STATISTICAL ANALYSIS OF ECONOMIC ACTIVITIES FOR REGIONAL DEVELOPMENT IN NEPAL

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Abstract

The main objective of this study has been the statistical analysis by the use of those statistical and quantitative tools that could be considered appropriate for applications in an underdeveloped economy, where in usually lies sufficient data and information gaps, towards a proper diagnosis of the problems and prospects of economic activities in its diversified regional environments. This study is conducted with reference to an underdeveloped country, Nepal, where detailed regional analyses have hardly been attempted earlier, to evaluate the regional structures of economic activities for the purpose of clarifying our visions for a proper kind of regional planning. Though Nepal is a small country, the variations in its topographical features are so pronounced that wide diversities in economic activities have been resulted, shaping the destiny of the people at different regional settings. In the absence of appropriate statistical analysis for the evaluation of detailed regional structures, the national plans of Nepal, despite all good intentions for regional developments expressed in the plan documents, have hardly been successful towards improving the economic conditions of people, in general, and also reducing the ~~general~~ regional disparities in developmental activities in particular.

The statistical and quantitative tools that have been applied with success in this dissertation can be broadly summa-

rised as follows:

(a) Because of the poor reliability of data and data-base as exist in Nepal, we have often relied on more than one measures for every economic activity considered and relevant regional indices have been formulated for those activities by various applications of multivariate statistical methods and these regional indices have been used for the depictions of diversified regional structures. Some of the main regional indices thus formulated are: (i) development index of agricultural and allied activities, (ii) composite index of industrial activities, (iii) composite index of tertiary and allied activities, (iv) development index of non-agricultural activities, (v) the over-all development index of all activities etc.

(b) As the theme of the study falls in the inter-disciplinary field of Regional Science - involving mainly Statistics, Geography and Economics in our case - it has been necessary for us to quantify some of the qualitative geographical features for making them amenable to statistical analysis with other quantitative variables. Here also the dependability of our quantifications have been enhanced by the use of the multivariate statistical approach and thus we have constructed, for example, a very important index like "the index of ruggedness" that has been shown to influence major economic activities such as those based on soil resources (like arable cropping) or those affected by terrain types (like transportation activity), etc.

(c) Various multivariate regression analyses have been used to identify relationships between different activities of development and their explanatory factors. In this way, we could identify the factors responsible for regional variations in developmental levels, growth of activities, population concentration, etc. At times we have determined conditional global regressions with the use of appropriate dummy variables when free global relations could not be depicted for the varying nature of terrains present in the country.

(d) Analysis on the growth of certain important activities have been attempted through various quantitative tools. Particularly, for the regional growth analysis of agricultural production, a quantitative model for the decomposition of growth by components has been used and the relative importance of those components in explaining the varying regional growth rates have been evaluated by use of certain advanced regression techniques.

(e) Linear Programming Techniques have been used to identify optimal transportation tasks and their changes over time in relation to the distributions of foodgrains between surplus and deficit areas (districts) within different zones and also those between different zones in Nepal. In applying these techniques the prevalent transportation orientations under the diversified ruggedness conditions of terrains have been given a due consideration.

(f) Analytic tools have been used for the regional production function analysis of the over-all manufacturing activities. Modified production models have however been used to suit our regional analysis, especially with the evaluation of technical efficiency. Unlike the usual analysis, we have evaluated the technical efficiency considered as to be constituted not only of (i) the internal technology factor of efficiency alone, but also of (ii) the localisation performance factor of efficiency.

(g) Quantitative methods have also been used for (i) the regional demand predictions through the analysis of norms and expenditure elasticities of various consumer items (ii) the regional prediction of the addition to labour force expect in future in various regions and also, (iii) the evaluation of the possible expenditure and income growth paths.

Our approaches and principles for the regional analysis have been the (i) examinations of regional variations of different economic activities, resources and facilities, and also the factors that influence them, with mostly the district level dat (all 75 districts) in order to identify the existing regional patterns of economic activities, (ii) setting the prospective patterns of regional economic activities, over a chosen time horizon, as should be desired or could be predicted on the basi of detailed analysis of requirements for the spatially varying growing population, and (iii) determination of the enhanced tas of productive and welfare activities on the basis of which our visions for regional development planning measures could be clarified and thereby the detailed decisions on planning measur could be chalked out on a firm footing.

Along these lines regional studies on economic activiti have been attempted in the dissertation in five chapters, entit

I Scope and objective of the study

II Agriculture and allied activities

III Industrial activities

IV Spatial analysis of subsidiary activities and facilities, and

V Synthetic regional analysis.

CHAPTER I

THE SCOPE AND OBJECTIVE OF THE PRESENT STUDY

1.1 Introduction

At the very beginning we emphasize that the main objective of the present study is to explore how the different statistical methods and techniques could be fruitfully utilized in understanding the problems and prospects of economic activities for the purpose of regional development planning in Nepal. Further it should be noted that a regional development planning approach is more generalised than a national development planning approach, since the "regional" or "spatial" dimension is incorporated explicitly in the former in addition to what is done in the latter. The explicit consideration of the "spatial" dimension is a must in a country where spatial variations in economic activities, their associations and linkages are present. Such variations are always present in large countries, for example, India and China, the two neighbouring countries of Nepal, because of their vastness in geographical size. Our present study is with reference to Nepal which is not a big country. Yet the variations in its topographical feature are so pronounced that the country could not but have wide diversities in economic activities shaping the destiny of the people of Nepal at different regional environments. But it is surprising that a great majority of the economic activity and growth analyses has been done for the country as a whole in many countries including Nepal. These analyses are mainly based on temporal variations alone, without the incorporation of spatial variations [McNee, 1959]. As such many non-spatial national planning framework which eliminated the consideration of the spatial variables from the decision - making processes did not have the desired spatial distribution of developmental activities. In them, the benefits of planning process did not "trickle down" to the bottom level of human settlements. For example, the Nepalese plans and the early Indian plans are of this type. In the absence of appropriate statistical analyses with spatial variables, there were only good intensions but no visions for regional developments in those national planning frameworks. To carry out good intensions for regional deve-lopments into practice, an appropriate spatial analysis of economic activities must precede the actual regional deve-lopment plan formulation. Detailed spatial analysis for the purpose of regional development plan formulations had not been done in Nepal, even though there were signs of awareness for regional developments in recent national plan formulati

Our effort in this study is thus to make appropriate statistical analyses with a due recognition of spatial variables on economic activities with the objective of providing guidelines for regional plan formulations in Nepal.

This kind of spatial analysis falls within the multidisciplinary field of what Isard's group (Philadelphia School of Regional Science) calls "Regional Science". Detailed discussions are available on the concept of Regional science in a seminar paper contributed by Isard et al [1958]. In a discussion paper offered on the above mentioned seminar paper, Preston [1958] observes that regional science has "a very promising application of statistical methods to problems that lie on the border between economics and geography". Isard, et al [1958] consider that a systems approach is preferable in analysing the problems of regional science. According to them "a systems approach consists of defining the structural units of a system and the relations which bind them as a system". The concept of regional systems has been discussed in considerable details by Pal [Pal, 1974]. "Regions" can be considered as the structural units of regional systems. By empirical examinations of relevant literature, Hartshorne [1958] has observed the use of the word 'region' to express any of the following three concepts.

Ad-hoc regions: or a regions inthe general sense, is simply a particular piece of area which may be in some way distinctive from other areas;

Formal regions: or a homogeneous or uniform region, is an area within which the variations of one or more selected features fall within a certain narrow range;

Functional regions: or a region of coherent organisation or a nodal region, is an area in which one or more selected phenomena of movement connect the diverse locations within it into a functionally organized unit.

The delineation of formal or functional regions, i.e., the formal or functional regionalisations are then to be based on certain spatial variables and spatial linkage variables depending on the context of study. Formal regionalisation is nothing but an identification of formal regional structure or regional configuration with reference to the conte of study. Functional regionalisation is established on th basis of certain spatial interactions between locations or areas with certain formal structures. But ad-hoc regions which are taken for granted for certain studies are not delineated and as such they have none of the defining features of a regional system to start with. For example, although the Nepalese topographic zones are formal regio topographically, they are really ad-hoc regions when they are used for planning purposes [for details see, Gurung, 1973]. As these ad-hoc regions are being used to control the planning activities in Nepal, they can be treated as "controlling sub-system" [for definition see, Hermansen, 1969] provided the planning objects, their attributes and interactions within such ad-hoc regions are fully evaluated. ~~But such evaluations are not in sight in Nepal [Gurung, 1973].~~ Nor there were studies with relevant spatial variables on formal and functional regionalisations in the context of economic development planning in Nepal. In our present study, Nepal is treated as a regional system (strictly speaking, a sub-national regional system). Our objective here is to evaluate this regional system with reference to certain decision-problems of its major economic activities. Our statistical analyses are aimed at fulfilling this objective. Certain known salient features of our universe of study, namely Nepal, are summarised below.

1.2 Salient Features of Nepal

1.2.1 Physical background*

Sandwiched between two vast countries India and China, Nepal is a tiny rectangular shaped country of 145 thousand sq. km. area on the lap of Himalayas. This Himalyan kingdom lies between 80° 4' - 88° 12' E longitude and 26° 22' - 30° 27' N latitude [Ministry of Health, 1976]. The country has an average length of 800 km. east-west and a breadth of about 175 km. north-south.

In structure and landforms Nepal is a part of the wider picture including the world's greatest 'fold' mountains the 'Himalaya' with the high 'oldland' crystalline plateau of Tibet on their northern flank, while to the south of them lies one of the world's great alluvial plains, the Indus - Ganga - Brahmaputra plain. While deep under the alluvium, it is thought there must lie northerly extension of the 'Gondwanaland' - the oldland crystalline block of penninsular and plateau India. The Gondwanaland block is now thought of as part of the world pattern of crustal plate movement, and

* In writing this sub-section the author has depended to some extent upon his discussions with Professor A.T.A. Learmonth, The open university (U.K.), who was a visiting Professor to the Indian Statistical Institute during December 1981 - February 1982.

probably moved northward, plunging under the crumpled folds of Tertiary sediments accumulated in the then great mediterranean sea called "Tethys" by the geologists, and perhaps even under the Tibetian oldland massif. The relative motion of convergence of the two oldlands is conceived as the tectonic mechanism for the folding and crumpling. The recumbent folds account for the fact that in places of fossils, sequences are reversed as compared with the order in which they were deposited. The emerging structural pattern and landform has been depicted in figure 1.1.

In this figure three lines, demarcating broad topographic divisions of Nepal, have also been shown. From north to south there are really three major zones running from west-northwest to east-southeast in consonance with the main structural lines of the Himalayas. Southern most zone can however be divided strictly into two sub-zones, namely, Inner Tarai and outer Tarai. These zones are as follows:

1. The Great Himalayas (popularly known as mountain area)

2. The Middle ranges or lesser Himalaya (popularly known as Hill area)

3.a The Churia hills linked with siwalik hills extending west-northwestwards into India. This is really the southernmost foot-hill range of the Himalaya (popularly known as Inner Tarai area).

3.b Almost flat foot-hill belts extending both east-southeast and west-northwestwards into India - the northern part of Indus-Ganga plain (popularly known as Tarai area).

The mountain area ranges in altitude from 4880 meters to 8848 meter above sea level and includes the famous mountain peaks such as Everest, Kanchanjunga, Makalu, Dhaulagiri, Annapurna, etc. The hill area ranges from an altitude of 300 meter to 4880 meter. The valleys like Kathmandu and Pokhara are included in this region. The Tarai area ranges from 60 meters to 300 meters above sea level and includes some of the most fertile land in the country.

Different types of soils and a wide range of climates are found in Nepal. The types of soils as have been formed on different rocks and perennial material under tropical, sub-tropical, temperate and alpine climatic conditions can broadly be summarised [For detail see, APROSC, 1978b] as follows:

Region	Rock and Parent Materials	Climate
Great Himalayas	Gravite, gneiss, migmites	Alpine and sub-alpine
Middle Himalayas	Phyllite, schist and shale	Temperate and sub-tropical
Churia Hills	Shale, sandstone and conglomerates	Tropical and sub-tropical
{Other Inner Tarai { outer Tarai	Gravels, sand, silt and clay	Tropical

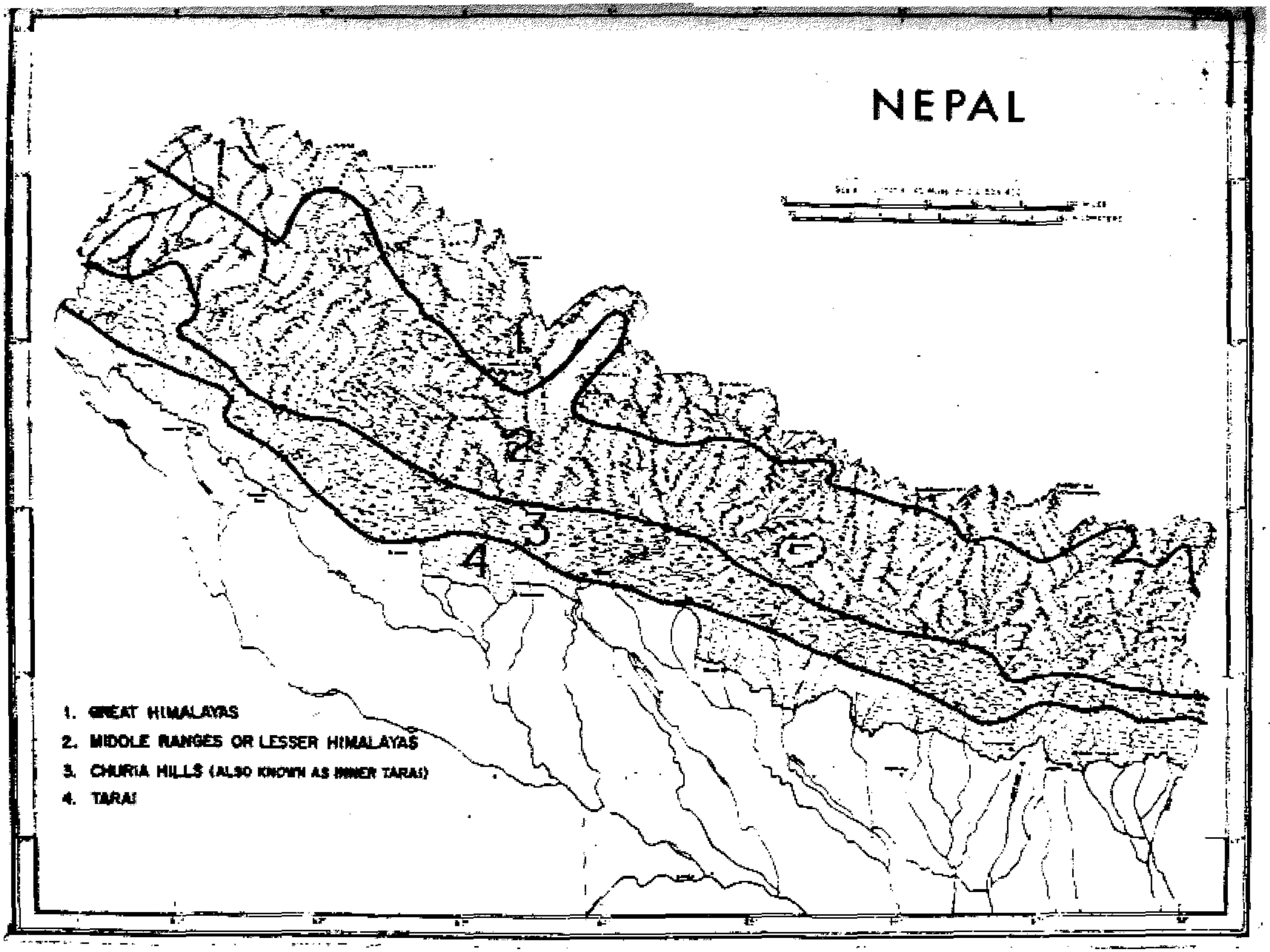


FIG-1·1: STRUCTURAL PATTERN AND LANDFORMS

FIG-1'2. RIVER SYSTEM OF NEPAL

These topographic zones of Nepal can be further sub-divided by the transverse river valley system. The major river systems are the Karnali in far-western part, Gandaki in the western part and Koshi in the eastern part of Nepal. The Department of hydrology and Meteorology has however identified the central part which is in between the eastern and western part of the country. This central part is really formed by the eastern tributary of Gandaki, western tributary of Koshi and also the Bagmati river system. These rivers originate in the Himalayas, flow ultimately to the south and have a well developed network of tributaries. The amount of water which flows is capable of irrigating vast area of land especially in the Tarai [see fig. 1.2].

Combining the three topographic zones with the above four hydrological divisions, we could get twelve topographic sub-zones which have been referred to planning sub-regions by Gurung [1973]. These sub-regions have been adjusted with the existing district boundaries. These ad hoc sub-regions together with the boundaries of all 75 districts of the kingdom are shown in fig.1.3. Gurung [1973] has however not identified these sub-regions as ad hoc sub-regions. But we have added this 'adjective' "ad hoc" according to our definition discussed in sub-section 1.1.

The detailed knowledge of the geological formations and their associated minerals is meagre in Nepal [Karan and Jenkins, 1958]. According to an World Bank report [1979a], Nepal is not known to possess large and commercially exploitable minerals. This is somewhat supported by Karan et al's analysis of geological formation in relation to minerals in Nepal.

Nepal receives a rainfall mostly from the southwest monsoon and it occurs between mid June and mid September. The average rainfall in a normal year is estimated to be 1400 mm. [Department of Hydrology and Meteorology, 1977]. Nepal is a small country but because of the disturbances at different parts of the Himalayan ranges, the amount of rainfall varies from place to place, particularly the southern Himalayan slopes receive more rainfall than its northern slope. The precipitation isohyets as prepared by the Department of Hydrology and Meteorology is reproduced in fig.1.4 which shows the detailed pattern of variations.

1.2.2 Economic background

The broad economic background of Nepal as are available in various existing publications is summarised below.

According to A. Sen's [1980] comparative study between nations through different economic indicators, Nepal is one of

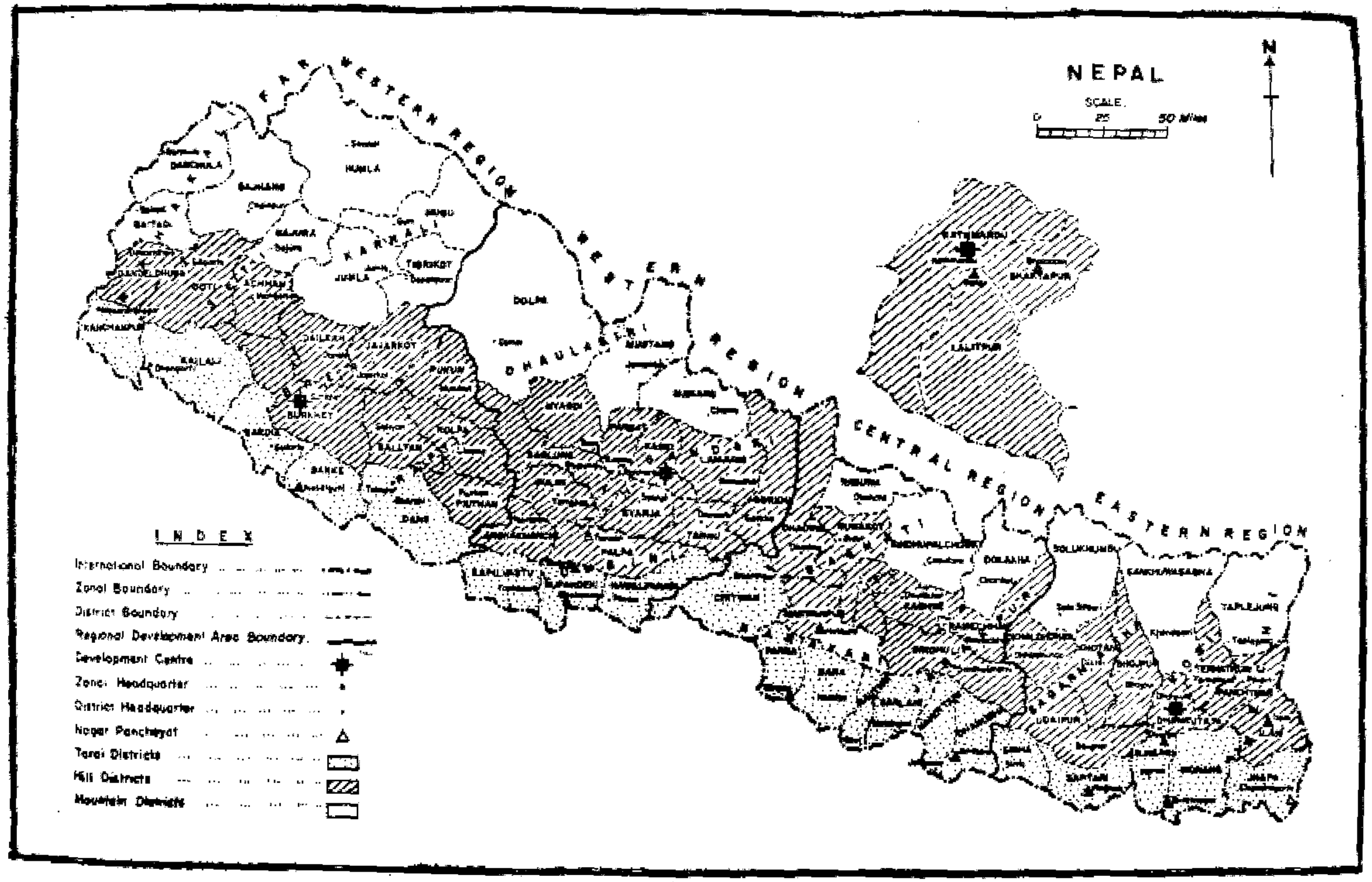


FIG-13: PLANNING SUB-REGIONS

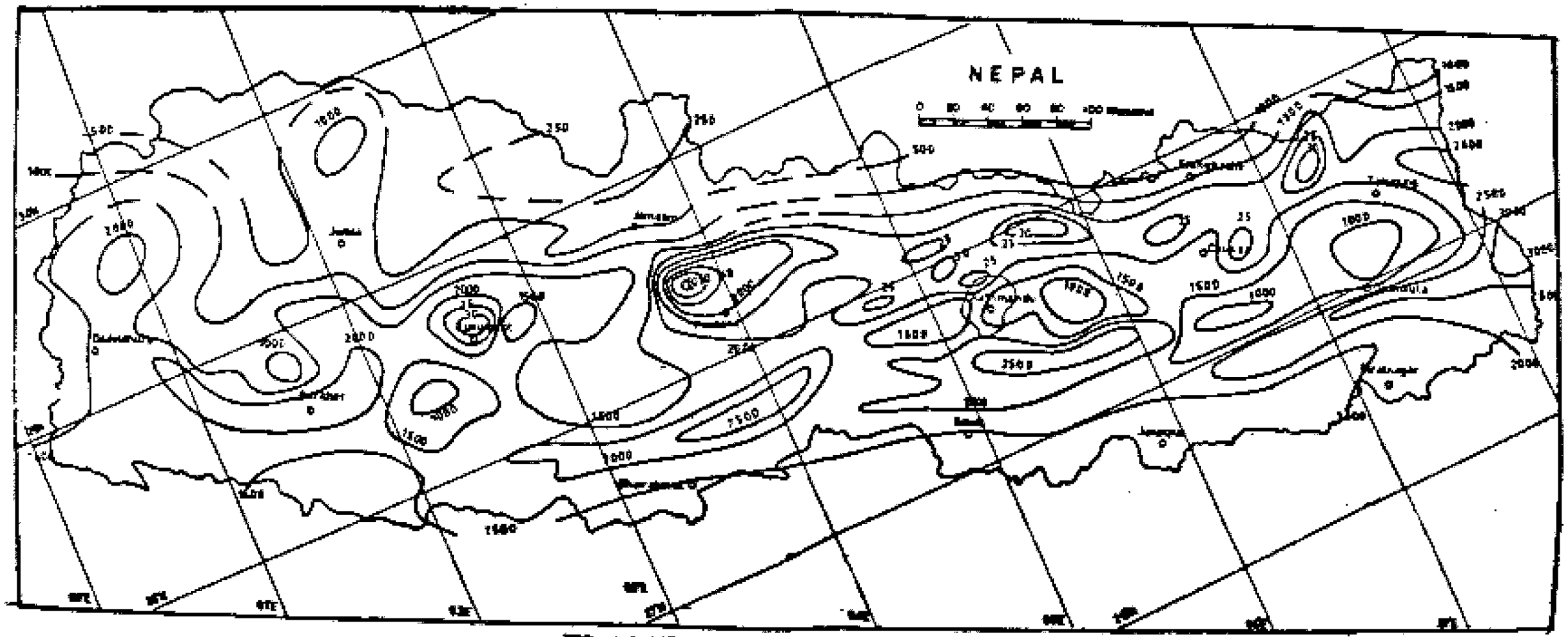


FIG-1·4: MEAN ANNUAL PRECIPITATION mm 1951-1970 the poorest countries in the world. It is however in the path of progress after mid-fiftees when efforts for development were initiated through planning approach. However its rapidly growing population, relatively weak resource base - particularly for industrialisation, inaccessibility due to ruggedness of the terrain, the landlocked position, relatively young administration have made its development task a formidable one. At the moment Nepal is predominently an agricultural country providing employment for about 94 per cent of economically active population. The World Bank report [1979b] gives an estimate of per capita income (GDP) of about N. Rs.1440.00 (equivalent to 120 U.S. dollar) in 1974-75. The agricultural sector accounted for more than 67 per cent of national GDP in 1974-75. The export earning is also mainly from agricultural sector (86 per cent in 1974-75). The landuse statistics shows that almost 40 per cent of the total area in Nepal is unproductive consisting of barren land, area under perpetual snow and so on [Agricultural statistics of Nepal, 1977]. The actual area under cultivation is about 2.326 million hectare (16.37 per cent of total land area). About 34 per cent of total geographic area is under natural vegetation or forest cover. The mountain area accounts for almost 34 per cent of total land area of the country but accommodate some 11 per cent of the total population (CBS, 1971) and about 4 per cent of cultivated land. The hill area accounts for 43 per cent of the total land, accommodates more than 51 per cent of the total population and about 23 per cent of cultivated land; where as the Tarai covering less than 23 per cent of the total land area accommodates over 38 per cent population and almost 73 per cent cultivated land. The population density of Nepal in 1971 was 127 persons per sq. km. which is rather unevenly distributed through different topographic zones. The Tarai region has the highest population density (238 per sq. km.) followed by hills (159 persons/sq. km.) and mountain (38 persons per sq. km.). As the country's non-agricultural activity base is poor, most of the population is residing in rural areas (about 96% population is rural). The urban population which comprise the remaining 4 per cent of the total population is distributed as follows: The towns of Kathmandu valley account for 54 per cent of total urban population followed by the towns of Tarai like Biratnagar, Bhadrapur, Birganj, Rajbiraj, Janakpur, Dharan, Butwal, Bhairahawa and Nepalganj with about 37 per cent, and other hill towns Ilam, Hetauda, Pokhara and Tansen, excluding Kathmandu valley, with the remaining 9 per cent [Tuladhar et al, 1977].

By every indication the pace of economic development in Nepal seems to be very poor. By 1979-80 the country has completed Fifth Five year plan. The First four plans had their emphasis on building physical infrastructure, especially roads. The focus of investment was however shifted towards the more directly productive sectors and the social services. But according to the World Bank study [World Bank, 1979b] the macro-economic performance was not at all satisfactory; while development expenditure had grown over 15 per cent annually in real terms, the real GDP has grown at less than 2.5 per cent annually at the instance of a higher population growth (2.6 per cent annually) during the Fifth plan period. Though the country is predominatly agricultural the agriculture production has almost remained stagnant which contributed mainly towards poor economic growth. The agricultural performance has in part, been the result of successive poor monsoons during the first two years of the plan, but it also reflects, according to the World Bank report, the failure to appropriately exploit irrigation infrastructure, diffuse improved agricultural technology and strengthen support services. The trade deficit has widened steadily, largely due to declining foodgrain exports to India. The tourism earnings and foreign aid disbursement have however improved. It seems unless the deteriorating situation of food balance can be reversed the economic future of Nepal will remain very gloomy on the face of fast increasing population growth.

1.2.3 Regional Planning background

Nepal is a land of spatial diversities. The differences in its physical setting has shaped the life of people differently. In the mountain area inclement weather and poor soils inhibit agricultural activities. Pastoralism and barter trade are the main basis of mountain economy. Population is spersed and there is considerable seasonal outmigration during the harsh winter. The hill area forms broad sub-tropical zone characterised by a maze of spurs and valleys human occupance is explicit in the landscape. The economy of the hill area is characterised by subsistence farming and there is considerable pressure of population on limited land resources. Kathmandu valley though lies within the hill area has acquired unique individuality by a full exploitation of its soil resources. The tarai area extends as a level strip abutting the foot-hills in the south. Humid tropical climate supports rich vegetation, soils are favourable for large scale agricultural exploitation. In addition to forest and agricultural resources the growth potential of this area has further enhanced by malaria eradication and expansion of transport services and consequent urbanisation. The regional differences thus exists not only in the altitudinally arran topographical zones but also longitudinally arranged planning regions, because of inherent regional differences in natural endowments and human occupance. Broadly, the eastern part is more advanced than western part in respect of the concentration of economic activities. Population concentration is however lower in western part. This has been demonstrated by statistical figures for the 12 planning sub-zones by Gurung [1973]. It should however be mentioned here that though tarai area accommodates 37 per cent of population it contributes 60 per cent of country's GDP and 75 per cent of government revenue [Gurung, 1973]. This clearly shows that the major economic activities are concentrated in Tarai area and it cannot be avoided because it has the advantage of flat terrain. Yet, balanced regional planning efforts must be there for non-Tarai area where major portion of the Nepalease population resides. If it is not done the migration of people from non-Tarai to Tarai area can never be checked.

