# SPATIAL AND TEMPORAL VARIATIONS IN THE DEVELOPMENT OF AGRICULTURE IN KERALA

By

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## DECLARATION

I hereby declare that the thesis entitled **Spatial and temporal variations in the development of agriculture in Kerala** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree diploma fellowship or other similar title of any other University or Society

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## CERTIFICATE

Certified that this thesis entitled **Spatial and temporal variations in the development of agriculture in Kerala** is a record of research work done independently by **Mr Allahad Mishra** under my guidance and supervision and that it has not previously formed the basis for the award of any degree diploma fellowship or associateship to h m

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*Allahad Mishra*

*DEDICATED*
*TO MY*
*PARENTS*

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| A M | Arithmetic Mean |
| ALP | Alapuzha |
| C D | Critical difference |
| C G R | Compound growth rate |
| C P I | Composite productivity index |
| C V | Coefficient of variation |
| E I | Entropy index |
| EKM | Ernakulam |
| H I | Herfindahl index |
| HYV | High yielding variety |
| IDK | Idukki |
| K g | Kilogram |
| KKD | Kozhikode |
| KLM | Kollam |
| KNR | Kannur |
| KSGD | Kasargode |
| KTM | Kottayam |
| Lin | Linear |
| Log | Logarithm |
| M E I | Modified entropy index |
| M T A | Modified taxonomic approach |
| MLPM | Malappurram |
| O I | Ogive index |
| P C A | Principal component analysis |
| PLD | Palkkad |
| PTA | Pathanamthitta |
| T A | Taxonomic approach |
| TSR | Thrissur |
| TVM | Trivandrum |
| WYD | Wayanad |

# INTRODUCTION

# INTRODUCTION

In a country like India where agr culture cont nues to contribute a major share of the nat onal economy any improvement n the standard of mass consumption will depend largely on the overall growth of agricultural output A ı analysis on the behaviour of agr cultural growth ın the present scenar o provides a bas s for future projections of agricultural output Such study can be carr ed out at an aggregate level for the country as a whole or at a disaggregate level for eacl state as a unit

The agricultural scenar o n Kerala s unique ın many aspects when compared to other parts of thc nat on Predominance of cash crops and plantat o crops high rainfall etc make it unique W th diverse ecolog cal conditions there exists a high degree of poly cropping The state enjoys an intense d versity of seasonal annual and perenn al crops like rice tapioca cashew rubber pepper coconut banana etc

Regional divers t es ın agro cl mate and population dens ty are l kely to be characterised by uneven economic and agr cultural development among various regions as well as the regional differences ın the developmcı t of agr culture aris ng out of various physical resources and interest of farmers

The introduction of new var et es and new technology not only leads o ntens fication of farm ng over the state but also results n the gro vth of d vers fied farm ng leading to the maximisation of benefits to the whole farm ng community The levels of crop diversif cation vary for different reg ons beca sc of varied agro climatic condit ons and resource endowment of the farmers as a result of wh ch mbalance ın development of agriculture exists w th n each state

Elimınat on of mbalance ın development cont nued to be one of the pr ncipal objectives of economic plann ng from the very beginning Aga n with ı

each state some distr cts lagged in agr cult ral development Such nbalances n development lead to d spar ties among the subjects of d fferent d str cts of a particular state The present study tries to measure the level of agr cult ral development among the different distr cts of the state n order to dentify where a d str ct stands n relat on to others

To realise a balanced reg onal development t is important to study the trends as well as rate of growth of d fferent d str cts on a cont nu o is bas overall development s significantly d fferent from time to time

It is to be noted that the development of a reg on depends upon m ny var ables or ndicators So t cannot be captured fully by any s ngle var able or ndicator To quant fy the development of a region t s necessary to make a ndex which s a comb nat o i of all the variables respons ble for the develop nc of agr culture

The present st dy was carr ed out w th the following object ves

- To study the s gn ficance of crop d versif cation and temporal dispar t es among d fferent d stricts or regions

- To compute the compound growth rates of d fferent crops by u s ng different types of growth curves

- To construct compos te product v ty ndices for each d str ct or reg on by cons dering the type of crop s relative importance to each distr ct or reg on

- To construct compos te ndex to quantify the development of agr culture based on suitable indicator variables for different d stricts or reg ons of Kerala

In order to accomplish the above ment oned object ves the present stu deals with district wise significance of crop var at ons distr ct w se d spar t cs agricultural development and the quantification of development levels agriculture for various districts in different per ods This will help n evolv effective plan outlays so as to reduce inter district disparities in agr cultu development

# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

The present study of development of agriculture n Kerala deals with following topics

2 1 Diversification vs development of agriculture
2 2 Development of agriculture in Kerala
2 3 Trend in agr cultural acreage and product on
2 4 Instability of agriculture over periods
2 5 Quantifying crop diversification
2 6 Quantifying agricultural development
  2 6 1 Taxonomic approach/ Composite Index method
  2 6 2 Principal Component Analysis

## 2 1 Diversification vs Development of agriculture

The level of diversification of crop enterprises reflects the extent economic development in the rural sector The diversification in agr culture practised with a view to avoid risk and uncertainty due to climatic and biolog vagaries The farmers generally grow subsistence crops n the early stages development With the increase n human population they try to produce more maximise total farm output At the third stage they again d vers fy agriculture strengthen the existing level of development (Chand and Singh 1985)

The introduction of HYVs of different crops dur ng green revolut increased the production of almost all crops throughout Ind a The mpact of t also affected all parts of Kerala

A study conducted by Singh *et al* (1985) on divers fication of cr showed that the cropping pattern was gradually oriented towards food grain cr n Punjab The imbalance n growth among the d str cts had been caus ng g

concern to the planners of the state as allotment of fund was a very difficult ta to the planners

Joshi (1987) studied the economic development among the states of Ind He found that there were clear cut disparities among the states By comparing t disparities it was very helpful for planners to make necessary arrangement allotment of funds to the weak regions for a balanced regional development

According to Rao (1987) state governments are only capable of tak the problem of interstate imbalance and local planning is the ma n criterion any strategy for balanced spatial development with in a state He also made t conclusion that state should make separate ideas for the development backward and special problem areas It is absolutely necessary for the state recognise the imbalance in growth and to make special efforts for a balanc growth

To find the disparities among the districts a study conducted by S n (1988) found that there existed wide variations from one region to another w respect to their agricultural performances It was also seen that agricultura backward regions possessed the potential for development It is essential th conditions be created where by the backward areas are able to contribute to t maximum of their capacity and their potentials are optimally utilised Otherw the regional imbalances would act as a drag to the overall growth rate of t state s economy

Sharma (1990) tried to find out the factors wh ch are mainly respons l for the disparities in agricultural development The factors might be fertil application to tractorisation The inter state disparit es in growth performances agriculture could be minimised by bringing the farmers with efficient extens education training activities sound government policies and efficient inj supply net work These measures might facilitate higher heights of agricultu production

## 2 2 Development of agriculture in Kerala

Kerala is one of the smallest states in southwest corner of India with 1 per cent of total area and 3 per cent of total population of the country Owing to its climatological features this state shows much more diversification agriculture compared to other states of India

The change in crop out put in Kerala was due to change in total area d different crops Although area under specific crops had significantly increas over the years the change in the magnitude of crop pattern was masked by t more significant effect of change in area under different crops and their yields

Agricultural production in a region is mainly determined by gross cropp area (GCA) cropping pattern and yield per unit area of crops So change production might occur by a change in GCA a change in cropping pattern change in the yield per unit area or combination of these

According to Lakshmi and Pal (1988) in Kerala where mixed cropp and multiple cropping dominate the agriculture system further increase in gro cropped area was not possible Another alternative is to effect fundamen changes in cropping pattern through appropriate crop planning with high yield cultivars and steady improvement in yield through scientific management Th also opined that despite significant development in agricultural technology t production of food grains remained stagnant during the past two decades

Silas and Abraham (1988) reported a collective area wise approa involving the co operation of all farmers in homogeneous crop field units and t application of systematic approach by using HYV technology Integrated nutri management and integrated pest or disease management are therefo indispensable for making break through in food grain production It was a pointed out that instead of speeding the efforts and resources over the ent

landscape involved in food grain production it was desirable to concentrate selected area with maximum potential and resources

In any state the selection and allocation of land to different crops based on physical economical and sociological considerations and the farmer take the decision by considering all the above factors

Thomas *et al* (1990) pointed out that climatic conditions in Kerala state and high expectation towards future prices for the cash crops resulted in the increasing trend in the acreage of cash crops

According to Krishnan *et al* (1991) the growth of major crops of Kerala was not significant The growth of food crops like rice and tapioca were negatively significant for both area and production as the growth of cash crops was healthy as compared with the food crops

Thomas *et al* (1991) revealed that the acreage under tapioca was continuously decreasing among different districts of Kerala

As the growth of food crops continuously decreases and that of plantation crops continuously increases the development of districts make a wide gap among them

Das (1992) found that only about 22 per cent of the gross cropped area in the state was having productivity above the state s average and this area accounted for 37 per cent of the total value of agricultural production

Bastine and Palanisami (1994) and Kumar and Pillai (1994) indicated that the farmers of Kerala were taking more interest in plantation crops rather than in food crops

## 2 3 Growth trend of agricultural crops

When it is proved that there are wide variations present among regions it is necessary to find the growth curves of different crops in the state fitting different trend models

Rao *et al* (1980) reported that fitt ng a trend to raw data and calc ilat coefficient of variation of residuals from the fitted trend generally accoui ted both the trend and fluctuations They also pointed out that though normally tr might be adequate it might not be workable when fluctuat ons were large frequent

To study the growth rate in a biological production process l agriculture a compound growth rate is more appropriate (Rath 1980)

Krishnanji (1980) discussed the conceptual problem of fitt ng the tre Due to abnormality of terminal years growth rates computed from one year another year are not accepted and he demonstrated how the choice betw alternative functions based on the value of $R^2$ could often be erroneous In f such a choice was logically improper

Since it is difficult to establish crop weather relationships for specif crops and regions it is even more difficult to establish relationship betw output aggregated over several crops and spatial units On the other h Dandekar (1980) showed how the linear function Y a+bt for estimating grov of agriculture over time was inappropriate He also analysed how it v erroneous to think of growth to be constant over a period Several other mod were also utilised by him viz $\log Y=a+bt+ct^2$ $\log Y$ a+bt and by add ng seve additional parameters to increase the $R^2$ value of different models

Rao (1985) made an attempt to study the growth of agriculture in Pun and the factors affecting it by using exponential function in the form ab [1]

pointed out that factors like infrastructure irrigation soil erosion water logg and sharecropping were playing significant role for growth of agriculture

Arya and Rawat (1990) calculated growth rates for area production a productivity of various crops of different distr cts of Haryana by f tt exponent al model and tested s gnif cance of growth coeff cient by the help student s t test The study indicated that inter district var ation existed and crop to crop variation between d stricts was visible It concluded how seve policies of government could control the variation among districts

A study conducted by Thomas *et al* (1990) not ced that though farmers of Kerala l ked to grow more plantation crops than food crops there no significant shift in cropp ng pattern n the state

Arya (1991) analysed the disparities of fertilizer consumption n Harya by using exponential function and noticed that there was a general increase in t levels of per hectare consumption of fertilizers in the d stricts while there w not much change in the rank ng of distr cts

The growth of Kerala agriculture was studied by Krishnan *et al* (1991) using exponential function and observed that during green revolution per when rest of country marked increase in production Kerala marked decelerat growth in agricultural production

Thomas *et al* (1991) used sem logarithmic model to arrive at trend area production and productiv ty of different crops of Kerala wh ch w decreasing

Singh and Singh (1991) obtained compound growth rates of several cro of Punjab and pointed out that for different periods the growth rates we decreasing constantly for several crops

By using log l near form logY a+bt Kal ta and Baruah (1992) comp growth rates of production and acreage of summer r ce autumn r ce as ve winter rice n Assam dur ng the period from 1951 52 to 1988 89 Tl ey opined that t was mportant to quantify the development of each re separately to correct uneven development among various regions and to mike of available resources of var ous reg ons

Das (1992) made sc of exponent al form $Y=ae^{bx}$ to calc late co ipo growth rate of var ous crops of Kerala He pointed out that agr c lt prod ct on followed an errat c trend and the acreage and prodi ct on of fc have been decreasing continuously while those of plantation crops v ncreas ng in Kerala

Bhowmick and Ahamed (1993) tr ed exponential function to study behaviour of trend and growth of area product on and productiv ty of o l s crops in Assam In their study the problem of multicollinearity autocorrelation have been taken care of by su table statist cal procedures

Exponential funct on was also utilised by Bast ne and Palan sam (19 to study the growth of principal crops n Kerala They found that the value agricultural product per unit of land in Kerala was one of the highest n country because of diverse crop comb nations The overall product performance of agricultural sector has been one of perennial stagnations dur the past and in view of the non availab l ty of extra land area They suggeste vest the stress on intensive use of limited sources to achieve the max mum y of d fferent crops

The linear model Y a+bt and the exponential model Y=ab were tr ed Bhatnagar and Nandal (1994) to obtain the linear growth rates as well compound growth rates of area and production of wheat in Haryana

Ajithkumar and Devi (1995) conducted a study by using semi log exponential and linear models and opined that the variability in area was comparatively lower than that of productivity and production of tea in Kerala

Borthakur and Bhattacharya (1999) fitted different functional forms which were having the highest coefficient of determination ($R^2$) to analyse the trend of area production and productivity of rice in Assam for three periods viz pre green revolution post green revolution and total period

## 2.4 Instability of agriculture over periods

Rao *et al* (1980) used coefficient of variation in order to have an idea of variability in trend and original values

Making use of coefficient of variation Krishnan *et al* (1991) concluded that instability of area was greater for tapioca ginger rubber and coffee in Kerala when compared to that of the yield

Arya (1991) observed that there were considerable variations in the level of per hectare consumption of fertilizers in different districts of Haryana state during the period of two decades (1966 86) using coefficient of variation and the variations were declining

Comparing the coefficients of variation Kalita and Baruah (1992) examined the degree of fluctuations in area production and productivity of rice in Assam

Das (1992) used coefficients of variation to measure the instability of different crops for different periods in Kerala and opined that variation in growth of most of the crops in Kerala have been significant

Kaur and Seth (1994) concluded that high degree of var at on in y e existed n d fferent districts of Punjab and inter d strict var ations decl ned ov the period from 1966 to 1989 for food crops whereas nter d str ct variat o ncreased for cash crops S milar stud es were conducted by Bast ne ı Palan sami (1994) for all crops n Kerala Bhatnagar and Nandal (1994) for vl c Haryana while Ajithkumar and Dev (1995) used coeff cient of varıat on measure the nstab l ty of tea for different distr cts of Kerala and Radha a Prasad (1999) carr ed o t tl s for rice and maize for Nortl Telangana zone Andhra Pradesh

## 2 5 Quantifying Crop Diversification

Krishna (1963) reported that adequate empir cal evidences were r available on diversif cat on motives on Indian farms and factors affecti d vers f cation So it s necessary to analyse the emp r cal relationsh p betwe crop d versif cation and related socio econom c var ables and the r relationsh This can be quant fied by using different ndices likew se crop divers f cat can be measured by using d fferent types of ndices (Theil 1967)

According to Bal ga and Tambad (1964) Sarkar (1972) S ngh and J (1979) and Sandhu and S ngh (1979) farm d versif cation stud es have be mainly focused on the existing standard issues of diversificat on n India

Hackbart and Anderson (1978) pointed out that socio econon diversification could be measured by using different types of ndices l Herfindahl Index and Entropy Index

Different measures of crop divers ficat on like Herfindahl Index Entropy Index defined both n acreage proport on as well as net crop inco proportion were tried by Gupta and Tewari (1985) and revealed that larger wealthier farms were relat vely less diversified It was also observed t

irrigat on cropp ng intensity location and sizes were responsible for h gh cro d versification

Singh *et al* (1985) applied Herfindahl Index Entropy Index and Modif e Entropy Index in m xed farming at micro level as well as macro level The pointed out that macro level diversification was significantly and adversel affected by fert lizer consumpt on inter crop value product vity variab lity et Whereas at m cro level t was inversely related to s ze of farm distance from th market and assets per hectare and d rectly related to family s ze and dairy nco ne

Joshi (1987) computed the above sa d ind ces by taking the value of eac indicator as a percentage of the average value of the correspond ng indicator the national level and opined that infrastructure and development were d rectl related to each other in India

Kaur and Seth (1994) proposed a composite index by assign ng area a weights They made use of this ndex in order to make an nter d str comparison in Punjab and reported a high degree of variation in crop yield amon distr cts and this var at on was decreas ng

Different ind ces l ke Herf ndahl Index Ogive Index Entropy Inde Mod f ed Entropy Index Composite Entropy Index etc were used by Chand ar S ngh (1985) to f nd the d spersion and concentration of crops of d ffere regions in H machal Pradesh n a g ven time

These ind ces were computed and compared by Shiyani a d Pand (1998) to measure diversification of agriculture in Gujarat and reported th Herf ndahl Index was better than Ogive Index whereas Composite Index v better than Entropy Index as well as Modified Entropy Index They al concluded that out of all indices Composite Entropy Index was better su ted measure the crop diversification

## 2 6 Quantifying agricultural development

### 2 6 1 Taxonomic Approach

To capture the agricultural development of a reg on t is necessar prepare a composite index by us ng all the factors respons ble for agr cult development of that region (Rao 1987)

Naram *et al* (1991) prepared a composite index us ng 14 soc o econc var ables to measure the socio econom c development of different states of Ir They also examined the statistical significance of changes of development nd over time by using the slippage test proposed by Ra (1987)

Datta and Ja n (1994) made use of Iyengar and Sudarshan s metho form a compos te index to study the interstate variations in rural developmer India They op ned that the states at higher levels of develop nent were n d vergent than states at lower levels of development

### 2 6 2 Principal Component Analysis

Most of the characteristics in agriculture are highly correlated Hc Pr ncipal Component Analys s in which the components are ndependent of c other and handy to have a comprehens ve study of all the characters can be u n present study

According to Kendall (1957) and Seal (1964) Princ pal Compo Analysis could be used to extract the cruc al factors from several variable reduce the dimensionality

Different researchers used Pr nc pal Component Analys s n agr cult experiments Mahajan *et al* (1981) made use of this analysis to f nd the cr factors responsible for late maturing r ce A similar study was conducted Aswa (1981) for chickpea

Rao (1983) used Principal Component Analysis to measure inter d sparities of development in India and found a very close relationsh p bet infrastructure and econom c development She also established that va components of infrastructure such as banking power transport and educ were closely and positively correlated with each other on the one hand and agr cultural and industrial development on the other

Nara n *et al* (1991) extracted crucial factors by us ng Pr n Co nponent Analysis for d fferent per ods for soc o econom c developme d fferent states of Ind a They identified factors like average da ly employ for factory workers per capita industrial income consumption of electr l teracy percentage total road length fertilizer consumpt on as important fa contributing most to the composite index of socio economic development

# MATERIALS AND METHOD

## MATERIALS AND METHODS

In the present study mainly secondary data were used Descr pt ons data along with the methodology adopted for the analysis are presented i chapter

The state of Kerala was formed in 1956 with eight districts But now are 14 d stricts viz Tr vandrum Kollam Pathanamthittta Allapuzha Kotta Idukki Ernakulam Thrissur Palakkad Malappuram Kozhikode Way Kannur and Kasargode These distr cts were formed at d fferent po nts of t m

Information on var ous aspects of agriculture n Kerala is ava d strictwise But the geographical area of various distr cts had undergone a change due to formation of new d stricts on var ous occas ons Hence the st d v ded into e ght reg ons for the conven ence of comp lation of t me series These reg ons comprise of Trivandrum (I) (Kolla n+ Pathanamth Allapuzha) (II) (Kottayam+ Idukki+ Ernakulam) (III) Thrissur (IV) Pala (V) Malappuram (VI) (Kozhikode + Wayanad) (VII) and (Kannur+Kasarg (VIII) However comparison was attempted both region wise and district wis the recent periods

For the convenience of study the regions can be named as F rst re Second region Th rd region Fourth reg on Fifth region S xth reg on Sev region and E ghth region

The d str ct wise data on acreage and product on of rice tap oca cas rubber coconut pepper and banana agr cultural income per hectare crop intensity agr cultural credit per hectare ra nfall fert lizer consumption hectare size of holdings and number of agricultural workers per hectare fo period from 1985 86 to 1997 98 were used for the study

The region wise comparisons were carried out for the per od from 1 71 to 1997 98 with an nterval of f ve years ncludng the per od 1997 98 l were collected from State Plann ng Board Tr vandrum and Directorate Economics and Stat st cs Government of Kerala Tr vandrum

## 3 1 Crop diversification and temporal disparities

I ar n d versilic t o nvolves tra sformation of a farm enterpr se to d verse farm enterprises ncludng da ry poultry sericulture p sc culture which assume critical mportance n supplement ng the farm ncome

Divers fication for the purpose of the present nvestigation is conf ne crop diversif cation only because the rural economy is bas cally cons dered t crop economy The level of d versification of crop enterprises reflects the ex of econom c development in the rural sector

To measure crop d versificat on the followng quantitative ndicators constructed for the var ous distr cts or regions at different t me per ods

3 1 1 Herfindahl Index
3 1 2 Entropy Index
3 1 3 Modified Entropy Index
3 1 4 Composite Entropy Index
3 1 5 Ogive Index

These quant tat ve ind cators were constructed usng the total cropp area of major crops of Kerala The major crops taken for study were r ce tap o cashew rubber coconut pepper and banana which contribute around 80 per c of total cropped area of the state The procedures of estimat on of var c quant tat ve indicators are given below

### 3 1 1 Herfindahl ındex (H I )

Th s can be expressed as H I $\sum^{N} P^{2}$

where N– Total number of crops

P Proport on of area under ı$^{h}$ crop to the total cropped area

W th ıncrease ın dıvers ficat on the H I would decrease Th s ndex t a value of one when there s complete spec al sat on and approacl es zero gets large ı e when dıversıf cation s perfect Thus the range of H I s betv zero and one However the major l mıtat on of the ndex ıs that t cannot a the hypothet cal mın mum value of zero for smaller values of N Sınce the H a measure of concentratıon ıt was transformed by subtractıng ıt from one H I The transformed value of H I would avoıd confus on to compare ıt other ndıces

### 3 1 2 Entropy Index (E I )

Entropy Index ıs regarded as an ınverse measure of concentrat on ha logarıthmıc character Thıs ındex has been wıdely used by many rese workers to measure dıvers f catıon (e g Hackbart and Anderson 1978 Gupta Tewarı 1985 Sıngh *et al* 1985)

Entropy Index ıs specıfied as

$$E I \quad \sum^{N} P \log P$$

$$\sum^{N} P \log\left(\frac{1}{P}\right)$$

where P Proportıon of area under ı$^{th}$ crop to the total cropped area

Thıs ındex would ıncrease w th ncrease ın dıvers f cat on an approaches zero when there ıs perfect concentratıon ı e when P equals one

some ı The upper bound of the ındex s log N However the upper l Entropy Index ıs determ ned by the base chosen for takıng logarıthms an number of crops The upper value of the ındex can exceed one when thc number of crops ıs hıgher than the value of the base of logar thm and t c less than one when the number of crops ıs lower than the base of the loga Thus the major l m tat on of Entropy Index ıs that ıt does not g ve a sta scale for assessıng the degree of d versıfıcatıon

### 3 1 3 Modıfied Entropy Index (M E I )

Modıf ed Entropy Index s used to overcome the lımıtat on of En Index by usıng varıable base of logarıthm nstead of fixed base of logarıth was computed as

$$MEI \quad \sum^{N}(P \log_{N} P)$$

The M E I however s equal to E I /log N

It ıs ımportant to note that the base of logar thm was shıfted to N number of crops) Thıs ındex has a lower l mıt equal to zero when the complete concentratıon and ıt assumes upper lımıt of one ın case of p dispersıon ı e ıts range ıs zero to one Max mum M E I ıs when Pı appro I/N

$$\sum^{N}\frac{1}{N}\log_{N} N \quad \sum^{N}\frac{1}{N} \quad 1$$

Thıs ındex ıs therefore quıte useful as compared to the Entropy I whıch does not have a fixed upper value However ıts lım tat on ıs th measures the devıatıons from equal dıstrıbutıon among exıstıng act vıtıes number of crops only and does not ncorporate the number of act v t es

This index measures the diversification given the number of crops and the
is not sensitive to change n the number of crops

**3 1 4 Ogive Index (O I)**

Ogive Index was calculated by the formula

$$O I \quad \frac{\sum^{N}\left(P \ \left(1/N\right)\right)^{2}}{1/N}$$

Like H I the Ogive Index is also a measure of concentration Her
was transformed as 1 O I The limitation of this index is that the upper b
tends to zero in case of perfect concentration

**3 1 5 Composite Entropy Index (C E I )**

This index possess all the desirable propert es of Modified Entropy I
and can be used to compare diversificat on across situat ons hav ng differen
large number of activities since it gives due weightage to number of act v
(Shiyani and Pandya 1998)

C E I is calculated by

$$C E I \quad \left(\sum^{N} P \log_{N} P\right) \times \left(1-\left(\frac{1}{N}\right)\right)$$

$$i e \ C E I \quad (\text{Modified E I}) \times \left(1 \ \left(\frac{1}{N}\right)\right)$$

The C E I depends upon two components viz distribution and numb
crops or diversity The value of composite Entropy Index is inve
proportional to the concentration and directly proportional to the number of c

or act vit es Both the components have range between zero and one and thu range of C E I is n between zero and one

Since the index used $\log_N P$ as weights t ass gned more we ght to l proportion and less weight to higher proportion

### 3 2 Compound growth rates of different crops for each district or reg

The trends of crop acreage as well as crop production were obta ne f tt ng four models

3 2 1 Lin lin model $Y = A+Bt$

3 2 2 Lin log model $Y = Y^{-} A+B\log t$

3 2 3 Log l n model $\log Y = A+Bt$

3 2 4 Log log model or exponent al model $Y = AB$

The exponential model fitted for calculating the compound growth rate s

$$Y = A B e^{\theta}$$

where Y= annual crop production or crop acreage

t time in years

$\theta$ – Random error components

A B are constants

Tak ng logarithm on both sides

$$\text{Log}_e Y = \log_e A + t \log_e B + \theta$$

$$Y' = A + B\ t + \theta$$

where $Y = \log_e Y$

$A = \log_e A$

$B = \log_e B$

Three year mov ng averages (of e ther yield or acreage) were take smoothen the uneven nature of the data The curves were fitted to these data the parameters were est mated by least square method Compound gro vtl

of acreage and production through exponential model were calculated by u
the formula

$(e^{B} \quad 1) \times 100$

**3 3 Construction of productivity index**

By us ng different nd ces the total crop d vers f cat on was comp among the distr cts or regions but the indiv dual crop nstab l ty among d str cts or reg ons over the per ods can be measured by us ng coeff c en variation wh ch can be expressed by

$$C V \quad \left(\frac{\sigma}{\mu}\right) \times 100$$

Higher the C V more s the d vergence

As compar son of crop diversifcation among districts or regions is sole objective find ng the C V for individual crop will not solve the problem

In order to make inter distr ct or inter region comparison a compo productivity index was calculated for each district and each region separat tak ng into cons derat on the type of crops and the r relat ve importance n c d str ct or region

The Compos te Prod ct vity Index (C P I ) was calculated for each d s or reg on at a particular point of t me by us ng the formula

$$C P I \quad \sum \frac{Y_d}{Y} \frac{a_d}{\sum a_d} \times 100$$

where $Y_d$ Yield of $i^{h}$ crop n the $d^{h}$ d strict

Yis Y eld of $i^{h}$ crop in the state

$\frac{a_{id}}{\sum a_d} \times 100$ Percentage area under the $i^{th}$ crop n the $d^{th}$ d strict

