THE PATTERN OF AGRICULTURAL DEVELOPMENT IN TAMIL NADU IN THE 1970s: A DISTRICTWISE DISAGGREGATION

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IN the post-1948 period the performance of Indian agriculture has been impressive. Foodgrain output registered an annual average growth rate of 2.6 to 2.8 per cent, which exceeded the per annum population growth rate of about 2.1 per cent.[1] Commercial crop outturn may have expanded slightly more rapidly, but both food and cash crops were insufficient to meet the demands of consumers, whose incomes were rising, industry, and exports.[2] The plans habitually fixed a target rate of about 4–5 per cent for agriculture in recognition of these needs, but this was not met over any sustained period.[3] Since India's cultivable area cannot be expanded much further, yields for food and commercial crops must rise to permit the realization of plan aims. There is thus a need to examine carefully the conditions associated with high or rising yields so that workable strategies for future growth may be developed.

A number of recent studies have examined the spatial variability of output and yield growth in Indian agriculture.[4] These studies permit the identification of higher yield or more rapidly growing areas and the special characteristics of these areas can then be examined in order to determine key elements in their

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1 For a recent survey of foodgrain production since independence, see Fred H. Sanderson and Shyamal Roy, *Food Trends and Prospects in India* (Washington, D.C.: Brookings Institution, 1979). Also see Walter C. Neale and John Adams, *India: The Search for Unity, Democracy, and Progress,* 2nd ed. (New York: D. van Nostrand, 1976), Chapter 5.

2 Per capita incomes have risen by about one per cent or a little more per year. The income elasticity of demand for foodgrains is high and for items such as meat, milk, eggs, vegetables, and fruits is generally above 1. India has a net export surplus of food items and with improved domestic supplies could meet numerous and large demands in the Middle East, Eastern Europe, and the Soviet Union, especially for tropical and semi-tropical items, fresh or processed.

3 The fourth five-year plan called for a 5 per cent per year growth of agriculture (Government of India, Planning Commission, *Fourth Five Year Plan, 1969–74* [Delhi: Publication Branch, Civil Lines, n.d.], p. 120).

4 The first major study was Dorris D. Brown, *Agricultural Development in India's Districts* (Cambridge, Mass.: Harvard University Press, 1971). For other references, see [1, p. 74, footnote 2].

success [2]. An important new study by Bhalla and Alagh provides a most detailed look at the performance between 1961 and 1971 of most of India's districts with respect to nineteen major crops.[5] The present paper grew out of an interest in replicating a study of Maharashtra's district-level agricultural productivity reported in this journal.[6] Unlike Maharashtra, Tamil Nadu is characterized by adequate rainfall, more irrigation, and much more rapid absorption of modern inputs and technology. This southern state thus affords an interesting comparison with the large and mostly arid Maharashtrian region in the west-central part of India.

Tamil Nadu is the second most urbanized state in India and also has a fairly dispersed and important industrial base.[7] Since the focus here is on agriculture, these features do not figure heavily in the discussion. There are now fifteen districts in the state, but the Nilgiris, a hill district, has been omitted, along with Madras city. Thanjavur and Pudukkottai have been merged. The twelve units considered in the analysis are shown in Figure 1.

With only twelve cases the number of variables used in a multi-variable statistical analysis must be constricted.[8] The ten variables used are listed in Table I. Variable 1 is the value of output per hectare. Variables 2, 3, 4, and 5 (rainfall, irrigation, farm labor, and animal power) are traditional inputs. New mechanical devices (pumps and tractors) and fertilizer are measured by variables 6, 7, and 8. Cropping practices are represented by cropping intensity (variable 9) and commercial cropping (variable 10). It is clearly reasonable to assume that all of the traditional and modern inputs will be positively associated with yields. Double cropping should also generate high output per hectare of net area sown, while the impact of commercial crops is uncertain since their type and price may vary.

Although the stress in the discussion that follows is on interdistrict variations in yields, it should be recognized that Tamil Nadu's districts are on the whole among the most productive in India and yields of food and cash crops are very high on a national basis. The contrasts between the districts of Tamil Nadu