The country's regional planning efforts are of recent origin. According to a review made by Bhoosan [1979] the regional planning with emphasis on spatial aspects was first initiated during Fourth Five Year Plan (1971-75) and it tends to be operative recently in the fifth five year plan [1975-1980]. The present regional policy in Nepal has been oriented towards growth centre and growth area approach which is related with the functional regionalisation principle. Four major axes of development corridors have been envisaged by the National Planning Commission [Fourth Five Year Plan, 1971-75] which are as follows:

(1) Koshi growth axis (Biratnagar - Dharan - Dhanakuta - Hedangna) in the eastern development zone with Dhanakuta as the regional centre.

(2) Kathmandu growth axis (Birganj - Hetauda - Kathmandu - Barabise/Dhunche) in the central development region with Kathmandu as the regional centre.

(3) Gandaki growth axis (Bhairahawa - Palpa - Syanja - Pokhara/Jomsom) in the western development zone with Pokhara as the regional centre, and

(4) Karnali growth axis (Nepalganj - Surkhet - Dailekh - Jumla) in the far western development zone with Surkhet as the regional centre.

These growth axes fall in four development zones showing only a kind of transportation arteries through Tarai, hill and mountain in each planning zones. Though it shows a kind of decentralisation tendencies in the national planning effort but it is not supported by any evaluation of the need for regional development efforts in different development zones. By merely naming certain urban centres as growth centres does not assure the spread of productive innovations when production themselves have not been planned for acceleration. Though there are concerns towards regionalisation of planning in Nepal [Sharma, 1979] but there were no sincere national commitment towards removing regional disparities on various aspects of people's life and living. All the available documents indicate that the widening gaps between the development of Tarai and non-Tarai areas and also between the eastern and western parts of the country remain unbridged and the vast hinterland area of the so called growth areas remains as alien to any kind of change as before. Most of the growth centres envisaged in the plan except the metropolitan Kathmandu are essentially parasitic in nature and have not yet contributed to the development of the zone in which they exist. Even the metropolitan Kathmandu's influence has been limited to a narrow hinterland of Kathmandu valley, while in a growth pole theory the capital city of a nation ought to have the leadership role influencing every nook and corner of the nation. The so called growth centres are merely administrative centres in which some urban activities have been present. Without the growth of productive activities in this centres which could only be possible by the growth of economic activities within their hinterland through the economics of surpluses, we cannot expect to have the "spread effect" of benefits from the growth centres to hinterlands. In other words the inherent growth potentials in each area of the country should be first studied in all areas of Nepal and the growth processes should be accelerated or conditioned through proper regional planning measure so that the central place and hinterland linkages do develop automatically. Without the background studies merely taking some urban centres as growth centres and providing some urban amenities to local urban people do not assure the self-sustaining growth of functional activities between urban centres and their hinterlands. The task force report related to Fifth Five Year Plan and regional development policies [Vikas, 1976] observes that there is no evidence of serious attempt to translate the regional development policies into operational terms. The only implementation of regional development policies has been restricted to road building. Road construction will undoubtably improve the accessibility of regions, but this by itself does not guarantee increased economic integration nor improve regional distribution of economic activities. This report again observes that the objectives of regional development should include much wider collection of economic activities than improvements in communications. It further states that while the delineation of four development zones is no doubt administratively convenient, it cannot be assumed to be regional economic units. On the contrary each of the development regions is itself a collection of much smaller economic areas, each of which has its own peculiar characteristics. Obviously, without the proper assessment of economic areas any attempt for regional development planning in Nepal on the basis of broad regional aggregation cannot yield successful results. Regional studies must be geared to the needs and resources of areas small enough to be regarded as homogeneous economic entities. Here comes the importance of formal regionalisation approach rather than functional regionalisation approach to start with. In fact, the task force report also observes that the "conventional growth centre theory, as applied in industrial countries, has little relevance to regional development problems in Nepal, since it depends on urban industry creating focal points for development" - a situation which cannot exist at the primitive stage of predominantly agricultural economy without much non-agricultural activities. All these observations are not to say that functional regionalisation approach has no role at the moment in Nepal. What all we want to say is that formal regional studies must precede the functional regional studies in Nepal. Only when we have the adequate knowledge of the formal structurer of different areas, we can think of identifying the linkages and interactions between areas of functional activities.

1.3 The scope of present study

Granting that the functional regional approach is premature without the formal regionalisation studies, our aim will be to make certain basic studies in an interdisciplinary way involving statistics, geography and economics. The geographers have genuine interest in the study of variations of earth' surface in many spatial phenomena. But according to Preston [1958], Keeble [1967] and Pal [1974], they are yet to have necessary analytic skills involving econometric theories and statistical techniques to make comprehensive formulation of regional problems. In the light of the demands of operational regional development plans in Nepal, the Geographer's initiation on the study of spatial variation particularly on physical aspects, now needs a deep probing into the way and means of regional decision-making for the planned economic activities. Isard's Group of regional scientists (The Philadelphia School of regional science) is pioneer in promoting theoretical concepts in this field [Isard et al, 1960, various issues of Regional Science Journal, and Paper and Proceedings of the Regional Science Association]. But all those theoretical methods cannot however be applied in an underdeveloped country like Nepal where the data base and statistical information system has not yet been appropriately developed. Gurung [1973] observes that the basic obstacle to the development and implementation of regional programs in Nepal are the low level of regional information and statistics. He has noted that there is a great lack of data regarding population dynamics, input-output relationships, trade patterns, savings and capital formations and so on. In the absence of this kind of data one cannot think of regional planning techniques like input-output analysis or the full fledged regional programming techniques to be applied in a comprehensive manner for the different regional economics [for detail, see, Isard et al 1960]. On the otherhand the work done in a developing country like India by Learmonth's Group of regional planners in the Mysore (Karnataka) state of India during 1956-58 is more operational in nature. The approach in this applied piece of work had to be mainly geographical since the scope of application of statistical methods was conditioned by the availability of the data. The team had however made certain statistical surveys, for example the transportation survey, village surveys and industrial survey on sampling basis [Learmonth et al 1960, 1962]. A substantial portion of their basic analysis was however made from the spatial data as were available from secondary sources mainly. The present author, doing this piece of work on Nepal while stationed in India, did not however have the resources and scope to have sample surveys to supplement the heavy information gap existing in Nepal. Naturally he had to base his analysis only with the limited data available to him from the secondary sources. Even then it was observed that the secondary data and informations have not, yet, been analysed appropriately for regional development plan formulations in Nepal. Though Learmonth's team could not exploit fully the statistical methods in their pilot regional studies in Mysore state, there had been subsequent works in India wherein statistical methods were fruitfully employed or evolved by a few regional scientists particularly Pal [1963a, 1963b, 1967, 1971, 1973, 1974, 1975, 1979a, 1979b, 1980]. The conditions of present Nepal and of India two or three decades ago appear to be similar in respect of the availability of statistical data and information. So the methods and approaches developed in India have a greater promise of application in Nepal, and the present work is designed to proceed through these approaches.

In Pal's approach [1974] a decision problem is characterised by the gap between the usual state of a regional system that emerge at a particular time in future and the proposed desired state at the same point of time of the regional system obtained as a by-product of preassigned goals and objectives. Bridging up this gap between the usual state and the desired state is called the solution of the decision problem. The ways and means by which we are in a position to moderate or, condition the ongoing processes (temporal interactions of activities available or possible in the regional system), so that the usual state changes into a desired state of a system, are called solution procedures. Our first task is to identify the existing state of the regional system including its on-going processes and trends towards finding its usual state at the future time point. It has really two purposes. First, we get ourselves acquainted with the regional system so that we can ascertain the regional objectives and policies for a desired growth and level of development of the system at the future time point (target year). Second, the knowledge of the present trend, structure and interactions help in identifying the ongoing processes implicit in the system, which are to be conditioned to convert the usual state into the desired state. On the basis of these, we have to visualise any attempt for moderation, conditioning or feed-back controls over the ongoing processes, if possible to arrive at a desired state.

With this approach present author attempts to make regional analysis in Nepal with the available secondary data. Complete regional formulation will however not be possible not only for the limitation of data but also for absence of certain resources with an individual research scholar working outside Nepal. Yet, it could be possible to make modest beginning towards pointing out the gaps between desired state and the existing or the usual state at various areas in the regional system for certain important economic activities of the nation. In this the geographer's concept of regionalisation has been accepted and different areas will be characterised by a formal regionalisation principles. Subject to limitations to data temporal interactions will also be analysed with growth studies and spatial interaction studies with some kind of programming techniques. It is relevant to note that usual spatial linkages are established by commodity flow studies but the basic data is not yet available in Nepal in details. Possibly because of this, the propounders of growth centres and growth axis scheme of regional planning in Nepal did not do any background functional regionalisation studies. In the absence of detailed knowledge of this kind of spatial linkages we have tried to apply the mathematical techniques of linear programming to determine a rational linkage pattern under certain optimality criterion with reference to the distribution of food-grains. We have also used simple mapping of composite formal regional structures identified through statistical procedures. Geographers usually identify the composite formal configuration involving many interrelated characteristics of variables by superposing technique of mapp

But when the variables are too many, mapping by superposing technique would not be of much help because of the multiplicity of classes for many variables. In this respect Pal [1963, 1971, 1974] has developed certain multivariate statistical methods which could be of great use in identifying the composite formal regional structure without the use of the cumberous superposing techniques. The identification of formal regional structures is particularly useful in such situations where our aim would be to reduce the regional disparities. Here our objective is to take lessons from the favourable formal structure, and try to examine whether the conditions that led to favourable structure could be created in or transferred to an area where relatively less favourable formal structure is existing. To identify the interactions between characteristics we have also used at many instances the regression techniques of statistics.

The designs of the chapters are as follows:

As agricultural and allied activities is the major activity in Nepal, this economic activity will be dealt in considerable details in Chapter 2. In this, we shall not only try to identify the formal structure of the activity but also try to evaluate the future prediction task and distribution with reference to food-grains. It has already been noted that unless the deteriorating food situation could be reversed the economic future of Nepal would remain very gloomy on the face of fast increasing population growth. That is why the study of food situation gains importance in our analysis. Though the industrial activity plays a very minor role in Nepal's economy at present, one cannot think of keeping the country predominantly agricultural without industrial diversification. Agricultural breakthrough is not yet in sight in Nepal. Even to achieve such an agricultural breakthrough, Nepal has to be geared to the path of industrialisation. Because without the support of industrial base advanced agricultural technology can hardly be applied. We have tried to analyse the nature of localisation of the little industrial activities that Nepal has at the moment and tried to identify the factors for such localisation in Chapter 3. In Chapter 4, we have dealt with other miscellaneous activities such as tertiary activities, transport, unbanisation and other important economic features and resources. Finally in Chapter 5, we have made a synthetic analysis on problems and prospects for regional development in Nepal.

CHAPTER II

AGRICULTURE AND ALLIED PRIMARY ACTIVITIES

2.1 Introduction

Agriculture is the principal sector of economic activities in Nepal. About 94 per cent of the total active population are engaged in agriculture and allied primary activities. Nepal's agricultural land is however limited because of the prevailing natural and geographical conditions. The cultivated area accounts for only about 16.4% of total geographical area. As such, while the population density per unit of geographical area was not high (about 82 persons per sq. km. of geographical area in 1971-72), it was alarmingly high when the density is considered per unit of cultivated area (about 500 persons per sq. km. of cultivated area in 1971-72). Although the natural and geographic conditions, including the nature of terrain, have largely conditioned the economic use of Nepal's territory, the excessive dependence of people on agriculture and other primary occupations seems to be paradoxical, particularly in the background of dwindling national export surplus position of this sector in recent time.

The nature of terrain in the Himalayan kingdom is widely varying. Naturally the over-all picture of Nepal as mentioned earlier cannot stand same in different areas within Nepal. In fact, the effect of the nature of terrain on the use of territory for cultivation can be readily comprehended by the very high Lorenz index [1905] value of spatial concentration for the cultivated area relative to the geographical area. It is as high as 0.632 when computed from 75 district breakdowns of Nepal. As highly adverse terrains were avoided on the one hand and, on the other hand, the favourable terrains were liked for human settlements, the Lorenz index of spatial concentration for cultivated area relative to population comes down to a lower value of 0.446. In the absolute sense, this value is still high. This is reflective of the fact that many areas with limited cultivated land have very high density of population per unit of cultivated land. In fact, it is because of this non-concomitance of people and cultivated land in many places in Nepal, the Lorenz index of spatial concentration for population in relation to geographical area practically does not increase. The value of this index is 0.455 which is very close to 0.446, the value just reported above for the cultivated land relative to population. This means that the overwhelmingly large active population that are categorised as agricultural and allied primary activity workers in every district (in 1971 census) are not possibly engaged entirely on cultivation in many places. We have no way to find out the varying proportions of the primary activities other than cultivated land based agricultural activities in the published sources of data. But our contention is supported by the fact that the Lorenz index of spatial concentration for livestock units relative to cultivated land is again higher, with a value of 0.540. However, whatever be the nature of primary occupation, as the main staple food has to come from the cultivated land, the areas with little cultivated land but with relatively high density of population per unit of cultivated land must have to be dependent substantially on other areas for staple food. This means that both cultivated land based agricultural activities and the other primary activities of the people with limited cultivated land must have to be sufficiently viable to serve complementarily. All these together emphasize the need for a proper regional analysis of the complex interactions between the nature of terrain, the agricultural and allied primary activities and the population involved in them.

This kind of regional analysis will be attempted in this chapter with district level breakdowns of data. There are hardly any quantitative regional analysis with such areal breakdowns in Nepal. Most of all-Nepal regional studies done so far mainly considers three altitudinal division (Tarai, Hills and Mountains), or, atmost, twelve zones with four longitudinal zones in each division (Eastern, Central, Western and Far-Western). The use of such small numbers in depicting the regional characteristics has obvious limitation in respect of the delineation of regions or the regionalisation. Moreover such small numbers hardly help in making statistical analysis for the evaluation of spatial interactions or interrelations. The question of availability of various useful data for identifying the regional activities and characteristics is however more pronounced with district level breakdowns. Yet, it is felt that a beginning must be made for a proper, quantitative and decision-making regional analysis that needs a consideration of sufficiently disaggregated spatial data. In that, if the question of reliability of inferences with such disaggregated data arises to start with, at least the techniques of statistical and quantitative analysis could be demonstrated that would provide guidelines for future regional research with more reliable data in Nepal. Motivated with this objective, the proposed regional analysis for agricultural and allied primary activities is attempted below in the following seven sections of this chapter.

2.2 Construction of Special Regional Indices

For identifying the spatial concentration of certain characteristic, two types of indices are very often used in regional litererature. One type is for getting an over-all notional value of concentration. The Lorenz index of concentration used already in previous section is of this type. In fact as early as 1937, Wright [1937] suggested the possibility of the use of the concept of Lorenz curve to measure the degree of evenness of geographic distributions. Later, Sergant Florence [1954] used another measure called the coefficient of localisation in measuring the over-all value of concentration. This type of over-all indices are certainly useful to get a synthetic picture of the geographic distribution, but the actual spatial distribution or concentration is not available in this type of measures and there comes the importance of the second type of measure of spatial concentration, commonly known as location factors. The location factors permit us to have estimations of a characteristic for each areal unit of observation, while the over-all Lorenz index of spatial concentration or the coefficient of localisation summarises the concentration by one value for the totality of all areal observations. In both types, two geographic distributions are however compared. For example, in the Lorenz index of spatial concentration of livestock units relative to cultivated land, the two geographic distributions of livestock and cultivated land have been compared. This is really a relative Lorenz index. If the cultivated land is replaced by actual geographic area of the spatial unit of observation, then it is called the absolute Lorenz index of concentration, or simply the Lorenz index for livestock. Similarly we have absolute and relative location factors depending upon the use of geographic area or other variable as the comparative second geographic distribution [for details see, Pal, 1971]. It is emphasized here that without the use of location factors we are not in a position to find out the core areas of concentration or the absence of concentration on space. The Lorenz indices of spatial concentration may be same for many distributions yet the actual areas or the intensities of concentration could be quite different for different distributions. It is because of this, the use of location factors are more common in regional literature than the over-all indices. We shall also use location factors as indices of spatial concentration for many characteristics from time to time. But, depending upon situations, we have also to construct certain composite index, combining various location factors that influence or are influenced by certain common characteristic. For the present study of Nepal, such special regional indices will be constructed by suitable statistical and quantitative methods described below.

2.2.1 Index of the ruggedness of terrain

It has already been indicated that the varying economic uses of Nepal's territory have been greatly influenced by the nature of terrain and its ruggedness. The National Planning Commission of Nepal is aware of it and it has been using cartographic techniques to map the details of topographic features and use them in planning decisions. In fact, divisions and zones already referred to above are delineated on the basis of topographic features and are used as areal reference frame in planning. In order to understand the spatial configuration of characteristics, the use of maps in conjunction with quantitative data is absolutely necessary. When topographic features are mapped they give certainly very good visual impressions of the terrain type. But there is a need for the quantification of the topographic features as far as possible so that they can be used for quantitative and statistical analysis with related social and economic features; merely the visual picture depicted on a topographic map is not sufficient. An attempt has been made here to quantify the topographic information and convert them into suitable spatial variable for regional analysis. As the topographic features, though inter-connected, are complex in nature, we have tried to construct here a composite index, called the index of ruggedness, which is a statistical combination of three initial topographic variables. The initial topographic variables are constructed as follows.

Using square grids of 7.5 minutes length (latitudinal and longitudinal lengths) on topo-sheets with scale 1:250000 published by the Topographical Survey Division, Department of Survey, in 1976, and also the data of heights above MSL given for some 300 meteorological stations provided by the Department of Hydrology and Meteorology [1977] of Nepal, the estimates of average height for each square grid have been worked. Taking into account the number of such grids in a district we have then constructed two initial variables:

x_1 = mean height in metre by districts.

x_2 = standard deviation of heights in metre by districts.

The third initial variable is

x_3 = the range between the maximum and minimum heights in metre in a district.

The maximum and minimum heights in a district are estimated from the data of heights actually indicated on the toposheets, supplemented by the data on heights of the meteorological stations. Pal [1973] has summarised various methods that are in use for combining mutually interdependent variables for constructing a composite index. Ignoring the subjective integration methods [e.g. Schwartzberg, 1962], the unweighted aggregation method [e.g. Mitra, 1965] and the subjective weighting method [e.g. Schwartzberg, 1962] for their subjective nature, other methods can be categorised into two groups:

(i) economic or other theory-based indices (many economic index numbers are of this type).

(ii) statistical methods.

The statistical methods can again be divided into two groups:

(a) specific representations equalising index [Pal, 1963a, 1971],

(b) aggregate representation maximising index [Kendall, 1939].

The correlation coefficient of a composite index with any constituent variable is termed as a specific representation. The squared aggregate representation of the composite index is the average of squared specific representations of constituent variables. Pal [1972, 1973] has shown that both equalising index and maximising index have relative merits and demerits. Broadly speaking, if the specific representations of a maximising index is not widely different, the two indices may depict almost similar spatial distribution of the composite characteristic. But if the specific representations are widely varying and the specific representation of certain important constituent variable falls below certain specified level, then we may have to go for equalising index. It should be noted however that the two indices coincide when the constituent variables are two in number. For this reason, it is often useful to construct the final composite index in two or more stages through sub-grouping. As we have three variables, here we tried first the maximising index of Kendall and examined the specific representations whether or not they are widely varying. The correlation matrix of the three initial topographic variables is given in Table 2.1.

Table 2.1: Correlation matrix of topographic variables

x_1	x_2	x_3
1.0000	0.8687	0.8273
0.8687	1.0000	0.9879
0.8273	0.9879	1.0000

It is interesting to note the strong inter-relationships of the three initial topographic variables. The highest relation between the standard deviation and the range variable is understandable; it means if the range is high, variance in heights is also high and vice versa. The high relationships of these variables with the height variable x_1 implies that higher the heights, greater is the variance of heights i.e., the ruggedness of the terrain. From such correlation matrix with high cell values, our maximising index or the Kendall's index ought to have high specific representations. In fact, they are 0.8642, 0.9769 and 0.9498 respectively for x_1, x_2 and x_3. For ruggedness measure, the variables x_2 and x_3 are really more important variables and the very high specific representations of these two variables are quite acceptable. Moreover the specific representation of the height variable x_1 is also quite high, not far from the other two specific representations. As such we accepted the corresponding Kendall's index as our index of ruggedness.

It should be noted that the central value of a location factor used in spatial distribution analysis is unity. This value represents the national (totality of areal units of observation) level value. Following that practice the initial variables x_1, x_2 and x_3 have been changed into variables $y_1 = x_1/\bar{x}_1$, $y_2 = x_2/\bar{x}_2$ and $y_3 = x_3/\bar{x}_3$, where $\bar{x}_1$, $\bar{x}_2$ and $\bar{x}_3$ are means of x_1, x_2 and x_3 respectively. Obviously unity is the mean value of y_1, y_2 and y_3. The Kendall's index is also transformed linearly so that it has the same unity as its mean value that represents the central value. By this linear transformation the values of specific representation and the aggregate representation remain unchanged. If r_1, r_2 and r_3 represents the specific representations, and

σ_1, σ_2 and σ_3, the standard deviations of the variables y_1, y_2 and y_3 respectively, then the Kendall's index with unit mean is given by

$$I = \frac{w_1 y_1 + w_2 y_2 + w_3 y_3}{w_1 + w_2 + w_3}$$

where $w_1 = r_1/\sigma_1$, $w_2 = r_2/\sigma_2$ and $w_3 = r_3/\sigma_3$

The aggregate representation of I, denoted by ρ is given by: $\rho = \sqrt{\frac{1}{3}(r_1^2 + r_2^2 + r_3^2)}$.

The empirical form of our index of ruggedness is given by: $I = 0.29591\ y_1 + 0.35632\ y_2 + 0.34777\ y_3$, $\rho = .93154$ The values of I for different districts of Nepal are presented in Appendix Table 1.

2.2.2 Agricultural Productivity Indices with respect to Land and Labour

In this sub-section our primary aim is to construct a composite index that would help us in identifying the spatial variation in the intrinsic quality of cultivated land by districts of Nepal. As is the practice, yield rates of crops will be taken to measure the revealed intrinsic quality of land, given the existing conditions and the crop combination or importance. We shall be interested not only in the land productivity. but also in the agricultural productivity with respect to labour. As, at the time of this investigation, the only source of labour data was the population census 1971-72, we chose 1971-72 as the reference year for our present study on spatial variation. Apart from the 1971-72 census data, the relevant agricultural and price data have been collected from price bulletin of the Department of Food and Agricultural Marketing Services [1979].

To identify the "geographical distribution of crop productivity in England" by counties, Kendall [1939] constructed a crop productivity index statistically from the yield rate variables of different crops by the aggregate representation maximising principle. There the implicit assumption was that the quality of cultivated land in a county in England was more or less suitable for all crops considered. This assumption is too simplifying for a country like Nepal where a local choice of crops cultivated is not randomly done, but is dictated by the possibilities under the prevalent natural and geographic conditions. As such in our present study, we are not inclined to combine the yield rates of different crops by weights estimated statistically. Here we shall follow the economic or theory-based method for weighting suitably the yield rates to get initial cropped land productivity indices.

If we divide the yield rate (quantity of production per unit of cropped area) of a particular ith crop for jth district by the national yield rate of the same crop, what we get is the location factor of yield of ith crop which measures the advantage or disadvantage of the jth district relative to the national level value. Let us denote

y_{ij} = the location factor of yield of ith crop in jth district, where

$i = 1, 2, \ldots\ldots n$: (crops),

and $j = 1, 2, \ldots\ldots N$: (districts)

Giving a due recognition of the local importance of the crops cultivated, these location factors of n crops can be aggregated with weights proportional to either (i) the cropped areas or (ii) the values of crops produced. As the local importance of different crops is varying from district to district, these weights are also varying. We have however used constant Nepali prices (retail prices) of crops to find the value of different crops produced in any district. Thus we have formed two initial indices of crop productivity, Z_1 and Z_2, where

$$Z_{1j} = \sum_{i=1}^{n} u_{ij} \, y_{ij}$$

= physically weighted crop productivity index;

with u_{ij} = proportion of total cropped area devoted to ith crop production in jth district, so that $\sum_i u_{ij} = 1$ for each j.

and $$Z_{2j} = \sum_{i=1}^{n} v_{ij} \, y_{ij}$$

= value weighted crop productivity index;

with v_{ij} = proportionate value of production of ith crop to all crops considered, so that $\sum_i v_{ij} = 1$ for each j.

In our study, the number of crops considered is thirteen, of which five are cereal crops and the remaining eight are cash crops. Paddy, wheat, maize, barley and millets are the cereal crops, while oilseeds, potato, sugarcane, tobacco, jute, tea, ginger, cardamum, the cash crops. These crops together cover a predominantly major part of cultivation practices. The data on the residual part of cultivation practices are however not available by districts in any published sources. But as this part is not very significant, we believe that the spatial variation depicted for the above coverage of crops will not be substantively different from the one with an extended coverage.

In the initial indices Z_1 and Z_2, the individual crop productivities were combined. One can as well construct another initial index which would measure the productivity of total cropped area without the areal breakdowns for different crops. This is really the location factor of total yields (total value of all crops produced) relative to total cropped area. This initial index will be denoted by Z_3, called the aggregate land productivity index, and written as:

$$Z_{3j} = \frac{V_j / A_j}{\sum_j V_j \;/\; \sum_j A_j},$$

where,

$V_j = \sum_i w_i \, P_{ij} =$ total value of agricultural output in jth district,

$A_j =$ total cropped area in jth district,

$w_i =$ national average retail price of ith crop,

$P_{ij} =$ total production of ith crop in jth district.

Whatever be the mode of combination, all these initial indices measure the over-all agricultural productivity relative to land. These indices will be combined statistically to derive a composite index of agricultural productivity relative to land (or, simply, agricultural land productivity index). For its construction, we proceed as follows.

The correlation matrix of Z_1, Z_2 and Z_3 is given in Table 2.2.

Table 2.2 : Correlation matrix of initial agricultural land productivity indices

Z_1	Z_2	Z_3
1.0000	0.9379	0.4824
0.9379	1.0000	0.4166
0.4824	0.4166	1.0000

Clearly Z_1 and Z_2 are similar kind of measures with very high correlation between them (correlation coeff. 0.9379), while Z_3 is not highly related with either of them. From the correlation matrix of Table 2.2 if one constructs an aggregate representation maximising index, there will be wide departures in the specific representations. In fact the specific representations of Z_1 and Z_2 will then be as high as 0.9587 and 0.9384 respectively, while that of Z_3 falls to a considerably lower value of 0.6778. One could have gone for the specific representations equalising index, the aggregate representation of which would not have been significantly different from that of the maximising index (equalising index ρ = 0.8416, while maximising index ρ = 0.8678). But, from the nature of correlation matrix it appears to be more appropriate to go for the final construction at two stages. First we combine the two similar kinds of measure Z_1 and Z_2 and then this intermediately combined index, Z_o say, is finally combined with the other initial index Z_3. We have already noted that both equalising and maximising indices coincide when the number of constituent variable is only two. So, in the proposed two stage construction, at least the optimality consideration is maintained at each stage and at the same time the wide divergence of specific representations as obtained in a single stage construction with three variables could be controlled through two-stage equalising principle. According to Pal [1963a], the formula for the equalising index Z_o is given by

$$Z_o = \frac{\sigma_2 Z_1 + \sigma_1 Z_2}{\sigma_1 \bar{Z}_1 + \sigma_2 \bar{Z}_2},$$

with any specific representation = aggregate representation

$$= \rho_o = \sqrt{\tfrac{1}{2}(1 + r_{12})},$$

where $\bar{Z}_1$ and $\bar{Z}_2$ are means, σ_1 and σ_2 are standard deviations and r_{12} is the correlation coefficient between the variables Z_1 and Z_2. In this construction, $\bar{Z}_o = 1$ and

$$\sigma_o = \sigma_{Z_o} = \frac{2\rho_o \sigma_1 \sigma_2}{\sigma_1 \bar{Z}_1 + \sigma_2 \bar{Z}_2}$$

Empirically, we have

$$Z_o = 0.47561\, Z_1 + 0.47165\, Z_2, \quad \rho_o = 0.98435$$

Now the correlation between Z_0 and Z_3 can be estimated as

$$r_{03} = 0.4567$$

If the final agricultural land productivity index formed by combining Z_0 and Z_3 is denoted by Z, the empirical estimation of Z takes the following form:

$$Z = 0.60064\ Z_0 + 0.38209\ Z_3, \quad \rho = 0.85342$$

Using the empirical form Z_0 in the above form of Z, we have the following explicit formulation for Z:

$$Z = 0.28567\ Z_1 + 0.28329\ Z_2 + 0.38209\ Z_3,$$

in which the derived specific representations r_i's and the corresponding aggregate representation ρ^* have the following estimated values:

$$r_1 = 0.85935, \quad r_2 = 0.82078, \quad r_3 = 0.85342 \quad \text{and}$$
$$\rho^* = 0.84469$$

The central value of this final agricultural land productivity index is the mean value $\bar{Z} = 1$.

Next we attempt to form the agricultural productivity index relative to labour, which will be denoted by W. This index is comparable to Z_3, with the replacement of total cropped area A_j by total labour of jth dist. Theoretically speaking, this measure of labour should have been the actual input of labour for the production of crops considered. But from the 1971-72 census source, we have no way to get the actual input of agricultural labour. The nearest to actual input of agricultural labour is the active population in agriculture and the allied primary activities, given in the census. We have no other way but to use this wider coverage of agricultural labour data for estimating the index W. In the absence of any other suitable name, we shall still call W the agricultural labour productivity index.

The values of the indices constructed in this sub-section are presented in the Appendix Table 1.