S nce the Compos te Product vity Index s an aggregate of produc performance of ndıvidual crops t ıs ı nportant to f nd the Crop Y eld Ind each crop for each dıstrıct or regıon over the per ods Crop y eld ndex estımated by

$$C_d \quad \frac{Y_d}{Y} \times 100$$

where $C_d$ ıs the crop yield ındex of ıth crop ın the dth dıstr ct

$Y_d$ ıs the average y eld of ıth crop ın dth dıstrıct

$Y$ – ıs the average yıeld of ıth crop ın the state

### 3 4 Construction of Composite Index or Development Index

The development of agrıculture depends upon many factors So erroneous and meanıngless to compute a sıngle ndex and compare development of agrıculture spatıally and temporally Hence there s a need bu ld ng a composıte ındex of development based on varıo ıs varıables whıch dırectly lınked wıth the development of agrıculture

For thıs purpose three methods were used

3 4 1 Taxonomıc approach

3 4 2 Modıfied Taxonomıc approach

3 4 3 Prıncıpal Component Analysıs

As stated above all the methods were used both for dıstrıct w se as wel for regıon wıse comparıson of development of agrıculture

#### 3 4 1 Taxonomıc approach

In th s approach the ındex developed by Naraın *et al* (1991) was us The dıstrıcts or reg ons were consıdered as the unıts of analysıs All the ımport varıables affectıng the development of agrıculture were utılısed

The data on mportant variables were collected from different publicatic of Economic Review and Stat stics for Planning published by the Govern nent Kerala

The important variables dentified were agr cultural income per hecta cropping intensity agricultural credit per hectare rainfall in m ll metre fertili consumption in Kg per hectare number of agricultural workers per hectare a s zc of hold ngs

The procedure of construction of development ndices can be descril briefly as follows

The three year moving averages of each identified variable were taken analysis This averaging was done to smoothen the uneven nature of data that h arisen possibly due to different methods of estimation in the state over the per c (or any other fluctuation)

Let $X_j$ be the observation on $j^{th}$ indicator variable in $i^{th}$ district or reg after smoothening by moving average

Where i– 1 2 n

j 1 2 k

As the development indicators included in the analysis are in differ units of measurement and since our objective is to arrive at a s ngle compo ndex t is essential to standardise the indicators So the standardised score for indicator or variable for the district or region can be given as

$$Z \quad \frac{X \ \bar{X}}{s}$$

where $s^2 \quad \sum \frac{(X \ X)^2}{n}$

$$X \quad \sum \frac{X}{n}$$

The best d str ct for each nd cator (w th max mum m n m standardised value depending upon the direction of the ind cator) s identif ed

C the pattern of development for the $i^{th}$ district or reg on was obta ned a

$$C \quad \left\{ \sum^{k} (Z \quad Z)^2 \right\}^{1/2}$$

where Z standard sed score of $j^{h}$ ind cator of $i^{th}$ distr ct or reg on and $Z_o$ standardised score of the $j^{th}$ ndicator of the best d str ct

The pattern of development is useful n dent fying the d str cts wl serve as model and it also helps n f xing the potential target of each indicator a given d str ct

The compos te index of development for district or region was obta ned

$$D \quad C/C$$

where $C = C + 2s$

$$C \quad \sum^{n} C/n \quad \text{and}$$

$$s \quad \left\{ \sum^{n} \frac{(C \quad \bar{C})^2}{n} \right\}$$

The value of the Composite Index s non negative and it lies between z and one The value of the index closer to zero indicates higher level

development while the value of the index closer to one indicates the lower l of development

With the help of standardised variables the distance between $^{h}$ and districts or regions was calculated using the formula

$$D_p \left\{\sum^{k}(Z \quad Z_p)^2\right\}^{\wedge}$$

ı – 1 2 n

p – 1 2 n

Here D = 0 $D_p - D_p$

The distance can be represented as $(D)_{n\times n}$

The minimum distance for $ı^{h}$ row say dı where ı 1 2 n was obtained from distance matrix for computation of upper and lower lim ts (C D ) as follows

C D d + $2\sigma_d$

where d $\sum^{n} d/n$

$$\sigma_d - \frac{\left\{\sum^{n}(d \quad d)^2\right\}}{n}$$

The distance matrix was used for fixing targets for different districts regions on each indicator For setting out the targets for example for district reg on A the model district or region is to be identified on the basis of compos index of development Districts having composite index lower than that of distr A and its distance with district A not exceeding the upper limit of C D wou serve as model districts for district A on all the indicators considered in tl analysis Similarly the potential targets for regions also can be calculate Thereafter the arithmetic mean of the original value of the indicator of mod

districts or regions w ll be computed The mean valt e so computed was refc to as potential target for d str ct or reg on A for the g ven ind cator procedure will be repeated for a given district or region for all ind c considered

After obta n ng the ieasure of development index (compos te index each distr ct or region over d fferent time periods the stat stical s gn ficanc changes in development of different districts or regions over d fferent per ods was examined

For compar ng reg onal development three comparisons were take account A comparison was made between 1970 71 and 1985 86 Anc comparison was made between 1985 86 and 1995 96 F nally a compar son made for different regions for the overall periods from 1970 71 to 1995 96

A similar study was also conducted for different districts for a pe from 1985 86 to 1995 96 owing to the limitation of available data

Slippage test was carried out to test the s gnificance of change n lev development of agriculture over different periods The development ind ces f all the time periods were ranked The smallest score was g ven the rank one next smallest two and for the largest the rank N where N the total numbe ndependent observations in all the time periods e 1 2 t

Let $R_i$ denote the si m of the ranks of the $i^{h}$ per od for all the distric regions and the test statistic is given by

$$M \quad \frac{12}{Nt(t+1)}\sum R_i^2 \quad 3N(t+1)$$

which is distributed as $\chi^2$ statistic with (t-1) d.f. The test statistic used to test the null hypothesis that there was no change in the development districts or regions over time.

### 3.4.2 Modification of Taxonomic approach

In the taxonomic approach development indices were computed taking the districts or regions and the seven variables as the units of analysis. While finding the pattern of development all the seven variables were standardised to make them unit free. The square root of sum of squared deviations from the maximum value gives the pattern of development. The basic assumption of this procedure is that all the variables have equal importance. But practically the fact is that the variables are not of same importance with respect to development.

To overcome this problem a panel of experts comprising scientists from College of Horticulture and College of Co-operation Banking and Management were requested to score for the variables contributing to the development of agriculture in Kerala viz.

1. Agricultural income per hectare
2. Cropping intensity
3. Number of agricultural workers per hectare
4. Agricultural credit per hectare
5. Rainfall
6. Fertilizer consumption per hectare
7. Size of holdings

The computation is similar to the taxonomic approach except that weighted average of squared deviations, weights being the average score given by the expert panel was used instead of the simple average. In short the pattern of development in $i^{th}$ district is given by

$$C(m) \left( \frac{\sum^{k} W(Z \quad Z_o)^2}{\sum^{k} W} \right)^{1/2}$$

where $Z_j$ standardised value of $j^{th}$ variable for $i^{th}$ district or region

$Z_o$ standardised value of the $j^{th}$ variable of the best developed district or region

W Average score given by the panel for the $j^{th}$ variable

The development indices were calculated with the help of the Taxonomic method described previously but using the weighted average

$$i.e \quad D_{(m)} \quad \frac{C(m)}{C(m)}$$

$$C_m \quad \overline{C_m} + 2s$$

where $\overline{C_m} - \sum^{n} \frac{C(m)}{n}$

$$s \quad \sum^{n} \frac{(C(m) \quad \overline{C}(m))^2}{n}$$

The value of this index also varies from zero to one and the interpretation is similar to that of taxonomic approach

### 3 4 3 Principal Component Analysis

When we consider multivariate data it is not uncommon to discover that at least some of the variables are correlated with each other One implication these correlations is that there will be some redundancy in the information provided by these variables

As in the case of agriculture the data are highly correlated this technique useful to

a Pick out patterns (relationship) in the variables

b Reduce dimensional ty of the data without a signif cant los information

In the present study pr ncipal component technique is used to cons the development index for both d strict w se as well as for region comparison

Hence distr ct wise or region wise data for all the var ables over al periods were taken for analysis The components were extracted with the hel variance covariance matr x

In the present nvestigation the first principal component tself capable of explaining almost all variation expressed by the variables cons de Hence the development indices were developed using the single componen other words the f rst principal component scores were used as the develop ndices

# RESULTS

The results of the study on Spatial and temporal variations in the gro vtl of agriculture in Kerala have been presented under different sub head ngs

## 4 1 Spatio temporal crop diversification indices

The approach adopted in this study is to utilise a variety of measure crop diversification to study the diversification level of a particular area i particular period Five measures of crop diversification were used for dist wise as well as region wise studies For the district wise study four per ods w taken nto cons deration whereas for reg on w se seven periods were us Var ous crop diversification indices worked out as per the methods descr bed chapter III are presented n Table 1a

### 4 1 1 District wise crop diversification

#### 4 1 1 1 Herfindahl Index

It may be observed that transformed values of Herfindahl Ind ces w max mum n the initial years for almost all districts except for Ernakulı Thrissur and Palakkad In Wayanad and Kozhikode the indices had high valı in all the per ods The value varied from 0 94 to 0 95 n Wayanad d strict vhere t ranged from 0 93 to 0 95 in Idukk distr ct The transformed Herf ndahl Indic of Trivandrum Pathanamthitta Allapuzha Kottayam Malappuram and Kann distr cts were in decreas ng trend whereas it was increasing n Ernakula Thrissur Palakkad and Kozh kode But the rest of the districts showed a const value through out the period Idukki d strict had a max mum value of 0 95 1985 86 but after that Wayanad showed the maximum value for all the oth periods

Table 1a Distr ct wise crop diversification ndices

| Ind cs | 1985 86 | 19 0 91 | 995-96 | 97 98 | I |
|---|---|---|---|---|---|
| | 0 8 | 0 78 | 0 76 | 0 7 | |
| | 0 62 | 0 60 | 0 59 | 0 59 | |
| M L | 0 4 | 0 7 | 0 70 | 0 69 | |
| C E | 0 63 | 0 6 | 0 60 | 0 59 | |
| O | 0 36 | 0 6 | 0 02 | 0 0 | |
| | 0 83 | 0 82 | 0 8 | 0 82 | |
| E | 0 67 | 0 65 | 0 64 | 0 64 | K |
| M E | 0 79 | 0 77 | 0 75 | 0 6 | |
| C I | 0 68 | 0 66 | 0 64 | 0 65 | |
| O | 0 53 | 0 43 | 0 36 | 0 4 | |
| | 0 84 | 0 8 | 0 78 | 0 77 | |
| E | 0 66 | 0 63 | 0 60 | 0 58 | |
| M I | 0 78 | 0 75 | 0 70 | 0 68 | |
| C | 0 6 | 0 64 | 0 60 | 0 58 | |
| O | 0 56 | 0 38 | 0 5 | 0 06 | |
| | 0 7 | 0 73 | 0 73 | 0 73 | |
| E | 0 54 | 0 5 | 0 53 | 0 5 | |
| M E I | 0 64 | 0 6 | 0 62 | 0 6 | |
| C E | 0 55 | 0 52 | 0 53 | 0 52 | |
| O I | 0 02 | -0 20 | -0 17 | 0 44 | |
| H I | 0 8 | 0 75 | 0 7 | 0 69 | |
| E | 0 62 | 0 58 | 0 54 | 0 5 | K |
| M | 0 3 | 0 68 | 0 6 | 0 6 | |
| C E | 0 63 | 0 58 | 0 55 | 0 52 | |
| O | 0 35 | -0 03 | -0 28 | 0 43 | |
| H | 0 95 | 0 93 | 0 93 | 0 93 | |
| E | 0 48 | 0 47 | 0 47 | 0 47 | |
| M E I | 0 57 | 0 56 | 0 55 | 0 56 | |
| C E I | 0 49 | 0 48 | 0 47 | 0 48 | |
| O I | 0 59 | 0 52 | 0 50 | 0 50 | |
| H | 0 80 | 0 80 | 0 80 | 0 8 | |
| E | 0 60 | 0 60 | 0 60 | 0 59 | D |
| M E | 0 70 | 0 7 | 0 70 | 0 70 | |
| C E | 0 60 | 0 6 | 0 60 | 0 60 | |
| O | 0 27 | 0 32 | 0 3 | 0 34 | |
| H | 0 73 | 0 74 | 0 75 | 0 | |
| E I | 0 53 | 0 53 | 0 53 | 0 54 | T |
| M E | 0 63 | 0 62 | 0 63 | 0 64 | |
| C E I | 0 54 | 0 53 | 0 54 | 0 55 | |
| O I | -0 8 | -0 5 | -0 06 | 0 0 | |
| H | 0 73 | 0 80 | 0 83 | 0 84 | |
| E | 0 44 | 0 49 | 0 49 | 0 50 | P |
| M E I | 0 53 | 0 57 | 0 58 | 0 59 | |
| C E | 0 45 | 0 49 | 0 49 | 0 5 | |
| O | 0 4 | -0 03 | 0 4 | 0 23 | |
| H | 0 83 | 0 8 | 0 8 | 0 8 | |
| E | 0 63 | 0 59 | 0 58 | 0 57 | ML |
| M E I | 0 75 | 0 70 | 0 68 | 0 68 | |
| C E | 0 64 | 0 60 | 0 58 | 0 58 | |
| O | 0 45 | 0 27 | 0 20 | 0 20 | |
| H | 0 68 | 0 67 | 0 68 | 0 68 | |
| E | 0 50 | 0 45 | 0 44 | 0 44 | Kk |
| M E I | 0 59 | 0 53 | 0 52 | 0 59 | |
| C E I | 0 50 | 0 46 | 0 45 | 0 44 | |
| O | 0 55 | -0 73 | -0 68 | 0 70 | |
| H | 0 94 | 0 95 | 0 94 | 0 95 | |
| E | 0 40 | 0 40 | 0 4 | 0 42 | WY |
| M E | 0 50 | 0 47 | 0 49 | 0 50 | |
| C E I | 0 40 | 0 40 | 0 42 | 0 43 | |
| O | 0 40 | 0 45 | 0 42 | 0 4 | |
| H I | 0 85 | 0 83 | 0 83 | 0 84 | |
| E | 0 70 | 0 63 | 0 6 | 0 59 | KN |
| M E I | 0 79 | 0 75 | 0 72 | 0 70 | |
| C E I | 0 68 | 0 64 | 0 62 | 0 60 | |
| O | 0 60 | 0 43 | 0 39 | 0 37 | |
| H | 0 8 | 0 84 | 0 89 | 0 8 | |
| E | 0 72 | 0 63 | 0 58 | 0 59 | KSC |
| M E | 0 85 | 0 75 | 0 69 | 0 69 | |
| C E | 0 73 | 0 64 | 0 59 | 0 59 | |
| O I | 0 56 | 0 49 | 0 57 | 0 25 | |

### 4 1 1 2 Entropy Index

Like the transformed values of Herfindahl Index Entropy Indices v also max mum in the initial periods except for Ernakulam region But un Herf ndahl Index values of Entropy Index were smaller These values v constant over the per ods for Kollam Allapuzha Idukki Ernakulam Thr and Wayanad d str cts whereas it was highly fluctuating in Pathanamth Kollam Palakkad Malappuram Kozhikode Kannur and Kasargode districts

### 4 1 1 2 Modified Entropy Index

In Entropy Index the major lim tation is that t does not g ve a stanc scale for assessing the degree of diversification Somet mes the value can be than one So to over come this limitation Modified Entropy Index is used values of all the districts were computed over various periods and are g ve Table 1a

It showed that like the other two indices except for Ernakulam Thris Palakkad and Kozhikode these values were greater n the nitial periods these were decreasing for most of the districts

In the first period 1985 86 Kasargode showed the maximum value of 0 followed by Kannur and Kollam districts each with a value of 0 79

The value of this ndex for most of the d str cts during 1990 91 w decreased but the change was more in Kasargode and the index value ran from 0 69 to 0 85 The maximum diversification occurred in Kollam d st during the same period

In the following period 1995 96 Kollam d str ct was the most divers f district in agriculture whereas the diversification level or the value of this n of Kasargode decreased from the n t al high values or high diversificat on leve

### 4 1 1 3 Composite Entropy Index

In Modified Entropy Index number of crops does not have any importance so to avoid that drawback Composite Entropy Index was computed for each district over different periods

It can be observed that like other indices these indices decreased for the districts as time progressed

Except in the first period all the other periods showed a consistency diversification level among the districts The index value was more in Kasargod during 1985 86 For other periods Kollam had the highest level of diversification The index values of Kollam district were 0 64 and 0 68 during 1995 96 and 1991 respectively Whereas in Wayanad crops were more concentrated with Composite Entropy Index varying from 0 40 to 0 43 It also showed that Allapuzha district the index was highly fluctuating through out the period

### 4 1 1 4 Ogive Index

As the Ogive Index approaches zero in extreme cases of perfect concentration as well as perfect diversification this index is not reliable to interpret the diversification level Index values of all the districts over the periods are given in Table 1a

### 4 1 2 Region wise Crop Diversification

The diversification level of all regions was also computed using the above said indices which are given in Table 1b

Table 1b Region wise crop diversification indices

| Indices | 1970 71 | 1980 81 | 1985 86 | 1990 91 | 1995 96 | 1997 98 | R |
|---|---|---|---|---|---|---|---|
| 1 H I | 0 79 | 0 81 | 0 81 | 0 78 | 0 76 | 0 76 | |
| E I | 0 61 | 0 61 | 0 62 | 0 60 | 0 59 | 0 59 | I |
| M E I | 0 71 | 0 71 | 0 73 | 0 71 | 0 70 | 0 69 | |
| C E I | 0 61 | 0 61 | 0 62 | 0 61 | 0 59 | 0 59 | |
| 1 O I | 0 26 | 0 33 | 0 36 | 0 16 | 0 02 | 0 01 | |
| 1 H I | 0 81 | 0 82 | 0 83 | 0 82 | 0 81 | 0 82 | |
| E I | 0 61 | 0 64 | 0 65 | 0 64 | 0 64 | 0 64 | SE |
| M E I | 0 71 | 0 75 | 0 77 | 0 75 | 0 75 | 0 75 | |
| C E I | 0 61 | 0 64 | 0 66 | 0 65 | 0 64 | 0 65 | |
| 1 O I | 0 35 | 0 45 | 0 51 | 0 44 | 0 39 | 0 43 | |
| 1 H I | 0 88 | 0 88 | 0 88 | 0 85 | 0 86 | 0 86 | |
| E I | 0 59 | 0 61 | 0 61 | 0 60 | 0 59 | 0 58 | T |
| M E I | 0 70 | 0 71 | 0 72 | 0 71 | 0 69 | 0 69 | |
| C E I | 0 60 | 0 61 | 0 62 | 0 61 | 0 59 | 0 59 | |
| 1 O I | 0 58 | 0 61 | 0 60 | 0 47 | 0 47 | 0 47 | |
| 1 H I | 0 73 | 0 71 | 0 73 | 0 74 | 0 75 | 0 77 | |
| E I | 0 49 | 0 51 | 0 53 | 0 53 | 0 53 | 0 54 | FO |
| M E I | 0 57 | 0 60 | 0 62 | 0 61 | 0 63 | 0 63 | |
| C E I | 0 49 | 0 51 | 0 53 | 0 53 | 0 54 | 0 54 | |
| 1 O I | 0 28 | 0 46 | 0 31 | 0 18 | 0 15 | 0 00 | |
| 1 H I | 0 69 | 0 69 | 0 73 | 0 80 | 0 83 | 0 84 | |
| E I | 0 37 | 0 41 | 0 44 | 0 49 | 0 49 | 0 50 | F |
| M E I | 0 43 | 0 48 | 0 52 | 0 57 | 0 57 | 0 59 | |
| C E I | 0 37 | 0 41 | 0 44 | 0 49 | 0 49 | 0 50 | |
| 1 O I | 0 75 | 0 66 | 0 41 | 0 03 | 0 13 | 0 23 | |
| 1 H I | 0 79 | 0 83 | 0 83 | 0 81 | 0 81 | 0 81 | |
| E I | 0 58 | 0 62 | 0 63 | 0 59 | 0 58 | 0 57 | SI |
| M E I | 0 67 | 0 72 | 0 73 | 0 69 | 0 67 | 0 67 | |
| C E I | 0 58 | 0 62 | 0 63 | 0 59 | 0 57 | 0 57 | |
| 1 O I | 0 18 | 0 41 | 0 45 | 0 27 | 0 20 | 0 20 | |
| 1 H I | 0 81 | 0 85 | 0 86 | 0 86 | 0 88 | 0 88 | |
| E I | 0 59 | 0 55 | 0 52 | 0 50 | 0 50 | 0 50 | SEV |
| M E I | 0 69 | 0 64 | 0 61 | 0 58 | 0 59 | 0 59 | |
| C E I | 0 60 | 0 55 | 0 53 | 0 50 | 0 51 | 0 50 | |
| 1 O I | 0 30 | 0 34 | 0 32 | 0 29 | 0 36 | 0 34 | |
| 1 H I | 0 83 | 0 88 | 0 84 | 0 84 | 0 86 | 0 83 | |
| E I | 0 66 | 0 65 | 0 69 | 0 64 | 0 61 | 0 60 | EI |
| M E I | 0 76 | 0 75 | 0 79 | 0 73 | 0 70 | 0 69 | |
| C E I | 0 65 | 0 64 | 0 68 | 0 63 | 0 60 | 0 59 | |
| 1 O I | 0 51 | 0 62 | 0 69 | 0 60 | 0 47 | 0 35 | |

### 4 1 2 1 Herfindahl Index

Unl ke d fferent d str cts the transformed values of Herf ndahl I d ces d fferent regions were maximum in the m ddle periods i e dur ng 1980 81 1985 86 for all the regions except fourth fifth and seventh reg ons where val es were max num d ring the last two periods These values were nax n in th rd region for all the per ods In the beginning period this reg on w t transformed value of 0 88 had the highest d versif cation level followed by eig reg on w th 0 83 In the sa ne period fourth region and fifth reg on showed n i imum index of 0 73 and 0 69 respectively

During 1980 81 except fourth f fth and sixth reg ons most of the reg showed high transformed index value whereas in the following period only fou and fifth regions expressed low transformed index Similarly for period w studies except fourth fifth and sixth regions other regions showed a consist value over the periods But for the above said three regions the diversif cation crops was maximum in the last period

### 4 1 2 1 Entropy Index

The Entropy Index indicated that n the first region this value varied fr 0 59 to 0 61 over the period It can be concluded that the diversificat on le over the period was constant for all the periods In case of fifth region th s va ranged from 0 37 in the initial period to 0 50 in the last period Hence d versification level over the period increased for fifth reg on

Similarly for reg ons like third sixth seventh and eighth divers fication level over the per od decreased

### 4 1 2 2 Modified Entropy Index

The value of Modified Entropy Index indicated that it was as expres as the other two indices Except for fifth region most of the regions over periods showed a constant index Irrespective of periods the diversification le were maximum in second region and eighth region

In eighth region the lowest value was 0 69 in 1997 98 and the h g value was 0 79 in 1985 86 In fifth region the value increased from 0 43 to over the six periods It can be concluded that in fifth region the diversifica level increased over the periods It is also noticed that the index for second re was almost constant from 1980 81 to 1997 98

### 4 1 2 3 Composite Entropy Index

In the initial period the value of Composite Entropy Index was hig eighth region followed by second region and first region After the first per second region had the maximum value for all the other periods For sec region the value ranged from 0 61 in 1970 71 to 0 66 in 1985 86 The value fourth region and fifth region over all the periods were less compared to o regions

However it may be noted that in the last period the indices were almo the same order for all regions except for second region

### 4 1 2 4 Ogive Index

As it is mentioned for district wise analysis the value of th s n approaches zero for both the extreme cases i e perfect concentration as wel perfect diversification So we can avoid this index for interpreting the result the computed Ogive Indices for various regions are given in Table 1b

## 4 2 Performance of different models for prediction of acreage production of crops

To analyse the trend of acreage and production of different crop seven major crops of Kerala following four different models were used compared

( ) L near model Y= A+Bt
(ii) L n log model Y A+Blog t
( ı ) Log lin model logY A+Bt
(iv) Exponent al model Y= AB

The funct onal form having the highest coefficient of determination was selected for fitting the trend

The different crops taken for analys s were rice tapioca pepper cash rubber coconut and banana The methodology used is discussed n chapter II

After finding the trend for the per od from 1970 71 to 1997 98 compound growth rates (C G R ) for acreage and production for all the se crops were computed by using the formula ($e^B$ 1)×100 and are given n Table

## 4 3 Crop wise performances of different models

### 4 3 1 Rice

For this crop as Table 2 shows $R^2$ value for production varies from 0 n l n log form to 0 19 in log lin form So it can be sa d that the best fit model the t me series model was the log l n form with predictab lity of 19 per cent for acreage the $R^2$ value was maximum with a value 0 68 in l near form C G R (Table 3) of both product on and acreage were 2 62 per cent and 13 per cent respectively

Table 2 Coefficient of determination for various models for different crops

| Crop | Model | $R^2$ | |
|---|---|---|---|
| | | Production | Acreage |
| Rice | L near | 0 18 ** | 0 68 ** |
| | Lin log | 0 01 | 0 31 ** |
| | Log lin | 0 19 ** | 0 67 ** |
| | Log log | 0 02 | 0 32 ** |
| Tapioca | Linear | 0 06 | 0 50 ** |
| | I in log | 0 01 | 0 20 ** |
| | Log I n | 0 05 | 0 50 ** |
| | Log log | 0 01 | 0 24 ** |
| Rubber | Linear | 0 85 ** | 0 93 ** |
| | L n log | 0 57 ** | 0 66 ** |
| | Log lin | 0 96 ** | 0 97 ** |
| | Log log | 0 90 ** | 0 78 ** |
| Cashew | Linear | 0 18 ** | 0 27 ** |
| | Lin log | 0 05 | 0 51 ** |
| | Log lin | 0 20 ** | 0 30 ** |
| | Log log | 0 06 | 0 60 ** |
| Coconut | L near | 0 39 ** | 0 77 ** |
| | Lin log | 0 22 ** | 0 71 ** |
| | Log I n | 0 34 ** | 0 77 ** |
| | Log log | 0 19 ** | 0 76 ** |
| Pepper | Linear | 0 64 ** | 0 72 ** |
| | Lin log | 0 35 ** | 0 45 ** |
| | Log lin | 0 65 ** | 0 74 * |
| | Log log | 0 36 ** | 0 48 ** |
| Banana | Linear | 0 45 ** | 0 52 ** |
| | Lin log | 0 26 ** | 0 39 ** |
| | Log lin | 0 45 ** | 0 58 ** |
| | Log log | 0 27 ** | 0 45 ** |

** significance at 1 % level

### 4 3 2 Tapioca

Like r ce th s food crop also showed very less $R^2$ value n all funct onal forms $R^2$ for production ranged between 0 01 and 0 06 (Table 2) T computed C G R of production was 5 10 whereas C G R for acreage v 16 23 wh ch implies that both acreage and product on of tap oca decrea during the same per od Log l n model for acreage had $R^2$ value of 0 56

### 4 3 3 Rubber

This was the crop among all the crops taken into consideration that l maximum growth The C G R of production and acreage were 183 06 and 54 respectively during the per od under report Of all the functional forms $R^2$ production was max mum in log lin model (0 96) followed by exponent al mo (0 90) The value of $R^2$ (0 97) was also max mum in log lin form for acrea followed by linear form (0 93) (Table 2)

### 4 3 3 Cashew

C G R for acreage under casl ew was 23 77 But C G R of produc was only –4 94 per cent Log lin model had maximum $R^2$ value for product and exponential model for acreage (Table 2)

### 4 3 4 Coconut

L near model for product on d d have a $R^2$ value of 0 39 while all o had almost same level of $R^2$ for acreage (0 71 to 0 77) C G R for p o ct on a acreage were 10 48 and 17 94 respectively

### 4 3 5 Pepper

Like other cash crops this crop also showed a high C G R for bo product on and acreage From the Table 2 it can be observed that for product the $R^2$ value were 0 64 and 0 65 for linear and log lin form respect vely where for acreage linear and log linear model showed a value of 0 72 and 0 respect vely (Table 2)

### 4 3 6 Banana

For banana production linear as well as log lin form gave a $R^2$ value 0 45 whereas the other two functional forms had $R^2$ of 0 26 and 0 27 The C G of production was 14 90 Similarly for acreage the first two models showed $R^2$ 0 52 and 0 58 respectively and the second two models gave the $R^2$ as 0 39 a 0 45 (Table 2) Mean while the value of C G R for acreage was 16 04