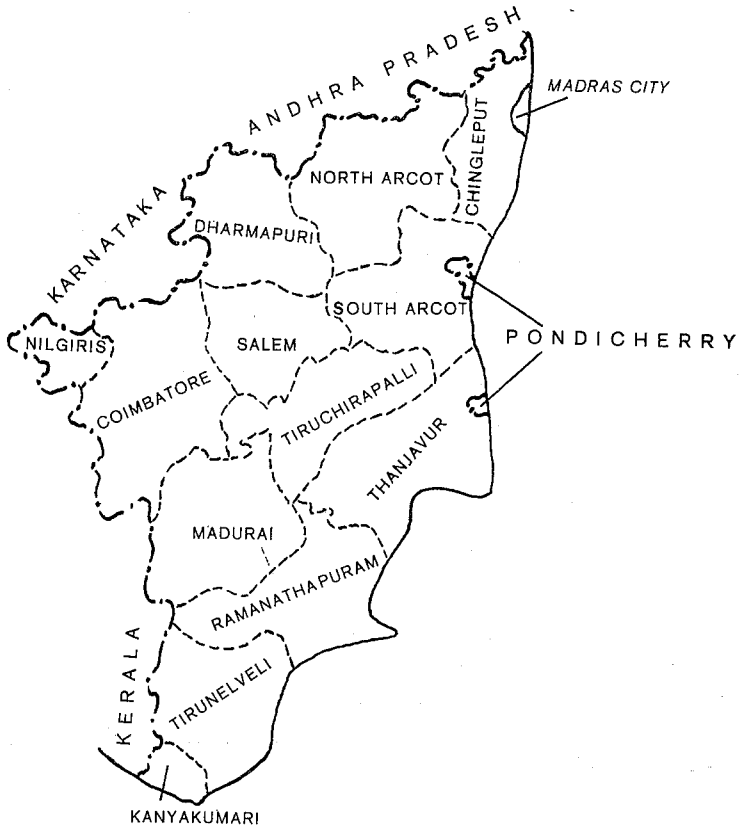
[5] [3]; This study disaggregates India's agricultural sector by crop and district, permitting the most detailed existing view of yields and growth at those levels.

[6] The Maharashtra paper appeared in this journal [1]. On a visit to Madurai-Kamaraj University in 1980 Adams met Benjamin and Varagunasingh who had begun to redo the Maharashtra paper for their state. This unexpected meeting led to collaboration on this paper.

[7] For a geographical overview of the state, see O. H. K. Spate et al., *India and Pakistan: A General and Regional Geography*, 3rd ed. (London: Methuen, 1967), Chapter 25. Also see R. L. Singh, ed., *India: A Regional Geography* (Varanasi: National Geographic Society of India, 1971), Chapter 25. A recent study examines the concentration of development in certain regions of the state. See C. T. Kurien and Josef James, *Economic Change in Tamil Nadu: A Regionally and Functionally Disaggregated Study* (Bombay: Allied Publishers, 1979).

[8] Degrees of freedom are lost and the correlation matrix, vital for factor analysis, becomes singular. The authors hope to work jointly on a block-level study that would permit the inclusion of more variables. It would also provide a useful disaggregation of the pattern reported in this paper.

Fig. 1. District Map of Tamil Nadu



and most of the rest of India would be much sharper than the within state differences.[9]

In a straightforward stepwise regression analysis, using agricultural productivity and seven independent variables, the effects of irrigation are strongly dominant. Irrigation blankets the other variables although they are separately related to agricultural yield levels and to irrigation and each other.[10] A factor analysis of the full list of ten variables of Table I makes overt the pattern of mutual interdependence and exhibits a clearer picture of some of the important relationships. Unlike the regression result which would attribute virtually all of the enhanced yields to irrigation alone, this resolution of a complex, multi-variable dimension recognizes the intertwined nature of the variables in the production process. (The

[9] Bhalla and Alagh [3] identify Tamil Nadu as having districts with above average yields in a number of crops (see Fig. 7, p. 80, for rice; Fig. 11, p. 104, for jowar; Fig. 17, p. 146, for oilseeds; Fig. 19, p. 174, for sugarcane).

[10] Yields per hectare were regressed on rainfall, irrigation, farm labor, animal power, tractors, pumps, fertilizer use, and road access. There is obvious multicollinearity and only irrigation is technically significant.

TABLE I

THE VARIABLES

No. (1)	Name (2)	Specification (3)	Mean (4)	Standard Deviation (5)
1.	Agricultural productivity	Crop value/ha. (Rs.)	2,004.33	565.84
2.	Rainfall	Annual rainfall (cm)	101.73	17.72
3.	Irrigation	Irrigated area/total cropped area (%)	47.17	14.46
4.	Farm labor	Agricultural workers/100 ha. (no.)	159.02	35.68
5.	Animal power	Working livestock/ha. (no.)	0.77	0.27
6.	Tractors	Tractors/1,000 ha. (no.)	0.90	0.68
7.	Pumps	Pumps/1,000 ha. (no.)	100.24	64.51
8.	Fertilizer	Fertilizer/ha. (kg)	44.86	16.75
9.	Cropping intensity	Double cropped area/nas* (%)	24.98	17.07
10.	Commercial cropping	Cash crop value/total crop value (%)	38.99	19.99

Source: All variables are derived from information available in Government of Tamil Nadu, *Annual Statistical Abstract for Tamil Nadu, 1972–1973* (Madras: Director of Stationery and Printing, 1978).
Note: The total values of food and cash crops were computed from output and price data for twenty crops. The output of each crop was multiplied by the state annual average price in order to obtain an estimate of value.
* Net area sown.