2.2.3 Composite Development Index of Agriculture and Allied Activities

The extent of interdepence between arable cropping and allied primary activities based on livestock, fodder, forestry, fishery, etc., is clearly varying in different areas of Nepal. Naturally, the active population (worker) engaged in agriculture and the allied activities have clearly varying proportions of income from the two counterparts (or complementary parts) in different areas. According to available estimates [World Bank Report, 1979a], agriculture and the allied activities together account for about 65% of GDP (Gross Domestic Product) of Nepal. Again livestock accounts for about 14% of GDP which forms a major part of the allied activity income. Giving allowance for other allied activities, the ratio of agricultural to allied activity incomes has been estimated to be at the order of 4:1 for the national total. As this ratio is obviously not maintained same in different districts of Nepal, it has become difficult to take the index of labour productivity W as a measure of development for agricultural and allied activities. Surprisingly official reports do not distinguish between the agricultural worker and the primary worker deriving income in varying proportions from both agriculture and the allied activities in different districts. Of course, as agriculture is the predominant activity, we can still get a broad regional pattern of the agricultural labour productivity by analysing W. But for a total evaluation and a proper ranking of districts for the development status in agriculture and allied activities, we thought it necessary to modify the index W. The modified index will be called the development index of agriculture and allied activities D. The modification is done as follows.

Let G_1 and G_2 be the total GDP of Nepal for agricultural sector and the allied activity sector. As these estimates are in the ratio 4:1, we have $G_2 = 0.25G_1$. We then distribute these national values G_1 and G_2 in different districts by the indicator method. Thus G_1 is distributed by the national value share $(V_j/\sum_j V_j)$ of agricultural output, referred to in the previous subsection. The other part G_2 is distributed by the national livestock share $(S_j/\sum_j S_j)$, where S_j is the estimate of total livestock units in jth district. The livestock units are in equivalent cattle units with the conversion factor as: 1 cattle unit = 2/3 buffalo = 5 sheeps. = 5 goats = 5 pigs [comparable to the standard followed in Learmonth et al, 1960]. The source of the livestock data is both the CBS (Central Bureau of Statistics, Nepal) and the DFAMS (Department of Food and Agricultural Marketing Services, Nepal). The DFAMS data were compiled from direct surveys in some eighteen districts only, while the CBS source provides estimated data for all districts of Nepal. There is considerable agreement in the data of the two sources for common districts. We have however accepted the direct survey data where available. For the rest of the districts we have no alternative but to accept the CBS estimates. After distributing the national values of G_1 and G_2 to districts by the said indicators, let G_{1j} and G_{2j} be the estimates of income in the two sectors, (i) agriculture and (ii) the allied activities, in jth district. The total of these incomes, $(G_{1j} + G_{2j})$ should really relate to the active population (i.e., worker) in agriculture and allied activities L_j. But in our index W, we have

$$W_j = \frac{V_j/\Sigma V_j}{L_j/\Sigma L_j} = \frac{G_1(V_j/\Sigma V_j)/G_1}{L_j/\Sigma L_j}$$

$$= \frac{G_{1j}/G_1}{L_j/\sum_j L_j} .$$

Let $g_{1j} = G_{1j}/(G_{1j} + G_{2j})$ and $g_{2j} = (1 - g_{1j})$ denote income shares for agricultural activity and the allied activities respectively. The corresponding national shares are already given as 0.8 and 0.2. Then the corresponding income share indices ζ_1 and ζ_2 are given by

$$\zeta_{1j} = g_{ij}/0.8 \quad \text{and} \quad \zeta_{2j} = g_{2j}/0.2$$

Our development index of agriculture and allied activities D is really the location factor of total agricultural and allied income relative to corresponding workers involved in the activities. Thus we have

$$D_j = \frac{(G_{1j} + G_{2j})/(G_1 + G_2)}{L_j/\sum_j L_j}$$

We shall now show the relationship between the indices D and W. From above relations,

$$D_j = \frac{(G_{1j}/g_{1j})/(G_1/0.8)}{L_j/\sum_j L_j}$$

$$= W_j / \zeta_{1j}$$

Thus, our labour productivity index W is to be divided by agricultural income share index ζ_1, we get the development index D. We shall record the data on g_1, ζ_1, ζ_2 and D in an Appendix Table 2.

2.3 Spatial Analysis of Development Level in Agriculture and Allied Activities

Indices constructed in the previous section are meant for identifying the level of development and its nature for the aggregate of agriculture and allied activities in different areas. As the development index D is proportional to the income per head of related workers, it serves as a single composite measure of development of the people engaged in these activities. Attempts will be made in this section to identify the spatial pattern of the level of development through this index. The level of development will also be examined for its nature and interactions with other regional indices and variables. In doing this analysis both statistical and cartographic techniques will be used in conjunction. As the ruggedness of terrain is a great influencing factor of peoples' activities in Nepal, we shall first examine the spatial interaction and association of ruggedness with broad features.

2.3.1 Influence of ruggedness factor.

In order to make a statistical analysis of the influence of ruggedness factor on other features, the ruggedness index τ has been constructed wherein both cartographic and statistical tools have been used. In this quantification process, only a generalised spatial pattern of ruggedness is depicted and certain details of ruggedness is ignored as we ignore analogically the random fluctuations in a time-series trend analysis. Yet we have tried to depict some details of ruggedness through different initial measures without banking on a single feature and have successfully combined them statistically for a composite measure because of the interdependences of various ruggedness features considered. Considering Nepal's average ruggedness as unity, the range of values of our ruggedness index, τ , is between 0.05 and 2.6; out of 75 districts of Nepal, 20 districts are officially considered as within Tarai area which is at the southern pheriphery of Nepal. These districts have the value of less than 0.27. But this value does not provide a sharp bounders between hill and Tarai districts. For example, a value of τ = 0.28 is associated with the hill district of Tanahu. Again the value of τ above 1.4 distinguishes all the officially recognised mountain districts (17 in number) except the district of Baitadi whose ruggedness is comparable to average Nepal value. Out of the remaining 38 hill districts, 29 districts have the value of τ in the middle range between 0.27 and 1.4, covering a wide variation of ruggedness. The remaining 9 hill districts, namely Rukum, Myagdi, Baglung, Kaski, Lamjung, Gorkha, Nuwakot, Dhading and Ramechhap have a ruggedness feature as high as that of a mountain district. Perhaps the accessibility aspect of these districts was considered for their recognition as hill districts officially. It is clear that there is a wide range of variation in the values of τ among hills and mountain districts and it is not enough to recognise these districts by three zones only, (namely Tarai, Hill and Mountains). Rather we have to get the actual values of ruggedness, τ, to understand the influence of ruggedness on other features and activities of people.

Before going to examine the interrelationships of ruggedness index with development features, we shall examine the relationship of development index, D, and the labour productivity index, W. It should be recalled that our development index D holds the relationship as follows:

$$D = W/\zeta_1$$

where ζ_1 is the income share of arable land based agriculture. As there is a variation in the values of ζ_1, the values of D are definitely modified compared with those of W. In fact, this has resulted into a relatively less dispersion in the values of D. Yet there is a strong relationship between D and W as shown in the following regression equation 2.1.

$$W = \underset{(0.03515)}{-0.25961} + \underset{(0.02974)}{1.22796}\,D \qquad \ldots \qquad (2.1)$$

$$r = 0.9856, \quad N = 75$$

In this we can clearly see that the marginal rate of change of W with respect to D is 1.228 which is considerably above unity. From this relation it could be calculated that the values of D and W are identical at the value of D = 1.139. We notice from this equation that the modification has increased the value of D compared with that of W so long as D is less than 1.139, while the value of W is relatively diminished for a value of D higher than 1.139. Had we judged the level of development by the value of W instead of D the advanced areas would have appeared more advanced and the underdeveloped areas would have appeared more underdeveloped. This shows that for the correct evaluation of development level the construction of the modified development index D was very necessary. The high degree of relationship (r= .986) between W and D tells us that agriculture is generally an important activity as compared with the allied activities, not only in the advanced districts but also in the under-developed districts.

Next we shall examine the influence or the association of ruggedness with the level of development when we plotted the values of D and τ in two-dimensional graph, the scatter of district points look like a hyperbola with assymptotically low values for both D and τ on either side. As such we tried to fit a linear regression equation of the form

$$D = \alpha + \beta x, \quad \text{where} \quad x = (\gamma + \tau)^{-1}$$

We fitted these linear regression equations with different selected values of γ and chose that values of γ which gave the maximum value of correlation coefficient, r_{Dx}. The estimated value of optimum γ is 0.4 and the corresponding regression equation is given below in equation 2.2.

$$D = \underset{(0.84868)}{0.25725} + \underset{(0.61613)}{0.76003}/(0.4 + \tau) \quad \ldots \quad (2.2)$$

$$r = 0.7654, \quad N = 75.$$

Surprisingly, if D is replaced by the variable W in this kind of regression exercise, the estimated value of optimum γ turns out to be the same value of 0.4. The corresponding regression equation is given below in equation 2.3:

$$W = \underset{(0.09949)}{-0.01683} + \underset{(0.08528)}{1.00747}/(0.4 + \tau) \quad \ldots \quad (2.3)$$

$$r = 0.8103, \quad N = 75.$$

A slightly better fit with W has been possible, because of the fact that the people with more of allied activities have been present in the more rugged terrain here and there without much regularity. Anyway, from the higher value of correlation coeff. for W, one can infer that the agricultural productivity is affected more adversely by the ruggedness of terrain. The broad asymptotic pattern in both D and W is that, the higher the value of D or W, the lower is the value of ruggedness index τ and the converse. Of course, as the correlation coeffs. are a little away from unity, one can expect local peculiarities over and above the general patterns of spatial relationships. The local peculiarities can be visualised directly from the tabulated data and the map analysis of the level of development discussed later.

That the agricultural activity, or rather the arable cropping is affected adversely by the ruggedness of terrain can be noticed in a more pronounced form in the relationship between the location factor of cultivated land relative to geographical area, I_{CG}, say, and the ruggedness variable τ which is given in equation 2.4 below:

$$I_{CG} = \underset{(.18045)}{-0.86899} + \underset{(.15424)}{2.21765}/(.4 + \tau) \quad \ldots \quad (2.4)$$

$$r = 0.8597, \; N = 75.$$

This equation is estimated with the same value of γ (=.4) as obtained under the optimal consideration on both equation (2.3) and equation (2.4). We have done this to maintain the comparability of the explanatory variables in the three equations (2.2), (2.3) and (2.4) given above. Here we clearly notice that the lower the ruggedness the higher is the extent of arable land. If the inversely transformed ruggedness is designated as variable x [i.e., $x = (0.4 + \Upsilon)^{-1}$], then the marginal rate of change of D, W, and I_{CG} with respect to x are increasing (values are 0.76, 1.01 and 2.22 respectively) in the order in which they are presented here.

Contrasting to these inverse relations of the three indices D, W and I_{CG}, a major representative of allied activities, namely the livestocks maintained by people gives a positive relation with the ruggedness index, though the statistical fit for any continuous curve is not very high. Here the statistical fit did not attain a high value, because the relationship between livestock and ruggedness is complex. From the scatter on a two dimensional graph of the ruggedness index Υ and the location factor of livestock units relative to population, I_{SP}, say, one can clearly identify the incidences of very high value of I_{SP}, say, between 2.25 and 5, with the value of Υ just in the neighbourhood of 1.9. When the value of T exceeds this critical value, the livestock per person comes down sharply to lower value. Incidences of the value of I_{SP} lower than 2.25 are associated with all levels of ruggedness, because of dual reasons: either for certain dependability of arable cropping with livestock, or for certain alternative occupation in the absence of adequate arable land. Even for the truncated values of I_{SP} the graph shows a positively increasing scatter of points (I_{SP}, T). The incidences of the association of very high values of I_{SP} around the critical value of ruggedness tell us that possibly at high altitudes, the pastures and fodders might not have been adequately present above that critical value of ruggedness.

We conclude this subsection by an examination of the interrelationship between the ruggedness index and the location factor of population relative to geographical area, I_{PG} (a variable proportional to population densities). The concentration of population in different geographical areas has been very peculiar in Nepal. People have penetrated in all sorts of terrain irrespective of the ruggedness. The choice of Kathmandu valley, a hilly region, as the capital region have contributed to the values of concentration index I_{PG} as high as between 8 and 12 in the three districts of this region, while all other districts have much lower values (around 3.5 or less). As such any attempt for a statistical fit becomes fruitless because of the expectedly abnormal concentration of population in the capital region. In fact the best possible fit of I_{PG} we obtained is the one with $x = (.4 + \tau)^{-1}$, giving a very low correlation coeff. $r_{xI_{PG}} = 0.2960$. But this correlation improves considerably when the three districts are excluded from the computation. The corresponding regression is given below in equation 2.5.

$$I_{PG} = \underset{(.72011)}{0.30355} + \underset{(.61553)}{0.88699}/(.4 + \tau) \quad \ldots \quad (2.5)$$

$$r = 0.6368, \quad N = 72.$$

Thus we have again found an inverse relation between ruggedness and population concentration with some statistical support for the districts of Nepal without those in the capital region. The low value of the correlation coefficients is indicative of the presence of further local peculiarities which will be discussed when we make the map analysis subsequently.

It is very clear that the influence of ruggedness is present in both arable cropping and other allied activities in varied manner and extent. As people of Nepal have to live with the ruggedness, the present analysis on its influence on various features is revealing how to condition the future activities in relation to varied extent of ruggedness. We shall next analyse factors of development under different ruggedness conditions.

2.3.2 Analysis for factors of development.

From our foregoing analysis it is clear that the less rugged terrain where the concentration of arable cropping has been possible is more developed. This fact can also be depicted in the map of the development index shown in figure 2.1. In this map we have identified the following four levels of development:

Level of development	Value Range of the development index D	Frequency of districts
Very high (VH)	1.75 - 2.80	11
High (H)	1.25 - 1.75	11
Medium (M)	0.75 - 1.25	19
Low (L)	0.25 - 0.75	34

In this classification, the value range around the national value of unity is designated as mediumly developed class. It should be clearly understood that all classes as designated above have the comparative scale of development in relation to the national level. The national level itself would appear to be underdeveloped in any international comparison. According to this classification, the level of development of agriculture and allied activities is relatively very high or high in all Tarai districts except Siraha and it is high in the three districts of capital region in hill area. From a comparision of this map with the map of I_{CG} (the extent cultivation) shown in figure 2.2, it can be noticed that all these districts of the Tarai area (with γ (0.27) and the capital region (with γ between .4 and .8), have similarly very high or high values of I_{CG}. Thus from the map analysis itself, the importance of the extent of available arable land in Nepal towards contributing a higher level of development can be understood.

While the extent of available arable land has been a necessary factor of development, it can hardly be used as a sufficiently controllable factor towards further development in future. The expansion possibility of arable land in future is limited even in the narrow Tarai belt. The more important factor towards this end would obviously be the intensification factor which we have wanted to measure through the land productivity index Z constructed earlier.

Our attempt for all-Nepal global relation, without dividing the districts under different ruggedness levels, between this factor Z and the development index D proved to be discouraging to start with. There is practically no

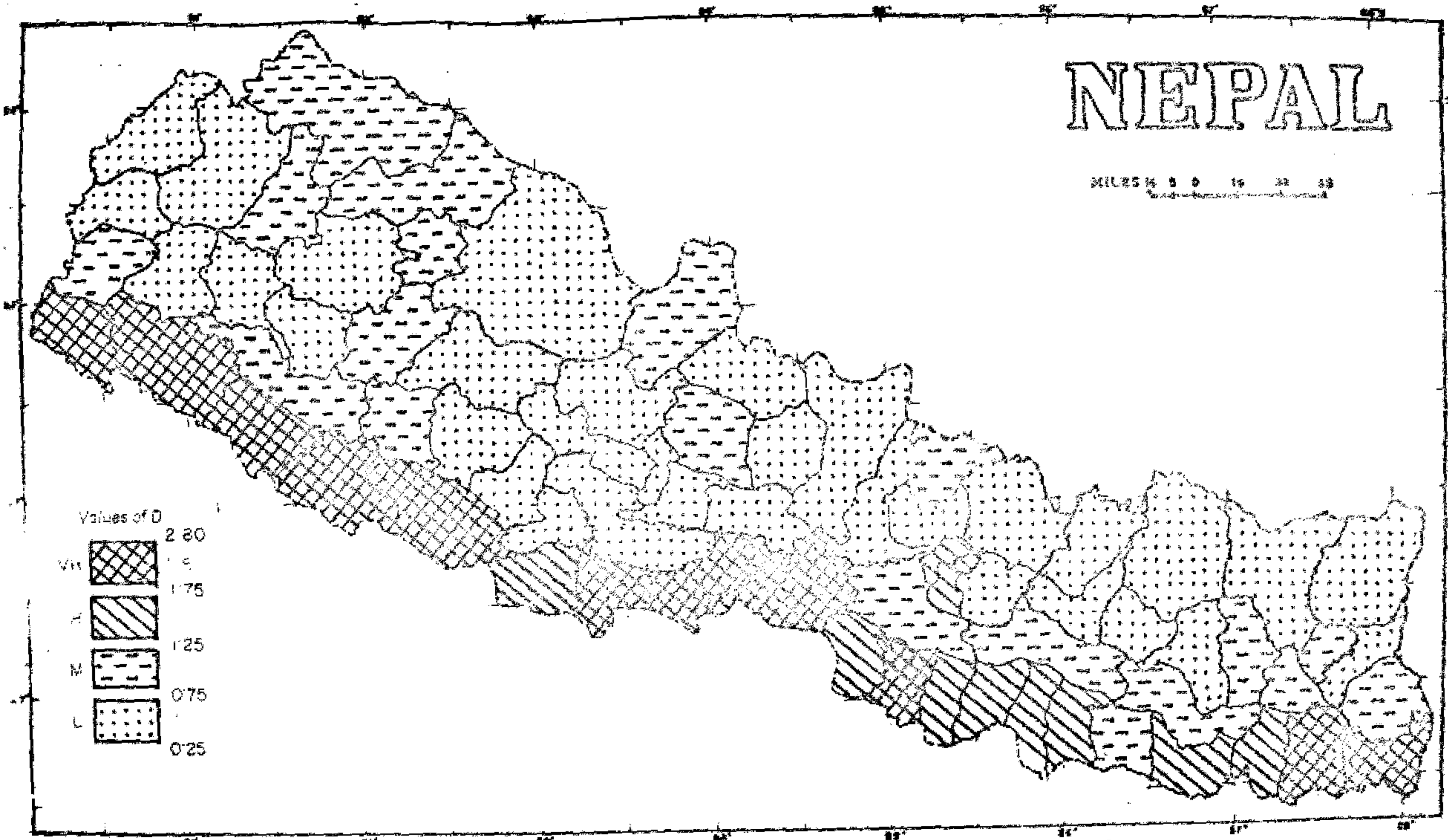


FIG-2·1: DEVELOPMENT INDEX OF AGRICULTURE & ALLIED ACTIVITIES (D)

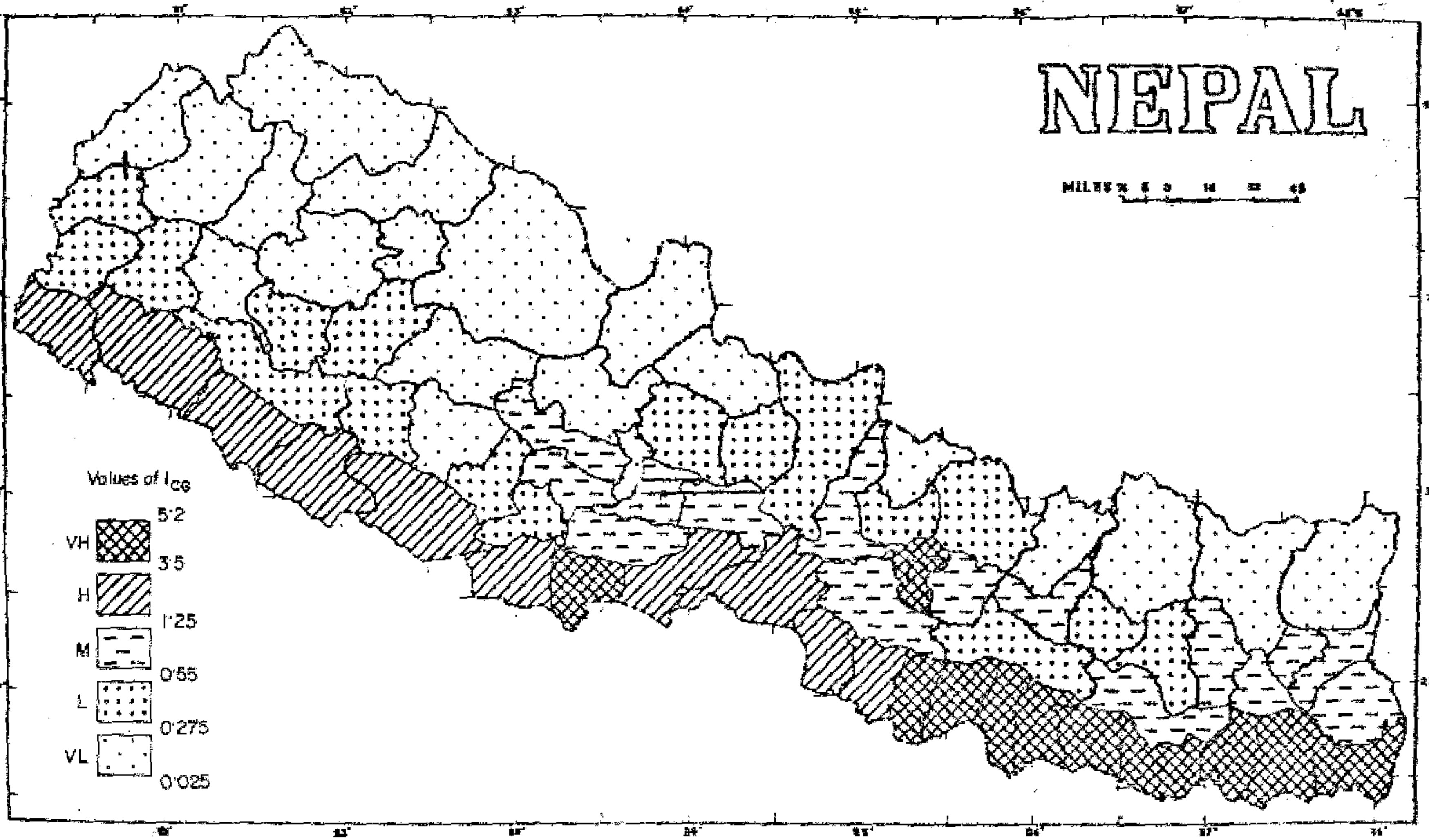


FIG-2·2: INDEX OF LOCATION FACTOR OF CULTIVATED AREA RELATIVE TO GEOGRAPHICAL AREA (I_{CG})

global relation ($r = -0.14$ only, for $N = 75$) between Z and D. It is however inconceivable to believe that D is not at all influenced by Z positively. Naturally we suspected certain distortion of facts in our search for a global relation when agricultural practices are conditioned by different levels of ruggedness. An apparent possibility of this distortion could be the m i x i n g-u p of Tarai and non-Tarai observations. A close examination to the data did not rule out this possibility and indeed we did get positive relations for two groups of districts, one with $\tau < 0.27$ and the other with $\tau \geq 0.27$. The correlation coefficients, though positive, are however, not very high ($r = 0.37$ for districts with $\tau < 0.27$ and $r = 0.53$ for districts with $\tau \geq 0.27$). Between these two groups, Tarai and non-Tarai (i.e., Hills and Mountains), the latter has a better interaction of the intensification factor Z on development level D. The corresponding regression equation is given below in equation 2.6.

$$D = \underset{(.39146)}{-0.59472} + \underset{(.27907)}{1.26979Z} \quad \ldots \quad (2.6)$$
$$r = 0.5300,\ N = 55 \text{ for } \tau \geq 0.27$$

The number of observations in Tarai group is very low and as such we tried for a conditioned global relation mixing-up of the two groups again. This we did in the following way.

As the relationship of the intensification factor Z is better manifested in non-Tarai group having more observations and also as the extension factor I_{CG} is predominantly pronounced in the Tarai group with lower ruggedness, we first tried to find a global relation between Z and D with the incorporation of a dummy factor Z^* for only the districts with $\Upsilon < 0.27$, whose explanation will be sought later through the extension factor I_{CG} and some other relevant factors. The dummy factor Z^* is estimated as follows: If the Tarai districts were to achieve its higher average level of development $\bar{D}_t (= \Sigma D/20)$ following the relation (2.6), they would then have required an inflated value of the intensification factor on the average, namely, $(Z + Z^*)$, so that $\bar{D}_t$ and $(\bar{Z}_t + Z^*)$ satisfy the equation (2.6), (here $\bar{Z}_t = \Sigma Z/20$). The actual estimate $\bar{D}_t = 1.86180$ and $\bar{Z}_t = 0.91550$ so that we have the estimate of $Z^* = 1.01908$. Next we design our multiple-stage least square regression estimates in the following manner:

<u>First stage:</u> Regression fit for

$$D = \alpha + \beta\,(Z + Z^*) + \epsilon',$$

where the dummy factor

$$Z^* = 1.01908 \quad \text{for } \Upsilon < 0.27$$
$$= 0 \quad \text{for } \Upsilon \geq 0.27,$$

and ϵ' = random term at the first stage fit.

Second stage: Regression fit for

$$\epsilon = f(I_{CG}) + \eta ,$$

where $f(I_{CG})$ is an appropriate function of the factor I_{CG},

$$\epsilon = (D - \alpha - \beta Z) = \beta Z^* + \epsilon'$$

= 1st stage residual of D over the actual Z

and η = 2nd stage residual of D over the actual Z and I_{CG}.

Third stage: Regression fit repeated if other relevant factors could be found through comparative map analysis to explain the second stage residuals.

In this way we could get the global relation for the mixed up populations (statistical) distinguished by the ruggedness condition as incorporated above at the first stage. This treatment has helped us to avoid the dampening of the estimate of β by the multicollinearity problem of the usual single stage multiple regression. Thus we have the following empirical estimate given in equation (2.7), at the first stage:

$$D = -0.60375 + 1.27691\,(Z + Z^*),$$
$$\quad\;\;(.10872)\quad(.08145)$$

with $Z^* = 1.01908$ for $r < 0.27$

$= 0$ for $r \geq 0.27$

and $r = 0.8781$, $N = 75$ ... (2.7)

The improvement of the regression fit (2.7) over that of eqn. (2.6) is striking. While the estimate of intercept and slope parameters α and β have no significant difference for the conditioned global and non-Tarai fits, the fit was much bettered in the global fit (with the value of $r = 0.88$ contrasting the value of $r = 0.53$ for the non-Tarai fit).

At the second stage we had to search for an appropriate function $f(I_{CG})$ that would explain the first residual ϵ involving the dummy factor Z^* of the Tarai group and given by (2.8):

$$\epsilon = D + 0.60375 - 1.27691 Z \quad \ldots \quad (2.8)$$

In this effort our first attempt was to make a global linear fit between first residual ϵ and I_{CG}. The corresponding correlation coeff. $r_{\epsilon I_{CG}} = 0.7116$. Next we fitted a quadratic fit which showed considerable improvement. The details of this quadratic estimate is given in equation (2.9) below:

$$\epsilon = -0.27612 + 0.87019 I_{CG} - 0.12881 I_{CG}^2 \quad (2.9)$$
$$(.08404) \quad (.14318) \qquad (.03113)$$
$$R = 0.7754, \; N = 75.$$

In this, all the regression parameters were checked to be significantly different from zero and the value of the correlation coeff. is also improved (from 0.71 to 0.78). Eliminating ϵ from (2.8) and (2.9), we have the expression of D as a function of Z and I_{CG} as follows in equation (2.10).

$$D = -0.87987 + 1.27691 Z + 0.87019 I_{CG} - 0.12881 I_{CG}^2 \quad \ldots \quad (2.10)$$

In this combined two-stage estimation the marginal rate of D with respect to Z is a positive value (= 1.27691). But a single stage multiple regression fit would have given a negative value (-0. 4042) for this marginal rate which is never a reality. In fact non-Tarai districts have more or less the same positive marginal rate as in this equation and the Tarai districts have even a higher positive value.

Thus for a correct evaluation of the marginal rate (or the regression parameter) without the multicollinearity disturbance between Z and I_{CG}, the multiple-stage fit as applied here has become very useful. In fact, this kind of multiple stage estimation has already been applied in pooling the cross-sectional and time-series data for the estimations of income elasticity of demand and price elasticity in pure forms without the multicollinearity effect.

Although the quadratic fit given in equation (2.9) has explained the first residual ϵ substantially, there is still a considerable amount of unexplained variation. As such we examined further the nature of spatial distribution of the second stage residual η given in equation (2.11)

$$\eta = D + 0.87987 - 1.27591Z - 0.87019 I_{CG} + 0.12881 I_{CG}^2 \quad \ldots \quad (2.11)$$

Thus our third stage begins with the search for further factors to explain the second-stage residuals. At this stage we mapped the second stage residuals η and also compared and contrasted it with other maps of possible explanatory factors. By comparisons of maps we are in a position to identify two explanatory factors I_{TG} and I_{SP}, where

I_{TG} = the location factor of the cropped area under Tarai cash crops (jute + sugarcane + tobacco + oilseeds) relative to the geographical area, and I_{SP} = the location factor of livestock units relative to population.