Table 3 Compound growth rate of production and acreage for different crops

| | C G R | |
|---|---|---|
| Crop | Production | Acreage |
| Rice | 2 62 | 13 76 |
| Tapioca | 5 10 | 16 23 |
| Rubber | 183 06 | 54 42 |
| Cashew | 4 94 | 23 77 |
| Coconut | 10 48 | 17 94 |
| Pepper | 27 77 | 20 34 |
| Banana | 14 90 | 16 04 |

The C G R of both production and acreage of all the seven crops are als g ven in figure 1 and figure 2 respectively

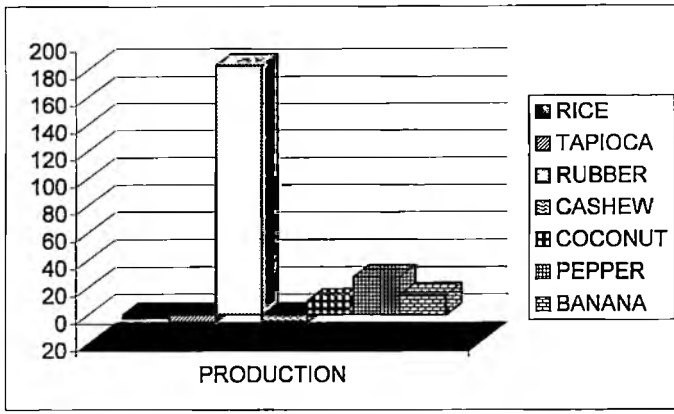


Figure 1 Production C G R of different crops

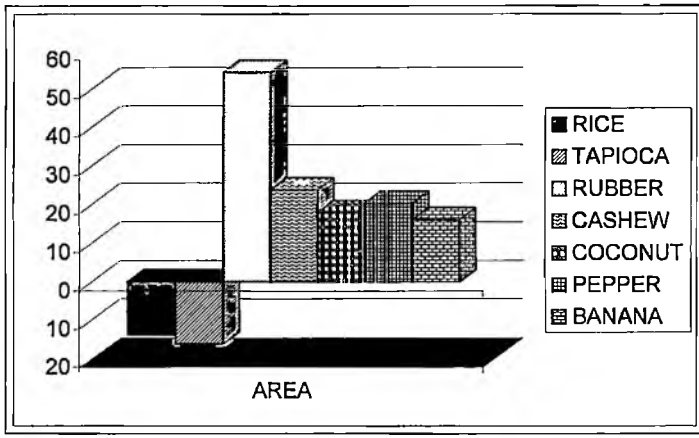


Figure 2 Area C G R of different crops

## 4 4 Composite Productivity Index

### 4 4 1 District wise analysis

As the crop variations among the districts exist it is important to id the crops which recorded highest variation in production in the state Table Table 4g present the range of var ations n average production of the seven crops in d fferent d stricts of Kerala dur ng 1985 86 1990 91 1995 96 1997 98

Increas ng trend in y eld was observed in case of Tapioca Co Rubber and Banana The maximum variation in production dur ng 1985 8 recorded n the case of cashew (145 87%) During 1990 91 1995 96 and 19 also cashew recorded the highest variation with coefficient of variat ons ( values 160 40 per cent 171 75 per cent and 159 06 per cent respect Whereas lowest variation was observed n case of banana with 41 59 per 36 77 per cent 36 02 per cent and 61 85 per cent in 1985 86 1990 91 19 and 1997 98 respectively The (C V ) varied from 88 14 per cent to 116 2 cent for rice 76 76 per cent to 90 61 per cent for tapioca 145 87 per c 171 75 per cent for cashew 57 90 per cent to 65 72 per cent for coconut per cent to 87 77 per cent for rubber 77 96 per cent to 150 76 per cent for p and 36 02 per cent to 61 85 per cent for banana

It is observed that production of individual crops showed wide var among the districts over the periods

In order to make an inter district comparison Composite Produc Index has been worked out for each district separately taking into conside the variety of crops and their relative importance in the district These have given in Table 5 Different districts behaved differently with respect to the r growth of productivity Dur ng 1985 86 the value of Composite Produc Index varied from 89 01 per cent in Malappuram to 116 34 per cent in Kannu

Table 4a Variation in yield of Rice among the districts of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1985 86 | 306980 | 16845 | 84303 64 | 88 14 |
| 1990 91 | 324907 | 10953 | 77612 71 | 101 00 |
| 1995 96 | 280405 | 10593 | 68092 86 | 100 60 |
| 1997 98 | 262494 | 8468 | 54614 93 | 116 23 |

Table 4b Variation in yield of Tapioca among the districts of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1985 86 | 769231 | 39282 | 234062 6 | 82 18 |
| 1990 91 | 554956 | 24708 | 200214 4 | 79 59 |
| 1995 96 | 496085 | 31790 | 178793 8 | 76 76 |
| 1997 98 | 678357 | 24624 | 195835 4 | 90 61 |

Table 4c Variation in yield of Cashew among the districts of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1985 86 | 26925 | 164 | 5728 786 | 145 87 |
| 1990 91 | 43881 | 214 | 7340 786 | 160 40 |
| 1995 96 | 39544 | 172 | 5911 786 | 171 75 |
| 1997 98 | 25287 | 117 | 4063 214 | 159 06 |

Table 4d Variation in yield of Coconut among the districts of Kerala

| Year | (Yield in million nuts) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1985 86 | 603 | 5 | 241 2143 | 61 26 |
| 1990 91 | 644 | 6 | 302 2857 | 57 90 |
| 1995 96 | 925 | 16 | 373 9286 | 63 31 |
| 1997 98 | 929 | 26 | 372 1429 | 65 72 |

Table 4e Var ation in yield of Rubber among the d stricts of Kerala

| Year | (Yield in tonnes ) | | | C V (%) |
|---|---|---|---|---|
| | Highest | Lowest | Average | |
| 1985 86 | 50271 | 1635 | 13192 86 | 87 77 |
| 1990 91 | 73854 | 2586 | 21908 64 | 77 17 |
| 1995 96 | 120946 | 3015 | 33896 79 | 85 52 |
| 1997 98 | 135125 | 3561 | 38709 64 | 83 05 |

Table 4f Variation n yield of Pepper among the districts of Kerala

| Year | (Yield in tonnes ) | | | C V (%) |
|---|---|---|---|---|
| | Highest | Lowest | Average | |
| 1985 86 | 6523 | 486 | 2365 786 | 77 96 |
| 1990 91 | 14096 | 274 | 3343 | 112 54 |
| 1995 96 | 22551 | 405 | 4897 714 | 150 76 |
| 1997 98 | 17998 | 308 | 3288 571 | 139 94 |

Table 4g Variat on in y eld of Banana among the distr cts of Kerala

| Year | (Yield in tonnes ) | | | C V (%) |
|---|---|---|---|---|
| | Highest | Lowest | Average | |
| 1985 86 | 45440 | 9400 | 25794 71 | 41 59 |
| 1990 91 | 55790 | 16856 | 34423 93 | 36 77 |
| 1995 96 | 74315 | 22190 | 42315 | 36 02 |
| 1997 98 | 74318 | 4205 | 31194 07 | 61 85 |

Table 5 District Wise Composite Productivity Index

| Year / District | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 97 02 | 100 32 | 90 45 | 98 08 |
| KLM | 96 76 | 107 94 | 97 55 | 87 69 |
| PTA | 111 89 | 103 97 | 106 73 | 105 56 |
| ALP | 112 82 | 99 48 | 99 26 | 81 78 |
| KTM | 99 66 | 102 65 | 97 30 | 98 37 |
| IDK | 89 21 | 122 06 | 113 68 | 111 24 |
| EKM | 103 32 | 93 50 | 97 60 | 96 26 |
| TSR | 103 37 | 107 17 | 100 08 | 106 40 |
| PLD | 105 41 | 101 60 | 89 99 | 98 97 |
| MLPM | 89 01 | 93 91 | 86 87 | 98 53 |
| KKD | 106 96 | 111 23 | 115 59 | 117 31 |
| WYD | 116 05 | 98 79 | 119 18 | 97 02 |
| KNR | 116 34 | 107 00 | 95 62 | 103 36 |
| KSGD | 109 58 | 104 03 | 111 14 | 99 30 |
| C V | 8 29 | 6 78 | 9 63 | 8 56 |

d str ct The first three posit ons were occupied by Kannur (116 34%) Wayan (116 05%) and Allapuzha (112 82%) whereas Malappuram (89 01%) Iduk (89 21%) and Kollam (96 76%) positioned themselves in the last three place and the C V was 8 29 per cent dur ng th s period

In 1990 91 Idukk (122 06%) topped the l st followed by Kozl kode a Kollam w th composite productiv ty nd ces 111 23 per cent and 107 94 per ce respectively and the C V further reduced to 6 78 per cent show ng red ct on nter d str ct variation vith respect to product v ty

Dur ng 1995 96 Composite Product v ty Index decreased in most of t d str cts and ranged from 86 87 per cent in Malappuram to 119 18 per ce t Wayanad districts and the CV was 9 63 per cent

In 1997 98 only f've districts recorded more than 100 per cent Composite Productivity Index Kozh kode (117 31%) topped the list followed l Idukki (111 24%) and Thrissur (106 40%) with a C V of 8 56 per cent The C for different years showed that the inter distr ct variation persisted w th respect crop productiv ty

### 4 4 1 1 Crop Yield Index

S nce the Compos te Productivity Index is an aggregate of d v d crops t s requ red to identify the crops which contributed max mum v iri t in production in different d stricts Hence Crop Yield Indices for d fferent cro in d fferent distr cts for different per ods are prov ded in Table 6a to Table 6g

#### 4 4 1 1 1 Rice

The range of Crop Y eld Index during 1985 86 for different d str c var ed from 69 63 per cent n Kozhikode to 119 03 per cent in Idukk d str ct

Table 6a District wise Crop Yield Index for Rice

| Year / D str ct | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 104 22 | 92 09 | 93 68 | 88 32 |
| KLM | 114 00 | 99 52 | 97 54 | 92 18 |
| PTA | 111 45 | 121 41 | 125 25 | 114 78 |
| ALP | 116 48 | 112 86 | 137 12 | 112 69 |
| KTM | 106 25 | 124 26 | 111 74 | 108 06 |
| IDK | 119 03 | 112 18 | 116 04 | 106 57 |
| EKM | 98 14 | 84 67 | 90 15 | 82 35 |
| TSR | 93 03 | 90 82 | 94 50 | 103 69 |
| PLD | 111 26 | 115 99 | 103 35 | 111 24 |
| MLPM | 82 88 | 80 95 | 85 97 | 85 49 |
| KKD | 69 63 | 63 96 | 60 53 | 61 88 |
| WYD | 103 84 | 107 31 | 114 39 | 113 48 |
| KNR | 88 90 | 85 81 | 77 51 | 83 30 |
| KSGD | 92 53 | 88 94 | 83 99 | 95 55 |
| C V | 13 50 | 17 16 | 19 60 | 15 48 |

Table 6b District wise Crop Yield Index for Tapioca

| Year / District | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 93 38 | 87 48 | 84 07 | 87 68 |
| KLM | 84 71 | 89 41 | 91 16 | 87 14 |
| PTA | 134 69 | 119 50 | 98 56 | 102 03 |
| ALP | 107 13 | 84 94 | 86 00 | 78 23 |
| KTM | 122 49 | 128 26 | 136 32 | 138 97 |
| IDK | 119 51 | 149 53 | 132 91 | 138 80 |
| EKM | 115 49 | 117 25 | 106 74 | 118 01 |
| TSR | 73 26 | 99 46 | 112 14 | 106 59 |
| PLD | 83 24 | 98 73 | 83 89 | 90 71 |
| MLPM | 82 05 | 98 22 | 121 44 | 116 41 |
| KKD | 70 28 | 76 29 | 108 35 | 88 82 |
| WYD | 126 33 | 146 54 | 130 83 | 136 71 |
| KNR | 126 39 | 99 00 | 110 16 | 106 94 |
| KSGD | 97 53 | 53 07 | 97 16 | 92 00 |
| C V | 20 52 | 24 79 | 16 29 | 18 74 |

with a C V of 13 50 per cent Allapuzha (116 48%) and Kollam (114 00 pos t oned themselves as the next best d stricts after Idukki dur ng 1985 86

In 1990 91 the Crop Yield Index of Kozh kode was 63 96 per cent vh vas the lowest n that period The C V (17 16%) was more when compared that of 1985 86 The C V further ncreased to 19 60 per cent in 1995 96

In 1997 98 Pathanamthitta w th a Crop Yield Index of 114 78 per c topped the l st followed by Wayanad and Allapuzha with ind ces 113 48 per c and 112 69 per cent respect vely

### 4 4 1 1 2 Tapioca

Crop Y eld Index for tap oca was lowest n Kozhikode (70 28%) a h ghest in Pathanamthitta (134 69%) dur ng 1985 86 and the C V was 20 52 p cent In the same per od for Kozh kode Palakkad and Thrissur districts the Cr Yield Indices were very low compared to Pathanamth tta Kannur and Kasargo districts In the following period under cons derat on the C V raised from 20 per cent to 24 78 per cent Idukki with a Crop Yield Index 149 53 per c replaced Pathanamthitta for tl e f rst place and Idukki and Wayanad d str occup ed the first two places respectively during 1990 91

During 1995 96 the h gh performer d str cts viz Wayanad Idukk of p periods slowed down a b t whereas Kottayam Malappuram d str cts i nprov the r performance from the last period Kottayam and Allapuzha d str cts w tl ndex values of 138 97 per cent and 78 22 per cent occupied the first and l places respectively in the last per od

### 4 4 1 1 3 Cashew

Among all the crops taken into cons deration cashew showed maxim var at on among the d stricts as the C V was very h gh It ranged from 41 29 pe

Table 6c Distr ct w se Crop Y eld Index for Cashew

| Year / D str ct | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 66 26 | 95 29 | 128 81 | 124 57 |
| KLM | 111 27 | 100 33 | 87 25 | 92 91 |
| PTA | 67 27 | 85 29 | 82 54 | 77 56 |
| ALP | 30 47 | 42 29 | 37 78 | 42 24 |
| KTM | 19 23 | 35 93 | 30 84 | 30 25 |
| IDK | 33 88 | 73 63 | 57 87 | 71 12 |
| EKM | 91 51 | 50 29 | 67 07 | 51 25 |
| TSR | 61 16 | 50 41 | 70 63 | 107 68 |
| PLD | 77 02 | 44 38 | 60 29 | 56 10 |
| MLPM | 72 45 | 79 31 | 66 57 | 63 89 |
| KKD | 78 08 | 63 27 | 79 40 | 80 46 |
| WYD | 37 22 | 32 19 | 70 53 | 121 55 |
| KNR | 117 92 | 155 61 | 159 52 | 174 14 |
| KSGD | 144 91 | 107 39 | 83 87 | 75 05 |
| C V | 48 02 | 45 66 | 41 29 | 44 13 |

Table 6d D str ct wise Crop Yield Index for Coconut

| Year / D str ct | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 97 06 | 108 84 | 89 67 | 103 89 |
| KLM | 83 53 | 96 11 | 101 43 | 79 82 |
| PTA | 121 31 | 108 40 | 102 33 | 93 12 |
| ALP | 118 68 | 91 00 | 85 66 | 67 99 |
| KTM | 92 34 | 84 56 | 67 72 | 69 32 |
| IDK | 84 25 | 87 15 | 72 78 | 63 56 |
| EKM | 118 27 | 107 37 | 101 16 | 93 49 |
| TSR | 127 55 | 118 26 | 106 95 | 108 72 |
| PLD | 85 53 | 70 06 | 65 14 | 82 21 |
| MLPM | 84 15 | 91 71 | 89 87 | 104 61 |
| KKD | 78 08 | 63 27 | 79 40 | 80 46 |
| WYD | 37 22 | 32 19 | 70 53 | 121 55 |
| KNR | 144 91 | 107 39 | 83 87 | 75 05 |
| KSGD | 144 91 | 107 39 | 83 87 | 75 05 |
| C V | 48 01 | 45 66 | 41 29 | 44 13 |

cent in 1995 96 to 48 02 per cent in 1985 86 In case of Crop Yield Index th values were as low as 19 23 per cent n Kottayam and as h gh as 144 91 per ce in Kasargode during 1985 86 In the next per od Kannur was hav ng t maximum Crop Yield Index of 155 61 per cent followed by Kasargo (107 39%) and Kollam (100 33%)

During 1995 96 Wayanad Trivandrum Ernakulam Thr ssur a Kozh kode improved their index values compared to 1990 91 where Kasargode Kollam Allapuzha Idukki Kottayam and Malappuram record lower valu es compared to 1990 91

Kannur (174 14%) continued to be at the top n the list followed Tr vandru m (124 57%) and Wayanad (121 55%) during 1997 98 whereas t positions of Kasargode Pathanamthitta further deteriorated However most of t d stricts increased their indices compared to 1985 86

### 4 4 1 1 4 Coconut

Like most of the plantation crops in Kerala Coconut also show max mum variat on in different periods which was clearly observed from C V which ranged from 23 62 per cent in 1990 91 to 32 12 per cent in 1995 The Crop Yield Index was max mum in Thrissur (127 54%) followed Pathanamthitta and Allap izha with indices 121 30 per cent and 118 67 per c respectively during 1985 86 The two lowest indices were 29 26 per cent 48 32 per cent for Wayanad and Kasargode respectively Mean wh le the C was 28 94 per cent dur ng this per od

In 1990 91 the Crop Yield Index for Wayanad further decreased fr 29 27 per cent to 27 36 per cent but for Kasargode it had ncreased by ne three folds For most of the d str cts the Crop Y eld Index had decrea co npared to the previous per od

During 1995 96 Kasargode topped the list with an all time high value of 166 22 per cent but most of the other districts slightly slipped from previous stage Whereas in the last period most of the districts improved their position But the Crop Yield Index drastically reduced from 166 27 per cent to 123 46 per cent for Kasargode at this stage In 1997 98 the Crop Yield Index varied from 128 85 per cent to 46 56 per cent in Kozhikode and Wayanad districts respectively The CV during this period was 25 41 per cent which was lower than the last period

### 4 4 1 1 5 Rubber

During 1985 86 the Crop Yield Index for Rubber was highest in Kozhikode (141 40%) and lowest in Wayanad district (61 15%) The other districts having high Crop Yield Index were Thrissur (120 80%) Kottayam (107 48%) and Trivandrum (102 96%) during this period

In 1990 91 Kozhikode occupied the first position followed by Thrissur and Allapuzha The CV (44 18%) was the highest among all the periods taken into consideration In 1995 96 the Crop Yield Index decreased from the previous stage for Kollam Allapuzha Thrissur Malappuram Kozhikode Wayanad and Kannur whereas Trivandrum Pathanamthitta Kottayam Idukki Ernakulam Palakkad and Kasargode districts showed a positive growth for Crop Yield Index

In the last period (1997 98) as all the districts showed the same pattern the CV (16 68%) value was nearly the same as it was in the previous period

### 4 4 1 1 6 Pepper

Like cashew the variability of pepper among the districts was also high different periods The CV was highest in 1995 96 (46 26%)

Table 6e District wise Crop Yield Index for Rubber

| Year / District | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 102 96 | 86 78 | 99 35 | 97 68 |
| KLM | 98 36 | 143 19 | 103 91 | 102 93 |
| PTA | 94 91 | 78 84 | 106 50 | 107 04 |
| ALP | 129 19 | 202 15 | 83 01 | 86 18 |
| KTM | 107 48 | 91 82 | 104 42 | 105 20 |
| IDK | 84 70 | 94 96 | 97 45 | 98 72 |
| EKM | 91 95 | 75 23 | 106 45 | 107 22 |
| TSR | 120 80 | 215 18 | 119 76 | 120 29 |
| PLD | 86 58 | 81 82 | 82 04 | 85 71 |
| MLPM | 100 10 | 131 15 | 87 87 | 91 68 |
| KKD | 141 40 | 232 11 | 106 29 | 104 09 |
| WYD | 61 15 | 73 65 | 53 80 | 49 78 |
| KNR | 91 64 | 101 52 | 89 47 | 88 26 |
| KSGD | 91 64 | 88 82 | 93 10 | 87 49 |
| C V | 19 27 | 44 18 | 16 10 | 16 68 |

Table 6f District wise Crop Yield Index for Pepper

| Year / District | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 113 55 | 95 43 | 86 56 | 137 70 |
| KLM | 138 65 | 129 42 | 84 10 | 114 76 |
| PTA | 119 50 | 105 50 | 100 74 | 118 09 |
| ALP | 65 30 | 42 60 | 47 10 | 62 00 |
| KTM | 33 68 | 66 06 | 50 09 | 50 56 |
| IDK | 82 89 | 146 01 | 139 99 | 137 30 |
| EKM | 63 02 | 65 85 | 52 26 | 53 60 |
| TSR | 55 56 | 68 10 | 38 58 | 79 44 |
| PLD | 102 75 | 45 10 | 36 42 | 78 15 |
| MLPM | 125 69 | 67 09 | 39 10 | 60 89 |
| KKD | 83 25 | 79 70 | 64 07 | 90 56 |
| WYD | 195 75 | 102 83 | 145 33 | 95 63 |
| KNR | 113 19 | 91 06 | 68 97 | 70 49 |
| KSGD | 90 65 | 98 49 | 58 58 | 87 88 |
| C V | 39 80 | 33 35 | 46 26 | 31 81 |

Table 6g District wise Crop Yield Index for Banana

| Year / Distr ct | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|
| TVM | 71 77 | 105 07 | 82 68 | 78 23 |
| KLM | 105 07 | 82 68 | 78 23 | 48 08 |
| PTA | 107 17 | 119 52 | 113 70 | 113 63 |
| ALP | 93 35 | 78 38 | 73 54 | 22 68 |
| KTM | 135 80 | 119 43 | 114 72 | 107 24 |
| IDK | 73 12 | 138 57 | 118 86 | 93 06 |
| EKM | 117 88 | 124 30 | 101 88 | 132 40 |
| TSR | 69 38 | 91 94 | 100 17 | 95 25 |
| PLD | 117 60 | 100 10 | 101 19 | 111 81 |
| MLPM | 109 85 | 101 67 | 114 07 | 158 55 |
| KKD | 94 76 | 88 40 | 88 71 | 71 89 |
| WYD | 120 60 | 123 06 | 135 80 | 186 11 |
| KNR | 101 18 | 71 40 | 85 51 | 85 44 |
| KSGD | 75 64 | 101 80 | 90 17 | 59 88 |
| C V | 20 06 | 19 36 | 17 61 | 45 60 |

Trivandrum Kollam Pathanamthitta Palakkad Malappuram Wayanad and Kannur districts had Crop Yield Index of more than 100 per cent Wayanad topped the list with 195 74 per cent in 1985 86

For most of the districts the Crop Yield Indices were decreasing for the crop till two successive periods Idukki showed a consistent progress over periods and had a Crop Yield Index of 146 01 per cent during 1990 91 Wayanad lost its dominance of initial periods and scored only 95 63 per cent during 1997 98 whereas Trivandrum and Idukki topped the list with Crop Yield Index approximately 137 per cent while the C V was only 31 81 per cent

**4 4 1 1 7 Banana**

The variability of this crop among different districts increased in 1997 period Otherwise in all the other periods the C V was in similar range

Pathanamthitta Wayanad Malappuram Palakkad Kottayam Ernakulam dominated the proceedings in all the four periods These five districts registered a Crop Yield Index of more than 100 per cent Trivandrum Kasargod Kollam and Allapuzha lost their tracks towards 1997 98 Allapuzha scored all time low value of 22 68 per cent Trivandrum and Kollam scored 45 02 per cent and 48 08 per cent respectively in 1997 98

**4 4 2 Region wise analysis**

As prior to 1985 86 some of the present districts viz Kasargod Wayanad and Pathanamthitta were not present Hence district wise data over entire period are not comparable So in order to facilitate comparison of periods prior to 1985 86 regions were formed as given in chapter III Composite Productivity Index was calculated for different regions over different periods from 1970 71 to 1997 98 (Table 7)

Table 7 Region wise Composite Productivity Index

| Region \ Years | 1970 71 | 1975 76 | 1980 81 | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 99 26 | 87 83 | 101 95 | 96 08 | 98 52 | 90 81 | 98 03 |
| SECOND | 111 89 | 106 21 | 102 63 | 104 33 | 101 16 | 100 60 | 89 87 |
| THIRD | 101 30 | 104 26 | 95 87 | 98 86 | 96 38 | 100 34 | 98 08 |
| FOURTH | 103 51 | 98 09 | 100 78 | 102 25 | 105 87 | 100 47 | 106 77 |
| FIFTH | 109 04 | 124 13 | 114 62 | 103 52 | 100 29 | 90 30 | 99 00 |
| SIXTH | 91 26 | 91 69 | 87 01 | 85 62 | 91 73 | 87 65 | 98 90 |
| SEVENTH | 95 60 | 99 33 | 99 82 | 108 74 | 105 96 | 117 06 | 111 11 |
| EIGHTH | 80 08 | 88 01 | 100 85 | 98 54 | 102 91 | 105 50 | 105 00 |
| C V | 9 60 | 11 21 | 7 13 | 6 51 | 4 49 | 9 07 | 6 08 |

## 4 4 2 1 Composite Productivity Index

Table 8a to Table 8g show the maximum and m n mum production of seven crops with their C V over different regions of the state Except rubber crops showed h gh fluctuat ons n production over the per ods L ke dist ct data maximum var at ons occurred n cashew (167 86%) dur ng 1995 96 other periods also cashew showed high var at ons as compared to the other cr S milarly lo vest var at on vas observed n banana for all the per ods w th a r of 26 74 per cent to 41 60 per cent The C V var ed from 50 59 per cent to 7 per cent for rice 76 16 per cent to 107 34 per cent for tap oca 84 24 per ce 167 86 per cent for cashew 36 00 per cent to 56 37 per cent for coconut 10 per cent to 110 88 per cent for rubber 78 82 per cent to 116 23 per cent pepper and 26 74 per cent to 41 60 per cent for banana C V ncre consistently for most of the crops as per od progressed

In 1970 71 second region topped the l st w th Compos te Product Index value of 111 89 per cent and other regions showed nearly the same va during this period with the exception of e ghth region

The variability among the regions for different periods was very low C V ranged from 4 49 per cent to 11 21 per cent

Fifth and first regions showed significant change n 1975 76 In region the value of Composite Productivity Index ncreased up to 124 13 per from 109 04 per cent whereas in the first region the value decreased to 87 83 cent in 1975 76 from 99 26 per cent in 1970 71

In 1985 86 few regions strengthened the r position whereas f rst f s xth and e ghth reg ons lost their pos t ons compared to the prev ous per The bottom three places were occupied by sixth (85 62%) first (96 08%) e ghth (98 53%) reg ons respectively The C V further decreased to 6 51 cent

Table 8a Variation in yield of Rice among the regions of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1970 71 | 72624 | 24134 | 49867 | 35 35 |
| 1975 76 | 85762 | 29532 | 48040 75 | 39 81 |
| 1980 81 | 73937 | 21716 | 38726 38 | 41 60 |
| 1985 86 | 73017 | 24486 | 41444 5 | 38 94 |
| 1990 91 | 87737 | 32964 | 55375 13 | 31 53 |
| 1995 96 | 104780 | 39337 | 70790 25 | 26 74 |
| 1997 98 | 74318 | 17122 | 48448 | 36 39 |

Table 8b Variation in yield of Tapioca among the districts of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1970 71 | 318925 | 56868 | 162250 6 | 50 59 |
| 1975 76 | 349667 | 59060 | 166398 9 | 55 28 |
| 1980 81 | 373782 | 45986 | 158995 3 | 64 70 |
| 1985 86 | 306980 | 47106 | 147531 4 | 57 09 |
| 1990 91 | 324907 | 38363 | 135822 3 | 68 92 |
| 1995 96 | 280405 | 31831 | 119162 5 | 68 83 |
| 1997 98 | 262494 | 19610 | 95576 13 | 77 94 |

