CHAPTER III

METHODOLOGY

In the previous chapter, a broad review of theoretical component of development with a focus on regional planning and a review of related past studies were discussed. In this chapter, drawing from earlier discussions, an empirical model used for the analysis of agricultural growth/development is discussed. This chapter is divided into two parts: Part I deals with the details of selection of study area, sources of data, reference period and crops considered in the study and part II deals with the details on techniques of analysis used to measure the growth in agricultural production, the decomposition of change in the production and the causative factors of agricultural income.

Study Area

The present study was carried out in Tamilnadu State. The purposive selection of the state was due to the fact that it is one of the developing states in the country in agriculture. Further, the Government of India sponsored agricultural programmes like intensive agricultural district programme (IADP) was in operation in this state. The state has varied agro-climatic factors like irrigation, soils and crop pattern to facilitate the delienation of the state into agro-climatic regions. The strong research and extension base has enabled the development of new technologies in agriculture and its transfer to farmers. Since about 60 percent of the area is under dry land, rainfed agriculture is being given greater emphasis. The inputs needed for agriculture are supplied through a network of private and public institutions.

Study Period

Since it is a macro level study, the area and yield of crops has to be in tune with the territorial source of data and the period of technological breakthrough. In Tamil Nadu green revolution had its beginning in 1965-66 with the introduction of high yielding varieties. This marked a new thrust in production potential, a shift in production function rather than a move to a higher level on the same production frontier. With the spread of the new varieties, there was not only a change in production potential but also the decision behaviour of farmers and their outlook. A new and higher mean level of production was achieved as compared to earlier decades.

In the recent history of agricultural development in Tamil Nadu (after its reorganisation in 1956), two distinguishing periods could be recognised viz., pre-green revolution period i.e. 1956-57 to 1965-66 and post green revolution period i.e. 1965-66 to 1990-91. This classifcation was in agreement with Sharma[97]

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97 Ushaben Sharma "Contrribution of HYVS to cereal output, yield and Area in Gujarat", *Indian Journal of Agricultural Economics*, 36(1); (1981), pp. 79-81.

and Rajendran[98] who followed the same time period.

For the present study the period of post green revolution was considered from 1965-66 to 1990-91 for which the data were available to the researcher. The reason for selecting the post green revolution period is to analyse the pattern and direction of agricultural growth and causative factors during this technically advanced period.

Regional Approach

The process of growth was not uniform all over the state and there were regional differences. To understand these differences and to identify the agriculturally developed and/or under-developed regions a disaggregated analysis was done with agro-climatic regions as the reference units without cutting across the district boundary. The agro-climatic regions as identified in the Agro-Climatic Regional Planning exercise for Tamil Nadu is adopted for the present study. The details of the agro-climatic zones and the districts covered under each region is given in Table 3.1 and also in Fig. 1.