While the spatial variation of η was positively matching to a considerable extent with that of I_{SP} in non-Tarai areas, it was better explained by the totality of cropped area devoted to four main cash crops of Tarai area, namely, jute, sugarcane, tobacco and oilseed. It is obviously logical to accept that the prosperity of primary workers (as depicted by D) is explained not only by the agricultural intensification and extension factors Z and I_{CG}, but also by the factor of allied agricultural activities depicted by I_{SP} and the factor of cash crop intensity depicted by I_{TG}. It should be noted that there is a spatial complementarity between I_{TG} and I_{SP}. The high incidences of I_{TG} can only be found in the Tarai area and in its periphery, with practically no or insignificant cultivation of these cash crops in the entire non-Tarai area. On the other hand, this absence of cultivation of Tarai cash crops in the non-Tarai area is made up considerably, as it were, by the high incidences of I_{SP} in many of the non-Tarai districts. Again as the extent of cultivation is also high in Tarai area, we have a high positive relation between I_{TG} and I_{CG} and also a high inverse relation between I_{SP} and I_{CG}. These relations are shown below in equations (2.12) and (2.13):

$$I_{TG} = \underset{(.18564)}{0.02118} + \underset{(.08981)}{0.84660}\, I_{CG} \quad \ldots \quad (2.12)$$

$$r = 0.74094\,, \quad N = 75$$

and $$I_{SP} = \underset{(.07269)}{0.88220} + \underset{(.00991)}{0.10606}/(I_{CG}) \quad \ldots \quad (2.13)$$

$$r = 0.7816\,, \quad N = 75$$

Because of these high relations we did not prefer in having a multiple regression of the first stage residual ϵ with I_{CG}, I_{TG} and I_{SP} at second stage. Moreover, the regression parameters of I_{CG} and I_{CG}^2, evaluated at the second stage, should better be not tampered by the incorporation of additional factors I_{TG} and I_{SP} at the second stage, because the residual η, obtained after eliminating the effect of factors Z and I_{CG}, is seen to be explained by a combination of I_{TG} and I_{SP}. As any single factor, either I_{TG} or I_{SP}, is not sufficient to explain the second stage residual η globally, we fitted a multiple regression at the third stage to explain η by I_{TG} and I_{SP}. This regression fit is given by equation (2.14)

$$\eta = -0.56355 + 0.13978 I_{TG} + 0.30999 I_{SP} \quad \ldots \quad (2.14)$$

$$R = 0.7205\,, \quad N = 75\,.$$

It should be noted that the relationship between I_{TG} and I_{SP} is not high ($r_{I_{TG}\, I_{SP}} = 0.3518$). It should also be noted that a single factor, either I_{TG} or I_{SP}, could not explain η sufficiently ($r_{\eta I_{TG}} = 0.3904$ and $r_{\eta I_{SP}} = 0.4295$). Because of the spatial complementarity between I_{TG} and I_{SP}, a simultaneous consideration of them gave a better fit in equation (2.14), but the regression should better be interpreted in the following way: Let us consider the linear combination

$$x_a = a\, I_{TG} + (1-a) I_{SP}$$

and find the regressions between η and x_a for variable a and designate that combination as the optimal combination for which $r_{\eta x_a}$ is maximum. In this way we can interpret by a linear correlation and not a multiple correlation. However, the optimal linear correlation has to coincide with the multiple correlation as obtained in equation (2.14) because both are the best fits of the two explanatory variables. Infact, we have evaluated different values of $r_{\eta x_a}$ and it has been seen that the optimal $r_{\eta x_a} = R$ of equation (2.14). A few estimates of $r_{\eta x_a}$ in the neighbourhood of optimal value of a are given below to substantiate our argument.

a	0.25	0.30	0.31	0.31078	0.32	0.35
$r_{\eta x_a}$	0.70449	0.71995	0.72043	0.72047	0.72009	0.71453

It is clear from these estimates that the optimal value of "a" is 0.31078 and the corresponding regression fit is given by equation (2.15)

$$\eta = -0.56355 + 0.44977\,(0.31078\,I_{TG} + 0.68922\,I_{SP}) \quad \ldots \quad (2.15)$$

$$r = 0.72047\,, \quad N = 75.$$

The equations (2.14) and (2.15) are identical, but in equation (2.15), we have avoided the question of multi-collinearity. And in this equation (2.15) the linear combination within the parentheses on the right hand side can be taken as a combined form depicting the spatial complementarity between I_{TG} and I_{SP}.

Denoting the empirical estimate of the right hand side of equation (2.15) by $\hat{\eta}$, the first residual ϵ can be seen as a function of I_{CG} and the optimal linear combination of I_{TG} and I_{SP}. The corresponding estimate will be denoted by $\hat{\epsilon}$ which has the following expression as given in equation (2.16):

$$\hat{\epsilon} = -0.27612 + 0.87019\,I_{CG} - 0.12881\,I_{CG}^2 + \hat{\eta}$$

i.e.,
$$\hat{\epsilon} = -0.83967 + 0.87019\,I_{CG} - 0.12881\,I_{CG}^2 + 0.44977\,(0.31078\,I_{TG} + 0.68922\,I_{SP}) \quad \ldots (2.16)$$

Similarly, we can see D as a function of factors Z, I_{CG} and the optimal combination of I_{TG} and I_{SP}. The corresponding estimate will be denoted by $\hat{D}$ which can be expressed in the form as in equation (2.17)

$$\hat{D} \doteq -0.60375 + 1.27691 Z + \hat{\epsilon}$$
$$= -1.44342 + 1.27691 Z + 0.87019 I_{CG} - 0.12881 I_{CG}^2 + + 0.44977 (0.31078 I_{TG} + 0.68922 I_{SP}) \quad \ldots \quad (2.17)$$

It is interesting to note that there is a striking improvement in explaining the first stage residual ϵ. This residual included the dummy Tarai factor Z^* whose explanation we wanted to seek, subsequently to the first stage regression fit. We have been successful in this effort, as indicated by the correlation coeff. $r_{\epsilon \hat{\epsilon}} = 0.90025$, and the hypothetical dummy Tarai factor Z^* in ϵ is now explained by the factors like I_{CG}, I_{TG} and I_{SP} that constitute $\hat{\epsilon}$ Had we taken a multiple regression of these three factors for $\hat{\epsilon}$, the relationship would have been a little more improved (multiple regression $R = 0.91050$). However our fit is not significantly different from the multiple regression fit and we have gained by evaluating the effect of I_{CG} at the second stage purely and separately from less important factors like I_{TG} and I_{SP} without multicollinearity disturbance. Thus finally D is sufficiently explained by factors like Z,

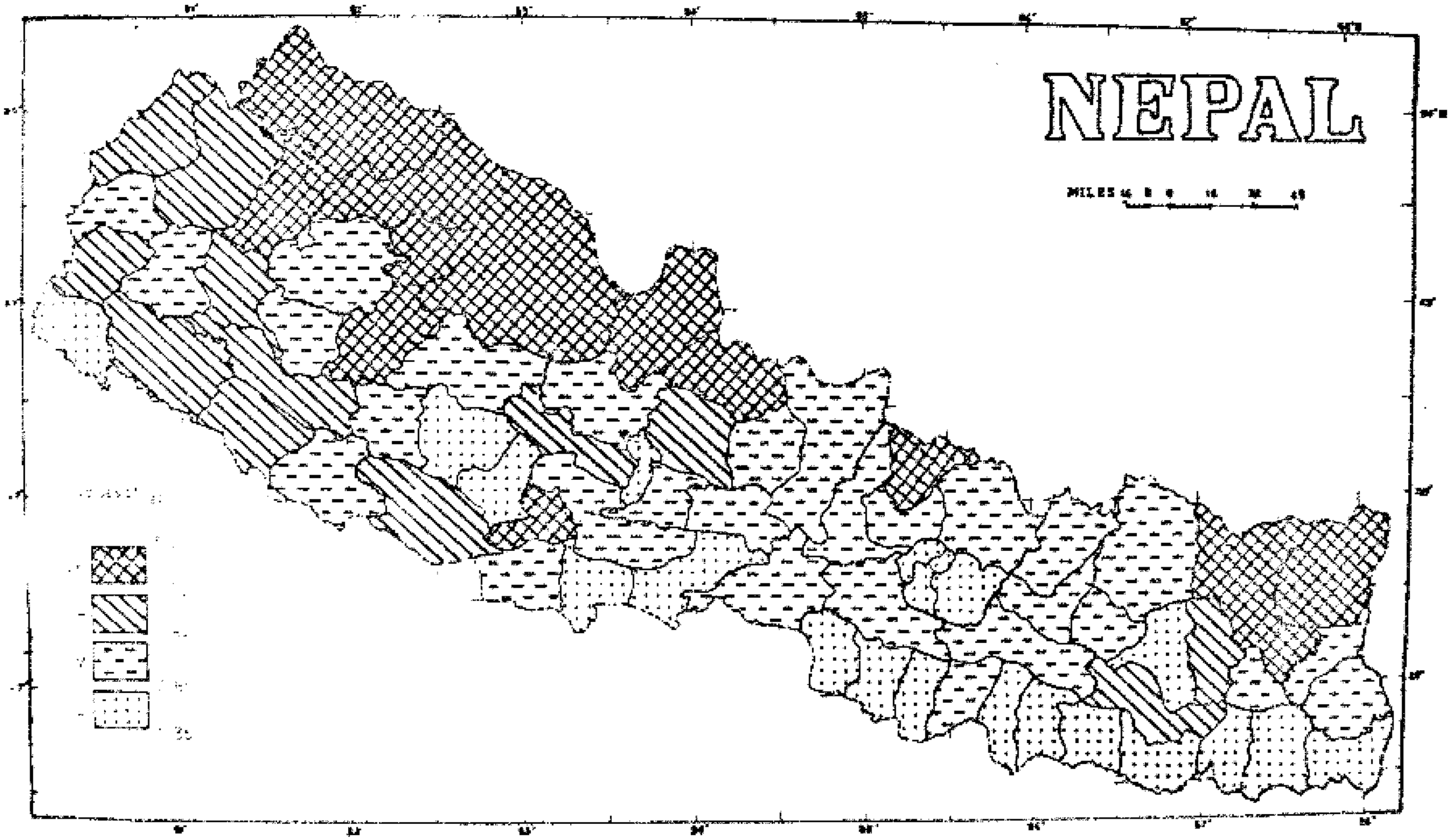


FIG-2·3: LOCATION FACTOR OF LIVESTOCK RELATIVE TO POPULATION (I_{sp})

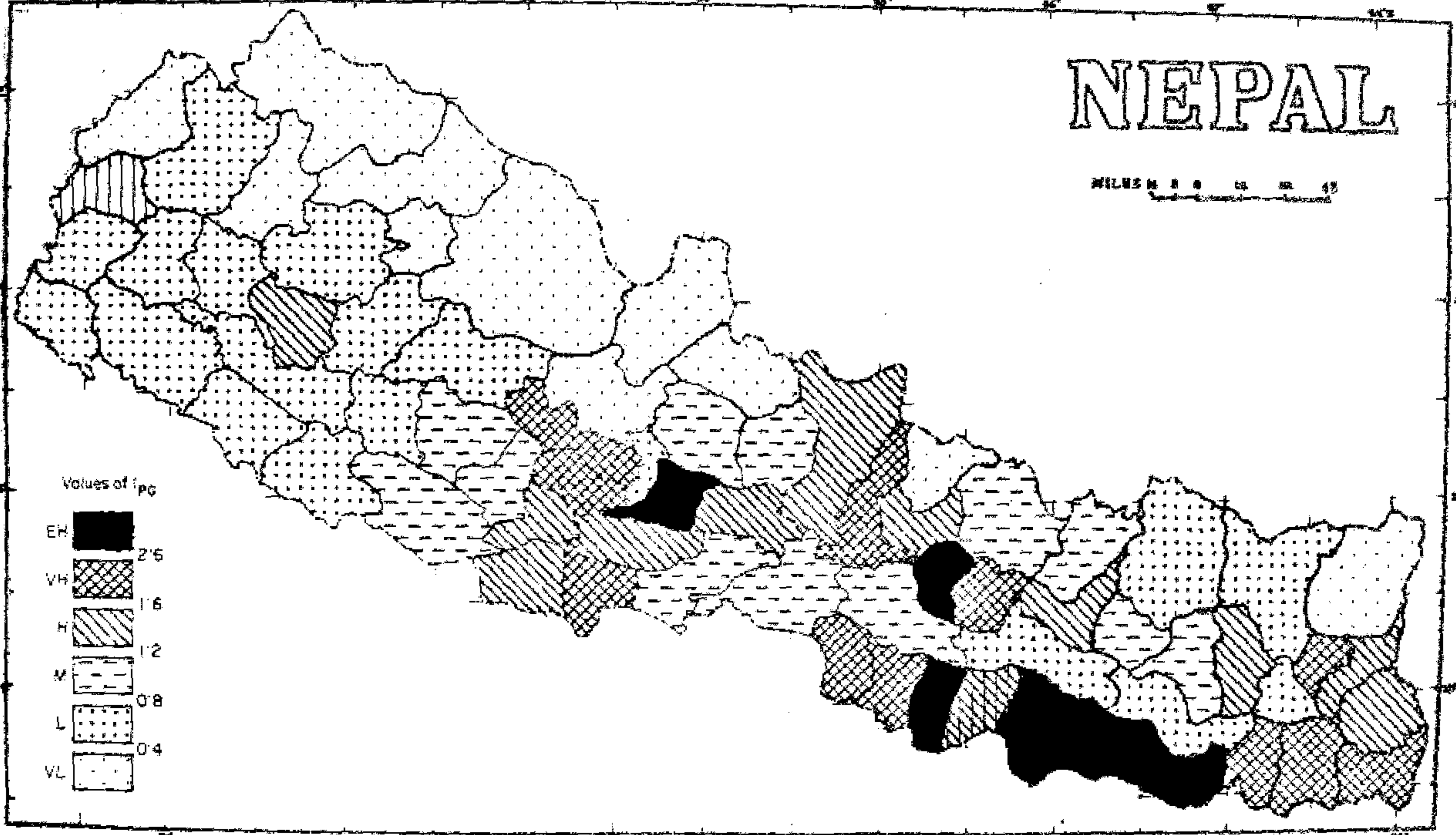


FIG-2·4: INDEX OF LOCATION FACTOR OF POPULATION RELATIVE TO GEOGRAPHICAL AREA (I_{PG})

I_{CG} and the optimal combination of I_{CG} and I_{SP}, incorporated at the three stages in the functional form of $\hat{D}$ ($r_{D\hat{D}}$ = 0.8929).

As our development index D is a measure per head of related worker, it is worthwhile to examine the spatial association of the population concentration index I_{PG} and the development index D at this stage. For this purpose we have mapped I_{PG} and shown in figure (2.4). A comparison of maps reveals the following facts:

(a) The very high level of development (D) in many of the districts of Western Tarai is associated with low values of population concentration (I_{PG}) and with high values of livestock maintained by people (I_{SP}) and also with high extent of arable land (I_{CG}) below the critrical value of I_{CG} = 3.5 above which the diminishing phase starts. Dependability of live-stocks and arable cropping, is well known. In fact livestocks can not only be used as draught animal in agriculture, but also be a source of indegeneous manure needed for intensive cultivation.

(b) The extremely high values population concentration with a value of I_{PG} above 2.6 have occurred in five districts in the Eastern Tarai area, in the capital region and also in the hill district of Syanja where the value of I_{CG} is just below the lower limit of high class of values of I_{CG} (Syanja's I_{CG} = 1.22 while the boundary value of H - class is

1.25). Except Syanja all these extremely populated districts have very high extent of arable land (I_{CG}) but have generally low level of livestock index I_{SP}. Profuse use of chemical fertiliser can be noticed in the capital region leading to intensive cultivation, but that has not been the case in Eastern Tarai districts. The complementarity link between the extent of arable cropping and the live-stocks to be maintained is not in sight in the Eastern Tarai districts. Because of the population pressure, very high level of development (D) has not been attained in the extremely populated districts despite the presence of very high extent of arable land there.

(c) A major western part of Nepal is still sparsely populated with generally very low (in the mountainous districts) and low values of I_{PG}. The wide range of variation in the values of D in this part can be considerably explained by the high values of I_{CG} coupled with generally high values of I_{SP} in the Tarai area and also the very high values of I_{SP} coupled with very low values of I_{PG} in the mountaneous area in the north.

(d) Low values of livestock index I_{SP} have mainly occurred in the eastern and central Tarai belt and in the capital region. This low value does not seem to maintain complementarity links with the very high or high extent of arable land there (as already referred to in (b)). But in these areas all sorts of values of I_{PG} from medium level

M to extremely high level EH have occurred. Such variations in population concentration could possibly be explained by activities other than the agricultural and allied activities.

(e) The central part with Kathmandu - Syanja axis is most highly populated non-Tarai area. Except the capital region all other districts in this belt have low level of development D. As the values of I_{CG} and I_{SP} are not on the higher side, the low level of development of D could be explained. But the explanation for the higher levels of population concentration there does not rest on the agricultural and allied activities alone. The above map analysis shows that population concentration is a much more complex phenomenon than what could be explained by the development level or the ruggedness of terrain, and it is because of this we did not get very high relation of the I_{PG} with τ discussed in the previous subsection. We shall further try to get the explanation for the spatial variation of I_{PG} after we analyse the details of activity pattern.

2.3.3 Analysis of Activity Pattern and Population Concentration.

We shall briefly review in this sub-section the activity pattern of the agricultural sector and the population concentration. The arable cropping is mostly devoted to the production of five cereals and a cereal-substitute

(Potato). About 91.42 per cent of national gross cropped area is devoted to the production of those six crops. Of the cereals and cereal-substitute, paddy is the most important crop with 53%. of gross cropped area devoted to this crop. The corresponding shares of other crops in this category are as follows: 19.36% for maize, 10.55%. for wheat, 5.05%. millet, 2.25%. for potato and 1.21%. for barley. The remaining crops considered are seven cash crops. Of these cash crops the oilseed (mainly mustard) is the most important one (5.033%.) and then comes jute (2.4%.) in order of the importance assessed by the area under these crops. Areal coverage is not much for other cash crops; only 0.667%. for sugarcane, 0.402%. for tobacco, 0.056%. for ginger, 0.019%. for cardamom and 0.003%. for tea. Though paddy covers most of the gross cropped area of the nation, it is not the most wide spread crop spatially. In order to compare different crops for the spatial distribution, both in terms of gross cropped area and crop output value, we have devised two measures that will be called (i) spatial concentration ratio and (ii) spatial concentration ratio quotient. The second measure is however a kind of variation of the first measure. For the first measure, we identify the top group of districts in each of which 1 (one) per cent or more of the national total of an item is concentrated, and findout the district average percentage of the item under consideration. The residual districts form the bottom group with less than 1 per cent of the national total in each district. We also find the actual average percentage for this group of districts also. The ratio of bottom group averages is our measure of the spatial concentration ratio between the top and the bottom groups of districts for an item. We have presented in Table 2.3 the number of districts in top and bottom groups, the group averages and the spatial concentration ratios with respect to all thirteen crops and the aggregate all crops both for their spatial distributions of grossed cropped area and crop output value. As there are polarisation of values to either very high or very low magnitudes in asymptotic nature for many features in Nepal, these measures presented in the Table 2.3 tell us much more than an over-all measure like the Lorenz index. Here the demarcating value of 1% between the top and bottom group is below a certain margin of the national average value of 1.33 (= 100/75). So the bottom group is really a low or under-developed group as compared with the national average level. This demarkating value taken uniformly for all crops and aggregate gives us the frequencies of districts in a group which differ from crop to crop. One can also compare the magnitudes of the average values between either the top group or the bottom group and the pooled group whose average is always at 1.33 here. In our Table 2.3, the top group averages of all crops are above this value of 1.33 meant for the pooled group.

Table 2.3: The spatial concentration ratios and ratio of different crops by gross cropped area and gross output value.

	Crops	Top-group of districts with 1% or more of national total in each district.		Bottom group of districts with less than 1% of national total in each district.		Crop concentration ratio (of top to bottom group averages)	Crop concentration ratio quotient relative to aggregate of all crops
		no. of districts	district average percentage	no. of districts	district average percentage		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				1.1 Gross cropped area			
	all crops	27	2.7230	48	0.5517	4.9359	1
cereals and substitute	paddy	21	4.0300	54	0.2846	14.1588	2.8685
	maize	47	1.8274	28	0.5039	3.6264	0.7347
	wheat	37	1.9162	38	0.7658	2.5023	0.5070
	millet	39	1.9674	36	0.6464	3.0437	0.6166
	potato	38	1.9697	37	0.6797	2.8978	0.5871
	barley	38	2.2418	37	0.4003	5.6008	1.1347
	oilseeds	23	3.7043	52	0.2846	13.0153	2.6369
cash crops	jute	6	13.1583	69	0.3051	43.1318	8.7384
	sugarcane	12	7.0683	63	0.2410	29.3350	5.9432
	tobacco	14	6.3607	61	0.1795	35.4341	7.1789
	ginger	6	16.4700	69	0.0171	963.0763	195.1167
	cardmom	5	19.8120	70	0.0134	1475.3617	298.9043
	tea	2	50.0000	73	0.0000	∞	∞

1.2 Value of crop output

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	all crops	33	2.3923	42	0.5013	4.7723	1
cereals and substitute	paddy	24	3.4550	51	0.3349	10.3165	2.1617
	maize	46	1.8657	29	0.4890	3.8155	0.7995
	wheat	40	2.1458	35	0.4049	5.3000	1.1106
	millet	36	2.1367	39	0.5918	3.6105	0.7566
	potato	36	2.1183	39	0.6087	3.4800	0.7292
	barley	36	2.3247	39	0.4182	5.5588	1.1648
cash crops	oilseeds	21	4.1433	54	0.2406	17.2240	2.9805
	jute	6	16.0950	69	0.0497	323.7770	67.8451
	sugarcane	12	7.3183	63	0.1933	37.8534	7.9319
	tobacco	14	6.5014	61	0.1472	44.1634	9.2541
	ginger	7	14.2500	68	0.0037	3876.0000	812.1870
	cardmom	5	19.8460	70	0.0110	1804.1818	378.0528
	tea	2	50.0000	73	0.0000	∞	∞

It is to be noted from the data of spatial concentration ratios that among cereals and cereal substitute, paddy has the highest ratio estimates in both the distributions of gross cropped area and the crop output value. On the other hand maize and millet (with respect to both the distributions) and also wheat (with respect to gross cropped area) are quite dispersed crops with the spatial concentration ratios considerably below that of the aggregate of all crops. Wheat has a higher concentration ratio for the crop output value compared with the cropped area. This improvement reflects the fact of intensive mode of wheat cultivation in the core wheat producing areas. But the most important crop, paddy, gives an opposite picture. This crop has a considerably lower estimate of the concentration ratio for the crop output value compared with that for cropped area. This reflects the incidence of lower productivity in core paddy area compared to its spatial counterpart. All cash crops are highly localised with very high or extremely high magnitudes of spatial concentration ratios. As the cash crops, particularly the highly localised ones, have certain advantage factors for their growth in the core areas of cash crops, the spatial concentration ratios are likely to be more for the output distribution than for the cropped area distribution. This fact is adequately reflected in our measures for the cash crops given in Table 2.3. From these data it is also clear that tea, cardamom and ginger are the most localised crops with extremely high magnitude of the spatial concentration ratios. Jute, tobacco, sugarcane and oilseeds come in the next rank with very high magnitudes of the spatial concentration ratio.

The spatial concentration ratio is estimated from the single spatial distribution of, say x, without its comparison to any other spatial distribution. All other spatial indices, like Lorenz indices or the location factors, are usually computed, say for the spatial distribution of x, to some other suitable spatial distribution, of say y, used for comparison. If all the spatial units of observation, here districts, have the same proportion of x relative to y, the values of the spatial concentration ratios for both the distributions would have been identical, showing comparable spatial distributions in both. So it is worthwhile to examine how higher (or lower) the spatial concentration ratio of an item is as compared to that of any other suitable spatial variable used for comparison. Here comes the importance of our second measure, designated already by "spatial concentration ratio-quotient". If Q_x and Q_y denote the spatial concentration ratios for the two spatial distributions x and y used for comparison, the spatial concentration ratio-quotient of x relative to y is denoted by Q_{xy} and defined as the following quotient of the two ratios:

$$Q_{xy} = Q_x / Q_y .$$

In our study of crops, an individual crop is considered as x and the aggregate of all crops is considered as y. The corresponding values of Q_{xy}, both for cropped area as well as for crop output value, have been presented in the last column of Table 2.3. An important point is that the concentration ratio-quotients depict the relative direction of concentration (higher or lower than unity for the two directions) unlike other usual measures of spatial concentration like the Lorenz index. In the computation of Lorenz index for (i) the distribution of x relative to y and (ii) the distribution of y relative to x, we shall get the same value. But in the present case of the spatial concentration ratio-quotient, for the two cases will give inverse estimates. That is if an item is localised or concentrated relative to a second item, the second item has to be less localised relative to the first item and this fact of reality is brought out only in the present measure of the spatial concentration ratio-quotient, and not in the Lorenz measure or the like, as would be evident from the data quoted below. It is to be noted that the estimates of spatial concentration ratio for geographical area, population and cultivated area are respectively 2.0093, 2.7109 and 7.3900. So we shall have the following three measures of spatial concentration ratio-quotients Q_{xy}, say, for item x over item y :

Q_{CG} = 3.6776 (: cultivated land over geogr. area)

Q_{PG} = 1.3491 (: population over geogr. area)

Q_{CP} = 2.7261 (: cultivated area over population)

Corresponding Lorenz measures already referred to in section 2.1 were as follows:

$$L_{CG} = L_{GC} = 0.632$$

$$L_{PG} = L_{GP} = 0.455$$

$$L_{CP} = L_{PC} = 0.446$$

Both the measures Q_{CG} and L_{CG} give highest estimates, but Q_{CP} comes between Q_{CG} and Q_{PG}, while L_{PG} is almost equal to L_{CP}. It demonstrates that the Lorenz measure, however useful that may be for many reasons, is not the adequate measure for an appropriate evaluation of the spatial concentration and our present measure certainly adds to the knowledge of what we already analysed in section 2.0 with the Lorenz indices. It looks more reasonable to infer that the cultivated area is much more concentrated relative to population than what population is relative to geographical area in Nepal. This inference can be drawn only though our spatial concentration ratio-quotients and not by the corresponding Lorenz indices.

Looking back to Table 2.3 for concentration ratio-quotients of different crops relative to the aggregate of all crops, we can have the following classifications:

(a) Extremely localised: Tea, cardamom and ginger ($Q_{xy} > 100$)

(b) Very highly localised : Jute, tobacco, sugarcane, oilseeds and paddy
$(Q_{xy} > 2)$

(c) dispersed or highly dispersed : Barley, wheat, maize, millet and potato
$(Q_{xy} < 1.25)$

Extremely localised crops are distributed in only a few districts. About 92% of national tea output is concentrated in the hilly district of Illam in the eastern border and the rest in the foot hill areas of the neighbouring Jhapa district. Similarly 93% of national cardamom output is concentrated in the same Illam district. Ginger is a little more distributed among extremely localised crops. Main ginger producing districts are: Sallyan (36%), Tanahu (21%), Syanja (19%), Palpa (19%) and Gulmi (7%). None of these districts are in Tarai area, though they are in its neighbourhood with ruggedness index value 0.85 (note that the hill districts have genarally the ruggedness index value between 0.27 and 1.40).