TABLE II

ROTATED FACTOR MATRIX

Variable	Factor Loadings			
	F_1	F_2	F_3	R^2
Agricultural productivity	0.869	0.000	0.000	0.82
Fertilizer	0.941	0.000	0.000	0.93
Irrigation	0.854	0.411	0.000	0.90
Animal power	0.720	0.000	0.423	0.72
Rainfall	0.259	0.910	0.000	0.90
Farm labor	0.000	0.909	0.000	0.86
Cropping intensity	0.505	0.742	−0.312	0.90
Commercial cropping	0.000	−0.712	0.579	0.90
Tractors	0.000	0.000	0.820	0.68
Pumps	0.280	0.000	0.797	0.76

Notes: 1. The maximum likelihood factor analysis method with varimax rotation was used to extract factors.
2. Loadings less than 0.250 have been replaced by zero.

exclusion of infrastructural, institutional, and contextual variables, due to the limited number of cases, remains a problem, which is discussed briefly below.) Table II contains this result.

Three factors emerge from the factor analysis. Agricultural productivity is unrelated to any but the first factor. The first factor combines the effects of irrigation, fertilizer, and animal power on yields. It is likely that HYV adoption

TABLE III

DISTRICT FACTOR SCORES ON F_1, F_2, AND F_3

F_1		F_2		F_3	
District	Score	District	Score	District	Score
Thanjavur	+1.711	Kanyakumari	+2.356	Salem	+2.246
Chingleput	+1.470	Thanjavur	+0.742	South Arcot	+0.989
Coimbatore	+0.698	Salem	+0.619	North Arcot	+0.615
North Arcot	+0.598	South Arcot	+0.527	Madurai	+0.435
South Arcot	+0.351	Chingleput	+0.248	Coimbatore	+0.396
Madurai	−0.105	North Arcot	+0.082	Chingleput	+0.167
Tirunelveli	−0.262	Dharmapuri	−0.302	Tirunelveli	−0.528
Tiruchirapalli	−0.316	Madurai	−0.467	Dharmapuri	−0.549
Ramanathapuram	−0.763	Tiruchirapalli	−0.694	Tiruchirapalli	−0.732
Kanyakumari	−0.911	Tirunelveli	−0.734	Ramanathapuram	−0.867
Salem	−0.949	Ramanathapuram	−1.114	Kanyakumari	−1.064
Dharmapuri	−1.573	Coimbatore	−1.263	Thanjavur	−1.108

is prevalent in areas with these features. Double-cropping is also common and to a limited extent higher rainfall and the use of pumps are found, as secondary loadings attest.

The second factor identifies foodcrop (rice) agriculture based on double-cropping of rainfed fields, connected to the double rainfall dose that parts of Tamil Nadu receive from the advancing (summer) and retreating (winter) monsoons. High farm labor input per hectare may be connected with less use of either animal power or mechanical power. Irrigation is of some importance.

The third factor highlights yet a third dimension of agriculture in the state, namely the use of tractors and pumps in areas involved in the commercial farming of groundnuts, cotton, and sugarcane. Animal power is applied frequently, but double-cropping is relatively rare since irrigation and rainfall are scarce.

It is of considerable interest that exceptional yields are associated with innovation of the biological-chemical type, using the Hayami-Ruttan nomenclature.[11] Rainfed agriculture does not generate equivalent yields, nor does commercial cropping. Yields per farm worker are not here considered and their distribution is likely to be different, thus it must not be presumed that the regions with lower yields per hectare have lower average levels of rural well-being.

The calculation of factor scores permits the identification of districts with the related features identified in the three factors (see Table III). Thanjavur, the Arcots, and Chingleput form a north coastal area specialized in the production of rice using irrigation and modern inputs and seeds. Animal power remains important, in contrast to the Punjab wheat areas where tractorization is occurring. The northern coastal zone also produces sugarcane and groundnuts at high yields and at a generally growing rate, but rice predominates. Coimbatore ranks third

[11] Y. Hayami and V. W. Ruttan, *Agricultural Development: An International Perspective* (Baltimore: Johns Hopkins Press, 1971). The Maharashtra study found a similar distinction but it was less clearly defined [1, p. 80]. The dual biological-chemical and mechanical paths to agricultural development are more sharply delineated in Rajasthan. See [2].

on this dimension, but not for identical reasons. The pattern for this district is high value of output per hectare and heavy fertilizer use, but only moderate levels of irrigation and animal power. Three-quarters of the value of output arises from commercial crops.