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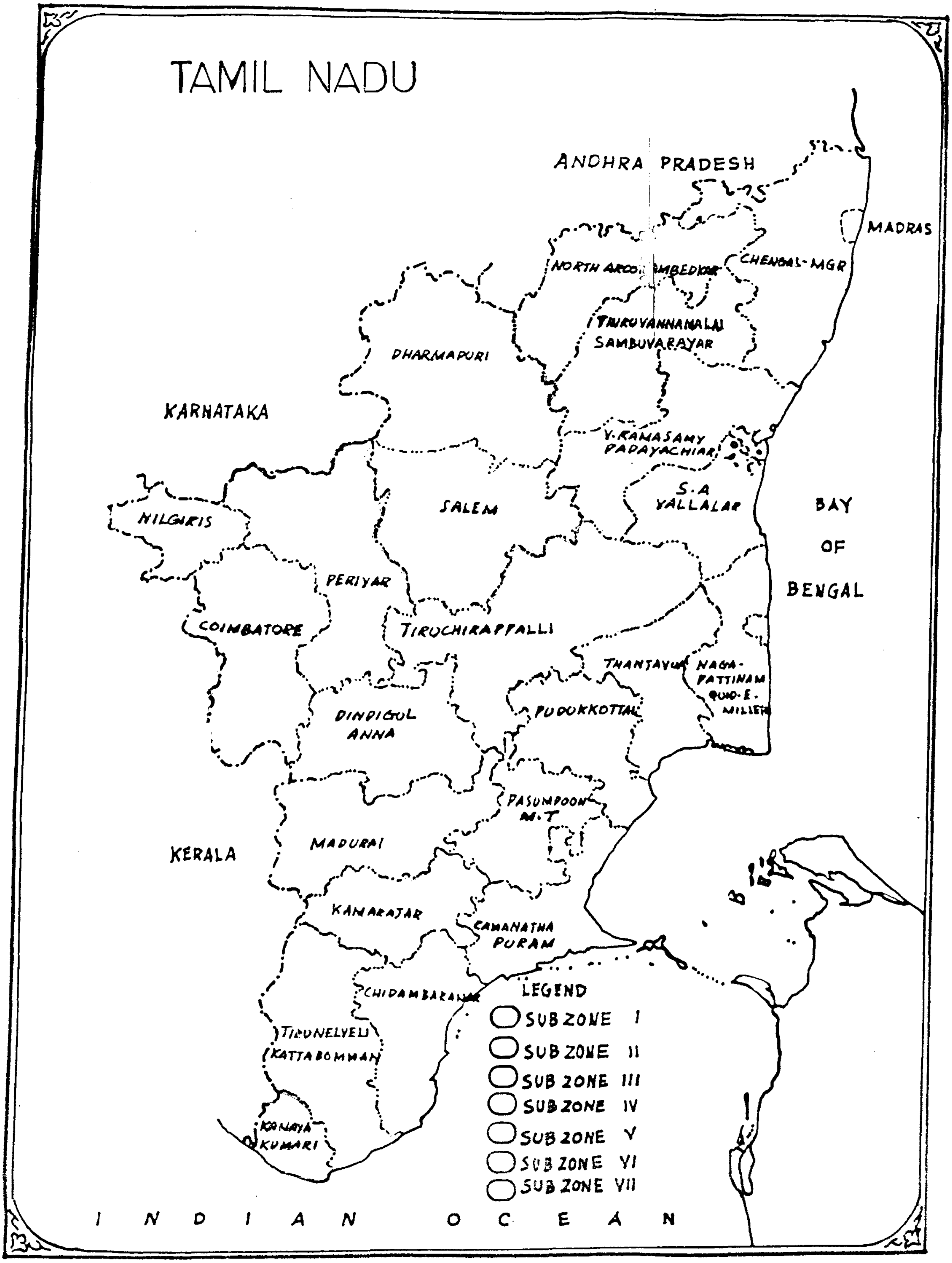
98 Rajendran, K. "Agricutlrual Growth in Tamil Nadu - A disaggregated Analysis", Ph.d. Thesis, Dept. of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore. (1989), p.70

Table-3.1

Distribution of Districts in Agro-Climatic Sub-Regions.

S.No.	DISTRICTS	AGRO-CLIMATIC SUB REGION
1.	Salem	I
2.	Dharmapuri	
3.	Madurai	II
4.	Dindigul Anna	
5.	Coimbatore	
6.	Periyar	
7.	Tiruchirappalli	
8.	Pudukottai	
9.	Chengalpattu MGR	III
10.	North Arcott Ambethkar	
11.	Tiruvannamali Sambuvarayar	
12.	Villupuram Ramaswamy Padayachi	
13.	Cuddalore - Vallalar	
14.	Thanjavur	IV
15.	Nagai Quaid-e- Milleth	
16.	Ramanathapuram	V
17.	Pasumpon Muthuramalingam	
18.	Kamarajar	
19.	V.O.Chidambaranar	
20.	Tirunelveli Kattabomman	
21.	Kanyakumari	VI
22.	Nilgiris	VII

TABLE 3.1 - FIG. - 1
MAP SHOWING THE AGRO-CLIMATIC REGIONS OF TAMILNADU



Out of the seven regions, five regions were considered for the present study. Sixth and seventh regions were not considered becuase of their peculiar nature i.e. hilly zone and high rainfall area. Further these regions together accounted for only 2.5 percent of the total geographical area of the state and differed vastly in cropping pattern, land use pattern and sources of irrigation.