On the other hand dispersed or highly dispersed crops are well distributed spatially. We have mapped important crops like maize, wheat and potato (figures 2.5, 2.6, and 2.7) among the crops of this group. These are double variable maps showing both national importance as well as the local importance of a crop under consideration. The national

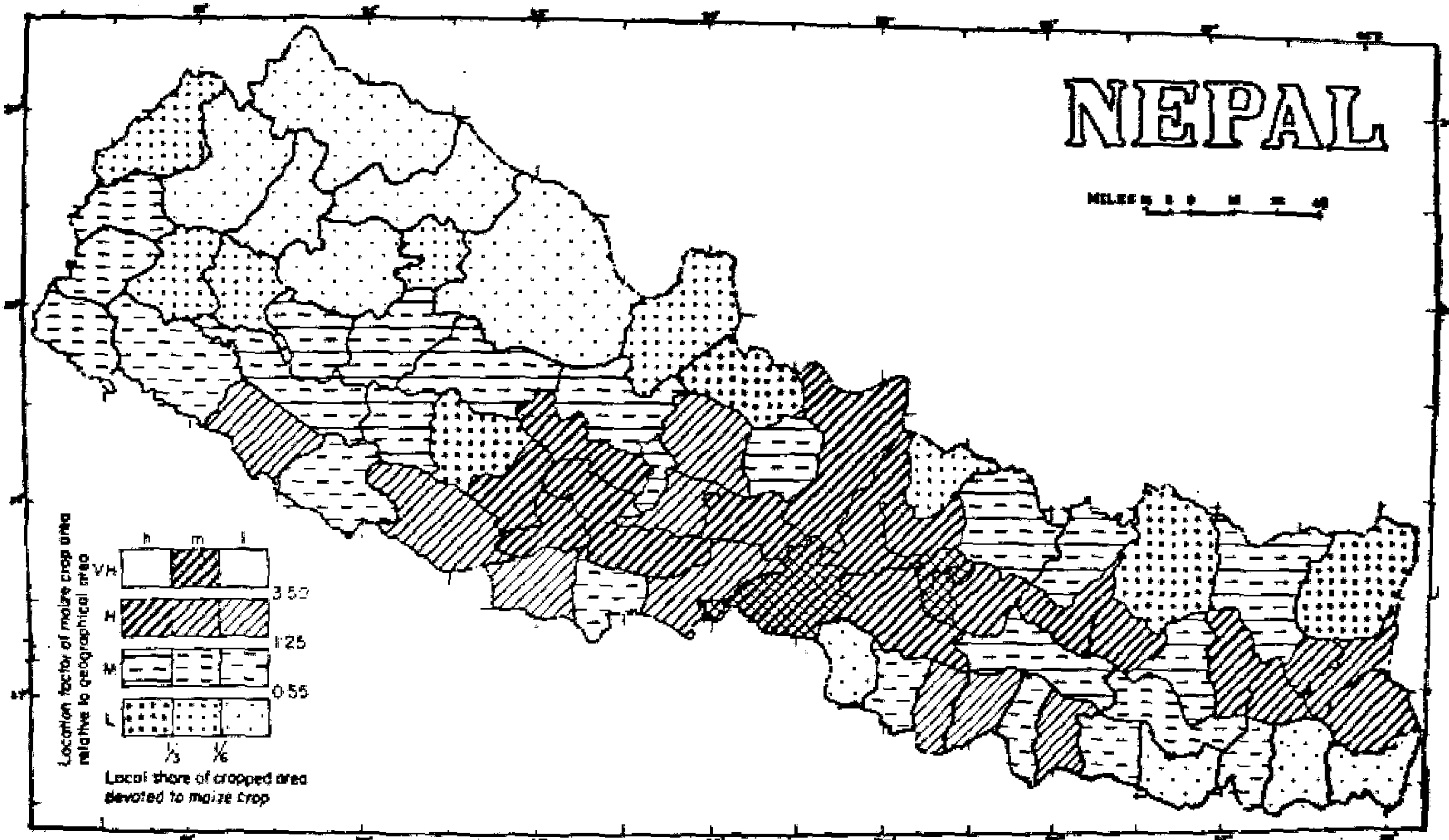


FIG-2·5: INDEX OF LOCATION FACTOR OF MAIZE CROP AREA

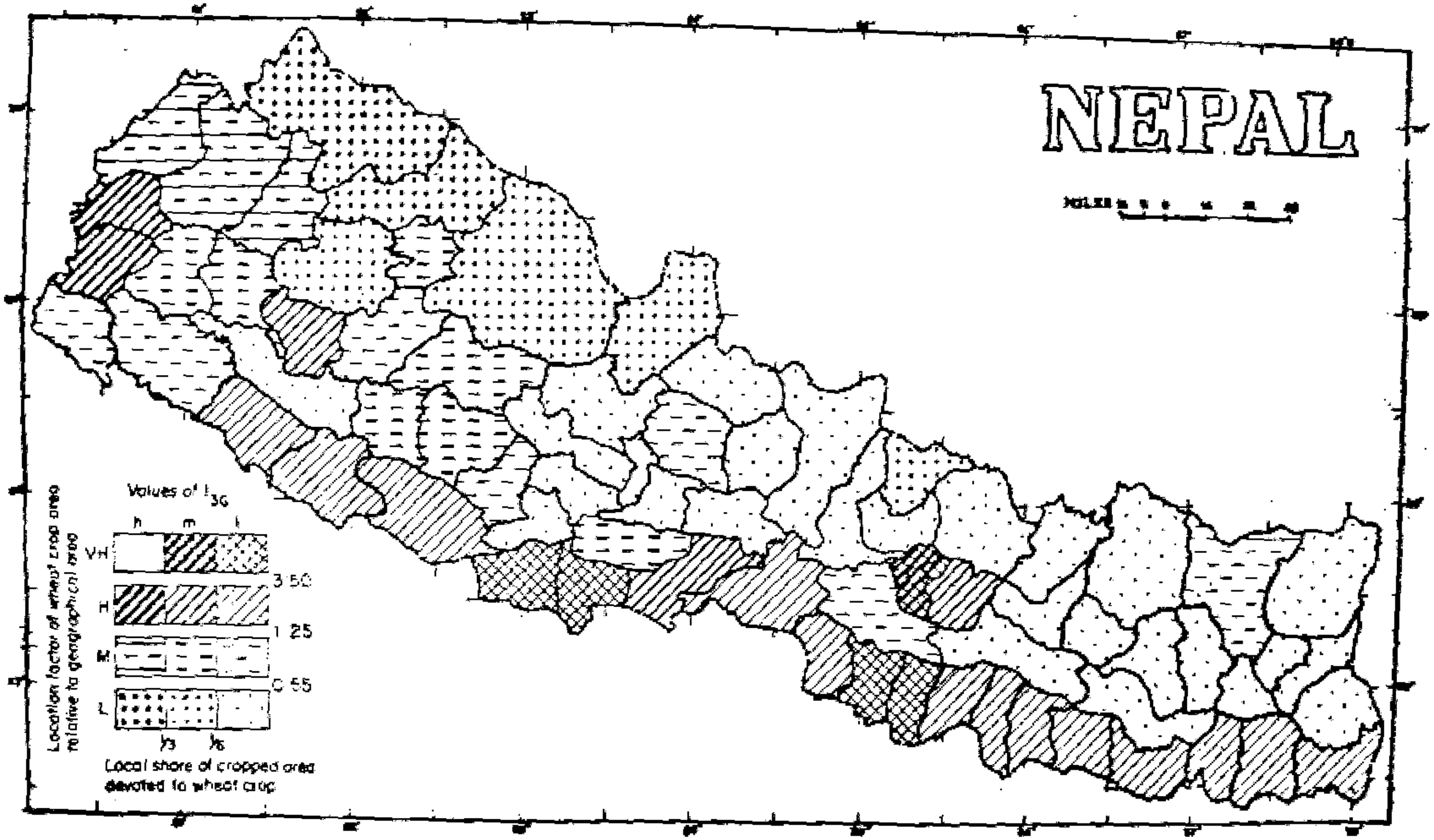


FIG-2·6 : INDEX OF LOCATION FACTOR OF WHEAT CROP AREA

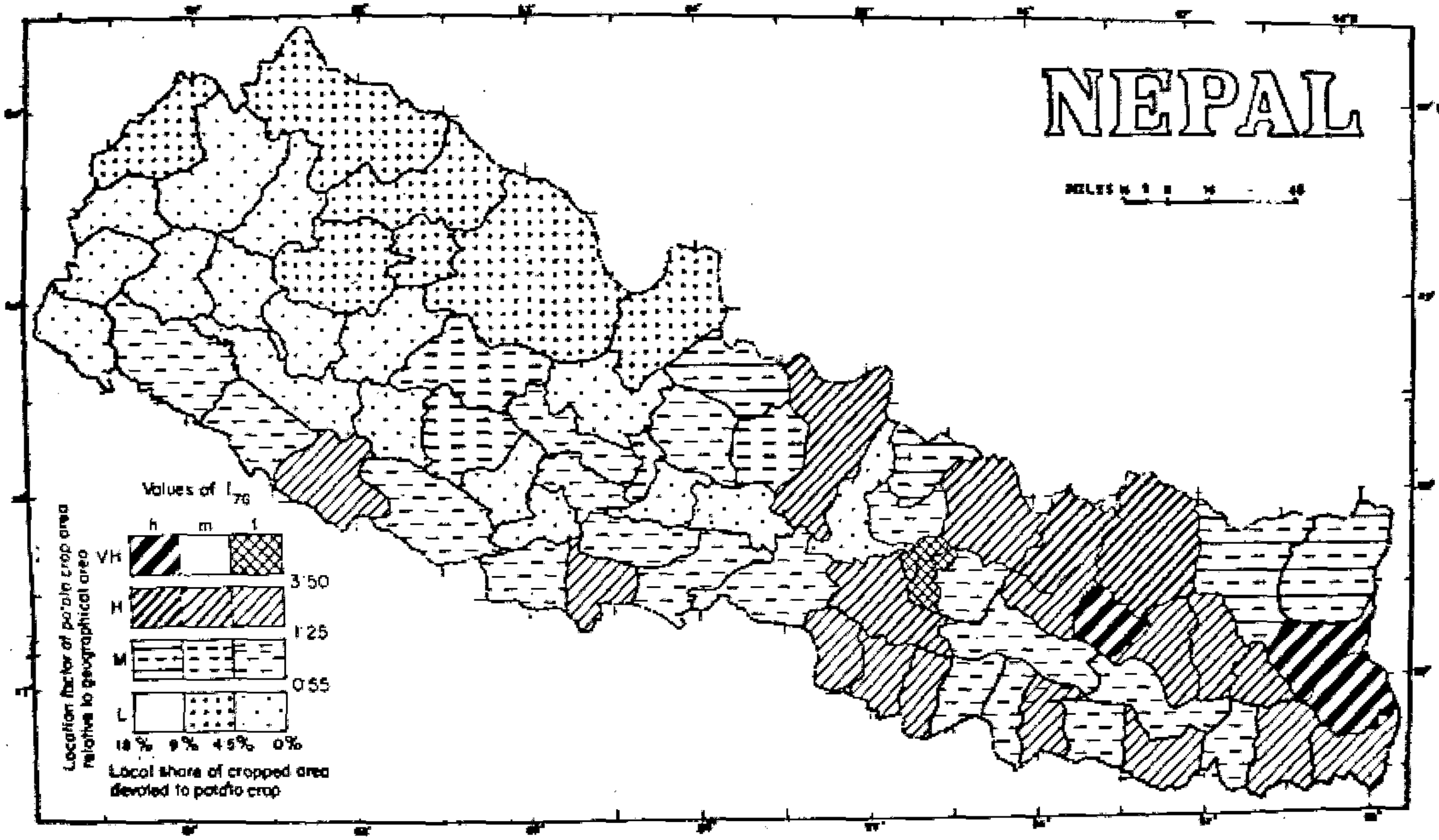
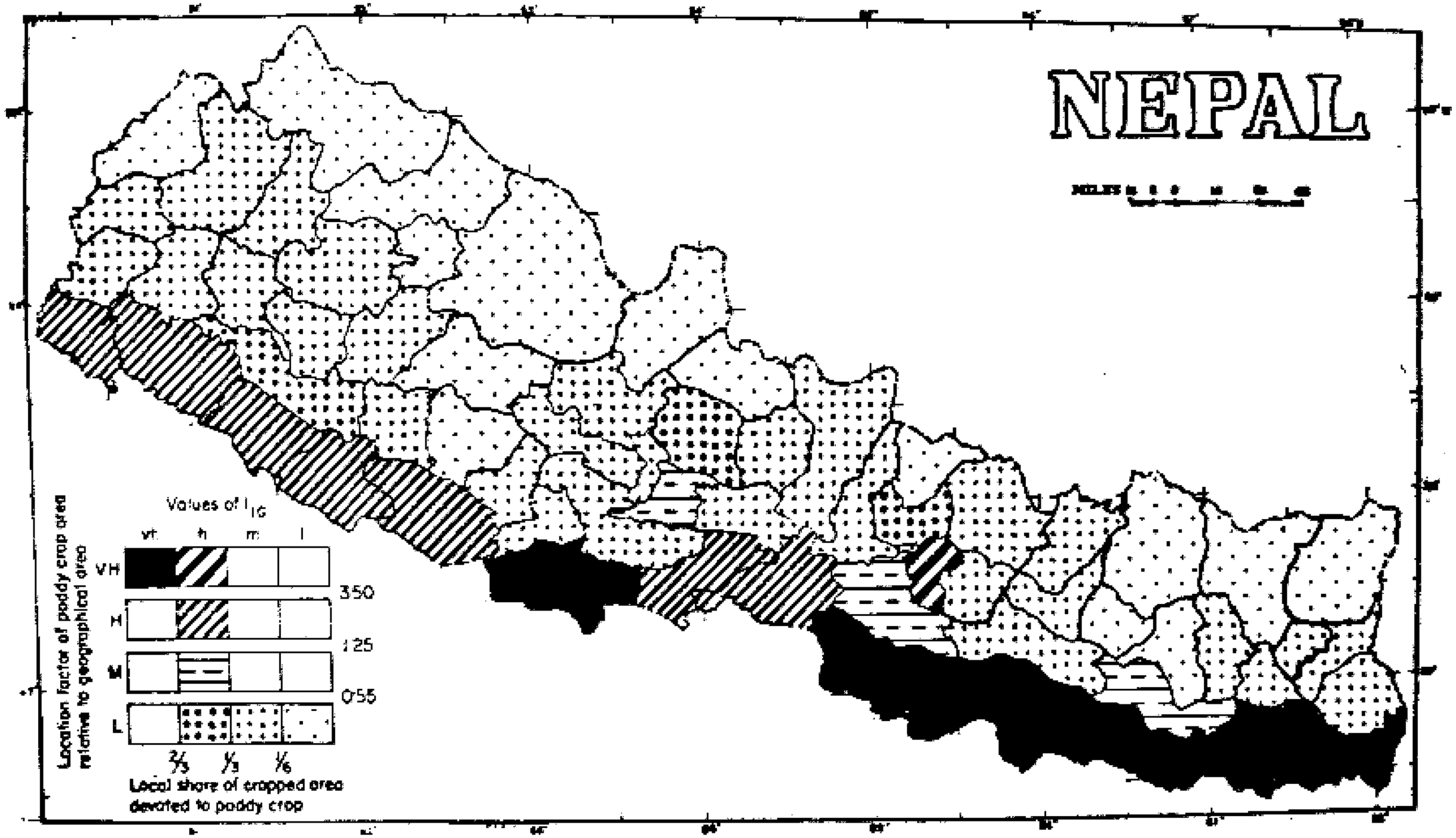


FIG-2·7: INDEX OF LOCATION FACTOR OF POTATO CROP AREA importance of a crop is measured by the location factor of the cropped area relative to geographical area. The local importance of the same crop is measured by the percentage of gross cropped area devoted to the crop in a district. The classificatory schemes for each such double variable map are shown in the figure itself. It can be seen that how the highly dispersed crops like maize and potato (spatial concentration ratio-quotient Q_{xy} below 0.75 for these crops in respect of both cropped area and the crop output) spread at all levels of ruggedness. Maize appears to be an important crop in almost all districts below 28°30' N latitude. Potato seems to be an important crop of most of the districts in eastern Nepal. Wheat seems to be an important crop of Tarai area (except the far Western Tarai districts of Kanchanpur and Kailali) in terms of national share while it is a locally important crop in the hilly and mountainous districts in the Far-Western side of Nepal (where maize and paddy are relatively unimportant crops). These dispersed and highly dispersed crops, likewise the extremely localised crops do not help much in delineating cropping regions over and above what we obtained through the mapping of the location factor of cultivated land relative to geographical area, I_{CG}.

Very highly localised crops, mostly concentrated in Tarai area, do however help us in further regionalising the

Tarai belt of high and very high values of I_{CG}. Figure (2.8) is a similar kind of double variable map for paddy as we have done in preceding three figures. The important paddy areas with high or very high local as well as national shares are all concentrated in the Tarai and the Kathmandu valley. The incidence of high or very high values of cultivated area (ref. to the map of I_{CG} in figure 2.2) is almost identical with the important paddy areas. In both the maps eastern area has higher values than the western Tarai. But further regionalisation possibility comes only through four Tarai cash crops and their localisation patterns. With the regionalisation purpose in our mind, we have mapped all four very highly localised cash crops in figure (2.9). In this figure we have first mapped the totality of cropped area under these four crops together. The location factor of this aggregate cash cropped area relative to the geographical area is asked for this purpose. The location factors of individual cash crops relative to geographical area are then used for further characterising the map of aggregate cash crops (4 crops). Core producing areas of each of these crops are identified by extremely high (above 6) or very high (between 3 and 6) values of corresponding location factor. It is to be noted that very high or extremely high values of location factor for any of these four crops have occurred only in the Tarai belt and no



FIG–2·8: INDEX OF LOCATION FACTOR OF PADDY CROP AREA

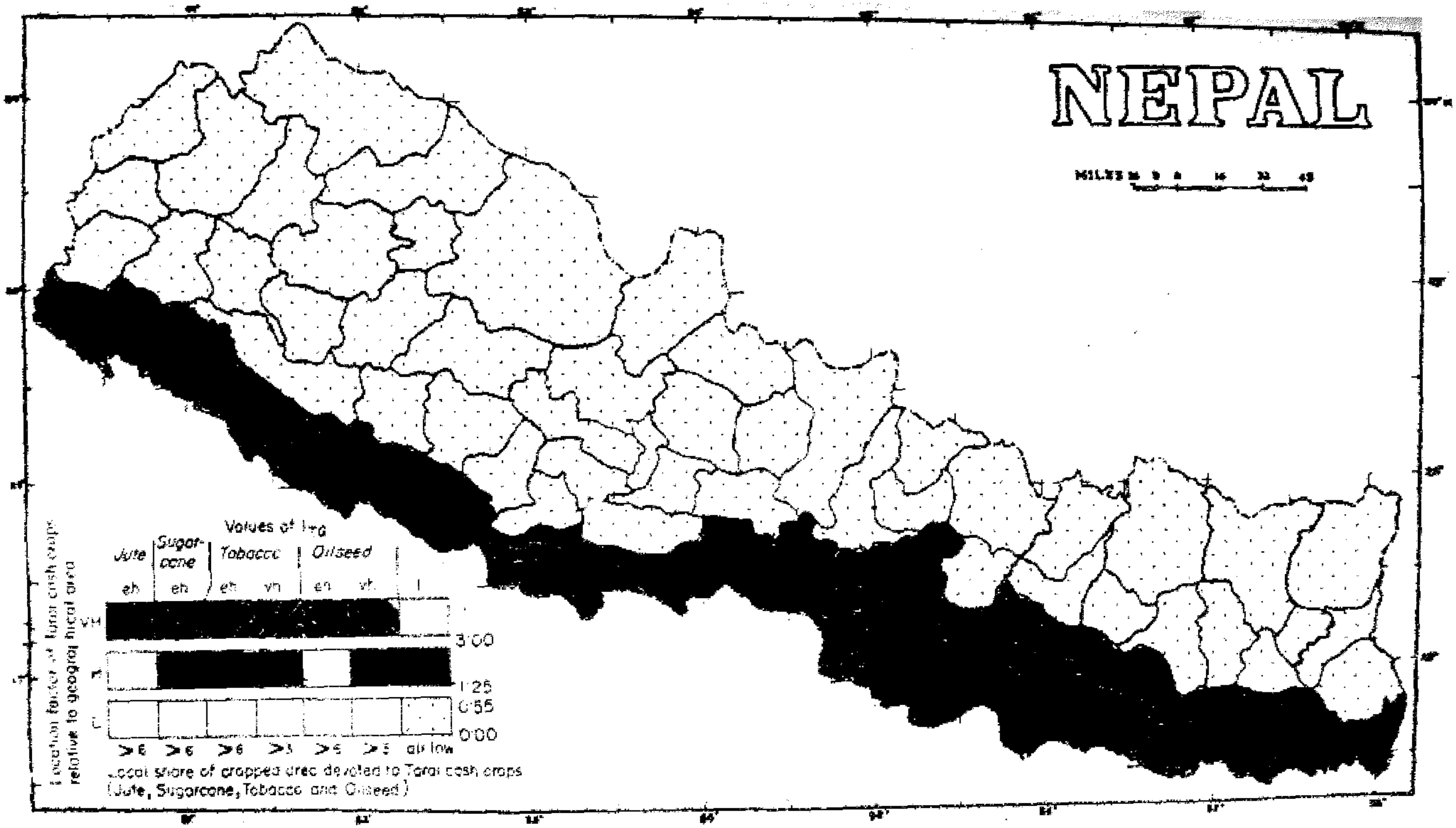


FIG-2·9: INDEX OF LOCATION FACTOR OF TARAI CASH CROP AREA where else. The high or very high values of the aggregate of four cash crops have been extended beyond the Tarai belt on the northern neighbourhood in the eastern side. This is, because the oil is a major counterpart of the aggregate cash cropped area and high oil producing areas (location factor above 1.25) are same as the high aggregate cash cropped areas as depicted in figure (2.9). Thus oilseed (musterd), likewise paddy, is an universal crop in the Tarai belt, although it is more important (unlike paddy) in the western side. Beyond the characterisation interms of cash crops as shown in figure.2.9,some other characterisations in terms of other crop are worth noticing. They are (i) except Kanchanpur and Kailali all other Tarai districts are important wheat area. These two districts are thus treated differently from other oil producing districts in the far western side in our regionalisation for cropping patterns, (ii) Though maize is a dispersed crop, very high concentration is noticed in (a) Chitwan dist. and (b) the three districts in Kathmandu valley. For this reason these two areas are treated separately from others in our regionalisation scheme. In addition to these three regions with high or very high paddy cultivation, other Tarai districts can be distinctly divided into five regions: one region of predominantly jute cultivation, two regions of predominantly sugarcane cultivation, and one region each r predominant tobacco cultivation and very high oilseed ltivation. In addition to these eight regions with high very high paddy cultivation (and extent of cultivation) e have already identified eleven more regions with different evels of the extent of cultivation with non-high values of $_{CG}$ as in figure (2.2). All these regions are defined below ith the name of districts included in each.

1.1 Far-Eastern Tarai of extensive cultivation (FETEC)
1. Jhapa, 2. Morang, 3. Sunsari, 4. Saptari
(Jute area).

1.2 Eastern Tarai of extensive cultivation (ETEC)
1. Siraha, 2. Dhanusha, 3. Mahottari, 4. Sarlahi
(tobacco area)

1.3 East-Central Tarai of extensive cultivation (ECTEC)
1. Rautahat, 2. Bara, 3. Parsa
(sugarcane area)

1.4 Mid-Central Tarai of extensive cultivation (MCTEC)
1. Chitawan
(oilseed area)

1.5 West-Central Tarai of extensive cultivation (WCTEC)
1. Nawalparasi, 2. Rupandehi, 3. Kapilvastu
(sugarcane area)

1.6 Western Tarai of extensive cultivation (WTEC)
1. Dang-deukhuri, 2. Banke, 3. Bardia
(oilseed area)

1.7 Far-Western Tarai of extensive cultivation (FWTEC)
1. Kailali, 2. Kanchanpur
(oilseed area)

1.8 Kathmandu valley extensive cultivation (KVEC)
1. Kathmandu, 2. Lalitpur, 3. Bhaktapur
(Capital region)

2.1 Far-Eastern Hills of medium cultivation (FEHMC)
1. Illam, 2. Panchthar, 3. Tehrathum,
4. Dhankuta, 5. Bhojpur, 6. Udaipur

2.2 East-Central Hills of medium cultivation (ECHMC)
1. Ramechhap, 2. Kavre-Palanchok, 3. Makawanpur,
4. Dhading

2.3 West-Central Hills of medium cultivation (WCHMC)
1. Tanahu, 2. Sanjya, 3. Palpa, 4. Gulmi,
5. Baglung

3.1 Eastern Hills of low cultivation (EHLC)
1. Khotang, 2. Okhaldunga, 3. Sindhuli

3.2 East-Central Hills of low cultivation (ECHLC)
1. Sindhupalchowk, 2. Nuwakot

3.3 West-Central Hills of low cultivation (WCHLC)
1. Gorkha, 2. Lamjung, 3. Kaski

3.4 Western Hills of low cultivation (WHLC)
1. Agra-Khanchi, 2. Pyuthan

3.5 Mid-Western Hills of low cultivation (MWHLC)
1. Sallyan, 2. Surkhet, 3. Jajarkot 4. Dailekh

6 Far-Western Hills of low cultivation (FWHLC)

1. Doti, 2. Dadeldhura, 3. Baitadi

1 Eastern mountaneous region of very low cultivation (EMVLC)

1. Taplejung, 2. Sankhuwasabha, 3. Solokhumbu
4. Dolakha, 5. Rasuwa

2 Western mountaneous region of very low cultivation (WMVLC)

1. Manang, 2. Mustang, 3. Myagdi, 4. Parbat,
5. Dolpa, 6. Rukum, 7. Rolpa, 8. Mugu,
9. Tibrikot, 10. Humla, 11. Jumla, 12. Achham,
13. Bajura, 14. Baghang, 15. Darchula

The details of cropping pattern in these 19 regions can be noticed directly from the following Tables 2.4 and 2.5. In Table 2.4, location factors of cropped area relative to geographical area have been recorded for all thirteen crops. These estimates show the relative national importance of the crops. While the local relative importance of different crops, measured by the percentages of gross cropped area devoted to different crops, are tabulated in Table 2.5. As the location factors of crops given in Table 2.4 are estimated in relation to the geographical area, we have also entered the national percentage share of geographical area for different regions in the Table 2.5. These estimates not only give the relative sizes of different regions in terms of geographical area, but also help us in obtaining the national percentage share of cropped area under different crops which is nothing but the product of the corresponding location factor and the national percentage share of geographical area. Again in Table 2.5 we have recorded additionally the national percentage share of total gross cropped area for different regions. The actual total gross cropped area for these thirteen crops together were about 22,661 sq. km. in 1971-72 for the nation. On basis of this national value and the regionwise percentage share one can easily get the estimate of total gross cropped area whose percentage shares under different crops are reported in Table 2.5. Certain salient features of cropping pattern as could be noticed from the data of Tables 2.4 and 2.5 are described below:

Region 1.1 FEPEC: Paddy is the most important crop and Jute is the most important cash crop. This is a region of diversified cropping pattern with other important crops like wheat, potato, oilseeds, sugarcane and tobacco.

Region 1.2 ETEC: Paddy is the most important crop and tobacco is the most important cash crop. Other important crops are maize, wheat and oilseeds.

Region 1.3 ECTEC: Paddy is the most important crop and wheat is the next important crop. Sugarcane is the most important cash crop and oilseed is the next important cash crop.

egion 1.4 MCTEC : Maize and Paddy are the most important crops and oilseed is the most important cash crop.

Region 1.5 WCTEC : Paddy is the most important crop followed by wheat and maize. Sugarcane is the most important cash crop.

Region 1.6 WTEC : Paddy is the most important crop followed by maize and wheat. Oilseed (mainly mustard) is the most important cash crops.

Region 1.7 FWTEC : Paddy is the most important crop followed by maize. Oilseed is the most important among the cash crops.

Region 1.8 KVEC : This is a multi-crop region having grown all most all the cereals and substitute crops. However among these crops, paddy and wheat are the most predominant ones followed by maize and potato. Even the millet is grown abundantly.

Regions (1.1 to 1.8) of extensive cultivation : In all these regions paddy in the predominant crop and generally followed by wheat and maize. These regions have however different cash crop specialisations as indicated already.

Regions (2.1 to 2.3) of medium cultivation : Generally maize is the most important crop. Locally, paddy is the next important crop, but the gross cropped area under paddy is nationally unimportant. Extremely localised cash crops of tea and cardamom are concentrated in limited area of region 2.1 only, while the extremely localised crop of ginger is concentrated in region 2.3. Potato seems to become more and more important as we go from western to eastern side of Nepal.

Regions (3.1 to 3.6) of low cultivation: Maize is the most important crop in all regions except in regions 3.6 where wheat takes the dominant place and maize becomes the next important crop. Millet seems to be an important associated crop with maize. Paddy is also an important, locally, crop in all these regions but it is unimportant nationally.

Regions (4.1 to 4.2) of very low cultivation : Maize is the most important crop locally followed by millet in the eastern mountaneous region 4.1, while wheat and maize are almost equally important crops from the local point of view in the western mountaneous regions 4.2.

Table 2.4: Location factors of different crops relative to geographical area by cropping region.

Cropping Regions	National % share of geographical area	Location factors of - Cereals and Substitute Crops					
		Paddy	Maize	Wheat	Millet	Potato	Barley
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.1 FETEC	4.17	5.36	0.45	1.87	0.75	1.56	0.71
1.2 ETEC	3.49	5.43	1.32	2.22	1.20	1.04	1.04
1.3 ECTEC	2.64	5.01	1.13	4.05	0.83	1.69	5.29
1.4 MCTEC	1.75	1.26	3.75	1.43	0.55	1.07	0.23
1.5 WCTEC	3.75	3.58	1.35	4.05	0.57	1.18	1.95
1.6 WTEC	4.14	2.00	1.89	1.65	0.49	0.85	0.31
1.7 FWTEC	3.05	1.69	1.12	0.79	0.53	0.58	0.01
1.8 KVEC	0.53	4.19	7.89	17.19	6.77	9.81	0.26
2.1 FEHMC	6.72	0.38	1.59	0.17	1.32	2.61	4.30
2.2 ECHMC	4.36	0.45	2.09	0.97	1.67	1.51	0.26
2.3 WCHMC	4.74	0.42	1.72	0.51	3.71	0.62	0.72
3.1 EHLC	3.93	0.20	1.14	0.28	1.21	1.91	0.40
3.2 ECHLC	3.08	0.28	1.29	0.50	1.59	1.43	0.60
3.3 WCHLC	3.99	0.40	1.23	0.37	2.72	1.14	0.52
3.4 WHLC	1.95	0.23	1.70	0.64	1.13	0.36	0.73
3.5 MWHLC	5.59	0.23	0.89	0.78	0.92	0.35	1.68
3.6 FWHLC	3.92	0.21	0.59	1.43	0.81	0.39	1.50
4.1 EMVLC	8.62	0.04	0.50	0.17	0.56	1.20	0.86
4.2 WMVLC	29.58	0.05	0.25	0.45	0.36	0.36	1.12
NEPAL	100.00	1.00	1.00	1.00	1.00	1.00	1.00

Contd.....

Contd..... Table No.2.4

Cropping Regions	Location factors of						
	Cash Crops						
	Oil-seed	Jute	Sugar-cane	Tobacco	Ginger	Card-mom	Tea
(1)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1.1 FETEC	1.88	21.31	2.21	3.51	-	-	1.83
1.2 ETEC	2.02	1.01	0.66	18.73	-	-	-
1.3 ECTEC	2.76	0.11	15.17	0.89	-	-	-
1.4 MCTEC	9.01	0.03	1.33	0.97	-	-	-
1.5 WCTEC	2.08	0.09	7.85	0.62	-	-	-
1.6 WTEC	4.59	0.05	0.20	1.05	-	-	-
1.7 FWTEC	3.26	0.04	0.12	0.49	-	-	-
1.8 KVEC	2.09	-	0.45	-	-	-	-
2.1 FEHMC	0.92	0.97	0.21	0.26	-	14.49	13.74
2.2 ECHMC	1.11	0.02	1.24	0.24	-	-	-
2.3 WCHMC	0.36	-	0.69	0.11	12.79	-	-
3.1 EHLC	1.08	-	0.21	0.20	-	-	-
3.2 ECHLC	0.22	-	0.39	0.05	-	-	-
3.3 WCHLC	0.15	-	0.30	0.01	-	-	-
3.4 WHLC	0.41	-	-	0.14	0.56	-	-
3.5 MWHLC	0.32	-	0.11	0.16	6.50	-	-
3.6 FWHLC	0.25	-	0.14	0.14	-	-	-
4.1 EMVLC	0.07	-	0.01	0.01	-	0.30	-
4.2 WMVLC	0.06	-	0.02	0.05	0.06	-	-
NEPAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00

N.B. : For the extremely localised crops given in last three columns, crop outputs have been considered in the computation of location factors while for all other crops cropped areas have been used for the same.