Table 8c Variation in y eld of Cashew among the districts of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1970 71 | 45285 | 5172 | 14405 5 | 84 24 |
| 1975 76 | 50931 | 3568 | 14986 | 98 83 |
| 1980 81 | 50516 | 1934 | 10237 5 | 150 23 |
| 1985 86 | 50885 | 2076 | 10025 38 | 155 40 |
| 1990 91 | 67496 | 2008 | 12846 38 | 162 90 |
| 1995 96 | 56055 | 1451 | 10345 63 | 167 86 |
| 1997 98 | 36355 | 1038 | 7110 625 | 156 51 |

Table 8d Variation in yield of Coconut among the regions of Kerala

| Year | (Yield in million nuts) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1970 71 | 1069 | 92 | 497 625 | 56 37 |
| 1975 76 | 889 | 56 | 429 25 | 54 46 |
| 1980 81 | 638 | 80 | 376 | 43 49 |
| 1985 86 | 709 | 108 | 422 125 | 45 74 |
| 1990 91 | 804 | 130 | 529 | 36 00 |
| 1995 96 | 969 | 183 | 654 375 | 40 11 |
| 1997 98 | 044 | 237 | 651 25 | 37 398 |

Table 8e Variation in y eld of Rubber among the districts of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1970 71 | 34044 | 1488 | 9841 375 | 102 40 |
| 1975 76 | 56668 | 3314 | 15786 88 | 106 82 |
| 1980 81 | 61214 | 4516 | 17541 63 | 102 12 |
| 1985 86 | 84401 | 6412 | 23087 5 | 108 23 |
| 1990 91 | 132481 | 11001 | 38340 13 | 100 90 |
| 1995 96 | 221461 | 15513 | 59319 38 | 110 88 |
| 1997 98 | 248472 | 18361 | 67741 88 | 108 1 |

Table 8f Variation n yield of Pepper among the d stricts of Kerala

| Year | (Y eld in tonnes ) | | | |
|---|---|---|---|---|
| | Highest | Lowest | Average | C V (%) |
| 1970 71 | 7287 | 222 | 3128 625 | 85 32 |
| 1975 76 | 7245 | 146 | 3072 5 | 86 35 |
| 1980 81 | 7654 | 170 | 3564 625 | 78 82 |
| 1985 86 | 9428 | 486 | 4140 125 | 80 50 |
| 1990 91 | 17374 | 345 | 5850 25 | 99 45 |
| 1995 96 | 25240 | 451 | 8571 | 116 23 |
| 1997 98 | 19845 | 844 | 5755 | 109 21 |

Table 8g Variation in yield of Banana among the districts of Kerala

| Year | (Yield in tonnes ) | | | |
|---|---|---|---|---|
| | H ghest | Lowest | Average | C V (%) |
| 1970 71 | 72624 | 24134 | 49867 | 35 35 |
| 1975 76 | 85762 | 29532 | 48040 75 | 39 81 |
| 1980 81 | 73937 | 21716 | 38726 38 | 41 60 |
| 1985 86 | 73017 | 24486 | 41444 5 | 38 94 |
| 1990 91 | 87737 | 32964 | 55375 13 | 31 53 |
| 1995 96 | 104780 | 39337 | 70790 25 | 26 74 |
| 1997 98 | 74318 | 17122 | 48448 | 36 39 |

The Composite Productivity Index declined for f rst second fourth fi and s xth reg ons during 1995 96 But seventh reg on topped the list with ndex 117 04 per cent In this per od var ab l ty among reg ons slightly ncreas as the C V stood at 9 07 per cent instead of 4 49 per cent n the prev ous per od

During 1997 98 the Composite Productivity Index ranged from 89 87 cent to 111 11 per cent in second and seventh regions respect vely

### 4 4 2 1 1 Crop Yield Index

It is also necessary to examine ind vidual crop s performance for d ffer reg ons by computing the Crop Yield Indices which are given in Table 9a Table 9g

#### 4 4 2 1 1 1 Rice

In 1970 71 fifth and second regions topped the list w th Crop Y Indices 117 74 per cent and 110 36 per cent respectively whereas regi seventh and s xth occupied the bottom positions w th the indices 70 04 per c and 87 44 per cent respect vely Var ab l ty of 1975 76 among d fferent reg further ncreased and the C V was 16 04 per cent In the same period fifth reg ma nta ned ts lead with a value of 134 68 per cent and s xth and seventh reg strengthened their pos t on with increase in Crop Yield Index

For the f rst time second region had the maximum index value of 114 per cent in 1985 86 In the next period second region could not ma ntain pos tion and it was lowest n 1997 98 The C V was all t me low of 9 95 per n 1997 98

Table 9a Region wise Crop Yield index for Rice

| Year / Region | 1970 71 | 1975 76 | 1980 81 | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 97 02 | 105 87 | 90 05 | 104 22 | 92 09 | 93 68 | 88 32 |
| SECOND | 110 36 | 100 03 | 109 32 | 114 97 | 110 15 | 123 71 | 107 19 |
| THIRD | 100 57 | 99 07 | 97 05 | 101 59 | 97 15 | 97 79 | 89 42 |
| FOURTH | 95 57 | 86 11 | 85 36 | 93 03 | 90 82 | 94 50 | 103 69 |
| FIFTH | 117 74 | 134 68 | 129 88 | 111 26 | 115 99 | 103 35 | 111 24 |
| SIXTH | 87 44 | 94 51 | 85 71 | 82 88 | 80 95 | 85 97 | 85 49 |
| SEVENTH | 70 04 | 79 22 | 76 01 | 90 89 | 91 18 | 98 21 | 97 57 |
| EIGHTH | 89 90 | 88 70 | 84 56 | 90 50 | 87 13 | 80 17 | 87 44 |
| C V | 14 18 | 16 06 | 17 09 | 10.58 | 11 51 | 12 49 | 9 75 |

**4 4 2 1 1 2 Tapioca**

Dur ng 1970 71 the range of Crop Yield Index var ed from 64 72 per in fifth to 114 92 per cent in second region The var ab l ty among regions the highest w th a C V of 17 98 per cent n 1970 71

In 1975 76 eighth region reg stered a Crop Yield Index of 110 96 per compared to 81 32 per cent n the prev ous period and the top three places w occup ed by th rd (114 15%) e gl th (110 96%) and seventl (110 43%) reg respect vely

Once again third and eighth regions dominated in Crop Yield Index tapioca whereas first fourth and fifth reg ons reg stered a lower growth dur 1985 86

In the last three periods eighth region improved its Crop Y eld Ind sixth reg on showed a constant increase in ndex value throughout the th per ods whereas all other regions had a similar type of growth as n prev periods

**4 4 2 1 1 3 Cashew**

Most of the regions had a uniform value for cashew dur ng 1970 71 Crop Yield Index var ed from 99 99 per cent to 100 01 per cent and variability among the regions was all time low w th a C V of 0 003 per c whereas in the next period all the regions except first (61 34%) registere similar performance for this crop

Fourth (61 16%) and f rst (66 26%) regions sl pped to the bottom pos t dur ng 1985 86

During 1990 91 the Crop Y eld Index of backward regions furt decreased but eighth reg on strengthened its Crop Y eld Index from 129 26 per

Table 9b Region wise Crop Yield index for Tapioca

| Year / Region | 1970 71 | 1975 76 | 1980 81 | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 75 72 | 86 65 | 103 00 | 93 38 | 87 48 | 84 07 | 87 68 |
| SECOND | 114 92 | 107 66 | 96 78 | 100 09 | 95 28 | 91 67 | 88 49 |
| THIRD | 112 47 | 114 15 | 115 18 | 119 96 | 130 76 | 128 13 | 132 79 |
| FOURTH | 93 08 | 82 10 | 90 15 | 73 26 | 99 46 | 112 14 | 106 56 |
| FIFTH | 64 72 | 85 49 | 84 72 | 82 24 | 98 73 | 83 89 | 90 71 |
| SIXTH | 96 32 | 72 28 | 76 16 | 82 05 | 98 22 | 121 44 | 116 41 |
| SEVENTH | 102 20 | 110 43 | 77 19 | 93 20 | 101 9 | 115 56 | 104 74 |
| EIGHTH | 81 32 | 110 96 | 113 07 | 115 20 | 85 93 | 107 08 | 104 26 |
| C V | 17 98 | 15 81 | 14 96 | 16 09 | 12 94 | 15 11 | 13 91 |

Table 9c Region wise Crop Yield index for Cashew

| Year / Region | 1970 71 | 1975 76 | 1980 81 | 1985-86 | 1990-91 | 1995-96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 99 99 | 61 34 | 82 79 | 66 26 | 95 29 | 128 81 | 124 57 |
| SECOND | 100 00 | 102 05 | 123 77 | 79 02 | 74 71 | 64 42 | 69 00 |
| THIRD | 100 00 | 102 06 | 96 64 | 63 82 | 51 35 | 56 98 | 54 22 |
| FOURTH | 100 00 | 100 62 | 46 57 | 61 16 | 50 41 | 70 63 | 107 69 |
| FIFTH | 100 00 | 102 06 | 50 89 | 77 01 | 44 38 | 60 29 | 56 10 |
| SIXTH | 100 00 | 102 06 | 55 89 | 72 45 | 79 31 | 66 57 | 63 89 |
| SEVENTH | 100 00 | 102 06 | 96 79 | 71 05 | 58 38 | 78 03 | 90 66 |
| EIGHTH | 100 00 | 102 06 | 126 44 | 129 26 | 134 48 | 126 04 | 24 21 |
| C V | 0 0037 | 13 85 | 34 78 | 26 32 | 38 25 | 33 38 | 32 06 |

cent to 134 48 per cent and the C V was all t me high of 38 25 per c In the last two per ods first region improved its performance and occi p ed first position and e ghth region slipped to second pos t on The variab l ty am regions decreased during tl e last two per ods

### 4 4 2 1 1 4 Coconut

In 1970 71 second region had tl e highest ndex value of 123 15 per c followed by fourth (114 26%) and seventh (112 71%) reg ons respect vely

In the follow ng per od first second th rd and fourth reg ons strengthe their posit ons and the variability among the reg ons was the highest with C V 22 87 per cent

Fourth region w th Crop Yield Index 139 07 per cent was placed at top second region sl pped to second pos t on in 1980 81 In the last two per c third fourth seventh and eighth regions had nearly the same Crop Yield Index before but other regions were hav ng highly fluctuating ind ces compared to ot periods The C V was steadily decreasing with t me

### 4 4 2 1 1 5 Rubber

For this crop the variability among regions for d fferent periods was same for d fferent periods with the exception of 1990 91 and 1975 76 The C was maximum (35 03%) n 1990 91

In 1970 71 and 1975 76 fourth reg on topped the list w th Crop Yi Index 139 61 per cent and 128 46 per cent respectively but in 1980 81 th region came n the first pos t on w th a value 122 08 per cent

Table 9d Region wise Crop Yield index for Coconut

| Year / Region | 1970 71 | 1975 76 | 1980 81 | 1985 86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 110 96 | 116 59 | 103 91 | 97 05 | 108 84 | 89 67 | 103 89 |
| SECOND | 123 15 | 136 95 | 120 95 | 118 11 | 116 77 | 124 98 | 103 31 |
| THIRD | 95 94 | 102 77 | 93 95 | 103 46 | 96 62 | 85 80 | 81 00 |
| FOURTH | 114 26 | 119 01 | 139 07 | 127 55 | 118 26 | 106 95 | 108 72 |
| FIFTH | 70 73 | 66 50 | 75 47 | 85 53 | 70 06 | 65 14 | 82 22 |
| SIXTH | 91 69 | 89 31 | 95 80 | 84 15 | 91 71 | 89 87 | 104 61 |
| SEVENTH | 112 71 | 108 30 | 104 53 | 110 32 | 105 60 | 122 52 | 122 94 |
| EIGHTH | 69 17 | 68 94 | 92 28 | 79 21 | 101 13 | 118 98 | 116 10 |
| C V | 19 30 | 22 87 | 17 57 | 16 11 | 14 38 | 19 79 | 13 41 |

Table 9e Region wise Crop Yield index for Rubber

| Year / Region | 1970 71 | 1975 76 | 1980 81 | 1985-86 | 1990 91 | 1995-96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 113 94 | 109 50 | 115 08 | 102 96 | 86 78 | 99 35 | 97 68 |
| SECOND | 106 92 | 113 44 | 111 21 | 98 63 | 108 74 | 104 46 | 104 45 |
| THIRD | 131 32 | 127 04 | 122 08 | 127 40 | 122 25 | 139 32 | 140 63 |
| FOURTH | 139 61 | 128 46 | 121 66 | 120 80 | 215 18 | 119 78 | 120 29 |
| FIFTH | 111 52 | 68 56 | 69 03 | 86.58 | 81 82 | 82 04 | 85 71 |
| SIXTH | 108 65 | 89 53 | 92 89 | 100 10 | 131 15 | 87 87 | 91 68 |
| SEVENTH | 103 60 | 95 48 | 100 05 | 122 43 | 185 60 | 94 00 | 90 14 |
| EIGHTH | 72 19 | 83 10 | 87 06 | 91 64 | 95 91 | 90 94 | 87 95 |
| C V | 16 93 | 19 59 | 17 06 | 13 47 | 35 03 | 17 1 | 17 48 |

During 1990 91 fourth region scored an all time high Crop Yield Index of 215 18 per cent Otherwise most of the regions had similar performance as the initial year

### 4 4 2 1 1 6 Pepper

It was one of highly fluctuating crops in the state Among all the period the C V values were highly fluctuating even touching as high as 70 52 per cent in 1970 71 to a low of 16 20 per cent in the immediately succeeding period (1975 76) During 1970 71 fourth second and first regions had Crop Yield Indices of 371 29 per cent 192 89 per cent and 173 31 per cent respectively After this period fourth region could not maintain its position and slipped to all time low in 1995 96 with a value of 38 58 per cent The Crop Yield Indices for first and sixth regions were highly fluctuating for all the periods Second third fifth and eighth regions were more consistent in all the periods compared to other regions

### 4 4 2 1 1 7 Banana

This is one of the most consistent crops over all the regions for different periods The consistency level increased after 1980 81 The C V was very high during the early periods

During 1970 71 all regions except seventh (169 46%) scored the Crop Yield Index around 90 per cent only whereas in the next period all the region except first registered Crop Yield Indices of more than 100 per cent

In most of the periods the Crop Yield Indices were more of similar nature except in 1997 98 where Crop Yield Index reduced to all time low for all the regions except for sixth (158 35%) seventh (134 28%) and fifth (111 81%)

Table 9f Region wise Crop Yield index for Pepper

| Year / Region | 1970 71 | 1975 76 | 1980 81 | 1985-86 | 1990 91 | 1995-96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 173 31 | 95 59 | 143 26 | 113 55 | 95 43 | 86 56 | 137 70 |
| SECOND | 192 89 | 119 09 | 114 87 | 116 64 | 108 54 | 85 68 | 108 95 |
| THIRD | 138 00 | 109 70 | 58 49 | 65 10 | 118 82 | 118 12 | 119 08 |
| FOURTH | 71 29 | 72 06 | 65 21 | 55 56 | 68 10 | 38 58 | 79 44 |
| FIFTH | 64 18 | 76 95 | 42 05 | 102 75 | 45 10 | 36 42 | 78 15 |
| SIXTH | 64 15 | 81 18 | 104 19 | 125 69 | 67 10 | 39 10 | 60 89 |
| SEVENTH | 65 04 | 94 68 | 141 33 | 138 20 | 94 37 | 127 64 | 94 47 |
| EIGHTH | 65 75 | 92 40 | 109 14 | 105 23 | 92 39 | 67 22 | 73 67 |
| C V | 49 21 | 16 19 | 36 57 | 26 05 | 26 36 | 44 88 | 25 87 |

Table 9g Region wise Crop Yield index for Banana

| Year / Region | 1970 71 | 1975-76 | 1980 81 | 1985-86 | 1990 91 | 1995 96 | 1997 98 |
|---|---|---|---|---|---|---|---|
| FIRST | 92 81 | 16 78 | 97 00 | 71 78 | 82 52 | 78 58 | 45 02 |
| SECOND | 92 34 | 166 91 | 82 26 | 103 62 | 93 43 | 87 02 | 59 09 |
| THIRD | 93 38 | 148 52 | 92 99 | 82 23 | 86 17 | 88 45 | 63 13 |
| FOURTH | 92 51 | 166 76 | 107 56 | 69 38 | 91 94 | 100 17 | 95 25 |
| FIFTH | 93 27 | 167 50 | 97 91 | 117 60 | 100 10 | 101 19 | 111 81 |
| SIXTH | 92 78 | 166 86 | 143 24 | 109 85 | 101 67 | 114 07 | 158 55 |
| SEVENTH | 169 46 | 166 97 | 96 27 | 102 93 | 102 62 | 114 86 | 134 28 |
| EIGHTH | 9 67 | 166 7 | 87 40 | 97 51 | 81 06 | 87 20 | 75 80 |
| C V | 4 76 | 0 | 17 48 | 17 78 | 8 69 | 12 9 | 39 92 |

## 4 5 Development Index Taxonomic approach

The development nd ces based on seven variables regard ng agr cult development have been co nputed as per procedure ndicated n chapter III It l been calculated both for d str ct w se as well as for region w se For d str ct w analysis three periods 1985 86 1990 91 and 1995 96 were taken However reg on wise analys s it was computed for five per ods viz 1970 71 1980 1985 86 1990 91 and 1995 96 Table 10 and Table 11 represent the values pattern of development and Compos te Index for each d strict and reg on alc w th the ranks allotted to the d str cts or regions on the bas s of these ndices

### 4 5 1 District wise analysis

It may be observed from Table 10 that out of 14 districts ncluded n analysis Ernakulam ranked f rst and Wayanad ranked last n agr cultu development during 1985 86 The value of development ind ces varied from 0 to 0 98 dur ng this period In this period the composite index for the state v 0 84

Cons dering the index up to 0 7 as an indicator of high developme ndex from 0 71 to 0 85 as med um development and ndex greater than 0 85 low development it was observed that there was no high agr culturally develop d str ct Pathanamthitta Allapuzha Kollam Ernakulam Thr ssur and Kozh kc were med um developed distr cts and Trivandrum Kollam Idukki Palakk Malappuram Wayanad Kannur and Kasargode were low agricultura developed districts during 1985 86 At the same time the state as a whole v included under medium developed category

The analys s of relat ve level of development in d fferent districts dur the period 1990 91 indicated that the districts Ernakulam and Wayanad contin to occupy the first and the last rank w th respect to the development agriculture The values of development ndex varied from 0 69 to 0 98 during th

Table 10 Development ind ces for various districts

| YEAR | 1985 86 | | | 1990 91 | | | 1995 96 | | |
|---|---|---|---|---|---|---|---|---|---|
| DISTRICT | C | $D_i$ | RANK | C | D | RANK | C | D | |
| TVM | 6 62 | 0 86 | 7 | 6 56 | 0 84 | 5 | 6 43 | 0 82 | |
| KLM | 7 22 | 0 94 | 12 | 6 63 | 0 85 | 6 | 6 39 | 0 82 | |
| PTA | 5 96 | 0 77 | 4 | 6 27 | 0 80 | 3 | 5 47 | 0 70 | |
| ALP | 6 55 | 0 84 | 6 | 6 73 | 0 86 | 7 | 6 28 | 0 80 | |
| KTM | 5 84 | 0 76 | 3 | 5 73 | 0 73 | 2 | 5 53 | 0 71 | |
| IDK | 6 84 | 0 89 | 8 | 6 40 | 0 82 | 4 | 7 03 | 0 90 | |
| EKM | 5 62 | 0 73 | 1 | 5 42 | 0 69 | 1 | 5 30 | 0 68 | |
| TSR | 5 80 | 0 75 | 2 | 5 71 | 0 73 | 2 | 5 56 | 0 71 | |
| PLD | 7 14 | 0 93 | 11 | 7 27 | 0 93 | 9 | 6 90 | 0 88 | |
| MLPM | 6 99 | 0 91 | 10 | 7 15 | 0 91 | 8 | 6 91 | 0 89 | |
| KKD | 6 49 | 0 84 | 5 | 6 29 | 0 80 | 3 | 6 44 | 0 83 | |
| WYD | 7 56 | 0 98 | 13 | 7 67 | 0 98 | 10 | 7 48 | 0 96 | |
| KNR | 6 93 | 0 90 | 9 | 7 31 | 0 93 | 9 | 6 93 | 0 89 | |
| KSGD | 6 99 | 0 90 | 9 | 7 10 | 0 91 | 8 | 7 52 | 0 96 | |
| STATE | 6 49 | 0 84 | | 6 22 | 0 80 | | 5 96 | 0 76 | |
| C V | 8 47 | 8 47 | | 9 62 | 9 62 | | 10 91 | 10 91 | |

period The class ficat on of distr cts into three groups of development nd c that only Ernakulam was n the category of high development the distr Tr vandrum Kollam Pathanamthitta Kottayam Thrissur and Kozh kode wer the category of medium level development and the districts Allapuzha Palakk Malappuram Wayanad Kannur and Kasargode were n the low develo category It was also observed that the level of development of the state increased dur ng 1990 91 over 1985 86

During the last period 1995 96 the development index ndicated Ernakulam maintained its dominance in agricultural development over all ot districts The previous year s second and fourth ranks were exchanged betw Thrissur and Pathanamth tta districts respectively The d str ct Waya improved its development level a bit and the district Kasargode occup ed the posit on during this period Pathanamthitta joined the highly developed d str along with Ernakulam in 1995 96 Tr vandrum Kollam Allapuzha Thrissur Kozh kode were in medium developed d stricts and Idukki Palakk Malappuram Wayanad Kannur and Kasargode were low developed distr during 1995 96 Palakkad and Malappuram improved their development lev whereas development index of Idukki sl pped from 0 82 to 0 90 dur ng t period The overall performance of the state was much higher compared to t p v ous periods

The district Ernakulam that occupied under medium category agricultural development dur ng 1985 86 moved to the h ghly develop category during 1990 91 It further mproved ts position n the last per od B the d strict Allapuzha moved down from medium developed category to lo developed category in 1990 91 Idukki was in medium developed category 1990 91 whereas in 1995 96 t came to low developed category Malappurar Wayanad Kannur and Kasargode were always in low developed category Tl overall performance of the state as a whole was improving Every time posit oned itself in the medium developed category but the development ndex state moved in upward direction throughout the period under consideration Th

development status of all the districts for three periods i e 1985 86 1990 91 1995 96 are also given in figure 3 figure 4 and figure 5 respectively As development index is calculated based upon deviations t is indirec proportional to the development status of a district Hence the figures were dra by taking 1 D

Another important aspect of the study viz change in the level development over three periods of time was statistically examined by slippage test The value of the test statistic M was worked out to be 1 36 wh was non significant at 5 per cent level This indicates the acceptance of n hypothesis i e no change in the level of development among the districts o time From this it can thus be concluded that the level of development v homogeneous over the three periods under consideration

The slippage test was repeated to see the significant change development between the periods 1985 86 and 1995 96 It was found that value of statistic M was 1 6 which was non significant at 5 per cent level T showed that there was no change in the level of development between these t periods

Agricultural planning has been done in the country as an instrument bringing about uniform regional development over time In this context t wo be useful to examine the extent of variability in developmental indices o different periods

For this purpose the coefficient of variation (C V ) of developm indices were worked out for 1985 86 1990 91 and 1995 96 which were 8 47 9 62 per cent and 10 90 per cent respectively This indicates that the extent variability in developmental indices of different districts over the three per c were almost of the same order

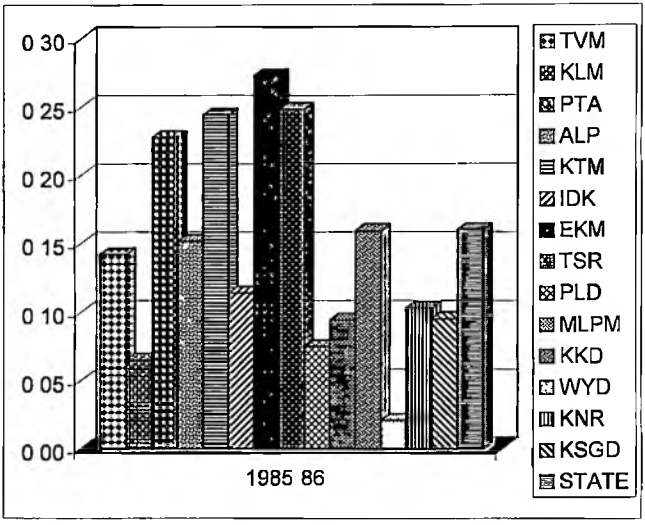


Figure 3 Developmental status of various districts during 1985 86

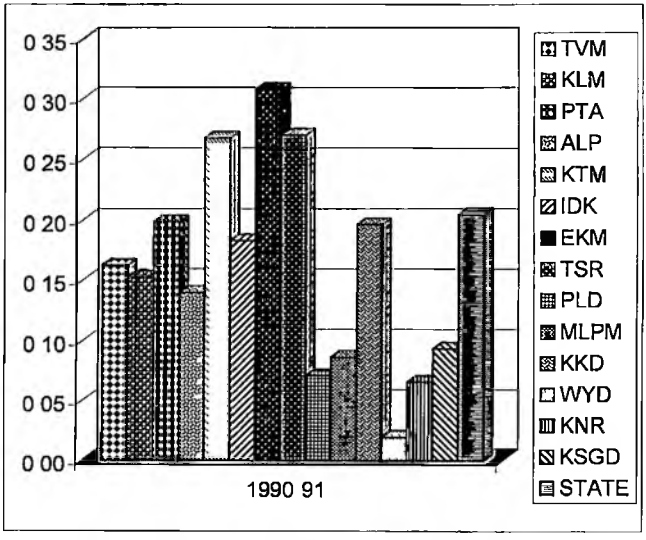


Figure 4 Developmental status of various districts during 1990 91

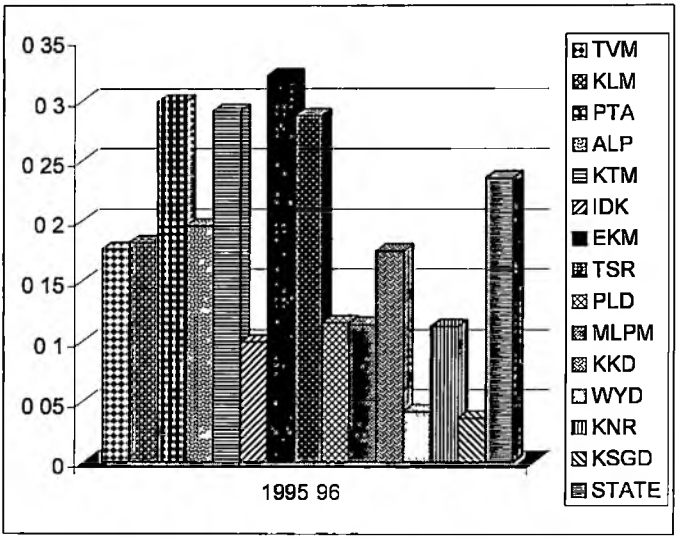


Figure 5 Developmental status of various districts during 1995 96

### 4 5 1 1 Distance matrix

The d stance matrix can be used for fix ng targets for different d str cts f each ndicator (Appendix I II III)

#### 4 5 1 1 1 District wise analysis

The potential targets for the low developed distr cts have been estimat by us ng the d stance matrix as well as the compos te ndex of development f three periods The estimates of the potential targets for each ndicator along w the actual ach eved values are given n the append x sect on It shows tl d rection of inequal ty existing among the indicators in d fferent distr cts

Out of 14 distr cts the least agriculturally developed d str cts ve Wayanad Kollam and Palakkad in 1985 86 It was observed that n the case Wayanad the size of hold ngs was higher than the potential target But the oth s x indicators were lower than the optimum values (Appendix IV)

Similarly for Kollam except agricultural income per hectare an cropp ng intensity other indicators were lower than the potent al targe (Appendix V) Whereas in Palakkad cropping intensity number of agr cultur workers per hectare fertilizer consumpt on per hectare and size of holdings wei higher than the potential targets (Appendix VI)

Dur ng 1990 91 the agriculturally underdeveloped districts wei Wayanad Kannur and Palakkad In this period in Wayanad except for s ze c holdings all the other indicators showed lower values than the potent al targe (Append x VII) Whereas in Kannur only ra nfall and size of holdings we higher than the potent al targets (Appendix VIII) Similarly n Palakkad excep cropping ntensity and size of hold ngs other indicators were lower than potent targets (Appendix IX)