Crops considered

Agricultural output growth was analysed cropwise for 12 major crops as listed below. They together accounted for about 60 percent of the normal gross cropped area of the state.

I.Food Crops

1. Rice
2. Cholam
3. Cumbu
4. Maize
5. Ragi
6. Blackgram

II. Non-food crops

1. Chillies
2. Sugarcane
3. Cotton
4. Groundnut

Data Source

As this study was based on time series data, secondary sources were mainly used. The data on area, yield, output, irrigated area, area under high yielding variety, fertilizer consumption and farm harvest prices of the crops considered were mainly collected for different districts as well as for the state and compiled for the agro-climatic regions. The data were collected from the various issues of the publications like, Season and Crop Reports of Tamil Nadu, Tamil Nadu - An Economic Appraisal, Fertiliser Statistics, Agro-stat-Tamil Nadu and Annual Reports of the Department of Agriculture, Government of Tamil Nadu.

Analytical parametres

Agricultural growth was analysed by area, output, productivity (yield) and irrigated area of crops. The factors which contributed for agricultural income was analysed through area, irrigated area, fertilizer consumption, plant protection chemicals consumed and area covered under high yielding varieties. Due to the paucity of data certain components were not considered at regional level but considered in the state level analysis.

Measurement of variables

Area: Total cropped area under the crops considered was taken in terms of hectare.

Irrigated area: Total area irrigated under the crops studied was taken in terms of hectare.

Yield- Yield of crops under study was arrived by dividing the total output of the crop by total cropped area of the particular crop. It is measured in Kgs./hectare.

Output - Output of each crop is the total prouction of the crop and it is measured in terms of tonnes except for cotton which is measured in terms of bales. The byproducts are not included.

High yielding varieties area- It is the area covered under high yielding varieties of the crop and measured in hectares.

Fertilizers and Pesticides consumption - The consumption of fertilizers in terms of nutrients and the pesticides consumption by active ingredients were considered and reported in tonnes.

The compilation for each Agro - Climatic Region was done from district level reported data of the respective region. Yield data for crops of the region were computed by dividing the output of the crop of the region by the total cropped area of the crop of the region.

Tools of analysis

Specific tools appropriate to analyse the data with reference to each of the specific objectives were selected and applied. They are discussed below.

Time Series Analysis

Most of the past works in price analysis utilised the time series methodology or spectral analysis. Unlike the regression based econometric tools, time series methods do not attempt to establish any causation among econometric variables.

As such their utility is restricted in policy oriented analysis and more importantly they are not amenable for treating joint relationships among variables. The distribution of the parameters of such models are as yet uncertain thus preventing robust confidence tests except perhaps few non-parametric ones.

However, one major drawback of the classical distribution based econometric tests is the requirement of independence among consecutive observations, which otherwise take care of the deficiencies of time series analysis. This requirement is totally absent in many of the economic time series variables. And even if met, perhaps it might be limiting in the sense that the economic processes are so random that it would rather be impossible to plan for the future.

Time series analysis on the contrary recognises the dependence among the successive observations and the evolutionary behaviour of the system studied. They characterise memory of the particular system considered on which are super imposed the noises. Given a set of data (Xt; t = 1 ....n) where 'n' is some finite number, the time series methodology tries to model the process that most likely generates the set, given that the set itself is perhaps one possible realisation of a stochastic process. Most of the models rely upon the autocorrelation of the series to determine the mechanism generating the series. Though there are various hypotheses and theories like the smoothing process, decomposition of the series into its components, autoregressive structure, moving average and their combinations, their relevance for any particular series remains largely an empirical question. There appear to be no rigorous theoretical guidelines available to choose among them and final choice depends largely on the purpose and certain amount of experimentation.