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Table 2.5: Percentage of gross cropped area devoted to different crops by cropping region.

Cropping Regions	National % share of gross cropped area	Percentage of regional gross cropped area devoted to — Cereals and Substitute Crops: Paddy	Maize	Wheat	Millet	Patato	Barley
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.1 FETEC	15.71	75.96	2.53	5.44	5.05	0.92	0.23
1.2 ETEC	12.90	78.07	7.31	6.36	1.81	0.63	0.35
1.3 ECTEC	9.79	71.18	5.22	11.82	1.11	1.10	1.88
1.4 MCTEC	3.33	31.25	33.25	7.98	1.46	1.26	0.15
1.5 WCTEC	10.68	65.05	10.18	15.51	1.03	0.88	0.78
1.6 WTEC	7.87	56.31	19.39	9.32	1.41	1.02	0.19
1.7 FWTEC	4.26	65.22	16.88	6.02	1.83	0.98	0.00
1.8 KVEC	3.33	35.16	23.61	30.38	5.34	3.49	0.04
2.1 FEHMC	4.99	25.92	45.05	2.57	9.65	8.90	1.96
2.2 ECHMC	4.09	24.93	45.89	10.18	9.70	3.45	4.41
2.3 WCHMC	4.06	25.40	41.32	6.23	20.64	1.72	1.13
3.1 EHLC	2.09	19.10	44.85	5.03	12.58	9.10	1.07
3.2 ECHLC	1.81	26.12	43.13	9.06	13.74	5.47	1.24
3.3 WCHLC	2.69	30.86	37.40	5.40	19.45	4.42	1.11
3.4 WHLC	1.21	19.05	54.46	9.87	10.20	1.31	1.59
3.5 MWHLC	2.66	26.30	36.92	17.30	9.24	1.59	4.38
3.6 FWHLC	1.83	24.46	24.72	33.06	8.83	1.88	4.09
4.1 EMVLC	1.80	10.68	44.68	9.73	13.39	10.72	6.04
4.2 WMVLC	4.90	14.27	28.57	29.59	9.10	6.02	10.26
NEPAL	100.00	52.987	19.356	10.555	5.062	2.248	1.214

Contd....

Contd..... Table No.2.5

Cropping Regions	Percentage of regional gross cropped area devoted to						
	Cash Crops						
	Oil-seed	Jute	Sugar-cane	Tobacco	Ginger	Card-mom	Tea
(1)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
1.1 FETEC	2.61	10.50	0.40	0.36	-	-	0.00*
1.2 ETEC	2.89	0.52	0.12	1.94	-	-	-
1.3 ECTEC	3.52	0.07	3.00	0.10	-	-	-
1.4 MCTEC	23.94	0.03	0.47	0.21	-	-	-
1.5 WCTEC	3.81	0.06	2.51	0.09	-	-	-
1.6 WTEC	12.01	0.05	0.07	0.22	-	-	-
1.7 FWTEC	8.86	0.03	0.05	0.13	-	-	-
1.8 KVEC	1.92	-	0.04	0.01	-	-	-
2.1 FEHMC	4.72	1.07	0.00	0.12	-	0.60	0.05
2.2 ECHMC	4.21	0.03	1.09	0.10	-	-	-
2.3 WCHMC	2.11	-	0.58	0.05	0.83	-	-
3.1 EHLC	7.89	-	0.25	0.13	-	-	-
3.2 ECHLC	0.76	-	0.44	0.03	-	-	-
3.3 WCHLC	1.04	-	0.31	0.01	-	-	-
3.4 WHLC	3.18	-	-	0.30	0.04	-	-
3.5 MWHLC	3.45	-	0.14	0.14	0.54	-	-
3.6 FWHLC	2.62	-	0.21	0.12	-	-	-
4.1 EMVLC	4.70	-	0.02	0.02	-	0.02	-
4.2 WMVLC	1.59	-	0.13	0.18	0.29	-	-
NEPAL	5.033	2.398	0.667	0.402	0.056	0.019	0.003

* Negligible.

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We shall conclude this subsection by examining whether the population concentration pattern as depicted by I_{PG} could anyway be explained through the details of activity pattern. We have noted already that the ruggedness factor τ has influenced both arable cropping and allied activities and hence the level of development. But the complex phenomenon of population concentration could not be much accounted by either the ruggedness factor ($r_{I_{PG},(.4+\tau)^{-1}} = .2960$) or the level of development attained ($r_{I_{PG},D} = 0.1879$). A comparison of maps of I_{PG} (figure 2.4) and different crops (figures 2.5, 2.6 and 2.8) however reveals certain interesting spatial associations. We have already noted that paddy, maize and wheat are the three important cereal crops accounting for about 83 per cent of the national gross cropped area. Let the location factor of gross cropped area under paddy, maize and wheat relative to geographical area be denoted respectively by I_{C_1G}, I_{C_2G} and I_{C_3G}. Paddy which is most related to the factor of inverse reggedness ($r_{I_{C_1G},(.4+\tau)^{-1}} = 0.8327$) is mainly a Tarai crop which accounts much of the high concentration of population in the Tarai area ($r_{I_{PG}I_{C_1G}} = 0.5833$). On the other hand, maize cultivation which has practically spread independent of ruggedness condition ($r_{I_{C_2G},(.4+T)^{-1}}$ = 0.1072) accounts much of the high concentration of population in the non-Tarai area ($r_{I_{PG} \cdot I_{C_2G}}$ = .8097). Wheat is an associated crop in the major part of Tarai area as well as in the western hills and mountains and the Kathmandu valley ($r_{I_{C_2G} I_{C_3G}}$ = 0.7417, $r_{I_{C_1G}, I_{C_3G}}$ = .5007). As such it shows the strongest relation with I_{PG} ($r_{I_{PG} I_{C_3G}}$ = .8879). But whatever be the statistical relation, maize seems to be the universal crop in Nepal that is capable of overcoming the ruggedness barrier, and which explains much of the complex phenomenon of population concentration in the major part of hilly and mountaneous area of Nepal (compare figures 2.4 and 2.5). However, we have fitted a multiple regression of all the three cereal crops as explanatory factors to I_{PG}; the details of the OLS (ordinary least squares) regression is given below in equation (2.18).

$$\hat{I}_{PG} = 0.14552 + 0.22235 I_{C_1G} + 0.47909 I_{C_2G} + 0.22318 I_{C_3G} \quad \ldots \quad (2.18)$$

$R = 0.9382, \quad N = 75.$

One can notice that the marginal rate of increase of I_{PG} is highest with respect to I_{C_2G} (maize) in this equation. But as in the ordinary least squares method of multiple regression, the regression coeffs are not independent (because of multicollinearity disturbance, we have fitted also the VLS (vertical least squares) regression method as developed by Pal and De [1979]. In VLS regression method, the regression coeffs do not suffer from multicollinearity disturbance. The corresponding VLS regression is given in equation (2.19).

$$\hat{I}_{PG} = 0.03409 + 0.29315 I_{C_1G} + 0.50477 I_{C_2G} + 0.20950 I_{C_3G} \quad \ldots \quad (2.19)$$

$$r_{I_{PG}\hat{I}_{PG}} = 0.9365, \; N = 75.$$

Here we notice that marginal rate of I_{PG} is highest for I_{C_2G} (maize), then comes I_{C_1G} (paddy) and lastly I_{C_3G} (wheat). Thus we notice that the population concentration which has appeared to be a complex phenomenon initially, is now explained sufficiently by the cropping pattern of cereal crops, namely maize, paddy and wheat, in the decreasing order of importance. Although the cultivation of these major cereals has been responsible for the population concentration, peoples' propersity as depicted by our development index D is however seen to depend upon the intensification factor Z, the extension factor I_{CG} and also on the cash crops cultivation I_{TG} and the livestock position I_{SP}.

2.3.4 Components of agricultural growth and the population increase.

So long we have been making the spatial analysis of structural factors at a particular point of time, namely 1971-72. In this subsection we shall attempt a spatial analysis of growth rates in a period in the neighbourhood or around 1971-72. We shall first analyse the growth rates of agricultural production by component factors and finally examine whether the population increase rates are anyway associated with the components of agricultural growth or not?

For analysing agricultural growth by components Minhas (1965, 1966) used a three factor model, while Pal (1971,1976) used a four factor model. Pal and De (1979a, b) further generalised the model for any number of factors for both production change and productivity change model. As we do not have agricultural labour data for different points of time by districts in Nepal, we are not in a position to apply any of Pal's model we shall start with the three factor model of Minhas, but make the spatial analysis of the components of agricultural growth by an application of the advanced VLS procedure developed and applied by Pal and De [1979a].

Let there be n crops, denoted by the second suffix $j = 1, 2, \ldots n$, and the period under consideration is (0-t) with the initial year denoted by the first suffix $i = 0$ and the terminal year denoted by the first suffix $i = t$. The total value of agricultural production at constant prices (over the period) in ith year, Q_i. is given by

$$Q_i = \sum_{j=1}^{n} W_j \, Y_{ij} \, C_{ij} \, A_i \; ; \quad i = 0, t$$

where W_j = constant price weights assigned to jth crop (national value).

Y_{ij} = yield rate per acre of jth crop in ith year.

C_{ij} = proportion of A_i devoted to the jth crop, and

A_i = gross acreage in ith year.

All of Q_i, Y_{ij}, C_{ij} and A_i are district level variables in our study. Crops considered are ten in number (i.e., $n = 10$); i.e., all those crops referred to in the previous subsection except three extremely localised crops, namely ginger, tea and cardamom. The three factor growth model of agricultural production is then given by:

$$X = A + Y + C + I \quad \ldots \quad (2.20)$$

where $X = (Q_t - Q_0)/Q_0$

= proportionate rate of change of total agricultural production (under n crops) in the period between 0th and tth year.

$A = (A_t - A_0)/A_0$

= proportionate rate of change of total gross cropped area (under n crops) in the period of length t years,

$Y = (\sum_j W_j(Y_{tj} - Y_{0j})C_{0j} \cdot A_0)/(\sum_j W_j Y_{0j} \cdot C_{0j} A_0)$

= proportionate rate of change of agricultural production contributed by the change in only the yield rates in the period,

$C = (\sum_j W_j Y_{0j}(C_{tj} - C_{0j})A_0)/(\sum_j W_j Y_{0j} C_{0j} A_0)$

= proportionate rate of change of agricultural production contributed by the change in only the crop associations in the period,

and I = sum of all interactions for changes in any two or in all three of Y_{ij}, C_{ij} and A_i.

The equation (2.20) is an identity. The components A, Y and C are called the basic components or factors each of which has the change in only one of A_i, Y_{ij} and C_{ij}. Pal and De have argued convincingly that the model identity is not of much use because of the existence of severe interpretative difficulty with the total interaction component I. They argue that, in the algebraic break-up of the model identity, the positive and negative signs in the basic components may be meaningfully interpreted, but there is an interpretative difficulty with the interaction component since the product of two negative changes and also the product of two positive changes have to be the same positive quantity algebraically. As such I should be treated, according to their arguments, as the residual term in the model identity and its magnitude should preferably be negligible as compared to that of X for a meaningful interpretation of the over-all growth rate by its constituent basic factors. Obviously, this condition is hardly met in every district of Nepal. As such they ignore the residual interaction component I in the model identity and make additional regression analysis for the identification of important contributory components to the spatial variation in the over-all agricultural growth and their relative importance. For the identification of relative importance of components in explaining the stated spatial variation in the pure form, they have specially developed and applied a procedure called the VLS procedure of regression analysis which eliminates some of the difficulties encountered with multicollinear variables in the OLS procedure of regression analysis. We shall use the same VLS procedure of regression analysis [Pal and De, 1979a] for our study with the district level data of Nepal. In our study, the period of reference is 1967-68 to 1977-78. The initial year (O) refers really to a three year average of raw data centered at 1968-69 and the terminal year (t) is again a similar average centered at 1976-77. Thus the rates calculated account a change over a span of eight years (= t years). We shall make our analysis by the corresponding percentage annual rates a_0, a_1, a_2 and a_3 which are related with X, A, Y and C in the following manner:

$$(1 + X)^{1/t} = 1 + 0.01\, a_0 = m_0 , \quad \text{say}$$

$$(1 + A)^{1/t} = 1 + 0.01\, a_1 = m_1 , \quad \text{say}$$

$$(1 + Y)^{1/t} = 1 + 0.01\, a_2 = m_2 , \quad \text{say}$$

$$(1 + C)^{1/t} = 1 + 0.01\, a_3 = m_3 , \quad \text{say}$$

As the annual multipliers m_i's ; $i = 0, 1, 2, 3$, are related to a_i's in a known linear manner, one can as well make the regression analysis with m_i's instead of a_i's. According to Pal and De [1979a], if r_i, denotes the specific representation of ith variable ($i = 0, 1, 2, 3$) for the composite index constructed by the aggregate representation maximising principle (ref. to Section 2.2), the VLS regression of 0th variable is then given by

$$\hat{x}_0 = \left(\frac{r_0}{\mu - r_0^2} \right) \sum_{i=1}^{3} r_i \, x_i \qquad \ldots \qquad (2.21)$$

where $x_i = (a_i - \bar{a}_i) / \sigma_i$; $i = 0, 1, 2, 3$

$\hat{x}_0$ = is the VLS regression estimate of x_0 , and

$\mu = \sum_{i=0}^{3} r_i^2$.

The VLS correlation coefficient, $r_{x_0 \hat{x}_0}$, is then given by

$$r^2_{x_0 \hat{x}_0} = 1 \Big/ \left[1 + \left(\frac{\mu}{\mu-1}\right)^2 \left(\frac{1}{r_0^2} - 1\right) \right] \quad \ldots \quad (2.22)$$

The relative importance of the explanatory variables x_1, x_2 and x_3 in explaning the accounted spatial variation of x_0 is given by the shares

$$g_{0i} = \frac{r_i^2}{\mu - r_0^2}, \quad i = 1, 2, 3 \quad \ldots \quad (2.23)$$

So that $\sum_{i=1}^{3} g_{0i} = 1$.

With our district level data for the 75 districts of Nepal, we have the following correlation matrix:

Table 2.6 : Correlation matrix of the transformed components of the agricultural growth.

a_0	a_1	a_2	a_3
1	0.85845	0.58139	-0.02515
0.85845	1	0.12759	-0.01952
0.58139	0.12759	1	-0.27374
-0.02515	-0.01952	-0.27374	1

In this correlation matrix the crop association change rate a_3, turns out to be almost an independent component for explaining the spatial variation of a_0. In fact in a VLS regression fit with all components this component turns out to be statistically in significant. From the VLS test procedures given below we are in a position to identify that a_0 is the best dependent variable and the corresponding explanatory variables are only a_1 and a_2. The test procedure suggested by them has been developed through a screening of the VLS regression procedure through maximum likelihood model. According to this procedure we have to compute different $r_{x_i \hat{x}_i}$ for all values of i, and compare each $r_{x_i \hat{x}_i}$ with the corresponding $r^*_{x_i \hat{x}_i}$ which is the possible lower limit of the correlation coeff. satisfying certain maximum likelihood condition for multicollinear variables. Each $r_{x_i \hat{x}_i}$ is computed from formula (2.24) mutatis mutandis, and it differs from $r^*_{x_i \hat{x}_i}$ only for the replacement of μ by μ_i^* as defined below:

$$\mu_i^* = \left(\mu - \delta \mu_i^*\right) \qquad \ldots \qquad (2.25)$$

so long we have, $\delta \mu_i^* = \sum_s \left| \frac{r_s}{r_i} (r_{is} - r_i r_s) \right| < (\mu - 1)$,

otherwise $r^*_{x_i \hat{x}_i} = 0$.

Fisher's Z - functions corresponding to the correlation coeffs. $r_{x_i \hat{x}_i}$ and $r^*_{x_i \hat{x}_i}$ are denoted as follows:

$$Z_i = \frac{1}{2} \ln \left(\frac{1 + r_{x_i \hat{x}_i}}{1 - r_{x_i \hat{x}_i}} \right), \quad Z_i^* = \frac{1}{2} \ln \left(\frac{1 + r^*_{x_i \hat{x}_i}}{1 - r^*_{x_i \hat{x}_i}} \right)$$

The test functions :

$$t_i = \sqrt{N-3}(Z_i) \quad \text{and} \quad t_i^* = \sqrt{N-3}\,(Z_i - Z_i^*)$$

which follow student's t-distribution, are then used to examine whether or not $r_{x_i \hat{x}_i}$ is significantly different from zero and also to examine whether or not the difference between $r_{x_i \hat{x}_i}$ and $r^*_{x_i \hat{x}_i}$ is insignificant. If any particular ith variable is such that $r_{x_i \hat{x}_i}$ is not significantly different from zero, the variable x_i is not taken as a conformal member of the group of multicollinear variables and its exclusion is desirable. If t_i^* is significantly high, a similar kind of conclusion is also made. [for details see, Pal and De 1979a]. First we applied this test procedure for the group of four variables a_0, a_1, a_2 and a_3. The empirical estimates are as follows :

Table 2.7 : Estimates of VLS correlations for the components of agricultural growth.

i	r_i	$r_{x_i \hat{x}_i}$	$r^*_{x_i \hat{x}_i}$	t_i	t_i^*
0	0.98144	0.93784	0.93198	14.59	0.40 (+)
1	0.83103	0.61935	0.52655	6.14	1.18 (+)
2	0.65291	0.41425	0.26115	3.74	1.47 (+)
3	-0.19635	0.10515	0	0.90(+)	-

N.B.: (+) indicates not significant at 5% level of chance.

According to the results of this test, the variable a_3 is not a singnificant member of the group of four variables. So excluding this variable from the group, we again apply the test procedure the empirical details of which are given below:

Table 2.8: Estimates of VLS correlations for the three components of agricultural growth.

i	r_i	$r_{x_i \hat{x}_i}$	$r^*_{x_i \hat{x}_i}$	t_i	t_i^*
0	0.99387	0.97816	0.97745	19.12	0.14 (+)
1	0.84906	0.64381	0.57730	3.49	0.90 (+)
2	0.62452	0.38615	0.25391	3.46	1.25 (+)

Now the group of three variables, namely a_0, a_1, a_2 form a conformal group of multicollinear variables satisfying the required maximum likelihood conditions used in the test procedure. By excluding variable a_3 the VLS correlation $r_{x_0 \hat{x}_0}$ has improved from a value of 0.93784 to 0.97816. The best dependent variable is thus turns out to be a_0 and the corresponding explanatory variables are only a_1 and a_2. The actual VLS regression fit is given by

$$\hat{x}_0 = 0.75959x_1 + 0.55871x_2$$

i.e., $\hat{a}_0 = 0.09700 + 0.89465a_1 + 1.04365a_2$ ... (2.26)

with VLS correlation coeff.: $r_{x_0 \hat{x}_0} = r_{a_0 \hat{a}_0} = 0.97816$, $N = 75$.

The relative importances of explanatory variables (in standardised form) in explaining the total variation of $r^2_{x_0 \hat{x}_0}$ = 0.9569 for the dependent variable x_0 are given by the shares:

$$g_{01} = 0.6489 \quad \text{and} \quad g_{02} = 0.3511 \quad \ldots \quad (2.27)$$

Thus the component a_1 had been a much more important contributor of over-all agricultural growth a_0 as compared with the other important component a_2. The third component a_3 had not been at all a contributor towards the over-all agricultural growth. In fact, the crop association had not changed much over the time period, practically for almost all districts.

Above statistical analysis reveals that the spatial variation in agricultural growth in the period under consideration is sufficiently accounted by the two factors - a_1 and a_2. More important is however the acreage change factor a_1. As the extension possibility was present in the Tarai area, the much of over-all agricultural growth was achieved there by this factor mainly. In fact the yield rate change factor a_2 showed decline (negative a_2), and not growth, in many hilly and mountaneous districts. It is because of this reason, the value of a_2 for all-Nepal was only 0.084 per cent per annum during the decade while that for a_1 for all-Nepal was 1.68%. per annum. The over-all growth during the period had been about 1.52%. The details of district level values of a_0, a_1 and a_2 are recorded in the Appendix table 3. From these values it can be seen that the positive values of a_2 (growth in yield rate factor) were mostly in Tarai area and Kathmandu valley. These were also the areas of high or very high amount of cultivated area (I_{CG}). But as the intensification factor Z had generally higher values in non-Tarai area, one could suspect a deterioration of this factor in the hilly and mountaneous district, so that a_2 was generally negative (i.e., decline in yield rate change). there. As the level of development D has been generally higher in Tarai area some positive association can also be noticed between D and the yield rate change factor a_2 ($r_{Da_2} = 0.6141$). As a contrast, it is interesting to note that D is practically independent of the more important factor of agricultural growth, a_1, ($r_{Da_1} = 0.1545$). This could be interpreted by the fact that an indiscriminate increase of acreage would not possibly relate to peoples' prosperity unless an improvement in yield rates (i.e., intensification factor) could also be achieved.

We next examine the population growth during the period 1971-1976 (estimated by using 1971 census data and the mid term population census data of 1976). The annual rate of population growth in per cent is denoted by g_0.

The data of g_0 is also recorded in the same Appendix table 3 along with a_0. As Tarai has generally higher population growth, some positive association is seen with the level of Development D, ($r_{Dg_0} = 0.66$). Possibly higher level of development in Tarai area generated forces of migration so that the population growth was higher there. But immigration has not taken place in the areas of very high population concentration. In fact g_0 is almost independent of the existing population concentration I_{PG} ($r_{g_0 I_{PG}} = 0.20$). The population growth rate g_0 is also somewhat related to the over-all agricultural growth a_0, ($r_{g_0 a_0} = 0.55$). But a comparison of values of a_0 and g_0 reflect the deteriorating situation in agricultural production relative to population increase by districts. More about population growth will be discussed later in the concluding Chapter IV. But in view of the deteriorating situation in agricultural growth we like to make regional analysis of the food situation and the dimension of planning task in respect of food in the following Section 2.4.

2.4 Food situation and the regional programming: 1977-78 and 1989-90.

In view of the slow or no agricultural progress the food-situation in relation to fast-growing population of Nepal has deteriorated in the recent period. For this reason we examine the food-situation in different districts and regions of Nepal for the year 1977-78 and try to visualise our food requirements at the end of the current decade, namely in 1989-90, so that we are in a position to visualise the dimensions of our regional planning tasks in respect of gearing the food-production mechineries to meet the future challenge. Here, by food we mean the staple foodgrains only provided by the five cereal crops, namely paddy, maize, wheat, millets and barley.

2.4.1 The estimation of the requirement of foodgrains for human consumption.

We have made normative estimations and predictions of foodgrains by districts of Nepal for the year 1977-78 and 1989-90. The norms are built up for different districts from the estimates of "per capita quantity of foodgrains consumed annually during the period 1973-75", which were obtained from the actual household budget surveys conducted in some eighteen districts by the Nepal Rastra Bank. These norms are generalised spatially for all districts of Nepal by taking into account the similarity of geographical environments and the nearness to the locations of the actual surveys [for details, see Nepal Rastra Bank, 1977 to 1980]. We shall call these estimates of per capita annual foodgrain consumption as the "actual survey norms". Using these norms on the estimates of population we can easily get the total requirement of foodgrains for each district of Nepal. For getting the estimates of population in different years, we have used the 1971 census estimates of population and the growth rates of population g_0 as referred to already. First we have used the actual survey norms of foodgrains on 1971 population to check whether these norms provide reasonable estimates of requirements as contrusted to the availability of foodgrains in the year 1971-72. On the basis of these norms we obtained districtwise estimates of total foodgrain requirements in 1971-72 and the aggregate of all districtwise estimates ultimately provide us with the corresponding all-Nepal estimate which is about 2,046,002 tonnes.

The requirements are estimated in the form of finished foodgrain products. To determine the actual availability of foodgrains in the finished form for human consumption, the production figures of the five cereal crops have been reduced by the following standardised allowances as provided in Agricultural Statistics of Nepal 1977;

1. Allowances of seed rates in kg. per hectare of cropped area

   Paddy = 50 , Maize = 30 , Wheat = 66 ,
   Millet = 25 , Barley = 40 .

2. Allowances for the consumption other than human consumption and the wastages

= 10% of residual prodn. after allowing for seed requirements.

3. Conversion allowance to obtain finished foodgrains for human cons.

40% loss of Paddy for finished rice and

3% loss oneach of maize, wheat, millet and barley.

Using the above mentioned allowances, the districtwise estimates of total availability of foodgrains for human consumption were obtained for 1971-72. An aggregate of these district estimates gave a total availability of foodgrains for Nepal of about 2,191,926 tonnes in 1971-72. Thus the difference of all-Nepal availability and requirement is the estimate of (net) exportable surplus of foodgrains for 1971-72 which works out to be about 145,924 tonnes. From a compilation made by the World Bank [1979a] on the export data the average export of rice was about 117,000 tonnes annually during the period, 1974-75 to 1976-77. As (i) rice forms the main bulk of exported foodgrains in Nepal (ii) the foodgrain imports were negligible compared to exports and (iii) the food situation was better prior to 1973 [World Bank Report 1979a] the net export figure of the quantity of foodgrains as we have obtained from the comparision of the estimates of availability and requirement does appear to be quite reasonable. Thus we infer that the actual survey norms are good enough to make normative estimations of requirement in 1971-72. The World Bank report referred to above also pointed out the export position had dwindled in recent years after 1971-72. From the estimates given in the report on rice export position in 1976-77, in both value and quantity terms, and the time series of the estimates of values of exports and imports of different food items, as provided in the Quarterly Economic Bulletin (1980) of the Nepal Rashtra Bank, we can make the estimates of export positions of foodgrains in 1977-78 for Nepal, as given below:

Table 2.9: Estimates of net foodgrain exports in 1971-72, 1976-77 and 1977-78.

Year	Export of		Import of foodgrains (in tonnes)	Net export of foodgrains (in tonnes)
	rice (in tonnes)	foodgrains (in tonnes)		
1971-72	136,939	149,862	3938	145,924
1976-77	98,000	107,249	6408	100,841
1977-78	66,264	72,517	8305	64,212

Above estimates of exports and imports of foodgrains indicate the deteriorating food situation of Nepal in both respects. In fact in view of this deteriorating situation particularly in the terminal year 1977-78, the actual consumption of foodgrains per capita seems to be lower than the previously estimated actual survey norms. In fact we have estimated first the availability of foodgrains for each district and hence for all-Nepal, and subtracted the all-Nepal net export figure of 1977-78 from the all-Nepal availability estimate to obtain the estimate of all-Nepal requirement of foodgrains for human consumption in 1977-78. This estimate of requirement is slightly lower (4%) than the estimate of all-Nepal requirement as we can built up from an aggregation of corresponding districtwise normative estimates of requirements in 1977-78. As such the actual survey norms obtained previously have been revised to lower values by the same national ratio to adjust for the all-Nepal requirement figure. These revised norms will be called the "revised 1977-78 norms" to distinguish them from the "actual survey norms". Thus we have made the districtwise estimates of availability and requirement of foodgrains for the year 1977-78 and reported the estimates in Appendix Tables (4.0 to 4.7).

Now we have two norms; (1) 1977-78 norms and (2) Survey norms, for the per capita requirement of foodgrains for human consumption. The districtwise estimates of population for 1989-90 obtained by using the growth rates g_0, are then multiplied by the norms to obtain the two alternative estimates, say, alternative I and alternative II, respectively, of foodgrains requirements in 1989-90. The alternative II obviously gives a higher estimate for Nepal. The all-Nepal estimates obtained from the aggregations of districtwise estimates are 2,937,131 tonnes under alternative I and 3,065,084 tonnes under alternative II. In alternative I, the 1977-78 standard of consumption is assured. If this standard is to be maintained in 1989-90 the excess in alternative II over alternative I can be thought of as exportable surplus in 1989-90 which is about 127,953 tonnes. This estimate is slightly more than the average annual export figure of foodgrains during the period 1974-75 to 1976-77. Thus if alternative II is aimed at, there is a possibility of having the said exportable surplus after maintaining the 1977-78 food consumption standard with the total requirement given in the alternative I. Thus the production machinery is to be geared to attain the requirement level of alternative II, but the internal distribution machinery for human consumption within Nepal is to be based on the requirement level of Alternative I.

2.4.2 Dimensions of the tasks ahead for cereal production.

The requirement levels under alternatives I and II give the impression of how much we must need to satisfy the evergrowing population in Nepal in various districts. The question of matching the requirement levels with the production levels in every district is ruled out, because of the wide disversities in productive capacities that exist in Nepal. The past trend of agricultural growth as analysed is so disappointing that one cannot expect to have the required production levels achieved by maintaining the status-quo in agricultural activities. As such, in order to match the production levels with the requirement levels, one has to first assess future tasks on the basis of certain consistent hypotheses on possibilities and then find out ways and means to achieve such targeted tasks. For this we have analysed the yield rate change factor of cereal crops between 1971-72 and 1977-78, in addition to our analysis with over-all agricultural growth by components. We have noted earlier that the yield rate components for over-all growth were mostly negative in non-Tarai districts. As cereals account for most of arable cropping in those areas, the yield rate change factor for cereals was also negative in most of non-Tarai districts. These negative rates imply that 1971-72 levels of production of cereals were higher as compared to that of 1977-78. But, it is not impossible to achieve again the 1971-72 level of production in those districts. Thus our consistent task hypothesis for these districts is as follows:

> In both alternative production tasks I and II, the cereals production level as was in 1971-72

> would be again achieved by 1989-90 in these 42 districts. [To identify these districts, note the similarity of production levels in both alternatives in the tabulated data given in Appendix Tables (5.1 to 5.7)].