In the last per od under study i e in 1995 96 Kasargode Wayanad and Idukki registered as the agriculturally underdeveloped d str cts It could be pointed out that in Kasargode except agr cultural income per hectare ra nfall and s ze of hold ngs other indicators needed improvement i e they were lower than that of potential targets (Append x X) The other d str ct Wayanad showed the same constraints as before whereas in Idukki ndicators other than ra nfall and s ze of hold ngs were lower than the potential targets (Appendix XI & Appendix XII)

By studying different nd cators contr but ng to the development of agriculture among d fferent d stricts t w ll be easy for planners and administrators to readjust the resources for br nging equ ty among d fferent d str cts

### 4 5 2 Region wise analysis

As ment oned earl er for region wise compar son f ve per ods were take and they were 1970 71 1980 81 1985 86 1990 91 and 1995 96 The development ind ces of different reg ons over d fferent periods are g ven Table11

During 1970 71 the value of composite indices varied from 0 63 to 0 94 The fourth region occupied the first rank whereas sixth region occupied the last rank in this period During this period the value of state was 0 70 Classifying the different regions into different category of agricultural development as mentioned earl er only fourth region was highly developed second third and eighth regions were medium developed and first fifth sixth and seventh were low develope I during 1970 71 But the state as a whole was n highly developed category dur g this per od

Dur ng 1980 81 the bottom place was occupied by first region w th i value of 0 88 whereas s xth reg on improved its position from e ghth rank to

Table 11 Development indices for various regions

| Year / Region | 1970 71 | | 1980 81 | | 1985 86 | | 1990 91 | | 1995 96 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | D1 | C1 | D1 | C1 | D1 | C1 | D1 | C1 | D1 |
| FIRST | 6 37 | 0 91 | 6 61 | 0 88 | 6 16 | 0 89 | 5 48 | 0 80 | 5 60 | 0 81 |
| SECOND | 5 22 | 0 74 | 4 70 | 0 63 | 3 88 | 0 56 | 4 29 | 0 63 | 3 60 | 0 52 |
| THIRD | 5 34 | 0 76 | 2 95 | 0 40 | 4 25 | 0 62 | 4 49 | 0 65 | 4 42 | 0 64 |
| FOURTH | 4 47 | 0 63 | 4 69 | 0 63 | 4 86 | 0 70 | 5 01 | 0 73 | 4 85 | 0 70 |
| FIFTH | 6 27 | 0 89 | 5 41 | 0 72 | 5 64 | 0 82 | 5 87 | 0 86 | 5 54 | 0 80 |
| SIXTH | 6 65 | 0 94 | 6 32 | 0 85 | 6 41 | 0 93 | 6 88 | 1 00 | 6 45 | 0 93 |
| SEVENTH | 6 08 | 0 86 | 5 60 | 0 75 | 5 64 | 0 82 | 5 69 | 0 83 | 5 05 | 0 73 |
| EIGHTH | 5 62 | 0 80 | 6 27 | 0 84 | 4 52 | 0 66 | 5 58 | 0 81 | 6 39 | 0 92 |
| STATE | 4 95 | 0 70 | 5 61 | 0 75 | 5 66 | 0 82 | 5 40 | 0 79 | 5 20 | 0 75 |
| C V | | 12 15 | | 19 80 | | 15 91 | | 11 85 | | 16 33 |

seventh rank There was a change for the first place and the third reg on occup ed it The development index ranged from 0 40 to 0 88 Most of the reg ons strengthened their position with the except on of first and e ghth regions dur ng this period There was a signif cant improvement in the development of f fth region n th s period Based on the development second th rd fourth reg on were ncluded n h ghly developed category F fth s xth seventh and e ghth regions were ncluded n medium developed category whereas the first reg on was the only one in low developed region dur ng 1980 81 The overal performance of the state sl pped from high developed category to med um developed category

In 1985 86 the f rst three places were occup ed by second th rd i e ghth regions respect vely w th respect to the development of agriculture Bu the sixth region again came to the last pos tion The overall performance of the state further sl pped from 0 75 to 0 82 but it ma nta ned med um level o development The h gh development reg ons were second th rd and e gl th med um development regions were fourth fifth sixth and seventh and low developed region was only the f rst region dur ng 1985 86

During 1990 91 the same two regions but having a h gh value compare to the last period ma ntained the f rst two positions Dur ng th s per od th number of regions decreased in highly developed category The performance o the state was improved compared to the prev ous period whereas the f fth reg o was (0 86) languish ng n the low developed category

In 1995 96 most of the regions improved the r performance except th e ghth reg on that sl pped from sixth pos tion to seventh position vhereas th overall performance of the state mproved The second th rd and fourth region were in highly developed category first f fth and seventh in medium develope category and sixth and eighth regions were in low developed category dur ng 1995 96 It was seen that overall performance of state was good only in on period i e in 1970 71 In other per ods the development index was very h gl

show ng low development level In most of the periods second third and four regions dominated the other regions n the level of agricultural development Tl performance of first region was ncreas ng over the per od whereas sixth reg was languishing at the bottom for most of the per ods Developmental status all the regions over all the periods is also given in f gure 6 f gure 7 f gure figure 9 and figure 10 respect vely

Reg on w se change in develop nent over d fferent per ods v stat stically exam ned by sl ppage test The value of test stat st c came to be 1 4 for all periods wh ch was non signif cant at 5 per cent level From this we c conclude that the levels of development for different reg ons were the same f all periods

The slippage test was repeated to find the s gnif cance of change of lev of development between 1970 71 and 1985 86 and t was found that the level development between the two per ods was the same The value of the stat s was 1 19 which was non sign f cant at 5 per cent level It was again worked o for 1995 96 over 1985 86 The test stat st c had a value of 1 187 wh ch was al non sign f cant at 5 per cent level

Extent of variability for development ndices over all the regions f different periods was computed The range of C V var ed from 11 85 n 1990 to 19 80 n 1980 81 The var ab lity level of 1970 71 was similar to that of 199 91 whereas the variability of 1985 86 was sim lar to that of 1995 96

### 4 5 2 1 Distance matrix

By us ng the d stance matrix targets for d fferent regions were f xed each ind cator (Appendix XIII XIV XV XVI XVII)

Like d str ct w se study potential targets of different per ods v computed for each ndicator or var able It can be seen that during1970 71 t

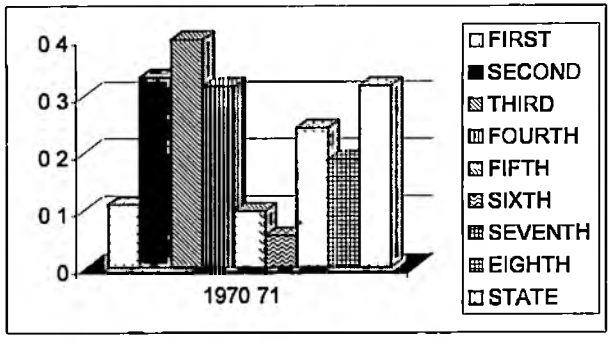


Figure 6 Developmental status of various regions during 1970 71

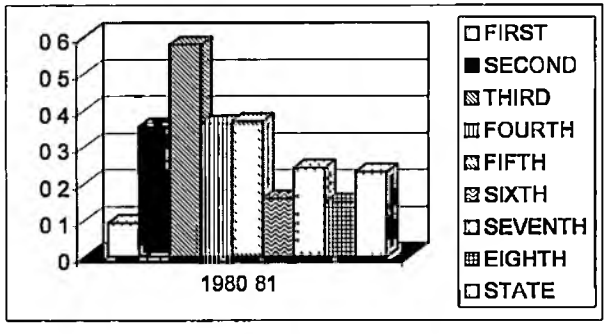


Figure 7 Developmental status of various regions during 1980 81

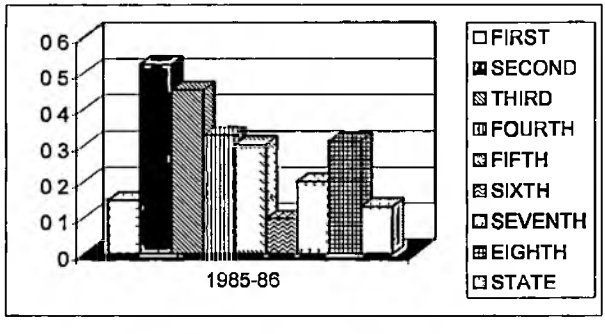


Figure 8 Developmental status of various regions during 1985 86

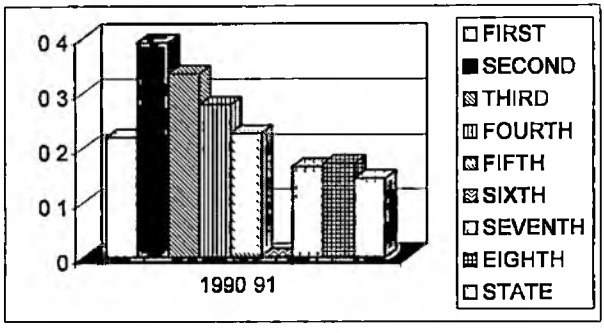


Figure 9 Developmental status of various regions during 1990 91

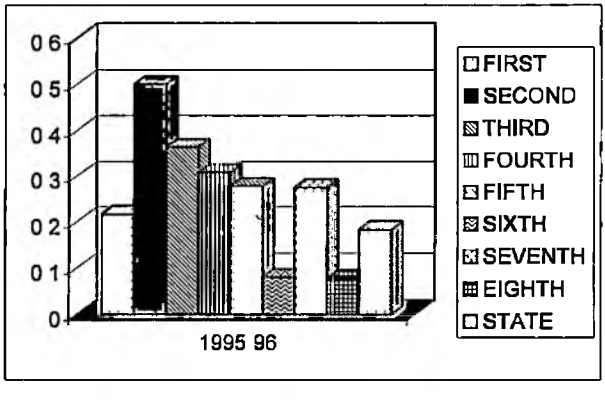


Figure 10 Developmental status of various regions during 1995 96

least agr culturally developed regıon was fifth reg on Only number o agricultural workers per hectare and raınfall were above the potentıal target Other f ve ndıcators were lower than the potent al targets The next lea developed was the f rst regıon where the nd cators v z agrıcultural cred t pe hectare raınfall fert lızer consumptıon and sıze of holdıngs were lower than th potentıal targets (Append x XVIII)

Durıng 1980 81 first regıon placed ıtself ın bottom posıtıon because a ındıcators except croppıng ıntensıty had lower value than the potent al target (Appendıx XIX)

In the other three per ods agaın fifth regıon languıshed at the bottor posıtıon for agrıcultural development where except raınfall and number c agrıcultural workers per l ectare all ınd cators were lower than the potentı targets It could be concluded that as f ve nd cators regıstered lower value tl ı the potentıal targets fifth regıon languıshed at the bottom posıtıon for the la three perıods (Appendıx XX XXI XXII)

In case of first regıon t occupıed seventh posıtıon ın 1985 86 later on moved to fifth posıt on ın 1990 91 and finally placed tself ın sıxth posıt o durıng 1995 96 Most of the t mes four of ıts ındıcators vız cropp ng ıntens t agr cultural workers per hectare agrıcultural credıts per hectare and ra nfall ha lower values than the potent al targets (Appendıx XXIII XXIV XXV)

Eighth reg on occupıed thırd posıtıon ın agrıcultural development 1985 86 and 1990 91 later on n 1995 96 ts posıt on deter orated and place tself ın seventh pos t on For the f rst two perıods e 1985 86 and 1990 91 on three of ts nd cators v z cropp ng ntensıty ra nfall and s ze of holdıngs ha lower values than the potentıal targets but at final perıod three above mentıone ndıcators wıth agrıcultural ıncome per hectare reported lower values than th potent al targets (Appendıx XXVI)

## 4 6 Modified Development Index

In taxonomic approach the development ndex was computed based seven variables assuming that each var able had equal mportance for development of agriculture But in real ty some variables are more important t the others In this context the modified development indices for both districts regions for different periods were obtained

### 4 6 1 District wise analysis

The computed values of development indices of d fferent distr cts o different periods are given in Table 12

It can be seen from the Table 12 that during 1985 86 the range development index varied from 0 71 in Ernakulam to 0 96 in Wayanad In same per od the value for the state was 0 82

Classifying the d str cts into three categories of development as g ven taxonomic approach it was observed that there was no high agr cultur developed district Pathanamthitta Kottayam Ernakulam Thrissur Kozhikode were in medium developed group and the rest of the d stricts were low developed category during 1985 86 The state was under medium develop category with a development index of 0 82 during th s period The extent variability was the least compared to the other periods (9 12%)

The corresponding progress of districts in 1990 91 showed that distr cts at the first three positions in 1985 86 continued to be so Wayanad a Palakkad distr cts were langu shing at the bottom as they were n prev c period The development index varied from 0 66 to 0 96

Ernakulam and Kottayam entered the highly developed category Medi level agriculturally developed category distr cts were Kollam Pathanamth tta

Table 12 Modified development indices for various districts

| Year / District | 1985 86 | | | 1990 91 | | | 1995 96 | | |
|---|---|---|---|---|---|---|---|---|---|
| | $C_i$ | $D_i$ | RANK | $C_i$ | $D_i$ | RANK | $C_i$ | $D_i$ | RA |
| TVM | 2 41 | 0 86 | 6 | 2 37 | 0 82 | 8 | 2 34 | 0 81 | |
| KLM | 2 55 | 0 91 | 12 | 2 31 | 0 80 | 7 | 2 21 | 0 77 | |
| PTA | 2 15 | 0 76 | 4 | 2 30 | 0 79 | 6 | 1 95 | 0 68 | |
| ALP | 2 51 | 0 89 | 10 | 2 60 | 0 90 | 10 | 2 38 | 0 83 | |
| KTM | 2 06 | 0 73 | 2 | 2 03 | 0 70 | 2 | 1 96 | 0 68 | |
| IDK | 2 42 | 0 86 | 7 | 2 24 | 0 77 | 5 | 2 54 | 0 88 | |
| EKM | 2 02 | 0 72 | 1 | 1 94 | 0 67 | 1 | 1 89 | 0 66 | |
| TSR | 2 13 | 0 76 | 3 | 2 09 | 0 72 | 3 | 2 04 | 0 71 | |
| PLD | 2 78 | 0 99 | 13 | 2 84 | 0 98 | 13 | 2 69 | 0 93 | |
| MLPM | 2 51 | 0 89 | 11 | 2 61 | 0 90 | 12 | 2 52 | 0 88 | |
| KKD | 2 27 | 0 81 | 5 | 2 19 | 0 75 | 4 | 2 26 | 0 78 | |
| WYD | 2 71 | 0 96 | 14 | 2 78 | 0 96 | 14 | 2 74 | 0 95 | |
| KNR | 2 43 | 0 86 | 8 | 2 62 | 0 90 | 11 | 2 44 | 0 85 | |
| KSGD | 2 43 | 0 86 | ) | 2 49 | 0 86 | 9 | 2 72 | 0 95 | |
| STATE | 2 32 | 0 82 | | 2 24 | 0 77 | | 2 15 | 0 75 | |
| C V | | 9 12 | | | 10 01 | | | 11 91 | |

Idukki Thrissur and Kozhikode and rest were categorised as low agricultura developed during 1990 91 The state maintained its position in the medium lev whereas the C V of development indices during the period was more (11 01 compared to the previous period

During 1995 96 almost all the districts improved their positions from fi period except Kasargode Ernakulam maintained its lead as before whereas t positions of second and third were changed The classification of districts r three categories of development indicated that Ernakulam Kottayam a Pathanamthitta occupied high agriculturally developed category the distri Trivandrum Kollam Allapuzha Kozhikode Kannur and the state were in t category of medium level development and Idukki Palakkad Malappura Wayanad and Kasargode were in the low developed category during 1995 96 was observed that the agricultural development of the state was continuou improving from period to period The C V further increased to all time high 11 91% during 1995 96

As a whole Ernakulam Kottayam and Thrissur were higl ly develop compared to the rest of the districts whereas Palakkad Wayanad a Malappuram were languishing at the third category for all the periods

Variability in modified development indices over different periods w computed in a similar manner as for development indices It was observed tl the C V varied from 9 12 per cent in 1985 86 to 11 91 per cent 1995 96 whi was increasing over time It was also observed that C V of modifi development indices over different time period were greater than that development indices over the same period

### 4 6 2 Region wise analysis

The manner in which development indices were mod fied for t districts was also used for region wise comparison where the mportance of t

variables was also taken into consideration The computed values of mod f index for various reg ons are given in Table 13

Fourth region ranked first and fifth reg on ranked last n agr cultu development in 1970 71 It can also be observed that except second and fou regions all regions registered low development compared to the state categorising the regions into three categories of development second and fou regions were high agriculturally developed third and fourth regions w med um agriculturally developed and first fifth and sixth reg ons were l agriculturally developed dur ng 1970 71 Whereas the state posit oned itself h gh agriculturally developed category

The analysis of level of development in these reg ons dur ng 1980 showed that the first three ranks of previous period also continued their status this period Fifth and sixth regions improved their position dur ng th s per The classif cation of regions based upon their development showed that previous period s three agriculturally developed regions were ncluded n same group F rst fifth sixth seventh and eighth regions pos t oned themsel in medium developed regions whereas no region was there in low agr cultura developed category dur ng 1980 81 In the same period the state as a vh sl pped from high to medium agriculturally developed category

In 1985 86 the second region with a development index 0 48 held the fi rank The sixth region further increased its value from 0 83 in 1980 81 to 0 94 1985 86 But first second and eighth regions improved their development le from the prev ous period

The categorisat on of different reg ons indicated that second th rd a eighth regions were in high agriculturally developed category first fourth f and seventh regions were i i medium agriculturally developed category whcr only sixth region placed tself n low agriculturally developed category But t

Table 13 Modified development indices for various regions

| REGION WISE | 1970 71 | | | 1980 81 | | | 1985 86 | | | 1990 91 | | | 1995 96 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C1 | D1 | Ranks | C1 | D1 | Ranks | C1 | D1 | Ranks | C1 | D1 | Ranks | C1 | D1 |
| FIRST | 2 323 | 0 86 | 6 | 2 464 | 0 84 | 7 | 2 054 | 0 83 | 7 | 2 056 | 0 79 | 5 | 2 139 | 0 81 |
| ECOND | 1 862 | 0 69 | 2 | 1 704 | 0 58 | 2 | 1 179 | 0 48 | 1 | 1 521 | 0 58 | 1 | 1 234 | 0 47 |
| THIRD | 1 942 | 0 72 | 3 | 1 042 | 0 36 | 1 | 1 414 | 0 57 | 2 | 1 675 | 0 64 | 2 | 1 638 | 0 62 |
| OURTH | 1 794 | 0 67 | 1 | 1 886 | 0 65 | 3 | 1 759 | 0 71 | 4 | 1 963 | 0 75 | 4 | 1 911 | 0 72 |
| FIFTH | 2 545 | 0 94 | 8 | 2 144 | 0 73 | 4 | 1 964 | 0 80 | 6 | 2 262 | 0 87 | 7 | 2 138 | 0 81 |
| SIXTH | 2 489 | 0 92 | 7 | 2 436 | 0 83 | 6 | 2 318 | 0 94 | 8 | 2 611 | 0 99 | 8 | 2 438 | 0 92 |
| EVENTH | 2 301 | 0 85 | 5 | 2 160 | 0 74 | 5 | 1 945 | 0 79 | 5 | 2 078 | 0 80 | 6 | 1 764 | 0 67 |
| IGHTH | 2 258 | 0 84 | 4 | 2 490 | 0 85 | 8 | 1 636 | 0 66 | 3 | 1 917 | 0 73 | 3 | 2 304 | 0 87 |
| STATE | 1 897 | 0 70 | | 2 153 | 0 74 | | 1 980 | 0 80 | | 2 061 | 0 79 | | 1 991 | 0 75 |
| CV | 12 481 | 12 48 | | 21 219 | 21 22 | | 18 245 | 18 25 | | 14 753 | 14 75 | | 17 767 | 17 77 |

was surprising to observe that inspite of three high developed regions development index of state further decreased to 0 80

In the beginning of 90s the modified indices showed that except for region the development indices of all other regions deteriorated But the rank first two regions were same as before The first region mproved its ndex as as rank during this period The range of index varied from 0 58 n second to t in sixth region and it was surprising to see that development ndex value of ei region increased to 0 74 in 1990 91 from 0 66 during 1985 86

The classification of regions in 1990 91 showed that only second third regions were in high agriculturally developed category first fourth sev and eighth regions were in medium category but the fate of sixth region was changed and it had a value of 0 99 during this period

The relative value of development ndex during 1995 96 showed second region ranked first with an index value 0 47 followed by the th rd eighth regions with ndices 0 62 and 0 67 respectively For the first t development index of eighth region was the lowest among all the per Whereas the second fourth fifth and seventh regions improved t development level considerably as compared to the prev ous per od

According to the classification of development second third and sev regions occupied high agriculturally developed category and eighth along sixth region positioned themselves in low agriculturally developed category the other regions along with the state placed themselves in med um develo category

To find out the uniformity of regional development over time C V computed for all regions over all the periods It showed that C V of modi development index was more compared to the C V of development index different regions over different periods The C V varied from 12 48 per cen

1970 71 to 21 22 per cent during 1980 81 In the m ddle per ods t max mum with the values 21 22 per cent and 18 25 per cent respect vely C V during 1990 91 decreased to 14 75 per cent from 18 25 per cent n 1985 which showed var ability decreased progressively

It can be seen from the C V of all the period that the variab l ty fa over different per ods was quite random

### 4 7 Principal Component analysis

Th s method has been tried for finding the composite indices for diffe districts as well as different regions at various periods

#### 4 7 1 District wise P C A

When P C A was carr ed out for d strict wise data for seven variable has been observed that the f rst component itself contributed around 99 95 cent of total variation (Table 14) Table 15 presents the f rst three co npon extracted It s also seen that the eigen value of first factor was 435806 79 As first component it self contributes 99 95 per cent of variation it was enot gl take the f rst component and find the component score for d fferent d str cts c all the per ods

The component scores of different districts over different periods and score of each district as a percentage over state are g ven in Table 16 where figures in parenthesis represent percentage performance of the district over stat

It can be noticed from Table 16 that the component scores for the y 1985 86 varied from 844417 in Trivandrum district to 2212880 n Kasarg district The first three positions were occupied by Kasargode Kannur Kozhikode with the scores 2212880 2006712 and 1710574 respectively M while the state had a score of 15169 76

Table 14 Total variance explained by various components of district wise Principal components analysis

| Components | Initial Eigen values | | |
|---|---|---|---|
| | Total | % Of Variance | Cumulative % |
| 1 | 435806 79 | 99 948 | 99 948 |
| 2 | 226 232 | 5 188E 02 | 100 000 |

Table 15 Components extracted for district wise analysis

| | Components | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Var1 | 0 038 | 0 016 | 0 002 |
| Var2 | 9 449 | 15 039 | 0 001 |
| Var3 | 0 168 | 0 052 | 0 045 |
| Var4 | 0 033 | 0 033 | 0 272 |
| Var5 | 660 089 | 0 215 | 0 000 |
| Var6 | 0 002 | 0 001 | 0 009 |
| Var7 | 0 027 | 0 074 | 0 099 |

Table 16 District wise component score and percentage of component score ove state

| | Component Scores | | |
|---|---|---|---|
| | 1985 86 | 1990 91 | 1995 96 |
| TVM | 844417 (55 66) | 1078044 (55 33) | 1125898 (55 60) |
| KLM | 1049482 (69 12) | 17702079 (90 85) | 1850561 (91 38) |
| PTA | 1605885 (105 86) | 1717395 (88 14) | 2023698 (99 93) |
| ALP | 1549851 (102 17) | 1878504 (96 41) | 1851115 (91 41) |
| KTM | 1655258(109 12) | 2016565 (103 49) | 2147433 (106 04) |
| IDK | 1598560 (105 38) | 2713123 (139 24) | 2459147 (121 43) |
| EKM | 1606364 (105 89) | 2091018 (107 32) | 2346614 (115 88) |
| TSR | 1685311 (111 10) | 19224454 (98 77) | 2100811 (103 74) |
| PLD | 1097222 (72 39) | 1318718 (67 68) | 1446336 (71 42) |
| MLPM | 1535987 (101 25) | 1919392 (98 51) | 2071963 (102 32) |
| KKD | 1710574 (112 76) | 2232552 (114 58) | 2477609 (122 35) |
| WYD | 1317325 (86 84) | 1743542 (89 48) | 1828950 (90 31) |
| KNR | 2006712 (132 28) | 2130394 (109 34) | 2229937 (110 16) |
| KSGD | 2212880 (145 87) | 2453774 (125 93) | 2399869 (118 51) |
| STATE | 1516976 (100) | 1948474 (100) | 2025081(100) |

The figures in parenthesis show the percentage of component score over state

If the state was considered as 100 per cent developed then th development level of Kasargode Kannur and Kozhikode over the state wer 145 87 per cent 132 28 per cent and 112 76 per cent respect vely But at th same time the backward d stricts Trivandrum Kollam and Palakkad had development level of only 55 66 per cent 69 18 per cent and 72 33 per cen respectively

In the following period Idukki Kasargode and Kozhikode occup ed th first three ranks Idukk improved from e ghth rank n 1985 86 to first ran during th s period Kollam which had 13$^{h}$ posit on n 1985 86 bettered t posit on by three ranks during 1990 91 If the percentage performance o d fferent districts over the state was cons dered Kottayam Idukk Ernakulam Kozhikode Kannur and Kasargode were better developed as compared to th state dur ng 1990 91

Dur ng 1995 96 the most s gnificant change occurred in the case o Pathanamthitta wh ch progressed from the 12$^{h}$ rank to the n nth rank Otherw s most of the d stricts performed similarly as in the prev ous per od Kozh kod toppled Idukki from the first rank and the performance of Tr vandrum Kollan Pathanamth tta Allapuzha Palakkad and Wayanad were below par compared t the state during th s period

Finally it can be concluded that for all the three per ods the performanc of Kottayam Idukk Ernakulam Kozhikode Kannur and Kasargode was alway better than that of the state whereas Thrissur and Malappuram registered bette than state in 1985 86 and 1995 96

### 4 7 2 Region wise P C A

PCA was also carried out for region wise data of f've periods It wa found that as in the case of distr cts the first component contributed nearly 99 9 per cent of the total variat on The Table 17 shows the various components

Table 17 Total variance explained by various components of region wise Principal components analysis

| Components | Eigen values | | |
|---|---|---|---|
| | Total | % Of Variance | Cumulative % |
| 1 | 521439 939 | 99 955 | 99 955 |
| 2 | 234 665 | 4 498E 02 | 100 000 |

Table 18 Components extracted for region wise analysis

| | Components | |
|---|---|---|
| | 1 | 2 |
| Var1 | 0 040 | 0 018 |
| Var2 | 5 368 | 15 318 |
| Var3 | 0 130 | 0 018 |
| Var4 | 0 038 | 0 035 |
| Var5 | 722 088 | 0 144 |
| Var6 | 0 002 | 0 004 |
| Var7 | 0 106 | 0 086 |

eigen values and the total variance contributed by each component So by using the first extracted factor (Table 18) the component scores of different regions were computed over different periods which are given in Table 19

It was found that during 1970 71 the eighth region with a component score of 2491560 topped the list followed by fifth and fourth regions w th scores of 2377331 and 2176073 respectively The performance of fourth fifth sixth and eighth regions were better than the state s performance during this period

In the following period only two regions viz fourth and eighth registered better performance than the state The performance of most of the regions increased and the most significant change occurred was for fifth region during this period

During 1970 71 the development score of fifth region was greater thar that of state whereas in the following period it was only slightly over half o state s component score

In 1985 86 eighth region topped the list with a development level o around 155 per cent over the state whereas first and fifth reg ons langu shed a the bottom as before

In 1990 91 five regions registered a better performance than the state Th first three ranks were occupied by eighth third and seventh regions respectively

Although first region occupied last position during this period i performance level was comparatively better than the previous period In th period the performance of only four regions were better than that of state

For the period 1995 96 the range of component scores was 2532907 third region to 1230802 in first region Except for the first and second rank all