The basic aim of the present study is to understand the pattern and direction of agricultural growth and underlying the components of the agricultural growth and use the knowledge for policy suggestions. To this end some of the time series tools applied are discussed below.

The Classical Decomposition of Time Series Data

Historically the decomposition of time series data has been applied to unearth the hidden patterns. Four major components namely, trend factor (T), cyclical factor (c), seasonal factor (s) and a fourth 'pure noise' (U) are generally identified.

Let (xt/t = 1........T) be the finite time series of random variable x, the classical decomposition assumes that the series is generated by the multiplicative process,

$$X = T \times C \times S \times U$$

and proceeds to distill the components of the various techniques.

The methods followed in this study are presented below.

Trend

Most of the economic variables show a tendency to grow over time. It is assumed that the underlying true secular trend is marked by the random fluctuations super- imposed upon it. Trend analysis seeks to identify the secular trend. Given the series (Xt/t = 1......T) trend X^T_t can be most generally modelled as $X^T_t = f(t)$

on which are superimposed the noises, collectively represented by Ut, giving the series X_t.

$$X_t = f(t, U_t).$$

The specific form of the above equation is an empirical question, though predominantly a linear version is used in the literature and equally an exponential trend. While the selection of any specific trend model is influenced to some extent by the purpose of anlysis, the co-efficient of determination provides some guidance about the appropriateness of the model selected.

Polynomial Trend

The general form of polynomial trend is given by

$$X_t = \sum_{i=0}^{P} a_i t^i + u_t$$

where 'P' is the order of polynomial. In particular when P = 1, the model becomes linear.

Exponential Trend: (Compound growth rate)

The growth implied by the slope of the linear trend is constant and even if the summary statistics so indicate the model may not portray reality adequately when T is large. Further, a_1 in the linear equation being related to the units of the series X_t, cross comparisons with the growth rates of related series become tedious. These twin problems are overcome to some extent when the series is defined by a compound growth rate 'r' from its base value X_0 when t = 0 by the relationship.

$$X_t = X_0 \ (1+r)t$$

The least squares estimation of the above form, more plausible in many economic series, is accomplished by taking logrithms on both sides and rearranging the terms.

$$\text{In } X_t = \text{In } X_0 + t \ \text{In}(I+r)$$

or

$$X_t = a_0 + a_1$$

Where the substitution of notations are obvious. The least square model is implemented by adding a stochastic component to the above equation and the compound growth rate 'r' can be recovered from the estimate a, as

$r = (\exp a_1) - 1 \times 100$

or

$r = (\text{anti log of } a_1 - 1) \times 100$

The estimated trend equation is used for forecasting when errors of forecasting are specified conditional on the variance of the corresponding statistical noises of the trend equations.

To test whether 'r' differs from zero siginficatly, its standard error is calculated using

$$SE(r) = 100 \times \frac{a_1}{\log 10^2} \log 10_e$$

$$'t' = r/SE(r)$$

T

E (log x) 2

T

E (log x) 2 – 1

log 0$\hat{1}$ E (t – f) 2

$$\frac{T}{(T-2)\ \overset{T}{\underset{1}{E}}\ (t-f)^2}$$

where 't' follows students t - distribution with (n-2) degrees of freedom. This analysis was done for area, yield, output and irrigated area of crops for each agro-climatic region and for the state for the period 1965-66 to 1990-91.

Decomposition analysis

The arithmatical accounting for agricultural growth components was attempted by many researchers on the additive decomposition scheme used by Minhas and Vaidyanathan with slight modification to suit their situation.[99] Two patterns were identified. They are four factor as well as seven factor models as contained in the literature. Four component model considered area, yield, crop pattern and residual to represent the interaction efffects of these three components. In the words of Minhas (1989), "it must be recognised that the usefulness of this additive model is questionable if the interaction or residual element is rather large". In order to bring the maximum extent of the residual effect out in the open, Minhas and Vaidyanathan attempted on the expanded framework of a seven factor additive model. The net import of these calculations is to reduce the pure effects on yield and crop pattern change. The four factor model's single interaction element was split into a three factor interaction between changes in area - yield, area - crop pattern, yield - cropping pattern and area - yield - cropping pattern. All these decomposition schemes, nevertheless, serve only to help orgainse data in a manner which is more suitable for the analysis of casual factors in the growth process.