Remaining 33 districts (20 Tarai districts and 13 growing non-Tarai districts) were having non-negative growth (i.e., either stagnant or some positive growth). But the present growth rates are not sufficient to achieve the targeted production levels matching the requirement estimates nationally. At the same time, one can expect, based on the analysis of productive forces in these districts, that the targeted production levels could possibly be achieved only through the stepping up of agricultural productivities in these relatively more progressive districts. Thus we have another consistent task hypothesis for the remaining districts as given below:

> The residual production levels for Nepal, after what is already accounted by the previous 42 districts in the target year 1989-90, are to be achieved by accelerated agricultural productive activities that would inflate the existing districtwise growth by a same multiplier for all 33 districts under each alternative such that the availability of foodgrains derived from these productions matches the requirements at the national level in the target year.

The ratio between the total cereals production and the availability of foodgrains as obtained after allowing for seeds, feeds (other than human consumption), wastages and other deductions works out to be about 1.35 for all-Nepal (on the basis of standards mentioned earlier). But this ratio is varying from district to district. Using the national ratio estimate on the national requirement estimates under alternatives I and II, we have estimated the total productions of cereals for all-Nepal from which we expect to get the matching availabilities of foodgrains for human consumption. The national estimates of total cereals production are then broken down to district estimates on the basis of the two task hypotheses, using 1971-72 productions of cereals (for 42 districts), the existing growth (for 33 districts) along with the necessary growth multiplier (for each alternative), the 1977-78 estimates of cereals production, etc. Noting the districtwise ratios of the foodgrains availability to the corresponding cereals production, the districtwise production figures of 1989-90 are then converted to availability figures which have been marginally adjusted to match the requirement figures nationally under the two alternatives. The 1977-78 estimates of cereal output, availability of foodgrains for human consumption and the corresponding requirement of foodgrains are given in Appendix

Table (6). In this table, we have also given the ratio of 1989-90 estimate to corresponding 1977-78 estimate under the two Alternatives I and II for (i) cereal output, (ii) foodgrain availability and (iii) foodgrain requirement. The availability figure has also been compared with the corresponding requirement figure in this table to understand the surplus — deficit situation in different districts and areas in 1977-78 and also in 1989-90 under different alternatives. Actual availability (including imports in some districts with distribution headquarters in them) and requ requirement figures under different alternatives are shown in Appendix Tables (5.0 to 5.7) and also in Appendix Tables (4.0 to 4.7). The cereal outputs finally decided for the production targets of 1989-90 have been shown in Appendix Table (7). Our next task will be to examine how best the deficit areas should be linked with the surplus areas for an optimal distribution of foodgrains.

2.4.3 The optimal spatial linkages for the distribution of foodgrains: 1977-78 and 1989-90.

For determining the optimal spatial linkages between surplus and deficit areas for foodgrains distribution we have applied the linear programming technique with the objective function of minimisation of transportation task for the actual 1977-78 situation and also for the visualised 1989-90 situation under alternative I. For the very existence of a particular type of transportation pattern conditioned by the ruggedness of terrain, we have however concluded that a global application of the linear programming technique for all districts at a single stage would be inappropriate. In Nepal the narrow corridor of almost flat land (i.e., low ruggedness) along the Tarai belt is utilized mainly for east-west flow of commodities and then from different suitable locations in the Tarai belt the necessary north-south movements take place. Based on our knowledge of cropping pattern done earlier and also certain distributional flow and agricultural zoning studies done by the APROSC [1978a, 1978b], we have divided Nepal into seven distributional zones each of which includes certain part of Tarai belt in the southern peripheri. These distributional zones are defined below along with the names of zonal centres which are important transportation node, in these zones, lying in Tarai belt.

Distribution Zone No.	Name of Zonal Centre	Districts included in the zone
I	Biratnagar (Morang district)	1. Taplejung, 2. Panchthar, 3. Ilam, 4. Sankhuwasabha, 5. Terhathum, 6. Bhojpur, 7. Dhankuta, 8. Jhapa, 9. Morang, 10. Sunsari, 11. Saptari.

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Distribution Zone No.	Name of Zonal Centre	Districts included in the zone
II	Janakpur (Dhanusha district)	1. Dolakha, 2. Solokhumbu, 3. Khotang, 4. Okhaldunga, 5. Ramechhap, 6. Sindhuli, 7. Udayapur, 8. Siraha, 9. Dhanusha, 10. Sarlahi, 11. Mahottari.
III	Birganj (Parsa district)	1. Rasuwa, 2. Sindhupalchowk, 3. Dhading, 4. Nuwakot, 5. Kavrepalanchowk, 6. Kathmandu Valley (3 districs), 7. Makawanpur, 8. Rautahat, 9. Bara, 10. Parsa, 11. Chitawan.
IV	Bhairahawa (Rupandehi district)	1. Mustang, 2. Manang, 3. Myagdi, 4. Baglung, 5. Parbat, 6. Kaski, 7. Lumjung, 8. Gorkha, 9. Gulmi, 10. Palpa, 11. Syanja, 12. Tanahu, 13. Nawalparasi, 14. Rupandehi.
V	Tulsipur (Dang-Deukhuri district)	1. Rukum, 2. Rolpa, 3. Sallyan, 4. Pyuthan, 5. Argakhanchi, 6. Dang-Deukhuri, 7. Kapilvastu.
VI	Nepalganj (Banke district)	1. Jumla, 2. Humla, 3. Mugu, 4. Dolpa, 5. Kalikot, 6. Jajorkot, 7. Dailekh, 8. Surkhet, 9. Bardia, 10. Banke.
VII	Dhangadhi (Kailali district)	1. Darchula, 2. Bajhang, 3. Bajura, 4. Baitadi, 5. Doti, 6. Achham, 7. Dadeldhura, 8. Kanchanpur, 9. Kailali.

At the first stage application of linear programming (LP) technique, we have solved for the distribution of food-grains between the above mentioned zones. For this we have used the distance matrix for actual route distances between zonal centres. The objective function here is the minimisation of total tonne kilometerage (tonnes of foodgrains multiplied by the kilometers of route distance moved). After having known the first stage solution with the optimal zonal movements of foodgrains, the LP technique is applied at the second stage for each of the seven zones for the distribution of foodgrains between districts within each zone. As there exists the transportation difficulties for north-south movements, in the rugged terrain, we have now inflated the actual route distances by additional factors of ruggedness applied piecewise by district boundaries along the route. If d is the total route distance between two locations (district headquarters), while the route is through the districts i = 1, 2, ... n, such that

$$d = \sum_{i=1}^{n} d_i$$

with d_i = the portion of the route distance in ith district we have defined the "ruggedness accounted distance", D, as follows:

$$D = \sum_{i=1}^{n} d_i(1 + T_i),$$

where T_i is the value of ruggedness index of ith district estimated earlier. Further, we have defined the "ruggedness intensity factor of the route", r, as follows:

$$r = D/d.$$

If a particular route is entirely within a district, say in ith district, the "within district ruggedness intensity factor" reduces to say r_i, where

$$r_i = (1 + \tau_i)$$

The "between district ruggedness intensity factor" with two end points of the route in jth and kth districts can be more specifically represented by r_{jk}, instead of r as noted above, where

$$r_{jk} = D_{jk}/d_{jk}$$

We have estimated and tabulated in Appendix Tables (8.0 to 8.7) the data of

d_{st} = the route distance between sth and tth zonal centres,

and also the data of

D_{jk} = the ruggedness accounted distance between jth and kth district headquaters in each zone, alongwith the data of r_i's and r_{jk}'s.

At the second stage application of LP technique, we have used the ruggedness accounted distance D_{jk}, which is more appropriate than the use of d_{jk}, in our optimization programme of minimising the total tonne kilometerage within each zone with varying ruggedness of terrain. If X_{ij} denotes the movement of foodgrains in tonnes between jth and kth districts in a zone, the objective function to be minimised is given by:

$$M = \sum_j \sum_k D_{jk} X_{jk} \quad \ldots \quad (2.28)$$

subject to constraints:

$$\sum_k X_{jk} = A_j \; ; \quad \text{j varying in the zone with} \quad \ldots \quad (2.29)$$

A_j = total availability of foodgrains in jth district in the zone

and $$\sum_j X_{jk} = B_k \; ; \quad \text{k varying in the zone with} \quad \ldots \quad (2.30)$$

B_k = total requirement of foodgrains in kth district in the zone

and also the non-negativity conditions

$$X_{jk} \geq 0 \text{ , for all j and k in the zone} \quad \ldots \quad (2.31)$$

At the first stage also, a similar kind of LP model was used with the replacements of the ruggedness accounted distances by the actual inter-zonal route distances d_{st}'s.

The LP solutions were attempted for 1989-90 under three situations given below:

Situation (b1): The availabilities and requirements are those under alternative 1, so that the total availability and the total requirement are balanced at the national level without any national surplus.

ituation (b2): The availabilities and requirements are those under Alternative II, so that here also the total availability and the total requirement are balanced at the national level without any national surplus. In this alternative, people are provided with foodgrains for consumption at a higher level than what is provided under alternative (b1).

Situation (s3): The availabilities are those under Alternative II and the requirements (or the supplies for human consumption) are those under Alternative I, so that certain national surplus is allowed. In fact, a national surplus of about 127,953 tonnes is obtained under this situation which is comparable to average national foodgrain export situation around the beginning of the fourth five year plan of Nepal (ref. to Table 2.9.

We have already mentioned that commodity flow-data are hardly available in a comprehensive form in Nepal. Naturally it is difficult to have the actual quantitative estimates of the flow of foodgrains between different locations in Nepal, in say, 1977-78. In the absence of such actual data we have also tried to get an LP solution for the movements of foodgrains between surplus and deficit areas. These movement pattern could be taken as the rational movement under the stated rationality of the minimisation of transportation task. Thus we are in a position to compare the foodgrains distribution tasks under a similar kind of rationality in two points of time, namely 1977-78 and 1989-90. The optimal LP solutions for situations (b1) and (b2) are presented in Appendix Tables (5.0 to 5.7), while those for 1977-78 and the situation (s3) are recorded in Appendix Tables (4.0 to 4.7). The inter-zonal movements are in Appendix Tables (4.0) and (5.0), while other tables give the inter-district movements within seven distribution zones separately. In these Tables, the zonal import for an importing zone is added to the actual availability figure of the district which includes the zonal distribution centre. Actual availability figures of such districts could easily be obtained by substracting the net import figures which could be estimated from the entries of Appendix Tables (5.0) and (4.0). Appendix Table (6) also gives the estimates of actual availability and requirements as ratios of 1977-78 figures, besides other things already reported. To compare the different LP solutions of 1989-90 under three situations (b1), (b2) and (s3) we have expressed the optimal transportation tasks as a forward ratio between 1989-90 and 1977-78 for aggregate inter zonal movements and also for the aggregate intra-zonal movements in seven zones. These forward ratios together with the optimal

1977-78 transportation task in tonnes km. are presented in Table 2.10. From a comparative assessment of these forward ratios among three situations (b1), (b2) and (s3). The situation (s3) seems to be most desirable on the grounds that it generally gives lower enhancement of distribution task in 1989-90 compared to that in 1977-78. As such we shall take situation (s3) as the most desirable situation to be set as the targets for 1989-90. This will not only (a) correspond to the minimal increase in distribution task of foodgrains, but also (b) provide some desirable national surplus (i) to take care of any adverse situation within the nation (such as the enhanced population growth) and (ii) to provide for a better exportable capacity. We shall call the situation (s3) as the final 1989-90 targets. Thus the final 1989-90 targets of cereal output foodgrains availability and foodgrain supply for human consumption are presented in Appendix Table 7 by districts and distribution zones. Forward ratios of these 1989-90 estimates compared with the corresponding figures of 1977-78 have also been given in this table. Such ratios for cereal output gives us the demension of acceleration of our productive efforts needed in different areas in order to face the challenge of our growing population.

Table 2.10 : The comparison of optimal transportation tasks for movements of foodgrains under different alternatives.

Type of transportation for foodgrain movements	Optimal 1977-78 transportation task in tonnes-km.	Ratio of optimal transportation tasks of 1989-90 to 1977-78		
		without national surplus		with national surplus (s3)
		Alternative I (b1)	Alternative II (b2)	
Between Zones in Nepal	18,367,253	3.994	4.298	1.611
within Zone I	3,553,645	1.089	1.308	0.967
within Zone II	14,843,615	1.266	1.371	1.257
within Zone III	24,043,748	1.418	1.497	1.312
within Zone IV	22,505,621	1.620	1.801	1.589
within Zone V	5,531,519	2.214	2.358	2.034
within Zone VI	10,994,563	1.422	1.535	1.398
within Zone VII	12,175,168	1.518	1.635	1.523
Aggregate of all within zonal movement	93,647,879	1.490	1.616	1.437

in different areas. The details of target achieving production tasks and the enhanced distribution task can be obtained from the data of relevant tables referred to above.

2.4.4 The estimations (tentative) of fertilizer input requirements for the future tasks on cereal production.

The cereal production tasks needed by 1989-90 under Alternatives I and II have been shown for different districts of Nepal. It is clear that the performances in the agricultural activities over the recent past period had not been satisfactory enough to expect a fulfilment of the targeted tasks spontaneously. There should be concerted efforts to achieve the targeted task. Our present exercise in this sub-section is an effort to suggest tentatively the consistent input programmes for fertilizers on the basis of the recent spatial pattern of interaction between this input and the cereal output. As the extension possibility of agricultural land is limited, we shall assume no or negligible increase in cropped area under cereals. As a result of this assumption, the targeted cereal production tasks are expected to be achieved by the intensification practices alone. The fertiliser inputs (with necessary water and seed inputs) give indications of operational tasks towards that direction and that is why this exercise.

The official records on the fertiliser data indicate very scanty use of chemical fertilizers. It is well known that there are uses of indegenous fertilisers, perticularly in hills and mountains where livestock densities are high. But we have no official records on that. Naturally, We has to bank on the chemical fertilisers alone for our spatial interaction studies between fertilizer doses and yield rates.

The data on chemical fertilizers were obtained from the annual report of the Agricultural Input Corporation [1979]. From our discussions with the authorities in Nepal we have been able to aportion the total fertiliser statistics for its use in cereal production. The aportioning ratios of fertiliser use in cereals production together with the actual total inputs are tabulated in App. Table (9) for different areas of Nepal. It can be seen from these ratio estimates that the present use of chemical fertilizer has gone mostly for cereal crops in most of the areas except certain special areas like the Kathmandu valley with substantial vegetable crops or the main sugarcane producing districts. Again it is noted from the original records of fertilizer data that where the cultivated land is limited the use of chemical fertilizer is scanty and the estimate, less dependable. For this reason, we have taken into consideration the cropping regions of non-Tarai area (except the Kathmandu valley) with medium or low extent of cultivated land, in addition to all the districts in the Tarai area and the Kathmandu valley with extensive cultivated area, for our statistical analysis made in this sub-section. Thus, in all, we have now 34 observations divided into 11 regions of medium and low extent of cultivation and 23 districts of extensive cultivation. These districts really formed eight crop regions 1.1

1.8, but here districts are treated separately because of their predominant importance in Nepal's over-all agricultural activities.

We shall use these 34 spatial observations in order to find the existing interactions through a regression analysis between the existing (1977-78) yield rate of cereals and the existing chemical fertilizer inputs. Though there did not exist any considerable growth trend, the existence of significant spatial variation in the agricultural performance had been noted already. Our aim here has been to get lessons from the nation's own regional practices and use them for conditioning the future programmes to achieve the targeted tasks. As a contrast, it should be noted here that it may not be easy to get results by applying the norms of other nations developed under different environmental conditions. Let us now denote the following:

f_c = fertiliser input in kg. per hectare of cereals producing areas in 1977-78,

y_c = yield of cereals in tonnes per hectare of cereals producing areas in 1977-78,

A_c = hecteres of cropped area under cereal crops,

F_c = total fertiliser input for cereals in tonnes in 1977-78, and

Y_c = total yield of cereals in tonnes in 1977-78,

so that we have, $0.001\ f_c = F_c/A_c$ and $y_c = Y_c/A_c$.

The OLS regression fit between f_c and y_c is as following:

$$f_c = -135.623 + 93.847 y_c \qquad \ldots \qquad (2.32)$$
$$r = 0.792 \ ; \quad N = 34.$$

Thus we have the marginal rate of increase

$$\frac{df_c}{dy_c} = 93.847$$

If no (or negligible) increase in cropped area under cereals over-time is assumed in each area, we can write

$$\frac{\Delta F_c}{\Delta Y_c} = 0.093847 \qquad \ldots \qquad (2.33)$$

where ΔF_c and ΔY_c denote the change over-time in F_c and Y_c. Further, if F_c^* and F_c^{**} denote the total fertiliser input requirement for the largeted task of 1989-90 under Alternatives I and II respectively, we can write then:

$$\left.\begin{aligned} F_c^* &= F_c + \Delta F_c^* = F_c + 0.093847\ \Delta Y_c^* \\ \text{and } F_c^{**} &= F_c + \Delta F_c^{**} = F_c + 0.093847\ \Delta Y_c^{**} \end{aligned}\right\} \ldots \qquad (2.34)$$

where ΔY_c^* and ΔY_c^{**} are respectively the increase in total yield of cereals in the period between 1977-78 and 1989-90 under the Alternatives I and II. We have used the above mentioned equations (2.34) for estimating F_c^* and F_c^{**}. Dividing these estimates by the estimate of A_c we have computed back the corresponding estimates of f_c^* and f_c^{**}, giving the fertiliser input requirement norms in kg/hectare for the cereals production task of 1989-90 under the two alternatives.

Thus the norm for fertiliser input requirement prediction, namely $\Delta F_c/\Delta Y_c$, given in equation (2.23), have been developed from Nepal's own areal performances. We have also checked that this norm is more or less same if the OLS fit is made either for only the 23 districts with extensive cultivation, or for the total of 19 crop-regions without a separate recognition of the individual districts with extensive cultivation. These estimates, given below, are very close to the corresponding estimates obtained earlier for the 34 observations.

$$\frac{\Delta F_c}{\Delta Y_c} = 0.096750, \ (r = 0.815, \ N = 23)$$

$$\frac{\Delta F_c}{\Delta Y_c} = 0.099092, \ (r \doteq 0.821, \ N = 19)$$

However we have used the estimate of equation (2.33) which is more dependable and useful because a higher value of N there. The related estimates are however recorded in the two following Tables (9) & (10) of Appendix for an union of both cases with N = 23 and N'= 19, although the statistical estimates have been built up primarily for N = 34. Thus from the results of this exercise we notice that there will be a necessity of improving the fertiliser dose (note the increase in values from f_c to f_c^* or f_c^{**}) in Appn. Table 10 substantially if we are to achieve our production targets of cereals for 1989-90 under the two alternatives by following the intensification practices as in vogue in certain advanced agricultural districts or areas of Nepal, particularly in Kathmandu valley.

CHAPTER III

INDUSTRIAL ACTIVITIES

1 Introduction

In this Chapter attempts have been made to analyse the regional pattern of industrialisation in Nepal. It cannot be gainsaid that the level of development in any country is greatly dependent on the level of its industrialisation. Even to transform the primitive agricultural technology of a country into an advanced one with improved productivity, there is a need for a concomitant growth of industrialisation. Thus it becomes imperative to investigate the present industrial structure of the nation. As it stands, Nepal as a whole does not have much industrial base and a substantial part of country's industrial requirements is met only through imports from foreign countries. Only ten percent of the national income is now originated from the industrial sector, and just a meagre 1 percent of the population depends on this sector for livelihood. This is a very sad state of affairs for the country as a whole. But even with this poor national base for industries, there do exist a few industrial areas or centres within the country. Naturally one has to identify these industrial bases and examine the structure and forces of growth in those specific pockets. Equipped with this knowledge and experience one can then think of a regional expansion of industrialisation or a dispersal of industrial activities.

To identify the regional structure of manufacturing industrialisation, the production function approach will be applied. Through this we shall also identify the relative technological efficiency of factor inputs for different districts. As the manufacturing industries do not cover unregistered and household industries, we shall also devise another index of industrialisation for the overall industrial activities in addition to that for manufacturing activities. Empirical studies of these kinds of regional data for Nepal are rather scarce. Partly no doubt, this is due to the general paucity of statistical data. Even so the existing statistical information has not been fully analysed with appropriate statistical tools. One of the objectives of this study is to examine how best we could use the statistical tools on the available information and data for the purpose of identifying the regional patterns of industrialisation in Nepal. In fact this study represents a first attempt of its kind in Nepal using regional production function analysis towards identifying the regional industrialisation patterns.

3.2 Analytical Methods

3.2.1 The production function model.

The estimation of the regional production functions will be made here for both the constant elasticity of subsstitution (CES) variety and its special case the Cobb-Douglas (CD) variety. The CD function is a special case of the CES function; the elasticity of substitution takes the value unity in the CD form whereas it can have any positive value in the general CES form. Because of this generality of the CES form, after its first introduction by Arrow et al [1961] it gained a permanent place in the studies of production functions. But Pal and Saha [1981] have noticed in their regional studies in India that the CD function is usually more appropriate for analysing the regional manufacturing activities with cross-sectional variations. Earlier, Fisher [1971] made a similar inference because of the genuine empirical phenomenon that the factor-shares remain relatively constant over space fitting the CD formulation. We shall however examine which form of these production functions suit the case of Nepal. Whatever be the form, the more important aspect of Pal and Saha [1981] is the introduction of a localisation qualifying variable on performance variable in the original functional form needed for the analysis of localisation economies due to regional technology specialisations at different locations. This introduction is comparable with that of a time series variable introduced over and above the factor inputs variables as in Solow's [1957]. 'Technological change''"model and Arrow's [1962] "Learning by doing hypothesis" model for measuring technological progress over time. Both technological progress and the localisation economies are components of the agglomeration economies. The residual productivity due to agglomeration economies over, and above the productivity explained by the factor inputs, could be measured by the introduction of the above mentioned variables. If such an additional variable is not introduced, any estimation of production function will generally amount to the increasing return to scale. In fact some location theorists like Shefer [1973] tried to infer the presence of localisation economies by the incidence of increasing return to scale in cross-section studies without the incorporation of any localisation qualifying variable [the terminology was used by Griliches, 1967]. The over-all scale, whether increasing or otherwise, is partly accounted for by agglomeration economies and partly by the internal technology scale in Pal and Saha's model. They have convincingly established that the degree of localisation economies can hardly be assessed by this overall scale parameter of production function, and there is a need to incorporate a localisation qualifying variable such as the location factor of energy-use; that is comparable to a "cumulated experience" variable as used in Arrow's "Learning by doing hypothesis" model of temporal production function analysis. An actual assessment of an internal technology scale for quality corrected factor-inputs is also necessary, without a pre-assigned restriction of unit return on it, so that its contrasts to the over-all scale parameter could be appropriately used as a measure for the degree of localisation economy (or diseconomy).

In general, varying patterns of localisation economies and concentration of industries emerge over geographic space in any country. The varying nature of these patterns are generally caused by several regional factors. For example, natural resourcebased industries are generally located near the areas of natural resource endowments, while some other industries are concentrated near the sites where market facilities are available. All these regional factors can be classified into the following three inter-dependent categories:

(i) natural resource endowments,

(ii) market facilities as generally available near the higher order human settlements; and

(iii) local infra-structural facilities such as power, transportations facilities, etc.

Whatever be the regional factor or factors responsible for the localisation of various industries at different locations, all manufacturing industries are seen to depend on the availability of power and energy to a greater or lesser degree. For example, a natural resourcebased industry hardly be started at the site of natural resource endowments unless the energy supply is assured requisite to run the industry. Similarly other manufacturing industries are not in a position to run unless energy supply is assured. Again, as we want to understand the present localisation of all manufacturing industries together, and not for different industries separately for want of data, a single comprehensive regional factor is all the more necessary. All we want to say is that the energy-use at different locations can be seen as a locational character or variable to act as a surrogate of a single comprehensive regional factor conceived as causing industrial localisations. In fact, in these days of global energy crisis, the energy use at different locations has become all the more a responsible factor for sustained manufacturing activities.

We prefer to take energy use by local industries and not the total availability of energy at the location, because we want to avoid other competing uses of energy for other purposes. But total energy use by industries at a location or locational unit of observation (district, in our study) is considered to be an input variable for the average production technology of manufacturing activities at that location. So, we convert the energy use variable as a localisation performance or qualifying variable by connecting it with the total geographical area of the locational unit and thereby delinking it from the total magnitude of manufacturing activities at that location. Thus we use the location factor of energy-use and not the total energy use as a localisation performance variable. By definition, the quotient obtained by dividing the district share of national total of an item by the corresponding share of geographical area is called the location factor of the item for the district [for details, refer to Pal, 1971]. Pal and Saha [1981a] have used the same location factor of the energy-use variable as the localisation of a qualifying or performance variable. Following Grilliche's [1967] formulation in a time-series production function analysis, they have analogically argued in the cross-sectional situation for regional production analysis that this qualifying variable is supposed to influence the qualities of factor inputs like capital and labour positively at different locations. This means that at a location with higher values of the location factor of energy use, the qualities of capital and labour engaged in the local manufacturing activities are better. They have empirically established that the localisation performance variable is strongly and positively related to the manufacturing level measured by the output variable. We shall try to establish such an "expected" result empirically for Nepal also. If this could be established convincingly, we can safely infer that our present choice of localisation performance variable as a measure of the comprehensive regional factor is appropriate. Assuming the neutrality of the localisation qualifying or performance variable on the factor inputs in a comparable scale of measurement, the production function can be written in the following form:

$$Y = F[K^*, L^*] = F[f(Q)K, f(Q)L] \quad \ldots \quad (3.1)$$

where,

$K = U^{-1} K'$

$U = \frac{\Sigma K'}{\Sigma L} = \frac{\bar{K}'}{\bar{L}}$ All Nepal average capital labour ratio (in thousand rupees per man-year)

K' = productive capital input value (value in Rs. thousand)

L = labour input (man-year)

Q = location factor of energy use to be called the localisation performance variable (no.)

Y = total value of output in Rs. thousand)

K^* = $f(Q)K$ and $L^* = f(Q)L$ are the quality adjusted capital and labour in a comparable unit of measurement (same as that of L)

It should be noted that the neutrality of f(Q), a function of Q, is assumed on $(U^{-1} K')$ and L which are in a comparable measurement unit and have the same "expected" or average value. The multiplication of K' by U^{-1} takes care of differential existence of factor intensities for different industries on the average, so that a same functional form f of relevant can be applied on capital inputs of different industries after having accepted the neutrality of the functional form on labour inputs of different industries. But as we are not in a position to estimate the industry-wise regional production function for lack of requisite break-downs in the data of total manufacturing activities by districts, the presence of the parameter U in the production function is not so important in the present study. Its importance lies elsewhere. First the modification of the CES production function by introduction of the parameter U is necessary in order to make the distribution parameter of the CES function free from the differential choice of the measurement units of input variables [Pal and Malakar, 1980]. Second, the introduction of the parameter U is also necessary for an appropriate statistical estimation of CES parameters which will be discussed later.

The CD and CES varieties of production functions with a particular form of localisation performance function $f(Q) = Q^{\lambda\lambda^*}$ used here is given as

$$\text{CD form}: \quad Y = \gamma (K^*)^{\delta\lambda^*} (L^*)^{(1-\delta)\lambda^*} \quad \ldots \quad (3.2a)$$

$$= \gamma K^{\delta\lambda^*} L^{(1-\delta)\lambda^*} Q^{\lambda\lambda^*} \quad \ldots \quad (3.2b)$$

$$\text{CES form}: \quad Y = \gamma\,[\delta (K^*)^{-\rho} + (1-\delta)(L^*)^{-\rho}]^{-\frac{\lambda^*}{\rho}} \quad \ldots \quad (3.3a)$$

$$= \gamma\,[\delta K^{-\rho} + (1-\delta) L^{-\rho}]^{-\frac{\lambda^*}{\rho}} \, Q^{\ell \lambda^*} \quad \ldots \quad (3.3b)$$

where

λ^* = homogeneity parameter for quality adjusted factor inputs (to be called internal technology scale parameter) ($\lambda^* > 0$)

λ = $\lambda^*(1 + \ell)$ = over-all homogeneity (or scale) parameter ($\lambda > 0$)

γ = average efficiency parameter ($\gamma > 0$)

ρ = substitution parameter ($\rho > -1$)

δ = average distribution parameter or the average capital coefficient at ($\bar{K}'$, $\bar{L}$) for the CES form ($0 < \delta < 1$)

σ = $(1 + \rho)^{-1}$ = elasticity of substitution ($\sigma > 0$)

It is further designated that:

ℓ = power parameter (for the localisation performance variable

ℓ^* = $(1 + \ell) = \frac{\lambda}{\lambda^*}$ = degree of localisation economy of diseconomy.

If $\ell = 1$, it implies that there is an absence of localisation economy or diseconomy, where as $\ell^* > 1$ implies the case of localisation economy and $\lambda^* < 1$ implies the case of localisation diseconomy. The factor $Q^{\lambda} = Q^*$, say, refers to the effective localisation performance factor depicting the regional technology specialisations at different locations. If $\lambda = 0$, then $Q^* = 1$ for all locations: there are no differences in the regional technology specialisations (indicating similar localisation performances everywhere). In this case of $Q^* = 1$, we need not necessarily have $Q = 1$ for all locations. So without screening for interactions of Q on K and L, through production function analysis, we are not in a position to evaluate the localisation performance factor Q^*.