Table 19 Region wise component scores and percentage of component scores over state

| REGION | 1970 71 | 1980 81 | 1985 86 | 1990 91 | 1995 96 |
|---|---|---|---|---|---|
| FIRST | 1535311 (78 78) | 1308586(48 34) | 8175823(53 94) | 1178572(58 31) | 1230802(55 9) |
| SECOND | 1905926 (97 80) | 2102731(77 67) | 1449474(95 64) | 1954964(96 73) | 2085825(94 74) |
| THIRD | 1502840(77 11) | 2491821(92 05) | 1478526(97 55) | 2484653(122 93) | 2532903(115 05) |
| FOURTH | 2176073(111 66) | 3061436113 09) | 1566658(103 37) | 2103295(104 07) | 2295964(71 81) |
| FIFTH | 2006921(102 98) | 1507593(55 69) | 1069840(70 59) | 1441498(71 32) | 1581010(102 85) |
| SIXTH | 2377331(121 98) | 2371615(87 64) | 1429146(94 29) | 2097689(103 79) | 2264411(102 85) |
| SEVENTH | 1537568(78 89) | 2699871(99 73) | 1572083(103 72) | 2172708(107 5) | 2353344(106 89) |
| EIGHTH | 2491560(127 85) | 2762650(102 05) | 2350233(155 07) | 2504532(123 92) | 2529776(114 9) |
| STATE | 1948881(100) | 2707100(100) | 1515628(100) | 2021122(100) | 2201649(100) |

The figures in parenthesis show the percentage of component score over state

the other ranks were constant for different regions The percentage performanc over the state was better for third fourth sixth seventh and eighth regions

Since first reg on occupied the bottom pos t on for four periods t can b considered as the worst performer whereas eighth third and seventh reg on gave a better performance through out the study period

# DISCUSSION

# DISCUSSION

The results of the investigation carried out on Spatial and tem variations in the development of agriculture in Kerala are discussed below

## 5 1 Spatio temporal variation

### 5 1 1 District wise Analysis

Owing to the climatic variations in Kerala the crop diversification is compared to other states Different diversification indices revealed that duri initial period of study (1985 86) the districts except Thrissur Palakka Kozhikode showed high index values depicting high level of crop diversi Later on most of the districts except the above three districts showed dec values of index This could be attributed mainly to farmer s preference for s crops In Thrissur and Palakkad it could be that the farms in other districts had to cash crops much earlier whereas the switch over took place in these distr cts

In general the trends of Entropy Index and Modified Entropy Inde almost similar among different districts However with exception of one districts no single crop dominated in most of the district All the districts ha own choice As a result less diversification was noticed in recent periods

In most of the periods diversification in cropping was mainly t plantation crops even the farmers of traditional food crops growing distr c Palakkad and Thrissur included plantations crops in the r farms Thus diversi of crops of Thrissur and Palakkad increased in recent periods

The most diversified district was Kollam (based on Composite E Index) where the cropping pattern had equal importance to all major crops Ho

as the period progressed the acreage of rice decreased there In other divers districts like Pathanamthitta and Kannur the cropping pattern was little bit bi towards plantation crops In recent years the level of diversification of Way district was very less as compared to other districts This was because out of s crops in present study the farmers of this district were concentrating more on pe and rice

In Trivandrum Pathanamthitta Allapuzha Kottayam Malappuram Kar and Kasargode districts diversification level decreased over the periods as farmers preferred only one or two crops Crops like coconut rubber and banana preferred in Trivandrum district Rubber got the importance in Pathanamthitta other crops In Allapuzha rice and coconut dominated the cropping system Ex rubber all other crops were in decreasing trend in Kottayam In Malappuram rubber had some existence No other crop had enough acreage In Kannu r Kasargode farmers preferred rubber over cashew The fluctuation in price of ca was responsible for changing of cashew area to rubber

Kozhikode showed constant low diversification level over the per During the initial period rice pepper and rubber contributed for crop diversifica Later on farmers preferred coconut and rubber to rice

It may be concluded from the above that there existed wide spatio temp variations in acreage allocation under different crops In general farmers sh their cropping pattern from the subsistence crops to commercial crops Or average relatively higher growth of acreage under rubber coconut and banana found in different districts whereas negative growth of acreage under rice tap and cashew were noticed in most of the districts

Out of five measures of diversification Composite Entropy Index was fo to be better suited based on the real situation As the Composite Entropy I

depends upon two components viz distribution and number of crops or div
The value of Composite Entropy Index is inversely proportional to the concen
and directly proportional to the number of crops or activities Both the comp
have range between zero and one and thus the range of Composite Entropy In
in between zero and one Since the index used $\log_N P$ as weights it assigned
weight to lower quantity and less weight to higher quantity Shiyani and P
(1998) in their study on diversification of agriculture in Gujarat also foun
Composite Entropy Index was more suitable compared to other indices

### 5 1 2 Region wise analysis

For region wise analysis all the indices showed higher crop diversifica
almost all the regions during the earlier periods of study However in subs
period the diversification level remained stable for all the regions In the
periods lack of technical knowledge larger holding size and less population
the farmers to experiment on different crops rather than to concentrate on one
crops Nevertheless afterwards different regions showed interest for particular
instead of multiple crops

When the period progressed the population size increased result
reduction of holdings size and different technical institutions came into exi
Therefore the farmers concentrated on specific crops As a result the diversif
level of different regions decreased continuously

For the first second and sixth regions different indices showed a steady
for most of the periods It can be pointed out that in first region during 1970
1980 81 farmers were mostly growing rice and coconut but after that they chan
coconut rubber etc Similarly initially the cropping pattern was influenced b
tapioca cashew banana and rubber in second and sixth regions but durin

period cropping pattern was mainly based on rice tapioca and rubber So tha the reason why diversification level decreased as period progressed

## 5 2 Performance of different prediction models for crop production acreage

The performance of different prediction models for crop product o acreage indicated that the models tried in the present study are not su tab represent trend in production of different crops in Kerala Nevertheless for r and pepper linear and log lin models are better than that of other two models fluctuations were very less for rubber and pepper compared to other crops

Three year moving average was adopted in order to iron out fluctuation to different estimation procedures that could have been adopted in successive Thus data after smoothening are used to fit trend

In case of acreage linear and exponential models gave high $R^2$ valu most of the cases Hence these models were useful for fitting the trends of acrea

Thus it could be concluded from above that in Kerala product on of dif crops reflected higher degree of var ability whereas it was stable for acreages

### 5 2 1 Compound growth rate (C G R ) of crop acreage and production

The C G R values for production of seven major crops provided interesting features of the state of agriculture in Kerala Traditional crops l ke tapioca and cashew had negative C G R values during 1970 71 to 1997 98 D the same period the C G R for acreage was positive for cashew This cou ascribed to the extension of area and new plantings in marginal land Muliyar ( also found similar result for his study in Kerala

In case of pepper and coconut the C G R values for both productio acreage showed a positive value However for coconut the C G R of acreag around 18 per cent while the C G R of production was only 10 5 per cent Thi be because of following reasons Around 50 per cent of acreage under coconu in the grip of root wilt and leaf rot diseases Moreover being a traditional c Kerala a substantial portion of the existing population is old and unprod Though irrigation is the most important single measure which can in productivity substantially only 12 per cent of this crop was under irrigation (E and Palanisami 1994) Fluctuating prices below optimum level of manag uneconomic smallholdings etc were the other factors leading to coconut prod decline over the periods

As mentioned above the C G R of both acreage and production were ne for rice and tapioca In rice even though production showed negative rate it w as high as that of area Though the impact of yield increase was observed duri period the decline in area was so high that the productivity gains could not p the decline in production

Rising operational cost due to high wage rates was an important factor decline in acreage of paddy cultivation The other factors that could be attribut conversion of paddy lands are problems in labour management production and risk higher profitability associated in the conversion for plantation crops a non agricultural purposes The same reasons that contributed to the reduction area and production of rice can be attributed to tapioca also (Silas and Abi 1988)

Once a staple food for the rural population now the demand for tap declining owing to the socio economic changes and the arrival of more cereal other states There is a tendency for conversion of lands cultivated purely tapioca towards more remunerative less labour intensive crop like rubber Mor

high fluctuations in price of this crop also contributed to the decline n are production of tapioca

Rubber recorded the highest C G R for both acreage and production was primarily because of stability in prices of rubber for many years This ha made possible mainly by regulating imports and releasing imported rubber in of impending price fluctuations (Krishnan *et al* 1991)

The major crops that were affected by shifting cropping pattern in fav rubber were rice tapioca and coconut Banana with its stability n price co demand among the people of the state showed posit ve growth in acreag production

## 5 3 Composite Productivity Index

### 5 3 1 District wise analysis

From the studies of variations among the districts it is found that c showed the highest variation at all the study periods It was because only districts out of 14 districts of Kerala were growing predominately cashew In other districts area under cashew was very low As a result var at on amon districts was high Banana showed less variation among the crops for both d wise as well as region wise study For banana the acreage was sim lar in r among the districts and regions over the periods probably because of the profitability of this crop

Composite Productivity Index of a district was computed by taking a seven crops and their relative importance to that particular district

It was observed that during 1985 86 Kannur topped the list followe Wayanad and Allapuzha In Kannur the Composite Productivity Index was hi

because of dominance of rice tapioca and banana whereas in Allapuzha tap oc banana dominated the Composite Productivity Index

In 1990 91 the Composite Productivity Index was highest in Idukk productivity of dominant crops of Idukki like tapioca rubber and pepper sh high value during that period

In subsequent period n most of the districts except Idukki Thr Malappuram and Kozhikode the Composite Productivity Index value decreased was because in the state there was hardly any change in cropping pattern ov years Other districts where farmers changed their cropping pattern to cash cr get more money largely influenced the Composite Productivity Index In most lower holding sizes lack of technical knowledge and planting in marginal directly formed the decreasing value of Composite Productivity Index

**5 3 1 1 Crop Yield Index**

**5 2 1 1 1 Rice**

As mentioned earlier for all distr cts except Thrissur Pathanan Wayanad and Kasargode the Crop Yield Index of rice was in decreasing tre most of the districts the middle periods reg stered maximum value compared initial and final period

Slow increase in the whole sale price of food crops compared to that o food crops percentage increase in both farm cultivation cost and do expenditure than the price received by the farmers and increased wage rates co the prime reasons for decreased growth

The major factors that neutralise the technological change in rice cult can be identified as fragmentation of holdings making them non economic

proportion of households who own lands do not have agriculture as the pi
means of income and availability of grains through public distribution at chea
As a result Crop Yield Index of rice for most of the districts decrea
Pathanamthitta Wayanad and Kasargode as the period progressed the acreage
crop decreased but the productivity remain the same so the Crop Yield
showed an increased value for these districts

### 52112 Tapioca

Like rice for tapioca also the Crop Yield Index was decreasing
districts except for Kottayam Idukki Malappuram Kozhikode and Wayanad
well known fact that the acreage of this crop has been decreasing continuous
acreage of Kottayam Idukki Thrissur Malappuram Kozhikode and W
decreased for tapioca It was as high as approximately 61 per cent in Ko
Other districts also showed a similar value for acreage However it regis
lower value of decrease in production Therefore the Crop Yield Index of tapi
these districts showed an increased value over the period

Despite development of varieties with high yield potential the y
tapioca remained more or less stagnant It was mainly due to poorly org
distribution of better seed materials Another reason for declining tapioca cult
might be greater availability of rice through public distribution system as
higher open market availability (Lakshmi and Pal 1988)

### 52113 Cashew

During 1990 91 and 1995 96 most of the districts registered maximur
Yield Index for cashew However the impressive initial performance failed t
any impact in later periods As it is grown only in few districts the C V is ve
compared to other crops The productivity barriers that can be identified are t

fertility status of the marginal lands in which cashew s cultivated pest problen tea mosquitoes and tree borers and relatively high cost of plant protection m due to widely distributed small farm holdings In most of the traditional c plantations large proportions of trees are old and have outlived the r eco bearing per od (Salam *et al* 1993)

St ll with the above disadvantages d stricts Wayanad and Kannur ma n their dominance in cashew Crop Yield Index over the per ods because the red in acreage was greater than that of reduct on in production

### 5 2 1 1 4 Coconut

The Crop Yield Index of coconut was higher during 1985 86 and 19 After that only few districts showed increasing Crop Y eld Index In beg periods due to higher price farmers changed their cropping pattern n fav coconut However the reasons that can be attributed to the overall decline r Yield Index were devastating disease of unknown origin (Pilla *et al* 199 unstable prices for coconut

The other reasons could be the presence of a very high proportion of ol and lack of irrigation facilities

### 5 2 1 1 5 Rubber

This is a crop for which the Crop Yield Index was similar for all the periods among the districts In some districts the increase in acreage and prod was more than double during the study period This could be because of stability in price and optimising the income from limited land resources Th significant change occurred with ncrease n rubber cultivation was reduct acreage in rice and tapioca

### 5 2 1 1 6 Pepper

Except for few districts pepper too did not exhibit healthy gro production The decrease in its growth could be ascribed to the tardy pace diversification of area under the crop Aga n the quick wilt (foot rot) disease serious threat to the growers of all the districts (Krishnan *et al* 1991)

Selvarajan (1989) concluded that drastic increase in the inc dence scourge in the growing areas lead to considerable yield loss Irrespective of v disadvantages Idukki and Wayanad districts improved Crop Y eld Index of th over the periods So these are two distr cts most suitable for pepper cultivation

### 5 2 1 1 7 Banana

The Crop Yield Index of some banana growing districts of Kerala w during the study period With each district having small patch of land und crop and having high productivity resulted in the high Crop Yield Index values

The acreage of this crop was slowly increasing in almost all d Domestic demand may be the only reason for this happening

## 5 3 Composite Productivity Index

### 5 2 2 Region wise analysis

The Composite Productivity Index was computed by taking all the crops together During 1970 71 second region topped the list It was bec dominance in rice tapioca cashew coconut rubber and banana However the region due to lower productivity of its major crop cashew recorded mi Composite Productivity Index

The Composite Productivity Indices for the first three periods were fluctuating in nature for all the regions This could be attributed to lack of te institutes lack of plant protection measures and use of large area for fooc production Although the Composite Productivity Indices of first three period highly fluctuating for different regions the indices had greater value than that three periods for most regions In case of last three periods though the product most of the crops increased from the beginning periods the reduction of acrea so high that it automatically counter balanced the growth of productivity in alm regions

**5 2 2 1 Crop Yield Index**

As described earlier region wise investigation was carr ed out from 1 to 1997 98 The crop index of most of the crops was high during the initial p Later on it has been decreasing continuously It is well understood that farm various regions switched over to plantation crops to make more income from holdings size Second reason could be high labour charges Farmers chang cropping pattern in favour of crops that demanded less labour

But these reasons are not sufficient for low growth of plantation crop district wise performances of various crops were similar to region wise perform

**5 4 Development Index**

**5 4 1 Taxonomic approach**

**5 4 1 1 District wise analysis**

As mentioned earlier in this approach development level of agricult each district based upon seven important variables or indicators which d re indirectly contribute to the development of agriculture were computed for periods

In the first period i e in 1985 86 Ernakulam and Wayanad posi themselves as the first and last rank respectively in the development level because except for size of holdings all indicators of Ernakulam had high than that of other districts The greater holding size of Wayanad district in this may be because of less population As the development index is the combinat all the variables or indicators mere greater value in one indicator does not sho similarity between two districts (Namasivayam *et al* 1987)

For the districts that occupied in the medium developed category the ranged from 0 73 to 0 84 Among them though there was a difference in ndex basically there was no difference in the development level It was because the similar values for indicators mainly due to similar cropping pattern and pref of crops among the farmers Allapuzha that showed a little variation due agricultural income per hectare from the other five medium developed d placed itself in the last position in the medium developed category w th a high of 0 84

Due to low agricultural income per hectare agricultural credit per hecta rainfall the predominately food crop growing Palakkad was included in th developed category in 1985 86 Idukki Kannur and Kasargode wher agricultural income per hectare was similar to the medium developed category included in low developed category This could be due to lower cropping inte very few agricultural workers per hectare low agricultural credit per hectare ar fertilizer consumption per hectare compared to medium level developed district

Table 20 Categorisation of districts into different development categories

| Development Level | Year | Districts |
|---|---|---|
| Highly Developed | 1985 86 | NIL |
| | 1990 91 | EKM |
| | 1995 96 | EKM PTA KTM |
| Medium Developed | 1985 86 | PTA ALP EKM KTM TSR KKI |
| | 1990 91 | TVM KLM PTA KTM TSR KKD |
| | 1995 96 | TVM KLM ALP TSR KKD |
| Low Developed | 1985 86 | TVM KLM IDK PLD MLPM WYD KSGD |
| | 1990 91 | ALP PLD MLPM WYD KNR KS |
| | 1995 96 | IDK PLD MLPM WYD KNR KS |

In the following two periods Ernakulam Trivandrum Kc Pathanamthitta Kottayam and Allapuzha improved their positions in the lev agricultural development During 1990 91 Ernakulam moved to high deve category with improvement in agricultural income per hectare This was becat improvement in production of important cash crops like rubber pepper and ba Allapuzha s less agricultural income per hectare due to reduction in producti tapioca and rice made it to slip from medium developed category to low deve category districts Though the index value of Allapuzha did not show difference it happened to be in the low developed category

During 1995 96 Pathanamthitta and Kottayam moved to high agricultura developed category Perhaps improvement in the production of rubber was the cause for both the districts

From the above discussion it can be concluded that though one ndicat influence the composite index of development all the indictors have importance to form the composite index of development

Since most of the d stricts had sim lar cropp ng pattern over the years was not much difference in the classification of districts into different cate over the periods Categorisation of different districts into d fferent develo c itegories is also given in Table 20

### 5 4 1 2 Region wise analysis

Region wise agricultural development studies showed that in the period i e in 1970 71 fourth region topped the list followed by second an regions respectively But when per od advanced second and third regions m themselves to the top slot due to enhanced grow ng of plantation crops like r pepper and cashew

Although second and third regions were in f rst and second places in m the per ods the two hardly had any difference in composite development values Most of the time fifth and sixth regions secured the bottommost po due to less production of cash crops The classification of regions into di development categories over the periods is given n Table 21

### 5 5 Modified taxonomic approach

In this approach the original method has been modified by giving diffe weightage to indicators In the original approach each variable was given importance where as in this method weightage had been given based on the given by experts

Table 21 Categorisation of regions into different development categories

| Development Level | Year | Regions |
|---|---|---|
| Highly Developed | 1970 71 | FOURTH |
| | 1980 81 | SECOND THIRD FOURTH |
| | 1985 86 | SECOND THIRD FOURTH |
| | 1990 91 | SECOND THIRD |
| | 1995 96 | SECOND THIRD FOURTH |
| Medium Developed | 1970 71 | SECOND THIRD EIGHTH |
| | 1980 81 | FIFTH SIXTH SEVENTH EIGI |
| | 1985 86 | FIFTH SEVENTH EIGHTH |
| | 1990 91 | FIRST FOURTH SEVENTH EIC |
| | 1995 96 | FIRST FIFTH SEVENTH |
| Low Developed | 1970 71 | FIRST FIFTH SIXTH SEVEN |
| | 1980 81 | FIRST |
| | 1985 86 | FIRST SIXTH |
| | 1990 91 | FIFTH SIXTH |
| | 1995 96 | SIXTH EIGHTH |

In almost all the periods similar results were obtained as that o taxonomic approach This can be easily observed from Table 22

The classification of districts or regions by taxonomic approach and mo taxonomic approach did not differ appreciably This could be verified fror ranking of this districts or regions by the developmental index provided in Tat and Table 23

One possible reason for similarity in classification by taxonomic ap and modified taxonomic approach could be that the variables selected purpose may not be giving substantially distinct information about develo Naturally there could be lot of relationship among the selected variables

Table 22 Performance of districts in taxonomic and modified taxonomic appro

| | 1985 86 | | 1990 91 | | 1995 96 | |
|---|---|---|---|---|---|---|
| Positions | TA | MTA | TA | MTA | TA | MTA |
| 1 | EKM | EKM | EKM | EKM | EKM | EKM |
| 2 | TSR | KTM | TSR | KTM | PTA | PTA |
| 3 | KTM | TSR | KTM | TSR | KTM | KTM |
| 4 | PTA | PTA | PTA | KKD | TSR | TSR |
| 5 | KKD | KKD | KKD | IDK | ALP | KLM |
| 6 | ALP | TVM | IDK | PTA | KLM | KKD |
| 7 | TVM | IDK | TVM | KLM | TVM | TVM |
| 8 | IDK | KNR | KLM | TVM | KKD | ALP |
| 9 | KNR | KSGD | ALP | KSGD | PLD | KNR |
| 10 | KSGD | ALP | KSGD | ALP | MLPM | MLPM |
| 11 | MLPM | MLPM | MLPM | KNR | KNR | IDK |
| 12 | PLD | KLM | PLD | MLPM | IDK | PLD |
| 13 | KLM | PLD | KNR | PLD | WYD | KSGD |
| 14 | WYD | WYD | WYD | WYD | KSGD | WYD |

With the above discussion it can be concluded that in the preser separate weightage did not have any significant impact on the classific districts or regions by developmental status

Table 23 Performance of regions in Taxonomic And Modified Taxonomic Approach

| | 1970 71 | | 1980 81 | | 1985 86 | | 1990 91 | | 1995 96 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Positions | T A | M T A | T A | M T A | T A | M T A | T A | M T A | T A | M T A |
| 1 | FOURTH | FOURTH | THIRD | THIRD | SECOND | SECOND | SECOND | SECOND | SECOND | SECOND |
| 2 | SECOND | SECOND | FOURTH | SECOND | THIRD | THIRD | THIRD | THIRD | THIRD | THIRD |
| 3 | THIRD | THIRD | SECOND | FOURTH | EIGHTH | EIGHTH | FOURTH | EIGHTH | FOURTH | SEVENTH |
| 4 | EIGHTH | EIGHTH | FIFTH | FIFTH | FOURTH | FOURTH | FIRST | FOURTH | SEVENTH | FOURTH |
| 5 | SEVENTH | SEVENTH | SEVENTH | SEVENTH | SEVENTH | SEVENTH | EIGHTH | FIRST | FIFTH | FIFTH |
| 6 | FIFTH | FIRST | EIGHTH | SIXTH | FIFTH | FIFTH | SEVENTH | SEVENTH | FIRST | FIRST |
| 7 | FIRST | SIXTH | SIXTH | FIRST | FIRST | FIRST | FIFTH | FIFTH | EIGHTH | EIGHTH |
| 8 | SIXTH | FIFTH | FIRST | EIGHTH | SIXTH | SIXTH | SIXTH | SIXTH | SIXTH | SIXTH |

T A Taxonomic Approach
M T A Modified Taxonomic Approach

## 5 6 Principal Component Analysis

Usually characteristics in any biological phenomenon are highly corre In the present context for both district wise and region wise analysis th component itself contributed around 99 9 per cent of total variation Therefore be concluded that it was a peculiar case of univariate analysis where all the variables or indicators were highly correlated with each other Therefore th component score can replace for the seven variables to make the composite in development with out any loss in information supplied by the seven r variables

Agricultural income per hectare itself is directly or indirectly rela cropping intensity fertilizer consumption per hectare number of agric workers per hectare size of holdings and agricultural credit per hectare In words it could be said that the seven variables are giving almost same inforr about agricultural development of a district or region This could be the reas similarity between the taxonomic approach and modified taxonomic appro classification the districts or regions by development status

### 5 6 1 District wise analysis

District wise analysis in 1985 86 showed that Kasargode ranked followed by Kannur and Kozhikode respectively in agricultural development was because in Kasargode the agricultural income per hectare due to high cash crops and food crop tapioca was the highest among all the districts take consideration For other two top ranked districts this was due to high gro production of rice tapioca rubber and banana

Though in the following period the agricultural income per hecta Kasargode was one of the highest due to reduction in the production of r c

tapioca it was ranked in the second position This may be due to fa experimentation on shifting from traditional crop (like rice tapioca) to pl intation In the same period with less high valued crop Tr vandrum was pl the bottom position

Most of the districts with s milar cropping pattern showed hardl significant change among themselves in their agricultural development Ho the change in ranking from period to period must have been due to the fluctua price For example when pr ce of cashew falls index for Kasargode also falls

### 5 6 2 Region wise analysis

Region wise analysis also revealed that over the period the regions more cash crops were generally the most developed in the field of agric Although there was a deviation with fourth region most of the times it ha rank It was due to the equal importance given for different crops over the per the farmers of this region In spite of a belt of food crops its farmers gave importance to high money yielding crops like rubber coconut and banana

Due to lack of technical knowledge funding and low price the third (KTM+IDK+EKM) was at the bottom position in agricultural level of devel during the beginning period Later on with availability of technology better for crops helped this region to position itself in the top category of agric development

## 5 7 Comparison of three methods of development indices

The three different methods of constructing development indices in d classification of agricultural development resulted in different classification important to find the most reliable one

The advantage of taxonomic approach over the other two is that it give importance to every indicator or variable However in Kerala due to p agricultural system it is erroneous to give equal importance to every indic variable To make the taxonomic approach more precise modified tax method was evolved by giving unequal weightage for each indicator based u relative importance However in the present study all the ind cators or varial highly correlated the expected improvement was not achieved by m taxonomic approach

Principal components contain totality of information supplied variables under consideration particularly in the present investigation with 100 per cent variability explained by the first component This is a situation u the seven variables system could be conveniently dealt by a univar ate ap without loosing any worthwhile information In other words this analysis considered the best as no approximation is involved and the districts or regior be compared based on a single score But this need not be the situat on alwa may have to consider more than one component Still this could be considere comprehensive compared to other methods

# SUMMARY

## SUMMARY

Development of a particular state is not uniform as it varies from p place as well as period to period Several programmes of the government hav launched to improve this type of imbalanced growth of agriculture The presen deals with various objectives that finally lead to quantification of agric development level of various districts The time series data on several indicat contribute to development of agriculture were taken from 1970 71 to 1997 98 the districts Prior to 1985 86 the geographical area of the districts expe changes due to the formation of new districts at different points of time Sc smooth comparison the districts were classified into seven regions based upc geographical position The comparison of agricultural development amo districts was made for three periods where as for regions it was made f periods

To know the development level of a region it is necessary t the diversification level based upon the major crops and trend of different c that region

In the present study five diversification indices viz Her Index Entropy Index Modified Entropy Index Composite Entropy Index and Index were worked out and compared Data on seven major crops viz rice t cashew rubber pepper coconut and banana grown in the state were utilised purpose In general the trend of Entropy Index and Modified Entropy Inde almost the same among different districts or regions However Herfindahl Inc Composite Entropy Index showed dissimilar results In most of the peric diversification in cropping pattern was mainly towards plantation crops e farmers of traditional food crops growing districts like Palakkad and T included plantation crops in their cropping pattern

Based on the real situation out of five measures of divers Composite Entropy Index was found to be better suited In most of the di regions it was noticed that as period progressed the divers fication level an districts or regions decreased

The Composite Productivity Index of Palakkad and Thrissur were stable throughout the period In Palakkad it varied from 0 45 in 1985 86 to 1997 98 However in Thrissur the index value ranged from 0 54 to 0 55 thr the period The most diversified district was Kollam where the cropping pat equal importance to all the major crops The Composite Entropy Index value district was approximately 0 65 from 1990 91 to 1997 98 However in the b period i e 1985 86 the diversification index was 0 68 Major ty of the distri importance to high value cash crops to food crops It was seen that those with high diversification level but cropping pattern biased with plantation cr more developed

In general there existed a wide spatio temporal disparity in the allocation under different crops Mostly farmers shifted their cropping patt subsistence crops to the commercial crops On an average relatively higher g acreage under rubber coconut and banana were found in different districts negative growth of acreage under rice tapioca and cashew were noticed in the districts

Four different prediction models were used to find the acreage and production of seven major crops of the state It was found production of different crops out of four models no model was suited base value of $R^2$ However the fluctuations were not high for acreage So based $R^2$ value linear and exponential models were good for prediction of acreage