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99 Minhas B.S. and Vaidyanathan A., (1972). op., cit. p. 50-70

The contribution of different factor elements to growth of output in the state and for the agro-climatic regions for the period 1965-66 to 1990-91 was attempted for the selected 12 crops. The model used in the present study is presented below.

With the help of the model developed by Minhas and Vaidyanathan (1965), the increase in aggregate output is decomposed into seven component elements, viz. (a) the contribution of changes in area, (b) changes in per hectare yield, (c) changes in cropping pattern, (d) interaction between area and cropping pattern, (f) interaction between yield and cropping pattern, and (g) the interaction between area, yield and cropping pattern.

The crops (C1s) considered were assigned constant weights W1 s, being the 1977-78 price of the respective crops. C_{io}'s and C_{ij}'s were proportions of area occupied by different crops in year 'o' and 'j' and represented the cropping pattern, Y_{io}'s and Y_{ij}'s in year 'o' and 'j'. To even out the annual fluctutations, three year averages was taken for C_{io}'s C_{ij}'s, Y_{io}'s and Y_{ij}'s.

F_j is the gross output in year 'j'

P_o is the gross output in year 'o'

A_j is the gross cropped area in year 'j'

A_o is the gross cropped area in year 'o'

No $P_o = A_o * W1 * c1_o * YI_o$

Pj = Aj * W1 C1 j * YI j

+ Ao*WI*CIo*(Y1j - Y1o)

+A*WI*CIj - C1o * Y1o

-(Aj - Ao) * WI * (C1j - C1o) * Y1o

-Ao*WI * (Ci) - (C1o) * (Y1j - Y1o)

+ (Aj - Ao) * WI * (C1j - C1o) * (Y1j - Y1o)

The elements on the right side of the equation represent the change in the aggregate to (a) area, (b) yield, (c) cropping pattern, interactions between (d) area and yield (e) area and cropping pattern, (f) cropping pattern and yield and (g) area yield and cropping pattern.

Functional Analysis

Aggregate production function was attempted using aggregate data for the different agro climatic regions as well as for Tamil Nadu state. This was worked out to estimate the contribution of technology to agricultural growth in the state and to identify the variables that influenced the agricultural output.

The nature of crop outputs are not uniform. Therefore, the output was converted into value terms by the respective farm harvest price of the crop. The value of selected crops' output were worked for individual districts and then pooled on agro-climatic basis to avoid any error in aggregating for regions.

By looking into the scatter for the relationship between dependent and independent variables individually the exponential form of functiion was fitted for different agro- climatic regions and for the state. The Cobb-Douglas form of function has the following advantages also.

i) Its iso-quants are negatively sloped and strictly convex for positive values of the independent variables and in agriculture the isoquants are expected to be negatively sloped.

ii) It is homogeneous of a given degree where the degree is defined by the sum of the co-efficients of the variables.

iii) The coefficients are actually the elasticities of production and therefore the elasticities are obtained directly.

iv) It can be converted into linear form by taking logarithms and solved by ordinary least square method.

It is also the most widely used form of production function in agricultural economics literature. Though this form was selected for the study, the R^2 and F values of the function fitted were carefully considered for the validity of the functional form. The specific functional form is:

$$Yt = At \times {}^{B1}_{1t} \times {}^{B2}_{2t} \times {}^{B3}_{3t} \times {}^{B4}_{4t} \; u^{et}$$

Y_t = Value of output of selected crops in lakh rupees.

X_{1t} = Gross cropped area (in hectares)

X_{2t} = Gross irrigated area (in hectares)

X_{3t} = Non food crop area (in hectares)

X_{4t} = Consumption of fertiliser (in tonnes).

A = intercept

B .... Bn -Parameters of the variables X_1......X_n to be estimated

u - Stochastic term

e - base to natural logarithm

t - number of years