	1·24	4	1·75	9	1·50	9

* These are "simple" averages of the respective coefficients for the early and late periods.
† "R" denotes rank.

important economic reason contributing to the preference of farmers to produce paddy rather than "light" irrigated crops.

(2) Whereas the standard deviations for 17 of the 20 crop/market situations considered are greater during the late period, the coefficients of variation for only 7 of the 20 situations are greater during the late period. This contrast in outcome is explained importantly by the higher average prices that prevailed during the late period.

The crops whose prices have become most unstable during recent years are cotton, safflower, and groundnut. Those crops whose prices have shown the strongest tendency to become more stable in recent years, on the other hand, are navene, wheat, jowar, and bajra. Paddy is more or less neutral in the sense that the coefficients of variation for it have changed the least of those for any crop.

What can be concluded from this analysis? Over the entire period of study, the prices of the "light" irrigated crops have been less stable than the prices of paddy. Additionally, in recent years price instability for cotton, safflower, and groundnut has become accentuated. Although the prices of certain "light" irrigated foodgrains have become more stable in recent years, it is seriously doubtful if the added stability even for them will provide farmers with adequate incentive to grow them in preference to paddy.

Thus, we conclude that a Government policy to guarantee greater price stability for the "light" irrigated crops is needed to provide economic incentive for farmers to reduce "unauthorized" cultivation.

V

CONCLUSION

This paper examines the possible role of price policies in confronting the problems of "unauthorized" cultivation and the wastage of water in major irrigation projects in India. The Tungabhadra Irrigation Project in Mysore State is used in illustration.

At present in the TBP, the net incomes per acre from the "light" irrigated crops as a group are over 45 per cent lower than those from paddy. On the other hand, the net income and quantity of foodgrains generated per acre-foot of water are more than twice as much from the "light" irrigated crops as from paddy. This basic conflict between the economics of crop production which face individual farmers in the TBP and the economics of crop production which face the project management at large in the TBP is seen as a root cause of "unauthorized" cultivation.

Four principal policy conclusions arise from the analysis in the paper.[41] The latter three presuppose that present localization regulations are not subject to change.

(1) Raising the level of the new-subsidized water rate structure and shifting its assessment to a volumetric basis in major irrigation projects would provide important economic incentives for less wastage of irrigation water. In addition, such a policy would contribute to the realization of larger Government revenues and a greater degree of "social justice."

41. It is recognized that these policies need to be complemented with research, education, and action toward such constraints in the development of major irrigation projects as are indicated in para 3 of the section on the "Level of Water Rate Structure" in Part III.

(2) Important economic, and hence largely self-regulating, incentives would be provided to farmers in the TBP to reduce "unauthorized" cultivation if the following price policies[42] were adopted:

(*a*) raise the rate charged for irrigating paddy relative to that charged for irrigating "light" irrigated crops, and preferably assess the water rates on a volumetric basis,

(*b*) provide price supports which would shift the prices of "light" irrigated crops, particularly the foodgrains, up relative to the price of paddy, and

(*c*) provide additional price stability for "light" irrigated crops.

RECENT TRENDS IN INPUT–OUTPUT PRICES AND THEIR IMPACT ON FARM INCOME

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It is well recognized that the Green Revolution has brought significant changes in the pattern of agricultural production in the country. The nature of inputs, the intensity of their use and the pattern of disposal of output have undergone change, with the result that the production has become more market-oriented today than in the past. The salient features of the agricultural technology in recent years have been (1) an enormous increase in the use of fertilizers and other purchased inputs, (2) a rise in the share of marketed surplus to total production, and (3) an increase in risk arising from technical and market forces. As the producers have moved into the market economy, price relationships have become increasingly important to them. The controversy as to the positive response of output to price incentives has been set at rest, as there is ample evidence that the producers do respond, provided they have the technological means and knowledge to do so and all the more so, if they purchase more inputs and have a greater marketed surplus.[1] Therefore, to achieve the production objectives for agricultural development the producer should be assured of not only the opportunity and physical possibility to increase production but also the incentive to do so. Incentives

42. See footnote 31.

1. Raj Krishna, "Long and Short Run Price Elasticity of Acreage under Crops," *Agricultural Situation in India*, Vol XX, No. 5, August, 1965. J. R. Behrman, "Price Elasticity of the Marketed Surplus of Subsistence Crop," *Journal of Farm Economics*, Vol. 48, No. 4, November, 1966. Structure and Behaviour of Prices of Foodgrains, National Council of Applied Economic Research, New Delhi, 1969, pp. 30-34.