It could be concluded that in Kerala production of d fferent cro highly fluctuating whereas it is uniform for acreages The compound growth r both production and acreage of different crops were also computed It was foun rubber recorded the highest C G R for both acreage and production The C value was 183 06 and 54 42 for production and acreage respectively in rubber was primarily because of stability in prices of rubber for many years The food viz r ce and tapioca showed negative C G R for both acreage as well as prod However the cash crops viz coconut and pepper showed positive C G R fo acreage and production The production C G R of rice and tapioca were 2 6 5 10 respectively However the C G R for acreage for these crops were and –16 26 respectively

Based upon the productivity of various crops of different di crop yield indices were computed for different periods It was found that exc few districts rice and tapioca showed decreasing value of crop yield index C showed maximum coefficient of variation among all the crops as few d dominated in cashew acreage The C V was highest (171 75 %) for cashew in 96 The Crop Yield Index of coconut was gradually decreasing because disease of unknown origin and unstable prices for different per ods Rubber s high Crop Yield Index during the study period because of the stability in pri the wish of farmers to optimise the income from limited land resources As a there was a decrease in acreage of rice and tapioca Crop Y eld Index also s that pepper was suitable only in Idukki and Wayanad districts whereas for l almost all the districts were suitable

Development of agriculture is a multidimensional process So of analysing the effect of a single variable or indicator composite in development index for different districts or regions were computed based on indicators that contribute to the development of agriculture In the present stud procedures were utilised viz taxonomic approach mod fied taxonomic ap

and principal component analysis based on seven important var ables that contr towards the development of agr culture The variables taken were (i) agr cu income per hectare (ii) cropp ng ntensity (iii) number of agr cultural worker hectare (iv) agricultural credit per hectare (v) rainfall (vi) fert l zer consumpt o hectare (vii) size of holdings

In taxonomic approach each variable was considered to have importance for development of agriculture In district wise analysis Ernakulan Wayanad occupied the first and the last positions respectively in the lev development of agriculture during 1985 86 as well as in 1990 91 In 1985 8( development indices of Ernakulam and Wayanad were 0 73 and 0 98 where 1990 91 the indices were 0 69 and 0 98 respectively During 1995 96 Kasar (0 96) occupied the last position and Pathanamthitta (0 70) with improveme yield of rubber occupied second position Almost all the districts showed un level of development of agricult re The potential targets were also computed b help of distance matrix and development ndex of different underdeveloped d s In Wayanad except size of holdings no other indicator came up to satisfactory for development of agriculture The districts such as Ernakulam Pathanamthitt Kottayam occupied the top category of agricultural development mostly due tc agricultural income or hectare Since before 1985 86 all the districts of Kerala not present to construct the development index for a period starting from 19 the state s existing districts were classified into eight regions according to geographical positions Region wise study showed that in the last period i e 19 second region occupied the first place followed by third and fourth re respectively In most of the periods second third and fourth regions occup ec agricultural developed status First and sixth regions always positioned themsel low agriculturally developed category due to less cultivation of high value cr( was observed that the regions dominating with high value crops viz ri coconut cashew were agriculturally better developed compared to other regions

The basic assumption of taxonomic approach is that all the variables equal contribution towards the development of agriculture However t is unl k happen so With this fact the taxonomic approach was modified in mo taxonomic approach by giving separate weightage to the indicators based o score given by experts This method was also used for construct on of agricu development indices of districts and regions The classification of districts or re by taxonomic approach and modified taxonomic approach did not differ apprec The possible reason for sim larity in classificat on by both methods could be th variables selected for the purpose may not be giving substantially di information about development of agriculture Obviously there could be l relationship among the selected variables As a result in the present study se weightage did not have any significant impact on the classification of distri regions on their development status

Characteristics in biological experiment are highly correlated present study the indicator agricultural income per hectare itself is direc indirectly related to cropping pattern fertilizer consumption per hectare num agricultural workers per hectare size of holdings and agricultural credit per he In other words it could be said that the seven variables are giving almost the information about agricultural development This problem of present stud overcome by using principal component analysis The first component for district wise and region wise analysis contributed around 99 9 per cent o variation which clearly depicted the high correlation of indicators The component score was taken by replacing the seven indicators to make the com index of development without losing any information supplied by the seven i variables

During 1985 86 Kasargode had the highest level of agricultural develo because of high agricultural income per hectare In the following two peri 1990 91 and 1995 96 Idukki and Kozhikode occupied the first position respec

Most of the districts with s m lar cropping pattern showed hardly any sign f c change in their agricultural development Region wise study showed that there hardly any change in the agricultural development of regions over the periods

As a whole modified taxonomic approach is an improvement over taxonor approach However in the present study as all the indicators are highly correlat the expected improvement was not achieved by modified taxonomic approach In present study almost 100 per cent variability was explained by the first pr nc component so this is a situation where the seven variables system could conveniently dealt by a un variate approach without losing any worthwl nformation Hence this method can be considered as the best as no approx mat o nvolved and the districts or regions could be compared based on a single compon score In the present context principal component analysis could be considered more comprehensive compared to other methods

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* Orig nals not seen

# APPENDICES

## Appendix I Districts wise distance matrix for the Year 1985 86

| | | | | | | | | | | | | | | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TVM | | 2 84 | 4 98 | 3 70 | 5 54 | 5 70 | 4 52 | 3 31 | 3 9 | 3 84 | 4 83 | 6 10 | 6 02 | 6 37 | 2 84 |
| KLM | 2 84 | | 4 26 | 3 | 4 44 | 4 18 | 4 02 | 2 72 | 3 7 | 2 79 | 3 7 | 4 60 | 4 50 | 4 93 | 2 72 |
| PTA | 4 98 | 4 26 | | 4 63 | 2 49 | 3 02 | 4 0 | 3 59 | 5 4 | 3 33 | 2 48 | 4 62 | 3 15 | 3 99 | 2 48 |
| ALP | 3 70 | 3 1 | 4 63 | | 3 8 | 4 7 | 3 85 | 1 66 | 2 30 | 2 96 | 3 5 | 4 9 | 5 0 | 5 46 | 66 |
| KTM | 5 54 | 4 44 | 2 49 | 3 8 | | 3 42 | 4 35 | 3 58 | 4 25 | 3 82 | 2 92 | 4 20 | 4 04 | 4 76 | 66 |
| IDK | 5 70 | 4 8 | 3 02 | 4 7 | 3 42 | | 4 50 | 3 79 | 4 65 | 2 77 | 2 5 | 2 02 | 6 | 2 47 | 6 |
| EKM | 4 52 | 4 02 | 4 0 | 3 85 | 4 35 | 4 50 | | 2 79 | 5 20 | 4 29 | 2 72 | 5 6 | 4 6 | 5 4 | 6 |
| TSR | 3 31 | 2 72 | 3 59 | 66 | 3 58 | 3 79 | 2 79 | | 3 4 | 2 6 | 2 44 | 4 54 | 3 83 | 4 31 | 66 |
| PLD | 3 9 | 3 7 | 5 4 | 2 30 | 4 25 | 4 65 | 5 20 | 3 4 | | 3 18 | 4 62 | 4 07 | 5 47 | 5 86 | 66 |
| MLPM | 3 84 | 2 79 | 3 33 | 2 96 | 3 82 | 2 77 | 4 29 | 2 6 | 3 18 | | 2 68 | 3 46 | 2 84 | 3 26 | 2 6 |
| KKD | 4 83 | 3 7 | 2 48 | 3 51 | 2 92 | 2 57 | 2 72 | 2 44 | 4 62 | 2 68 | | 4 04 | 2 53 | 3 49 | 2 6 |
| WYD | 6 0 | 4 60 | 4 62 | 4 9 | 4 20 | 2 02 | 5 6 | 4 54 | 4 07 | 3 46 | 4 04 | | 3 35 | 3 76 | 2 02 |
| KNR | 6 02 | 4 50 | 3 5 | 5 0 | 4 04 | 6 | 4 6 | 3 83 | 5 47 | 2 84 | 2 53 | 3 35 | | 25 | 1 25 |
| CSGD | 6 37 | 4 93 | 3 99 | 5 46 | 4 76 | 2 47 | 5 4 | 4 3 | 5 86 | 3 26 | 3 49 | 3 76 | 25 | | 25 |

| | |
|---|---|
| μ | 9 |
| σ | 0 48 |
| 2 σ | 0 96 |
| C D | μ A |
| | μ A |

Where $D$ M n mum value of d stance
μ Mean of m n mum value of d stance
σ— Standa d dev at on of m n mum value of d stance
A 2*s andard dev at on

## Appendix II Districts wise distance matrix for the Year 1990 91

| | | | | | | | | | | | | | | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 3 37 | 4 75 | 5 3 | 5 7 | 6 02 | 4 33 | 4 40 | 5 96 | 5 9 | 3 79 | 5 64 | 5 06 | 5 82 | 3 37 |
| | 3 37 | | 6 36 | 6 46 | 6 06 | 5 99 | 5 84 | 6 04 | 7 39 | 6 28 | 4 45 | 5 93 | 5 47 | 6 05 | 3 37 |
| | 4 75 | 6 36 | | 7 32 | 4 97 | 5 23 | 5 83 | 6 5 | 7 72 | 6 57 | 4 60 | 5 69 | 5 09 | 5 98 | 4 60 |
| | 5 31 | 6 46 | 7 32 | | 5 37 | 6 02 | 5 44 | 5 40 | 6 04 | 5 63 | 4 25 | 5 34 | 5 33 | 6 8 | 4 25 |
| | 5 17 | 6 06 | 4 97 | 5 37 | | 5 82 | 6 60 | 7 6 | 8 07 | 7 4 | 5 30 | 6 23 | 6 6 | 6 84 | 4 97 |
| | 6 02 | 5 99 | 5 23 | 6 02 | 5 82 | | 7 30 | 7 84 | 9 05 | 7 55 | 5 70 | 6 06 | 5 59 | 5 88 | 5 23 |
| | 4 33 | 5 84 | 5 83 | 5 44 | 6 60 | 7 30 | | 2 76 | 5 45 | 4 44 | 2 65 | 5 61 | 4 43 | 5 2 | 2 65 |
| | 4 40 | 6 04 | 6 5 | 5 40 | 7 6 | 7 84 | 2 76 | | 3 23 | 2 16 | 2 28 | 4 29 | 3 40 | 3 9 | 2 16 |
| | 5 96 | 7 39 | 7 72 | 6 04 | 8 07 | 9 05 | 5 45 | 3 23 | | 2 90 | 4 69 | 3 77 | 4 54 | 5 | 2 90 |
| M | 5 9 | 6 28 | 6 57 | 5 63 | 7 41 | 7 55 | 4 44 | 2 6 | 2 90 | | 2 93 | 3 18 | 2 3 | 2 8 | 2 6 |
| | 3 79 | 4 45 | 4 60 | 4 25 | 5 30 | 5 70 | 2 65 | 2 28 | 4 69 | 2 93 | | 3 95 | 2 53 | 3 6 | 2 28 |
| | 5 64 | 5 93 | 5 69 | 5 34 | 6 23 | 6 06 | 5 6 | 4 29 | 3 77 | 3 18 | 3 95 | | 2 38 | 2 87 | 2 38 |
| | 5 06 | 5 47 | 5 09 | 5 33 | 6 6 | 5 59 | 4 43 | 3 40 | 4 54 | 2 3 | 2 53 | 2 38 | | 4 | 4 |
| | 5 82 | 6 05 | 5 98 | 6 8 | 6 84 | 5 88 | 5 12 | 3 9 | 5 | 2 81 | 3 6 | 2 87 | 4 | | 4 |

| | |
|---|---|
| μ | 3 08 |
| σ | 21 |
| 2 σ | 2 42 |
| C D | μ A |
| | μ A |

Where $D$ M n mum value of d stance
μ Mean of m n mum value of d s ance
σ— Standard dev at on of m n mum value of d stance
A 2*standard dev a on

## Appendix III Districts wise distance matrix for the Year 1995-96

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M | | 3 68 | 4 35 | 4 7 | 5 74 | 6 48 | 5 6 | 3 72 | 4 9 | 4 36 | 5 53 | 6 83 | 5 60 | 6 2 | 3 |
| M | 3 68 | | 3 27 | 2 68 | 4 38 | 4 47 | 4 0 | 2 28 | 3 96 | 2 63 | 2 83 | 4 44 | 2 97 | 4 33 | 2 |
| | 4 35 | 3 27 | | 3 55 | 68 | 3 43 | 3 42 | 2 52 | 5 00 | 3 2 | 2 67 | 5 41 | 3 36 | 3 77 | |
| | 4 7 | 2 68 | 3 55 | | 4 09 | 4 53 | 4 6 | 79 | 2 50 | 2 32 | 3 24 | 4 25 | 3 39 | 4 60 | |
| M | 5 74 | 4 38 | 68 | 4 09 | | 3 57 | 4 3 | 3 53 | 5 28 | 4 | 3 22 | 5 3 | 3 83 | 4 32 | |
| | 6 48 | 4 47 | 3 43 | 4 53 | 3 57 | | 4 64 | 3 63 | 5 26 | 3 08 | 2 80 | 4 2 | 1 84 | 28 | |
| M | 5 6 | 4 0 | 3 42 | 4 6 | 4 13 | 4 64 | | 2 90 | 6 2 | 4 46 | 2 87 | 6 43 | 4 42 | 5 08 | 2 |
| | 3 72 | 2 28 | 2 52 | 1 9 | 3 53 | 3 63 | 2 90 | | 3 69 | 85 | 2 27 | 4 72 | 2 79 | 3 63 | |
| D | 4 9 | 3 96 | 5 00 | 2 50 | 5 28 | 5 26 | 6 12 | 3 69 | | 3 39 | 5 06 | 3 24 | 4 09 | 5 23 | 2 |
| M | 4 36 | 2 63 | 3 2 | 2 32 | 4 | 3 08 | 4 46 | 85 | 3 39 | | 2 74 | 4 5 | 2 05 | 2 6 | |
| D | 5 53 | 2 83 | 2 67 | 3 24 | 3 22 | 2 80 | 2 87 | 2 27 | 5 06 | 2 74 | | 4 72 | 2 9 | 3 9 | 2 |
| D | 6 83 | 4 44 | 5 41 | 4 25 | 5 3 | 4 2 | 6 43 | 4 72 | 3 24 | 4 15 | 4 72 | | 3 | 4 52 | 3 |
| R | 5 60 | 2 97 | 3 36 | 3 39 | 3 83 | 84 | 4 42 | 2 79 | 4 09 | 2 05 | 2 9 | 3 | | 92 | |
| D | 6 12 | 4 33 | 3 77 | 4 60 | 4 32 | 28 | 5 08 | 3 63 | 5 23 | 2 6 | 3 9 | 4 52 | 1 92 | | |

| | |
|---|---|
| μ | |
| σ | |
| 2 σ | |
| C D | μ |
| | μ |

Where $D$ M n mum value of d stance
μ Mean of m n mum va ue of d s ance
σ Standa d dev at on of m n mum value of d stance
A 2*standard dev a on

Appendix IV Potential targets for Wayanad during 1985 86

| /YD | TVM | KLM | PTA | ALP | KTM | IDK | EKM | TSR | PLD | MLPM | KKD | KNR | KSGD | A M | POTE TAR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20326 | 0 024507 | 0 02521 | 0 02865 | 0 015621 | 0 022767 | 0 024701 | 0 022356 | 0 020252 | 0 013726 | 0 021977 | 0 024419 | 0 026949 | 0 028434 | 0 023044 | 0 00 |
| 18 | 155 | 160 | 105 | 160 | 131 | 107 | 138 | 145 | 149 | 123 | 126 | 105 | 112 | 132 | 1 |
| 25906 | 1 305283 | 0 687232 | 0 682016 | 0 873531 | 0 530243 | 0 419514 | 0 555285 | 0 869376 | 1 013478 | 0 847675 | 0 389344 | 0 45941 | 0 57546 | 0 708296 | 0 28 |
| 8154 | 0 819349 | 0 547584 | 0 60382 | 0 586086 | 0 447889 | 0 469128 | 1 352876 | 0 754523 | 0 360629 | 0 372374 | 0 719351 | 0 473426 | 0 352729 | 0 604597 | 0 32 |
| 997 | 1281 | 1592 | 2434 | 2350 | 2510 | 2423 | 2436 | 2555 | 1664 | 2329 | 2593 | 3042 | 3354 | 2351 | 3 |
| 47531 | 0 054348 | 0 045317 | 0 098063 | 0 070224 | 0 119634 | 0 054752 | 0 070693 | 0 060227 | 0 068049 | 0 043577 | 0 067048 | 0 043019 | 0 030648 | 0 063508 | 0 01 |
| 81 | 0 19 | 0 22 | 0 33 | 0 23 | 0 45 | 0 62 | 0 26 | 0 26 | 0 46 | 0 32 | 0 27 | 0 5 | 0 57 | 0 36 | 0 |

Appendix V Potential targets for Kollam during 1985 86

| 1 | KLM | TVM | PTA | ALP | KTM | IDK | EKM | TSR | PLD | MLPM | KKD | KNR | KSGD | A M | POTENTIA TARGET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 02521 | 0 024507 | 0 02865 | 0 015621 | 0 022767 | 0 024701 | 0 022356 | 0 020252 | 0 013726 | 0 021977 | 0 024419 | 0 026949 | 0 028434 | 0 022863 | 0 00235 |
| | 160 | 155 | 105 | 160 | 131 | 107 | 138 | 145 | 149 | 123 | 126 | 105 | 112 | 130 | 30 |
| | 0 687232 | 1 305283 | 0 682016 | 0 873531 | 0 530243 | 0 419514 | 0 555285 | 0 869376 | 1 013478 | 0 847675 | 0 389344 | 0 45941 | 0 57546 | 0 710051 | 0 02282 |
| | 0 547584 | 0 819349 | 0 60382 | 0 586086 | 0 447889 | 0 469128 | 1 352876 | 0 754523 | 0 360629 | 0 372374 | 0 719351 | 0 473426 | 0 352729 | 0 609348 | 0 061764 |
| | 1592 | 1281 | 2434 | 2350 | 2510 | 2423 | 2436 | 2555 | 1664 | 2329 | 2593 | 3042 | 3354 | 2414 | 822 |
| | 0 045317 | 0 054348 | 0 098063 | 0 070224 | 0 119634 | 0 054752 | 0 070693 | 0 060227 | 0 068049 | 0 043577 | 0 067048 | 0 043019 | 0 030648 | 0 065024 | 0 019707 |
| | 0 22 | 0 19 | 0 33 | 0 23 | 0 45 | 0 62 | 0 26 | 0 26 | 0 46 | 0 32 | 0 27 | 0 5 | 0 57 | 0 371667 | 0 151667 |

Where I Agr cultural ncome per hectare
II Cropping ntens ty
III Number of agr cultural workers per hectare
IV Cred t loans for agr culture per hectare
V Rainfall
VI Fert l zer consumpt on per hectare
VII S ze of l old ngs

Appendix VI Potential targets for Palakkad during 1985 86

| PLD | PLD | TVM | PTA | ALP | KTM | IDK | EKM | TSR | MLPM | KKD | KNR | KSGD | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 0 013726 | 0 024507 | 0 02865 | 0 015621 | 0 022767 | 0 024701 | 0 022356 | 0 020252 | 0 021977 | 0 024419 | 0 026949 | 0 028434 | 0 023694 | 0 009968 |
| II | 149 | 155 | 105 | 160 | 131 | 107 | 138 | 145 | 123 | 126 | 105 | 112 | 128 | 21 |
| III | 1 013478 | 1 305283 | 0 682016 | 0 873531 | 0 530243 | 0 419514 | 0 555285 | 0 869376 | 0 847675 | 0 389344 | 0 45941 | 0 57546 | 0 682467 | 0 33101 |
| IV | 0 360629 | 0 819349 | 0 60382 | 0 586086 | 0 447889 | 0 469128 | 1 352876 | 0 754523 | 0 372374 | 0 719351 | 0 473426 | 0 352729 | 0 631959 | 0 27133 |
| V | 1664 | 1281 | 2434 | 2350 | 2510 | 2423 | 2436 | 2555 | 2329 | 2593 | 3042 | 3354 | 2482 | 818 |
| VI | 0 068049 | 0 054348 | 0 098063 | 0 070224 | 0 119634 | 0 054752 | 0 070693 | 0 060227 | 0 043577 | 0 067048 | 0 043019 | 0 030648 | 0 064748 | 0 0033 |
| VII | 0 46 | 0 19 | 0 33 | 0 23 | 0 45 | 0 62 | 0 26 | 0 26 | 0 32 | 0 27 | 0 5 | 0 57 | 0 363636 | 0 09636 |

Appendix VII Potential targets for Wayanad district during 1990 91

| WYD | TVM | KLM | PTA | ALP | KTM | IDK | EKM | TSR | PLD | MLPM | KKD | KNR | KSGD | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 08688 | 0 13601 | 0 12289 | 0 12184 | 0 06826 | 0 10924 | 0 12127 | 0 10896 | 0 10063 | 0 06273 | 0 09153 | 0 11266 | 0 10612 | 0 11874 | 0 10622 | 0 01934 |
| 118 | 145 | 150 | 100 | 150 | 123 | 107 | 128 | 135 | 139 | 120 | 126 | 105 | 110 | 126 | 8 |
| 0 42591 | 1 30528 | 0 68723 | 0 68202 | 0 87353 | 0 53024 | 0 41951 | 0 55529 | 0 86938 | 1 01348 | 0 84768 | 0 38934 | 0 45941 | 0 57546 | 0 7083 | 0 28239 |
| 0 24686 | 0 86891 | 0 57378 | 0 6233 | 0 58296 | 0 46929 | 0 4519 | 1 44086 | 0 797 | 0 35858 | 0 36464 | 0 73059 | 0 44074 | 0 30545 | 0 616 | 0 36914 |
| 2640 | 1633 | 2681 | 2600 | 2844 | 3053 | 4107 | 3166 | 2914 | 1997 | 2906 | 3380 | 3225 | 3714 | 2940 | 300 |
| 0 05768 | 0 07348 | 0 05984 | 0 12267 | 0 08749 | 0 16109 | 0 08066 | 0 09892 | 0 08101 | 0 08391 | 0 05046 | 0 08689 | 0 04908 | 0 03895 | 0 08265 | 0 02497 |
| 0 68 | 0 16 | 0 2 | 0 33 | 0 2 | 0 41 | 0 57 | 0 23 | 0 24 | 0 42 | 0 3 | 0 26 | 0 45 | 0 52 | 0 33 | 0 35 |

Where I Agr cultural ncon e per hecta e
II Cropp ng n e s y
III Number of ag cultural workers per hec are
IV Cred t loans for agr culture per hectare
V Ra nfall
VI Fert l ze co sump on per l ectare
VII S ze of l old ngs

Appendix VIII Potential targets for Kannur district during 1990 91

| KNR | KNR | TVM | KLM | PTA | ALP | KTM | IDK | EKM | TSR | PLD | MLPM | KKD | KSGD | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 0 10612 | 0 13601 | 0 12289 | 0 12184 | 0 06826 | 0 10924 | 0 12127 | 0 10896 | 0 10063 | 0 06273 | 0 09153 | 0 11266 | 0 11874 | 0 10623 | 0 00011 |
| II | 105 | 145 | 150 | 100 | 150 | 123 | 107 | 128 | 135 | 139 | 120 | 126 | 110 | 128 | 23 |
| III | 0 45941 | 1 30528 | 0 68723 | 0 68202 | 0 87353 | 0 53024 | 0 41951 | 0 55529 | 0 86938 | 1 01348 | 0 84768 | 0 38934 | 0 57546 | 0 72904 | 0 26963 |
| IV | 0 44074 | 0 86891 | 0 57378 | 0 6233 | 0 58296 | 0 46929 | 0 4519 | 1 44086 | 0 797 | 0 35858 | 0 36464 | 0 73059 | 0 30545 | 0 6306 | 0 18986 |
| V | 3225 | 1633 | 2681 | 2600 | 2844 | 3053 | 4107 | 3166 | 2914 | 1997 | 2906 | 3380 | 3714 | 2916 | 309 |
| VI | 0 04908 | 0 07348 | 0 05984 | 0 12267 | 0 08749 | 0 16109 | 0 08066 | 0 09892 | 0 08101 | 0 08391 | 0 05046 | 0 08689 | 0 03895 | 0 08545 | 0 03637 |
| VII | 0 45 | 0 16 | 0 2 | 0 33 | 0 2 | 0 41 | 0 57 | 0 23 | 0 24 | 0 42 | 0 3 | 0 26 | 0 52 | 0 32 | 0 13 |

Appendix IX Potential targets for Palakkad during 1990 91

| LD | PLD | TVM | KLM | PTA | ALP | KTM | IDK | EKM | TSR | MLPM | KKD | KSGD | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 0 06273 | 0 136011 | 0 122894 | 0 121842 | 0 068256 | 0 109239 | 0 121275 | 0 108957 | 0 100626 | 0 091534 | 0 112655 | 0 118738 | 0 110184 | 0 047454 |
| II | 139 | 145 | 150 | 100 | 150 | 123 | 107 | 128 | 135 | 120 | 126 | 110 | 127 | 12 |
| III | 1 013478 | 1 305283 | 0 687232 | 0 682016 | 0 873531 | 0 530243 | 0 419514 | 0 555285 | 0 869376 | 0 847675 | 0 389344 | 0 57546 | 0 703178 | 0 3103 |
| IV | 0 358578 | 0 86891 | 0 573784 | 0 623302 | 0 58296 | 0 469295 | 0 451899 | 1 440856 | 0 796996 | 0 364638 | 0 730589 | 0 305445 | 0 655334 | 0 296756 |
| V | 1997 | 1633 | 2681 | 2600 | 2844 | 3053 | 4107 | 3166 | 2914 | 2906 | 3380 | 3714 | 3000 | 1002 |
| VI | 0 083909 | 0 073483 | 0 059836 | 0 122674 | 0 08749 | 0 161093 | 0 080656 | 0 09892 | 0 081015 | 0 050458 | 0 086888 | 0 038947 | 0 085587 | 0 001678 |
| VII | 0 42 | 0 16 | 0 2 | 0 33 | 0 2 | 0 41 | 0 57 | 0 23 | 0 24 | 0 3 | 0 26 | 0 52 | 0 310909 | 0 10909 |

Where I Agr cultural ncome per hectare
II Cropping intens ty
III Number of agr cultural workers per hectare
IV Cred t loans for agriculture per hectare
V Rainfall
VI Fert l zer consumpt on per hectare
VII S ze of hold ngs

Appendix X Potential targets for Kasargod during 1995 96

| | TVM | KLM | PTA | ALP | KTM | IDK | Ernakulam | TSR | PLD | MLPM | KKD | WYD | KNR | A M | POTENTI TARGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 | 0 284485 | 0 256714 | 0 274367 | 0 156377 | 0 245862 | 0 210342 | 0 243167 | 0 209123 | 0 122716 | 0 193977 | 0 225689 | 0 144044 | 0 206632 | 0 213346 | 0 0064 |
| | 134 | 153 | 120 | 145 | 122 | 108 | 127 | 132 | 155 | 125 | 130 | 160 | 130 | 133 9231 | 29 9230 |
| 6 | 1 305283 | 0 687232 | 0 682016 | 0 873531 | 0 530243 | 0 419514 | 0 555285 | 0 869376 | 1 013478 | 0 847675 | 0 389344 | 0 425906 | 0 45941 | 0 696792 | 0 12133 |
| 02 | 0 694418 | 0 440939 | 0 457313 | 0 463999 | 0 382515 | 0 315933 | 1 163763 | 0 616181 | 0 254984 | 0 259928 | 0 525809 | 0 157789 | 0 287081 | 0 463127 | 0 24752 |
| | 1706 | 2802 | 3064 | 2803 | 3251 | 3722 | 3552 | 3181 | 2191 | 3137 | 3751 | 2770 | 3376 | 3023 | 609 |
| 73 | 0 06097 | 0 047651 | 0 114763 | 0 081199 | 0 149282 | 0 056104 | 0 089931 | 0 07071 | 0 065393 | 0 043101 | 0 071474 | 0 042583 | 0 039136 | 0 071715 | 0 04214 |
| | 0 15 | 0 18 | 0 3 | 0 18 | 0 39 | 0 5 | 0 2 | 0 22 | 0 39 | 0 25 | 0 22 | 0 6 | 0 4 | 0 306154 | 0 1438 |