The second factor virtually singles out Kanyakumari at the south end of the subcontinent for its rainfed, double-cropped agriculture. The district is also in contrast to Thanjavur and Salem as its position in the first and third factor score rankings demonstrates. Thanjavur, Salem, South Arcot, and Chingleput also rank highly on this dimension. In contrast, Ramanathapuram and Coimbatore rank low on this rain-based factor.

Salem, in the center of the state, and the Arcots, along with Madurai and Coimbatore, utilize above-average numbers of tractors and pumpsets. These areas produce commercial crops such as groundnuts and sugarcane. Kanyakumari and Thanjavur, each of which dominates the rain-based or irrigation-based factor, rank lowest here.

Although the state is comparatively small and compact, and although the districts are rather large units and few in number to capture subtle regional differences, these results confirm the existence of three different agricultural regimes. Land productivity is closely linked to the availability of irrigation, which is used to support a mixed but food-dominated style of farming, that increasingly relies upon biological and chemical inputs. The double monsoon creates opportunities for another rice-oriented type in which human labor input is important, rather than animal power. A comparative specialization in commercial crops, and a reliance upon tractors and other mechanical devices, is best exemplified by Salem district, but these traits are found also in at least parts of the nearby Arcots and Madurai and also in Coimbatore to the immediate west. There is an important dichotomy between the delta or coastal regions of Thanjavur and Chingleput and the drier and more hilly regions of Ramanathapuram, Salem, and Dharmapuri.

Although the three factors account for 82 per cent of the variation in interdistrict output per hectare, a number of critical parts of the picture have been omitted. Evidence from similar studies suggests a possible role for credit institutions such as banks and cooperatives, for extension and other government policies, for infrastructure, for soil types, for land tenures and related institutions, and for other influences [2, pp. 721–22].

Some correlational evidence is indicative of the involvement of these absent elements. The simple intercorrelations of eight variables are displayed in Table IV. Agricultural productivity and rainfall are carried forward from Table I and the previous discussion, but six new indicators represent some infrastructure (road availability, proportion of electrified villages, share of agriculture in bank credit) and urban-industrial (urban population share, literacy rate, modern sector employment) characteristics. In interpreting the correlations, especially those dealing with urban-industrial development, it should be remembered that Madras city has been excluded. Nontheless, there is clearly a connection among road services, literacy, and modern sector employment. Modern sector employment is related strongly to urbanization, but urbanization is not linked to the other

TABLE IV

CORRELATION MATRIX

	Apd	Rnf	Rds	Ev	Urb	Lit	Me	Bc
Agricultural productivity	—							
Rainfall	0.35	—						
Roads	0.20	0.57	—					
Electrified villages	0.24	−0.38	−0.26	—				
Urbanization	0.40	−0.49	0.06	0.60	—			
Literacy	0.05	0.27	0.71	0.03	0.24	—		
Modern employment	0.25	−0.21	0.56	0.39	0.79	0.64	—	
Bank credit	0.22	0.53	0.38	0.08	−0.10	0.49	0.02	—

two. Urbanization does connect up with locally high agricultural productivity and village electrification (which is very high all over the state) but relates negatively to rainfall. Chingleput and Coimbatore districts, the first forming the hinterland around Madras, are both well-served with roads, have higher than average urban populations, and relatively large industrial work forces. They thus typify these patterns; both also have high levels of agricultural productivity.

On the whole, Tamil Nadu conveys a sense of vigorous agricultural diversity with at least three rather marked types of farming development. While there is considerable concentration on irrigated and rainfed rice production, important commercial crops like cotton, sugarcane, and oilseeds are also found, and become of greatest importance where ecological conditions are not so well suited for rice. Even by the early 1970s there is voluminous absorption of fertilizer and related biological and chemical inputs in the rice tracts of the northern districts, best exemplified by Thanjavur. But mechanization in the form of tractors and pumps has gone hand in hand with commercial cropping in Salem, in particular, as well as the Arcots and Madurai.

The generally progressive dimensions of agricultural change in Tamil Nadu contrast sharply with the previously reported state of affairs in Maharashtra. There, rainfall was still the dominant source of above-average productivity, and the use of fertilizer was light and keyed to that rainfall rather than to irrigation. Also, the traditional character of Maharashtra's agriculture was signalled by the association of above average yields with labor and animal power. Pumps, tractors, irrigation, and double-cropping were of significance in only a very few of the state's twenty-six districts. Taken together, the two states represent two extremes of Indian agriculture. One has abundant water which provides a basis for modernization and the other is still struggling with unfavorable conditions and traditional dry crops—*jowar*, ragi, pulses—which have not yet benefited from scientific research. Further work with neighboring states, such as Andhra Pradesh and Karnataka, at intermediate levels of development may shed additional light on what has been achieved and how much remains to be done in India's diverse but potentially bountiful agriculture.

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