Appendix XI Potent al targets for Waynad district during 1995 96

| WYD | TVM | KLM | PTA | ALP | KTM | IDK | EKM | TSR | PLD | MLPM | KKD | KNR | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 144044 | 0 284485 | 0 256714 | 0 274367 | 0 156377 | 0 245862 | 0 243167 | 0 209123 | 0 225689 | 0 122716 | 0 193977 | 0 225689 | 0 206632 | 0 2204 | 0 076356 |
| 160 | 134 | 153 | 120 | 145 | 122 | 127 | 132 | 130 | 155 | 125 | 130 | 130 | 133 5833 | 26 4167 |
| 0 425906 | 1 305283 | 0 687232 | 0 682016 | 0 873531 | 0 530243 | 0 555285 | 0 869376 | 0 389344 | 1 013478 | 0 847675 | 0 389344 | 0 45941 | 0 716851 | 0 290945 |
| 0 157789 | 0 694418 | 0 440939 | 0 457313 | 0 463999 | 0 382515 | 1 163763 | 0 616181 | 0 525809 | 0 254984 | 0 259928 | 0 525809 | 0 287081 | 0 506062 | 0 348273 |
| 2770 | 1706 | 2802 | 3064 | 2803 | 3251 | 3552 | 3181 | 3751 | 2191 | 3137 | 3751 | 3376 | 3047 | 277 |
| 0 042583 | 0 06097 | 0 047651 | 0 114763 | 0 081199 | 0 149282 | 0 089931 | 0 07071 | 0 071474 | 0 065393 | 0 043101 | 0 071474 | 0 039136 | 0 075424 | 0 03284 |
| 0 6 | 0 15 | 0 18 | 0 3 | 0 18 | 0 39 | 0 2 | 0 22 | 0 22 | 0 39 | 0 25 | 0 22 | 0 4 | 0 258333 | 0 34167 |

Where I Agr cultural ncome per hectare
II Cropp ng ntens ty
III Number of agr cul ural workers per hectare
IV Ag cultu al loans per hectare
V Ra nfall
VI Fert l zer consumpt on per hectare
VII S ze of l o d ngs

Appendix XII Potential targets for Idukki during 1995 96

| K | IDK | TVM | KLM | PTA | ALP | KTM | EKM | TSR | PLD | MLPM | KKD | KNR | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 0 210342 | 0 284485 | 0 256714 | 0 274367 | 0 156377 | 0 245862 | 0 243167 | 0 209123 | 0 122716 | 0 193977 | 0 225689 | 0 206632 | 0 219919 | 0 009577 |
| I | 108 | 134 | 153 | 120 | 145 | 122 | 127 | 132 | 155 | 125 | 130 | 130 | 133 9091 | 2ɔ 90909 |
| II | 0 419514 | 1 305283 | 0 687232 | 0 682016 | 0 873531 | 0 530243 | 0 555285 | 0 869376 | 1 013478 | 0 847675 | 0 389344 | 0 45941 | 0 746625 | 0 ɔ27111 |
| V | 0 315933 | 0 694418 | 0 440939 | 0 457313 | 0 463999 | 0 382515 | 1 163763 | 0 616181 | 0 254984 | 0 259928 | 0 525809 | 0 287081 | 0 504266 | 0 18833ɔ |
| V | 3722 | 1706 | 2802 | 3064 | 2803 | 3251 | 3552 | 3181 | 2191 | 3137 | 3751 | 3376 | 2983 | 739 |
| VI | 0 056104 | 0 06097 | 0 047651 | 0 114763 | 0 081199 | 0 149282 | 0 089931 | 0 07071 | 0 065393 | 0 043101 | 0 071474 | 0 039136 | 0 075783 | 0 019678 |
| II | 0 5 | 0 15 | 0 18 | 0 3 | 0 18 | 0 39 | 0 2 | 0 22 | 0 39 | 0 25 | 0 22 | 0 4 | 0 261818 | 0 23818 |

Where I– Agricultural income per hectare
II Cropping intensity
III–Number of agricultural workers per hectare
IV–Credit loans for agriculture per hectare
V–Rainfall
VI– Fertilizer consumption per hectare
VII Size of holdings

Append x XIII Reg on wise d stance matrix 1970 71

| | | | | | | | | | *D* |
|---|---|---|---|---|---|---|---|---|---|
| FIRST | | 2 65 | 5 66 | 3 74 | 3 51 | 3 22 | 2 81 | 4 63 | 2 65 |
| SECOND | 2 65 | | 3 66 | 3 56 | 3 82 | 3 31 | 2 61 | 3 40 | 2 61 |
| THIRD | 5 66 | 3 66 | | 5 52 | 5 90 | 6 16 | 4 85 | 4 99 | 3 66 |
| FOURTH | 3 74 | 3 56 | 5 52 | | 3 24 | 3 93 | 3 05 | 3 09 | 3 05 |
| FIFTH | 3 51 | 3 82 | 5 90 | 3 24 | | 2 42 | 3 96 | 2 62 | 2 42 |
| SIXTH | 3 22 | 3 31 | 6 16 | 3 93 | 2 42 | | 4 38 | 2 88 | 2 42 |
| SEVENTH | 2 81 | 2 61 | 4 85 | 3 05 | 3 96 | 4 38 | | 4 14 | 2 61 |
| EIGHTH | 4 63 | 3 40 | 4 99 | 3 09 | 2 62 | 2 88 | 4 14 | | 2 62 |

| | | |
|---|---|---|
| μ | 2 75 | |
| σ | 0 39 | |
| 2* σ | 0 78 | |
| C D | μ+A | 3 53 |
| | μ A | 1 97 |

Where *D*– M n mum value of d s ance
μ Mean of m n mum value of d s ance
σ– S anda d dev a on of m n mum value of d s ance
A 2*standa d dev at on

Appendix XIV Region wise distance matrix for the Year 1980 81

| | | | | | | | | | *D* |
|---|---|---|---|---|---|---|---|---|---|
| FIRST | | 3 31 | 6 71 | 4 33 | 2 76 | 3 02 | 5 40 | 4 77 | 2 76 |
| SECOND | 3 31 | | 4 47 | 2 82 | 2 14 | 3 06 | 3 91 | 4 22 | 2 14 |
| THIRD | 6 71 | 4 47 | | 4 64 | 5 52 | 5 78 | 4 18 | 5 19 | 4 18 |
| FOURTH | 4 33 | 2 82 | 4 64 | | 3 42 | 3 19 | 3 45 | 3 25 | 2 82 |
| FIFTH | 2 76 | 2 14 | 5 52 | 3 42 | | 3 69 | 4 73 | 4 93 | 2 14 |
| SIXTH | 3 02 | 3 06 | 5 78 | 3 19 | 3 69 | | 3 33 | 2 21 | 2 21 |
| SEVENTH | 5 40 | 3 91 | 4 18 | 3 45 | 4 73 | 3 33 | | 2 88 | 2 88 |
| EIGHTH | 4 77 | 4 22 | 5 19 | 3 25 | 4 93 | 2 21 | 2 88 | | 2 21 |

| | | |
|---|---|---|
| μ | 2 67 | |
| σ | 0 65 | |
| 2* σ | 1 29 | |
| C D | μ+A | 3 96 |
| | μ A | 1 38 |

Where *D*– M n mum value of d stance
μ Mean of m n mum value of d stance
σ– Standa d dev a on of m n mum value of d stance
A 2*standard dev at on

Appendix XV Region wise distance matrix for the Year 1985 86

| | | | | | | | | | *D* |
|---|---|---|---|---|---|---|---|---|---|
| FIRST | | 4 06 | 5 44 | 3 11 | 4 33 | 4 08 | 5 39 | 5 61 | 3 11 |
| SECOND | 4 06 | | 2 52 | 2 97 | 3 59 | 3 37 | 2 97 | 3 68 | 2 52 |
| THIRD | 5 44 | 2 52 | | 3 93 | 5 07 | 4 66 | 2 60 | 4 99 | 2 52 |
| FOURTH | 3 11 | 2 97 | 3 93 | | 3 33 | 3 09 | 3 54 | 4 51 | 2 97 |
| FIFTH | 4 33 | 3 59 | 5 07 | 3 33 | | 3 38 | 4 73 | 5 56 | 3 33 |
| SIXTH | 4 08 | 3 37 | 4 66 | 3 09 | 3 38 | | 3 27 | 4 66 | 3 09 |
| SEVENTH | 5 39 | 2 97 | 2 60 | 3 54 | 4 73 | 3 27 | | 4 18 | 2 60 |
| EIGHTH | 5 61 | 3 68 | 4 99 | 4 51 | 5 56 | 4 66 | 4 18 | | 3 68 |

| | | |
|---|---|---|
| μ | | 2 98 |
| σ | | 0 39 |
| 2* σ | | 0 78 |
| C D | μ+A | 3 76 |
| | μ A | 2 20 |

Where *D*– M n mum value of d stance
μ Mean of m n mum value of d stance
σ– Standard dev a on of m n mum value of d stance
A 2*standa d dev at on

Appendix XVI Region wise distance matr x for the Year 1990 91

| | | | | | | | | | *D* |
|---|---|---|---|---|---|---|---|---|---|
| FIRST | | 4 22 | 6 41 | 2 98 | 3 25 | 4 63 | 5 38 | 6 01 | 2 98 |
| SECOND | 4 22 | | 3 13 | 2 95 | 3 38 | 3 55 | 2 18 | 3 71 | 2 18 |
| THIRD | 6 41 | 3 13 | | 4 58 | 5 79 | 5 73 | 3 19 | 5 57 | 3 13 |
| FOURTH | 2 98 | 2 95 | 4 58 | | 2 89 | 3 06 | 3 31 | 4 60 | 2 89 |
| FIFTH | 3 25 | 3 38 | 5 79 | 2 89 | | 2 89 | 3 88 | 4 78 | 2 89 |
| SIXTH | 4 63 | 3 55 | 5 73 | 3 06 | 2 89 | | 3 11 | 4 36 | 2 89 |
| SEVENTH | 5 38 | 2 18 | 3 19 | 3 31 | 3 88 | 3 11 | | 3 64 | 2 18 |
| EIGHTH | 6 01 | 3 71 | 5 57 | 4 60 | 4 78 | 4 36 | 3 64 | | 3 64 |

| | | |
|---|---|---|
| μ | 2 85 | |
| σ | 0 45 | |
| 2* σ | 0 90 | |
| C D | μ+A | 3 75 |
| | μ A | 1 95 |

Where *D*– M n mum value of d stance
μ Mean of m n mum va ue of d stance
σ– Standard dev at on of m n mum value of d s ance
A 2*standard dev at on

Appendix XVII Reg on wise distance matrix for the Year 1995 96

| | | | | | | | | | *D* |
|---|---|---|---|---|---|---|---|---|---|
| FIRST | | 4 32 | 6 22 | 3 18 | 3 76 | 4 30 | 5 41 | 5 91 | 3 18 |
| SECOND | 4 32 | | 3 33 | 3 16 | 3 78 | 3 89 | 2 51 | 3 72 | 2 51 |
| THIRD | 6 22 | 3 33 | | 4 43 | 6 42 | 5 58 | 4 28 | 4 57 | 3 33 |
| FOURTH | 3 18 | 3 16 | 4 43 | | 3 62 | 2 82 | 3 51 | 4 16 | 2 82 |
| FIFTH | 3 76 | 3 78 | 6 42 | 3 62 | | 3 52 | 3 62 | 5 02 | ɔ 52 |
| SIXTH | 4 30 | 3 89 | 5 58 | 2 82 | 3 52 | | 3 43 | 2 71 | 2 71 |
| SEVENTH | 5 41 | 2 51 | 4 28 | 3 51 | 3 62 | 3 43 | | 2 73 | 2 51 |
| EIGHTH | 5 91 | 3 72 | 4 57 | 4 16 | 5 02 | 2 71 | 2 73 | | 2 71 |

| | | |
|---|---|---|
| μ | 2 91 | |
| σ | 0 36 | |
| 2* σ | 0 72 | |
| C D | μ+A | 3 63 |
| | μ A | 2 19 |

Where *D* M n mum value of d stance
μ Mean of m n mum va ue of d stance
σ— Standard dev a on of m n mum value of d stance
A 2*standard dev a on

Appendix XVIII Potential targets for fifth region during 1970 71

| FIFTH | FIFTH | SECOND | THIRD | FOURTH | SEVENTH | EIGHTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|
| I | 0 01205 | 0 02466 | 0 03155 | 0 01648 | 0 01679 | 0 01421 | 0 02074 | 0 00869 |
| II | 117 | 146 | 120 | 177 | 170 | 122 | 147 | 30 |
| III | 0 86847 | 0 55473 | 0 4818 | 0 80718 | 0 55176 | 0 67469 | 0 6140 | 0 2544 |
| IV | 0 33143 | 0 26315 | 0 50081 | 0 46855 | 0 37536 | 0 42677 | 0 4069ɔ | 0 0755 |
| V | 2780 | 2641 | 2082 | 3015 | 2131 | 3451 | 2664 | 116 |
| VI | 0 01873 | 0 02481 | 0 03333 | 0 02337 | 0 02888 | 0 01195 | 0 02447 | 0 00574 |
| VII | 1 77 | 2 65 | 4 84 | 2 27 | 1 35 | 3 06 | 2 8ɔ4 | 1 064 |

Appendix XIX Potential targets for first region during 1970 71

| FIRST | FIRST | SECOND | THIRD | FOURTH | FIFTH | SEVENTH | EIGHTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|
| I | 0 02175 | 0 02466 | 0 03155 | 0 01648 | 0 01205 | 0 01679 | 0 01421 | 0 01929 | 0 0025 |
| II | 160 | 146 | 120 | 177 | 117 | 170 | 122 | 142 | 18 |
| III | 0 74964 | 0 55473 | 0 4818 | 0 80718 | 0 86847 | 0 55176 | 0 67469 | 0 65644 | 0 0932 |
| IV | 0 165 | 0 26315 | 0 50081 | 0 46855 | 0 33143 | 0 37536 | 0 42677 | 0 39435 | 0 22935 |
| V | 2127 | 2641 | 2082 | 3015 | 2780 | 2131 | 3451 | 2683 | 556 |
| VI | 0 01633 | 0 02481 | 0 03333 | 0 02337 | 0 01873 | 0 02888 | 0 01195 | 0 02351 | 0 00719 |
| VII | 1 21 | 2 65 | 4 84 | 2 27 | 1 77 | 1 35 | 3 06 | 2 65667 | 1 44667 |

Wl ere I Agr cultural ncome per hectare
II Cropp ng ın ens ty
III Number of agr cultural workers per hectare
IV Cred t loans for agr culture per hectare
V Ra nfall
VI Fert l zer consumpt on per hecta e
VII S ze of hold ngs

Appendix XX Potential targets for first region during 1980 81

| FIRST | FIRST | SECOND | THIRD | FOURTH | FIFTH | SIXTH | SEVENTH | EIGHTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|---|
| I | 0 0228 | 0 03942 | 0 06733 | 0 02206 | 0 01679 | 0 01798 | 0 02063 | 0 01806 | 0 0289 | 0 0061 |
| II | 158 | 146 | 127 | 148 | 158 | 125 | 124 | 105 | 133 286 | 24 714 |
| III | 1 28085 | 1 04735 | 0 85535 | 0 94652 | 1 18576 | 1 05559 | 0 61778 | 0 91795 | 0 94661 | 0 3342 |
| IV | 0 216 | 0 27261 | 0 67866 | 0 49248 | 0 35584 | 0 20189 | 0 36816 | 0 41838 | 0 39829 | 0 18229 |
| V | 1813 4 | 2913 1 | 3451 8 | 4240 8 | 2089 | 3286 7 | 3739 9 | 3826 7 | 3364 | 1550 6 |
| VI | 0 02454 | 0 04056 | 0 03962 | 0 03423 | 0 04096 | 0 02461 | 0 03028 | 0 02238 | 0 03323 | 0 00869 |
| VII | 0 2 | 0 53 | 1 82 | 0 3 | 0 56 | 0 5 | 1 61 | 0 6 | 0 84571 | 0 64571 |

Appendix XXI Potential targets of fifth region during 1985 86

| FIFTH | FIFTH | SECOND | THIRD | FOURTH | SEVENTH | EIGHTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|
| I | 0 01373 | 0 06948 | 0 06982 | 0 02025 | 0 04474 | 0 05538 | 0 05194 | 0 03821 |
| II | 149 | 143 | 125 | 145 | 123 | 165 | 140 2 | 8 8 |
| III | 1 18576 | 1 04735 | 0 85535 | 0 94652 | 0 61778 | 0 91795 | 0 87699 | 0 3088 |
| IV | 0 36063 | 0 57258 | 0 78187 | 0 75452 | 0 54206 | 0 42935 | 0 61608 | 0 25545 |
| V | 1482 7 | 2008 4 | 2048 5 | 2170 7 | 2178 05 | 3256 | 2332 33 | 849 63 |
| VI | 0 0688 | 0 05252 | 0 05925 | 0 052 | 0 0453 | 0 03001 | 0 04781 | 0 021 |
| VII | 0 46 | 0 78 | 1 33 | 0 26 | 1 08 | 1 07 | 0 904 | 0 444 |

Wl ere I Agr cultural ncome per hectare
II Cropp ng ntens ty
III Number of agr cultural workers per hectare
IV Cred t loans for agr culture per hectare
V Ra nfall
VI Fert l zer consumpt on per hectare
VII S ze of hold ngs

Appendix XXII Potential targets for fifth region during 1990 91

| FIFTH | FIFTH | FIRST | SECOND | THIRD | FOURTH | SEVENTH | EIGHTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|
| I | 0 06273 | 0 136011 | 0 312992 | 0 339471 | 0 100626 | 0 19954 | 0 224859 | 0 218917 | 0 156186 |
| II | 139 | 145 | 133 7473 | 119 5891 | 135 | 122 4835 | 161 9558 | 136 ?96 | 2 70405 |
| III | 1 013478 | 1 305283 | 0 746352 | 0 506211 | 0 869ɔ76 | 0 405884 | 0 499612 | 0 72212 | 0 29136 |
| IV | 0 349543 | 0 890317 | 0 553249 | 0 805429 | 0 795108 | 0 513872 | 0 366192 | 0 654028 | 0 304485 |
| V | 1997 325 | 1633 25 | 2708 371 | 3441 817 | 2913 8 | 3009 835 | 3469 663 | ?862 789 | 865 4641 |
| VI | 0 083909 | 0 073483 | 0 084274 | 0 115716 | 0 081015 | 0 074518 | 0 045515 | 0 079087 | 0 00482 |
| VII | 0 42 | 0 16 | 0 73 | 1 21 | 0 24 | 0 94 | 0 97 | 0 7083 3 | 0 288333 |

Appendix XXIII Potential targets for fifth region during 199ɔ 96

| FIFTH | FIFTH | SECOND | THIRD | FOURTH | FIFTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|
| I | 0 122716 | 0 687458 | 0 699371 | 0 209123 | 0 36973ɔ | 0 491421 | 0 368706 |
| II | 155 | 142 | 119 | 1ɔ2 | 147 | 135 | 20 |
| III | 1 013478 | 0 746352 | 0 506211 | 0 869376 | 0 405884 | 0 631956 | 0 38152 |
| IV | 0 254984 | 0 452123 | 0 621355 | 0 616181 | 0 352757 | 0 510604 | 0 25562 |
| V | 2190 65 | 2889 658 | 3508 633 | 3180 6 | 3260 175 | 3209 767 | 1019 117 |
| VI | 0 065393 | 0 074161 | 0 097735 | 0 07071 | 0 057889 | 0 075124 | 0 009731 |
| VII | 0 39 | 0 66 | 1 09 | 0 22 | 0 82 | 0 6975 | 0 3075 |

Where I Agr cultural ncome per hectare
II Cropping ntens ty
III Number of agr cultural workers per hec are
IV Cred t loans for agr culture per hecta e
V Ra nfall
VI Fert l zer consumption per hecta e
VII S ze of hold ngs

Appendix XXIV Potent al targets of first reg on during 1985 86

| FIRST | FIRST | SECOND | THIRD | FOURTH | FIFTH | SEVENTH | EIGHTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|
| I | 0 02451 | 0 06948 | 0 06982 | 0 02025 | 0 0 373 | 0 04474 | 0 05538 | 0 04557 | 0 02106 |
| II | 155 | 43 | 125 | 145 | 149 | 123 | 165 | 141 667 | 13 333 |
| III | 1 28085 | 1 04735 | 0 85535 | 0 94652 | 1 18576 | 0 61778 | 0 91795 | 0 92845 | 0 3524 |
| IV | 0 81935 | 0 57258 | 0 78187 | 0 75452 | 0 36063 | 0 54206 | 0 42935 | 0 5735 | 0 2458 |
| V | 1133 4 | 2008 4 | 2048 5 | 2170 7 | 1482 7 | 2178 05 | 3256 | 2190 73 | 1057 33 |
| VI | 0 03268 | 0 05252 | 0 05925 | 0 052 | 0 0688 | 0 045ɔ | 0 0ɔ001 | 0 05131 | 0 01863 |
| VII | 0 19 | 0 78 | 1 33 | 0 26 | 0 46 | 1 08 | 07 | 0 8 | 0 64 |

Appendix XXV Potential targets for f rst reg on during 1990 91

| FIRST | FIRST | SECOND | THIRD | FOURTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|
| I | 0 136011 | 0 312997 | 0 339471 | 0 100626 | 0 2510 | 0 115019 |
| II | 145 | 133 7473 | 19 5891 | 135 | 129 4455 | 15 5545 |
| III | 1 305283 | 0 746357 | 0 506211 | 0 869376 | 0 707313 | 0 59797 |
| IV | 0 890317 | 0 553249 | 0 805429 | 0 795108 | 0 717929 | 0 17239 |
| V | 1633 25 | 2708 371 | 3441 817 | 2913 8 | 3021 329 | 1388 079 |
| VI | 0 073483 | 0 084274 | 0 5716 | 0 081015 | 0 093668 | 0 020185 |
| VII | 0 16 | 0 7ɔ | 1 21 | 0 24 | 0 726667 | 0 566667 |

Wl ere I Ag cultu al ncome per hec a e
II Cropp ng ntens ty
III Numbe of agr cultural orke s per l ec are
IV Cred loans for agr cu ture per hec a e
V Ra nfal
VI Fert zer consumpt on pe ec a e
VII S ze of l o d ngs

Appendix XXVI Potential targets for first region during 1995 96

| FIRST | FIRST | SECOND | THIRD | FOURTH | FIFTH | SEVENTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|
| I | 0 284485 | 0 687458 | 0 699371 | 0 209123 | 0 122716 | 0 369733 | 0 41768 | 0 133195 |
| II | 134 | 142 | 119 | 132 | 155 | 147 | 139 | 5 |
| III | 1 305283 | 0 746352 | 0 506211 | 0 869376 | 1 013478 | 0 405884 | 0 70826 | 0 59702 |
| IV | 0 694418 | 0 452123 | 0 621355 | 0 616181 | 0 254984 | 0 352757 | 0 45948 | 0 23494 |
| V | 1705 5 | 2889 658 | 3508 633 | 3180 6 | 2190 65 | 3260 175 | 3005 943 | 1300 443 |
| VI | 0 06097 | 0 074161 | 0 097735 | 0 07071 | 0 065393 | 0 057889 | 0 073178 | 0 012208 |
| VII | 0 15 | 0 66 | 1 09 | 0 22 | 0 39 | 0 82 | 0 636 | 0 486 |

Appendix XXVII Potential targets for eighth region during 1995 96

| EIGHTH | EIGHTH | FIRST | SECOND | THIRD | FOURTH | FIFTH | SEVENTH | A M | POTENTIAL TARGET |
|---|---|---|---|---|---|---|---|---|---|
| I | 0 4264 | 0 284485 | 0 687458 | 0 699371 | 0 209123 | 0 122716 | 0 369733 | 0 395481 | 0 03092 |
| II | 122 | 134 | 142 | 119 | 132 | 155 | 147 | 138 1667 | 16 16667 |
| III | 0 499612 | 1 305283 | 0 746352 | 0 506211 | 0 869376 | 1 013478 | 0 405884 | 0 807764 | 0 308152 |
| IV | 0 261111 | 0 694418 | 0 452123 | 0 621355 | 0 616181 | 0 254984 | 0 352757 | 0 498636 | 0 237525 |
| V | 3504 325 | 1705 5 | 2889 658 | 3508 633 | 3180 6 | 2190 65 | 3260 175 | 2789 203 | 715 122 |
| VI | 0 035662 | 0 06097 | 0 074161 | 0 097735 | 0 07071 | 0 065393 | 0 057889 | 0 071143 | 0 035481 |
| VII | 0 85 | 0 15 | 0 66 | 1 09 | 0 22 | 0 39 | 0 82 | 0 555 | 0 295 |

Where I– Agricultural income per hectare
II– Cropping intensity
III–Number of agricultural workers per hectare
IV–Credit loans for agriculture per hectare
V Rainfall
VI– Fertilizer consumption per hectare
VII Size of holdings

# SPATIAL AND TEMPORAL VARIATIONS IN THE DEVELOPMENT OF AGRICULTURE IN KERALA

By

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## ABSTRACT OF THE THESIS

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## ABSTRACT

Agricultural scenario of Kerala is unique as compared to other states of India The present study entitled Spatial and temporal variations in the development of agriculture in Kerala was undertaken mainly with an objective of constructing composite indices to quantify the development of agriculture based on suitable indicator variables for each district or region of Kerala The significance of the districtwise and temporal disparities in agricultural development have been studied The agricultural growth with respect to acreage and gross production of major crops is also estimated using different growth curves

The time series data from 1970 71 to 1997 98 collected from State Planning Board and Directorate of Economics and Statistics Government of Kerala Trivandrum were used for the study As all the districts were not present before 1985 86 state was divided into several regions Districts wise analysis was carried out from 1985 86 to 1997 98 whereas region wise analysis was carried out from 1970 71 to 1997 98

For measuring the diversification level of districts or regions five indices viz Herfindahl Index Entropy Index Modified Entropy Index Composite Entropy Index and Ogive Index were computed All the quantitative indices were constructed by using the total cropped area of seven major crops of Kerala It was found that in most of the periods the diversification in cropping pattern was mainly towards plantation crops The most diversified district was Kollam where the cropping pattern had equal importance to all the major crops Based on the real situation out of the five measures of diversification Composite Entropy Index was found to be better suited It was also noticed that as time progressed the diversification level among the districts or regions decreased

The Compound growth rates of both production and acreage were computed and it was found that rubber recorded the highest C G R The food crops v z r ce and tapioca showed negative C G R whereas cash crops viz coconut an l pepper showed positive C G R for both production and acreage

Productivity ndex were constructed for each distr ct taking nto consideration tl e v riety of c ops a d thei el t ve importance i n a part cular d str ct 11 e res lt revealed that different d stricts behaved differently with respect to the rate of growtl of productivity

Development is a multidimensional process so nstead of analys ng a s gle var able composite index or development index for different districts or regions were computed by using several indicators wh ch contributed to the development of agr culture In the present study three methods were used to compute the development index based on seven indicators

In the first approach i e Taxonomic approach during 1985 86 1990 91 and 1995 96 Ernakulam occupied the first place in agriculture development However Wayanad and Kasargode were the two least agriculturally developed districts during the above said periods It was also observed that there was hardly any change in the level of development of agriculture over different periods of study

In Taxonomic approach each variable was cons dered to have equal contribution towards the development of agriculture However it s unlikely to happen so With this fact the Taxonomic approach was modified in Mod f ed Taxonomic approach by giving separate weightage to the indicators based on the score given by experts In the present study separate weightage did not have any significant impact on the classification of districts or regions on their agricultural development status Obviously the selected variables might be highly correlated

Characteristics in biological experiment are highly correlated In the present study Principal Component analysis was used to overcome this problem The first component of both district wise and region wise analysis contributed around 99 5 per cent of total variation Therefore without loosing any information supplied by the seven variables the first component score was taken as the composite index of development Hence in the present context Principal Component analysis could be considered as the best method as no approximation is involved It could be considered as a more comprehensive method

The Potential targets for the under developed districts or regions are also estimated to assess the position of those districts or regions compared to the model districts or regions Accordingly suitable development programmes can be launched or special care can be taken to allocate resources optimally on per capita basis to reduce spatial disparities in development