3.2.2 Statistical estimation of the model parameter.

The CD form as given in equation (3.2) can be easily estimated by the OLS (ordinary least squares) procedure. But the estimation of the CES form is a bit cumbersome because of the nonlinear way the substitution parameter enters the model (3.3). This parameter is usually estimated at the initial stage by another equation incorporating an additional explanatory variable through certain assumptions [Arrow et al. 1961, Pal 1965, Dhrymes 1965]. Thus wage rates formed on additional explanatory variable introduced through the assumption of a perfect market in the initial equation by Arrow et al [1961]. In their original model, the modification by the incorporations of u parameter and the variable Q was absent, i.e., in their case $K^* = K = \hat{K}$ and $L^* = L$ (algebraically, $u = 1$, and $\ell = 0$). They have also assumed the unit value for the return to scale parameter (algebraically, $\lambda^* = \lambda = 1$). Both Dhrymes [1965] and Pal [1965] independently gave the generalised estimation procedures in which the restriction of unit return to scale is not admitted a priori. Dhrymes also claimed in his generalisation that the assumption of a perfect market is not implicit in his generalisation. Under the assumption of $\lambda^* = 1$ in his model it reduces to the model of Arrow et al [1961] developed under the assumption of perfect market. As such Dhrymes inferred that under perfect market with $\lambda^* = 1$, his model reduces to that of Arrow et al [1961]. But clearly it is sufficient for deriving the model of Arrow et al from that of Dhrymes with additional assumption that $\lambda^* = 1$ and without any further assumption of perfect market. So there is a controversy and it could be resolved if we examine the line of argument in Pal's [1965] generalisation. Pal's generalised deduction followed a similar kind of mathematical reasoning as in Arrow et al. [1961]. Arrow et al started with that form of the CES parameter σ which holds with $\lambda^* = 1$, while Pal started with the generalised definition of σ without the restriction. The details of Pal's generalisation [1965] are based on the following algebraic steps:

Writing the production function Y, homogeneous within degree λ^*, as given in equation (3.1), we have

$$Y = F[K^*, L^*] = (L^*)^{\lambda^*} F[\frac{K^*}{L^*}, 1]$$

i.e., $y = g(x)$ ... (3.4)

where,

$$y = \frac{Y}{(L^*)^{\lambda^*}}, \quad x = \frac{K^*}{L^*} \quad \text{and} \quad g(x) = F(x, 1)$$

Then,

$$\frac{\partial Y}{\partial L^*} = (L^*)^{\lambda^*-1} (\lambda^* g(x) - xg') \quad \ldots \quad (3.5)$$

with $g' = g'(x) = \frac{dg(x)}{dx} = \frac{dy}{dx}$

$$\frac{\partial Y}{\partial K^*} = (\lambda^*-1)(L^*)^{\lambda^*-1} \cdot g' \quad \ldots \quad (3.6)$$

$$\frac{d}{dx}\left(\frac{\partial Y}{\partial L^*} / \frac{\partial Y}{\partial K^*}\right) = \frac{d}{dx}[(\lambda^* g(x) - x(g')/g]$$

$$= (\lambda^*-1) - \frac{\lambda^* g g''}{(g')^2} \quad \ldots \quad (3.7)$$

with $g'' = \frac{dg'}{dx}$

and, $$\sigma = \frac{d(\frac{K^*}{L^*})(-\frac{dK^*}{dL^*})}{d(-\frac{dK^*}{dL^*})(\frac{K^*}{L^*})}$$

$$= \frac{d\,(K^*/L^*).(\frac{\partial Y}{\partial L^*} / \frac{\partial Y}{\partial K^*})}{d\,(\frac{\partial Y}{\partial L^*} / \frac{\partial Y}{\partial K^*}).(K^*/L^*)}$$

i.e.,

$$\sigma = \frac{g'(\lambda^* g - xg')}{x\,[(\lambda^* - 1)(g')^2 - \lambda^* gg'']} \qquad \ldots \qquad (3.8)$$

Note that if we put $\lambda^* = 1$ in the generalised relation (3.8), then it reduces to that of (3.9) which was the starting point of Arrow et al. [1961].

$$[\sigma]_{\lambda^* = 1} = -\frac{g'(g - xg')}{xgg''} \qquad \ldots \qquad (3.9)$$

Now using relation (3.8), we have

$$(\lambda^* - 1) + \sigma^{-1} = \frac{\lambda^*(\lambda^* - 1)gg' - x(\lambda^* - 1)(g')^2 + x(\lambda^* - 1)(g')^2 - \lambda^* x gg''}{g'(\lambda^* g - xg')}$$

$$= \frac{\lambda^* g[(\lambda^* - 1)g' - xg'']}{g'(\lambda^* g - xg')}$$

or, putting $a_2 = \dfrac{\lambda^*}{(\lambda^* - 1) + \sigma^{-1}}$ ... (3.10)

we have,

$$a_2 = \frac{g'(\lambda^* g - xg')}{g[(\lambda^* - 1)g' - xg'']} = \frac{\frac{dy}{dx}(\lambda^* g - xg')}{y\frac{d}{dx}(\lambda^* g - xg')}$$

or, $$\frac{dy}{y} = a_2 \frac{d(\lambda^* g - xg')}{(\lambda^* g - xg')}$$

Integrating it, we have

$$\ln y = a_1 + a_2 \ln (\lambda^* g - xg') \qquad \ldots \qquad (3.11)$$

In the deductions of Arrow et al., for $\lambda^* = 1$, he obtained $a_2 = \sigma$ and a similar equation corresponding to (3.11) mutatis mutandis. Using equation (3.5) in equation (3.11), we have

$$\ln y = a_1 + a_2 \ln \left(\frac{\partial y^*}{\partial L^*} \cdot \frac{L^*}{(L^*)^{\lambda^*}} \right) \qquad \ldots \qquad (3.12)$$

Now according to the economic theory, we get the marginal product of labour as

$$\frac{\partial y^*}{\partial L^*} = w \left(\frac{1 + \epsilon_\lambda^{-1}}{1 + \epsilon^{-1}} \right) \qquad \ldots \qquad (3.13)$$

where,

w = wage rate per unit of labour

ϵ_λ = market supply elasticity of labour

ϵ = market demand elasticity of output

under perfect competition these elasticities tend to become infinite and then the equation (3.13) reduces, under perfect market, to equation (3.14) given below.

i.e., $$\frac{\partial y^*}{\partial L^*} = w \qquad \ldots \qquad (3.14)$$

using the general equation (3.13) and denoting

$C = wL^* =$ total wages

The equation (3.12) can be written as

$$\ln y = a_1 + a_2 \ln C + a_3 \ln L^* + a_0 \ln Z \quad \ldots (3.15)$$

where,

$$a_0 = m.a_2 , \quad a_3 = (1 - a_2)\lambda^* \quad \ldots (3.16a)$$

with,

m is a constant, and

$$Z^m = \left(\frac{1 + \epsilon^{-1}\lambda}{1 + \epsilon^{-1}}\right) \quad \ldots (3.16b)^*$$

The term given in (3.16b) embodies the market condition for the equation (3.15). The equation (3.15) can then be taken as the general equation without any restrictions on the market condition and on the return to scale parameter. Now under perfect market we get $m = 0$ and hence the last term of the equation (3.15) vanishes so that we obtain equation (3.17) as quoted in Pal [1965]:

$$\ln y = a_1 + a_2 \ln C + a_3 \ln L^* \quad \ldots (3.17)$$

This form (3.17) is algebraically similar to that used by Dhrymes [1965] and it reduces to the form used by Arrow et al [1961] when we put $1 = \lambda^* = a_3 / (1 - a_2)$. As Dhrymes'

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* Dhrymes [1965] also used the same relation but its final equation does not contain it.

estimating equation does not incorporate the last term of equation (3.15) which is related to the market condition, it cannot have the claim of incorporating the most general imperfect market. Under the most general imperfect market, the term Z is likely to be a variable in relation (3.15). But if the market imperfection has the restriction that the market supply and demand elasticities are such that "Z^m is a constant other than unity or even unity, i.e., $(1 + \epsilon_\lambda^{-1})$ is proportional to $(1 + \epsilon^{-1})$", then the equation (3.15) turns out to be a constant which can be accommodated algebraically in its first constant term, so that it again takes the form (3.17). So the estimating equations of both Pal and Dhrymes, and also of Arrow et al., can be viewed as holding under the same restricted imperfect market condition that $(1 + \epsilon_\lambda^{-1})$ is proportional to $(1 + \epsilon^{-1})$. This restriction also accommodates the perfect market condition. Thus Dhrymes model is not a generalisation over that of Arrow et al. in terms of market condition, but it is so, like that of Pal, in terms of return to scale parameter.

Now one can modify the equation (3.17) into the equation (3.18) as given below to accommodate our localisation performance variable i.e.,

i.e., $\ln y = a_1 + a_2 \ln C + a_3 \ln L + a_4 \ln Q$ ... (3.18) with $\lambda = a_4/a_3$, $\lambda^* = a_3/(1 - a_2)$, and $\rho = a_3/a_2$. Once the parameter ρ, λ^*, and λ are determined from equation (3.18), the CES form can then be transformed into a suitable linear form that permits statistical estimations of other two CES parameters δ and γ. But this kind of estimation has been possible only with the use of an additional explanatory variable C, over and above what occurs in the actual functional form, which could be incorporated only through the restricted imperfect market condition discussed earlier. But such a restricted imperfect market cannot easily be verified empirically for its consistency. So we think that it is not proper on our part to use such a derived form for initial estimations, particularly when we are using an aggregate industrial production function with an empirical localisation performance factor and not the individual firmwise production function. On the other hand, Kmenta [1967] employed second degree approximation by Taylor's series-treating the original CES form as a function of ρ. On this approximated form one can easily apply the OLS procedure of multiple linear regression to estimate the CES parameters. But it is emphasized here that the distribution parameter δ is not an unit-free parameter, while the substitution parameter ρ is a unit-free number. Pal and Malakar [1980] have shown that unless the original CES form is modified by introduction of the capital - labour ratio parameter u, the estimations by Kmenta's approximating procedure becomes inappropriate, giving arbitrary estimates of δ and ρ. In that approximated form even the unit-free property of ρ of the original CES form is lost. But after the introduction of the parameter u in the original CES form, the parameter δ, also, becomes an unit-free parameter, standing for the average capital coefficient at the central point $(\bar{K}^{-1}, \bar{L})$, with this modifications of the CES form the stated in-appropriateness of Kmenta's approximation is remedied. Here comes again the importance of considering the modified CES form with the additional parameter u. Thus using this modification, Kmenta's approximation takes the following form as given in equation (3.19):

$$\ln y = \ln \gamma + \lambda^* \ln L + \alpha \ln (K/L) + \beta \{\ln (K/L)\}^2 + \\ + \lambda\lambda^* \ln Q$$

or, identically,

$$\ln y = \ln \gamma + \lambda \ln L + \alpha \ln (K/L) + \beta \{\ln (K/L)\}^2 + \\ + \lambda\lambda^* \ln (Q/L) \quad \ldots \quad (3.19)$$

with,

$$\delta = \frac{\alpha}{\lambda^*}, \quad \text{and} \quad \rho = -\frac{2\beta\lambda^*}{\alpha(\lambda^* - \alpha)}$$

It is to be noted here that when $\beta = 0$, the equation (3.19) reduces as an exact log-transformation of the CD function.

Thus Kmenta's fit is an extension of CD fit with the last variable of equation (3.19). So, one can easily varify by testing the null hypothesis, $H_0: \beta = 0$, whether or not the general CES form is statistically different from the particular CD form. If the null hypothesis is not rejected, we shall infer that CD form is good enough for our regional analysis.

3.2.3 Revision of model framework in view of data problems.

We have already pointed out that regional investigations are often beset with data problems in developing countries, particularly in Nepal. First, there is no regular surveys of industries that would be needed for any time series studies in Nepal. Second, the data collected in a very few ad hoc surveys have not been presented in an usable form for this kind of analysis. For example, regional breakdowns by districts have been presented for all manufacturing industries conducted by CBS for the reference year 1972-73 but not for different industries within districts, although the aggregates have been established on the basis of data obtained for 22 industries considered. So with the use of this source of manufacturing industry data we are not in a position to investigate either the detailed regional industrial patterns or by regional production function analysis for individual industries. Third, not all input data needed for the usual production function analysis have been recorded. For example, even the data on productive capital input have not been presented in the report noted above [CBS, 1975]. What is given there is only the data on fixed capital and financial position. The total of these two could possibly be a feasible approximation for the "total invested capital" but not for the actual 'productive capital input' in the year under consideration. While we may examine the data of "total invested or investible capital" for a statistical fit to examine how far it could be used as an explanatory input variable, but we do not have much reliance on it for its use as a substitute for the actual capital services consumed in the production in that particular year. Fourth, data recorded in the report cited [CBS, 1975] are not always comparable over districts (or industries) because of their arbitrarily varying coverages. For example, the data on wages paid to labourers suffer from this kind of incompleteness. Some portions of labour input are stated to be nonpaid workers, but possibly they might have been paid in kind in the form of meals, clothing, lodging facilities, etc. As the recorded wages do not include even imputed values for these supporting expenses in kind related to nonpaid workers here and there, we are again not in a position to place much reliance on such wage data even if we use them in the analysis. A few more problems can possibly be listed. But we do not want to make this review bulky with such negative aspects. All we want to conclude here is that our theoretical model framework is subject to revision to suit the situation. Despite the revision of the model framework it will be possible for us to obtain useful findings of interest to regional industrial planning in Nepal.

Mention of ad hoc industrial surveys conducted by the CBS has already been made. To the best of our knowledge there have been three such surveys in recent years with the reference years of survey as 1965-66, 1972-73 and 1976-77. Of these the first survey report was available neither in published form nor in memeographed form. The last survey results are still being processed and its reports are yet to appear. Only a mimeographed report of the 1972-73 survey results came out in 1975. We have no alternative but to analyse the manufacturing industrialisation patterns with the aid of data presented in this report. Nor we can make any comparative study over a pair of time periods on details of production relations. Even the detailed data by industries are not available in this report. The only available data are: (i) the aggregate of 22 manufacturing industries by districts and (ii) the national total of all districts by those 22 industries (to be called activities). Though these two aggregates were obviously built up from individual firms' d a t a for different industries, the district totals industry by industry are not available. Regarding the coverage of industry, only the registered firms are included in this survey. Thus we are in a position to analyse only the two types of aggregate production functions on the basis of the variations over (1) districts and (2) industries (activities). The first will be called the regional aggregate manufacturing production function and the second will be called the national industrial activity function. These are proposed to be fitted only with a surrogate of productive capital input K', in the absence of actual data. We shall actually put $K' = E + D$, where E = the value of energy consumption including fuels in the year of reference, and D = the value of depreciation on fixed capital in the year of reference. These substitutions seem to be reasonable on the following grounds : capital services can be thought to have strong positive correlation with the energy use E and the fixed capital consumption, in the form of depreciation D, can be comparably added to E, so that the sum can be used to stand for a surrogate of productive capital input K'. It should be noted here that there are classical comments [Walter, 1963] on the dificulties of using even the usually recorded productive capital data. On the face of those comments we believe that our surrogate variable could be a better indicator of actual capital services variable. It should be emphasized that because of the partial nature of the fixed capital data, it can never be used as a substitute of actual capital services input in production. Moreover, aggregated fixed capital data over different industries at different locations are not very meaningful, because the industry-specific fixed capital holdings become noncomparable when aggregated with varying industrymixes at different locations. So the fixed capital data are more inappropriate as a substitute for capital services for the estimation of the regional aggregate production function, compared with the estimation of the national activity function. We shall however try the variable, say, K = total invested capital (sum of fixed capital and the total source of finance), an alternative to K', as a substitute for "productive capital" and accept whichever relation gives the better statistical fit and at the same time economically consistent estimates. In the national activity function in which industrymixes are absent, we shall also use $\tilde{\bar{K}}$ as a variable inducing agglomeration just as we have used E as localisation-inducing variable. The district size is however neutralised for comparison by use of the geographical area A, while the industrysize will be neutralised for comparison by use of the labour data L. Thus granting the revision of the model framework with the surrogated productive capital input K' (alternatively $\hat{K}$) and also using the labour input L and output Y, we propose to fit the regional production functions with the use of the following input qualifying variable:

$$Q = \frac{(E/A)}{(\Sigma E/\Sigma A)}$$ = location factor of energy use (or the localisation performance variable) and also the national activity function without this variable Q.

These two aggregate functions would be useful in analysing the over-all manufacturing industrialisation patterns by regions and by activities. The details of regional production relations for different industries could have added more meaning to them. But unfortunately we do not have the breakdowns of data necessary to permit detailed analysis. We shall however try to find out the regional industrial pattern and growth on the basis of the only available data on the number of factories by industries and by districts given together with the year of establishment.

3.2.4 Regional indices of technical efficiency (or, the Joint productivity indices of factor inputs).

It has been already mentioned in subsection 3.2.1 that the varying regional technology specialisation leads to varying localisation performances at different locations. In this connection the role of the localisation qualifying or performance variable Q gains importance. With the introduction of this variable and with the knowledge of interaction on the factor inputs K and L through the estimation of parameter λ, we have now two types of factor inputs, namely the quality adjusted factor inputs K^* and L^* where $K^* = Q^{\lambda} K$ and $L^* = Q^{\lambda} L$, and also the actual factor inputs K and L in the comparable measurement units (i.e., the unit of L). Thus two kinds of productivity measures indicating the individual efficiency of a single factor input are now possible. Denoting by $x_1 = K$, $x_2 = L$, and $x_1^* = K^*$, $x_2^* = L^*$, these two productivity measures of any single factor input can be written as

$P_i = Y/x_i =$ productivity of the ith factor input, $(i = 1, 2)$, as per usual concept.

$P_i^* = Y/x_i^* =$ productivity of ith quality adjusted factor input.

Denoting, $Q^* = Q^{\lambda} =$ localisation performance factor, clearly we have,

$$P_i = P_i^* Q^* \qquad \ldots \qquad (3.20)$$

For the two model formulations, we have the following mean values of factor inputs as shown below :

CD mean values : $x_0 = x_1^{\delta} x_2^{1-\delta}$

$$x_0^* = (x_1^*)^{\delta} (x_2^*)^{1-\delta}$$

$$= Q^* x_0 .$$

CES mean values: $x_o = [\delta x_1^{-\rho} + (1 - \delta) x_2^{-\rho}]^{-1/\rho}$

$$x_o^* = [\delta (x_1^*)^{-\rho} + (1 - \delta)(x_2^*)^{-\rho}]^{-1/\rho}$$

$$= Q^* x_o .$$

Whatever be the model formulation, we have the relation

$$x_o^* = Q^* x_o$$

for joint measures of factor inputs, a similar equation to the corresponding relation of any single factor input, namely

$$x_i^* = Q^* x_i , \quad i = 1, 2$$

So, by an analogy, from relation (3.20), we shall have the relation (3.21) as

$$P = P^* Q^* \quad \ldots \quad (3.21)$$

If we are in a position to define P = joint productivity index of factor inputs x_1 and x_2, then we shall automatically have:

$P^* = P/Q^* =$ Joint productivity index of quality factor inputs x_1^* and x_2^*.

In order to formulate P, Pal and Saha [1981b] examined the concept of technical efficiency as given first by Farrel [1957] for the production relation with two factor inputs, capital and labour, only without the incorporation of variable Q. Farrel [1957] has however defined the concept in comparison with a production relation that can be called the frontier production function. In the frontier production function we have a kind of unattainable minimum of factor inputs that would ideally be necessary to produce any particular output and the actual factor-inputs to produce the same output for any corresponding observation will always be higher, maintaining however the same factor intensity ratio in both. The ratio of this ideal to the actual values of any factor input is taken to define the technical efficiency index for that observation . In this scale, the ideal value of technical efficiency index is unity and all values are less than unity for actual observations. When the efficiency measure could be obtained with such a frontier (or ideal) production function. We shall call it an absolute technical efficiency measure. As the scatter of observations in relation to the frontier production is one sided and also as there is arbitrariness in the relative position between the scatter and the so-called function, the determination of such a function is difficult and questionable. So the technical efficiency measure of Farrel [1957] is modified and used by Pal and Saha [1981a, 1981b] by replacing the frontier production function with the usual average production function having the both sided scatter. We shall call this modified measure the relative technical efficiency index or simply the technical efficiency index. In this measure unity is the central value representing the average level, while the values above and below unity represent relatively more and less efficient observations respectively.

With the changed notations the average production function with two explanatory variables x_1 and x_2 can now be written as

$$Y = \gamma x_o^{\lambda'} \qquad \ldots \qquad (3.22)$$

while that with three explanatory variables x_1, x_2 and Q s given by

$$Y = \gamma (x_o^*)^{\lambda^*} \qquad \ldots \qquad (3.23)$$

e shall denote Farrel's technical efficiency index by F' and F^* corresponding to production functions (3.22) and 3.23) respectively.

Following the line of arguments given by Pal and Saha, we shall now examine below Farrel's technical efficiency measure. As the algebraic structure of function (3.23) with x_1^* and x_2^* as explanatory variables is same as that of function (3.22) with x_1 and x_2 as explanatory variables, we shall make such an examination with reference to relation (3.24) below.

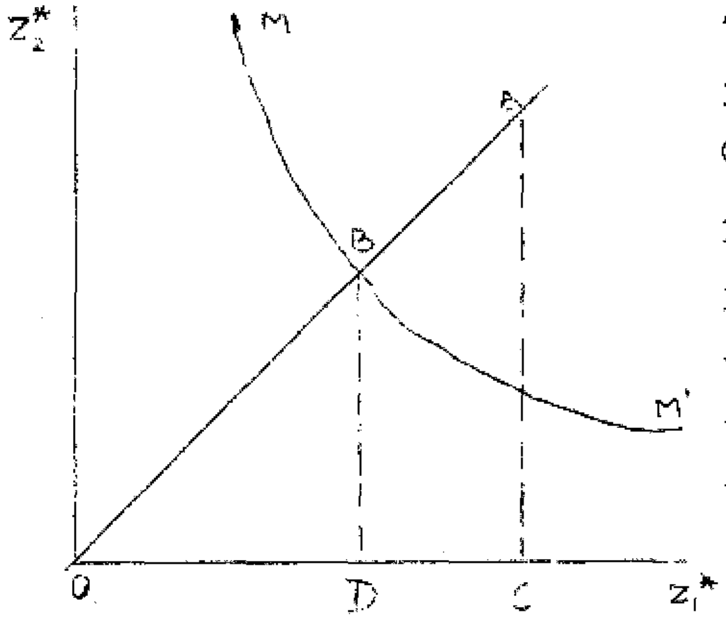
Denoting,

$$Z_i^* = x_i^*/(Y^{1/\lambda^*}), \quad i = 0, 1, 2 \ldots \qquad (3.24)$$

The production function (3.23) can now be written as given in (3.25) below:

$$\begin{aligned} 1 &= Y^{1/\lambda^*} Z_0^* \\ &= Y^{1/\lambda^*} (Z_1^*)^{\delta} (Z_2^*)^{1-\delta} \quad : \text{ CD form} \\ &= Y^{1/\lambda^*} [\delta(Z_1^*)^{-\rho} + (1-\delta)(Z_2^*)^{-\rho}]^{1/\rho} : \text{ CES form} \end{aligned} \qquad \ldots \quad (3.25)$$

In the graph given below we have represented this function by MM' (called the isoquant for unit output) and any arbitrary observation is denoted by the point $A = (Z_1^*, Z_2^*)$.



The line joining the point A and the origin O cuts the curve at $B = (Z_1^*, Z_2^*)$. AC and BD areperpendiculars on the Z_1^* - axis. According to Farrel's concept of technical efficiency, (F^* is given by) $F^* = \frac{OB}{OA}$.

Since $\frac{OB}{OA} = \frac{OD}{OC} = \frac{BD}{AC}$, we have, $F^* = \frac{\hat{Z}_1^*}{Z_1^*} = \frac{\hat{Z}_2^*}{Z_2^*}$,

and also, $\frac{Z_1^*}{Z_2^*} = \frac{\hat{Z}_1^*}{\hat{Z}_2^*}$ ... (3.26)

As $(\hat{Z}_1^*, \hat{Z}_2^*)$ is a point on the curve MM', it satisfies the relation (3.25). So in CD form, we have

$$1 = y^{1/\lambda^*} \hat{Z}_2^* \left(\frac{\hat{Z}_1^*}{\hat{Z}_2^*}\right)^{\delta}$$

$$= y^{1/\lambda^*} \hat{Z}_2^* \left(\frac{Z_1^*}{Z_2^*}\right)^{\delta} \quad \text{by use of relation (3.26)}$$

$$= \frac{\hat{Z}_2^*}{Z_2^*} y^{1/\lambda^*} Z_2^* \left(\frac{Z_1^*}{Z_2^*}\right)^{\delta}$$

$$= \frac{\hat{Z}_2^*}{Z_2^*} y^{1/\lambda^*} (Z_1^*)^{\delta} (Z_2^*)^{1-\delta}$$

i.e., $1 = \left(\frac{\hat{Z}_2^*}{Z_2^*}\right) y^{1/\lambda^*} Z_o^*$ ... (3.27)

Again following the same line of argument as above we arrive at relation (3.27) for the CES form also. Then

$$F^* = \frac{\hat{Z}_2^*}{Z_2^*} = \frac{1}{y^{1/\lambda^*} Z_o^*} = \left(\frac{Y}{y}\right)^{1/\lambda^*} \Big/ x_o^* \quad \ldots \quad (3.28)$$

i.e., $$F^* = \left(\frac{Y}{\hat{Y}} \right)^{1/\lambda^*} \quad \ldots \quad (3.29)$$

where, $\hat{Y} = \hat{Y}(x_1, x_2, Q)$ denotes the functional value corresponding to the production function (3.23). In relation (3.23), the parameter γ is determined from the average condition. So the division of Y by γ in (3.28) just makes F^* an index. Because of the appearance of x_o^* in the denominator of relation (3.28) F^* can be taken to be the productivity index P^* comparably with the definition of productivity P_i^* This comparison is rather exact when $\lambda^* = 1$ as taken in Farrel's exposition (to be exact, $\lambda' = 1$ in Farrel's). Then by relation (3.21) the joint productivity index of factor inputs, according to Pal and Saha [1981b], should be

$$P = P^* Q^* = F^* Q^*$$

$$= \frac{(Y/\gamma)^{1/\lambda^*}}{x_o} \quad \ldots \quad (3.30)$$

which is again comparable with the usual definition of productivity P_i. If we started with production function (3.22) instead of (3.23), then we would have arrived at the relation (3.23) instead of relations (3.28) or (3.29) i.e.,

$$F' = \frac{(Y/\gamma)^{1/\lambda'}}{x_o} = \left(\frac{Y}{Y'}\right)^{1/\lambda'} \quad \ldots \quad (3.31)$$

$$= P', \text{ say}$$

where $\hat{Y} = \hat{Y}(x_1, x_2)$ denotes the functional value corresponding to the production function (3.22). In fact Farrel did not introduce the localisation performance variable and he arrived at P' as his measure of technical efficiency. Thus we have now three measures of technical efficiency P, P^* and P' with the relation (3.21) connecting P and P^*. Pal and Saha [1981b] has also proposed that one can as well choose power functions of these indices by the corresponding scale parameter λ^* of λ', denoted respectively by S, S^* and S', for the three measures of technical efficiency. Thus, we have

$$S = P^{\lambda^*}, \quad S^* = (P^*)^{\lambda^*} \text{ and } S' = (P')^{\lambda'}$$

The connecting relation between S and S^* will then be (3.32) instead of (3.21) i.e.,

$$S = S^* T^* \qquad \ldots \qquad (3.32)$$

with $T^* = (Q^*)^{\lambda^*} = (Q)^{\lambda\lambda^*}$. If we take the logarithm to convert the relation (3.32) or the relation (3.21) into linear form, then we will have the same relation (3.33) for both:

$$\ln P = \ln P^* + \ln Q^*$$

or identically, $\ln S = \ln S^* + \ln T^* \qquad \ldots \qquad (3.33)$

whatever be our choice of the index form, whether S or P, the relative ranks of different observations will remain unchanged. Only the range of values of S will be lower than that of P if the return to scale λ^* is diminishing, whereas it would be higher for increasing return to scale. If there is a substantial departure in the value of λ^* from unity, we prefer to choose S instead of P as a measure of technical efficiency so that the nature of the return to scale parameter is rightly reflected in the distribution of S. Whatever be the system Pal and Saha [1981b] have shown that S' (or P') is very close to S^* (or P^*) and also that S (or P) is similarly away from both S' (or P') or S^* (or P^*). This will be tested empirically from the correlation matrix of ln S, ln S^* and ln S' In addition, they put the following arguments in favour of the above mentioned claim. From relation (3.29) or (3.31) corresponding to the production functions (3.23) and (3.22), we have

$$\ln S^* = \ln Y - \ln \hat{Y} \quad : \quad \hat{Y} = \hat{Y}(x_1, x_2, Q)$$

and, $$\ln S' = \ln Y - \ln \hat{Y} \quad : \quad \hat{Y} = \hat{Y}(x_1, x_2)$$

As both $\hat{Y}(x_1, x_2, Q)$ and $\hat{Y}(x_1, x_2)$ give the functional estimate of the same Y (with good statistical fit), both ln S^* and ln S' appear to be comparable random terms in the statistical fits. As such ln S^* and ln S' are likely to have a strong relation between them. Further it can be tested statistically that λ (= $\lambda^* + \ell\lambda^*$) and λ' are not different so that the role of $T^* = Q^{\ell\lambda^*}$ in the three variable case is taken care of by the factor inputs themselves in the two variable case. So, although Q is not explicitly introduced in the two variable case, quality adjustment is implicit to allow for the existence of significant departures in the value of λ' compared with λ^*. We notice that $\ln T^*$ is proportional to the explanatory variable $\ln Q$ and in relation (3.33), we have $\ln S$ as the sum of this term and the random term $\ln S^*$. As such $\ln S$ is expected to have a poor relation with $\ln S^*$. As $\ln S'$ is a comparable random term like $\ln S^*$, the relation between $\ln S$ and $\ln S'$ is also expected to be similarly poor. Thus Pal and Saha inferred by theoretical reasoning and also empirically that Farrel's measure S' (or P') is not an appropriate measure of technical efficiency for instance of significant localisation performance factor T^* (or Q^*) with significant λ^*. Rather one should use S (or P) for the joint productivity index of factor-inputs, as the technical efficiency index. The factor S^* (or P^*) will then be called the <u>internal technology factor of efficiency</u>, while T^* (or Q^*) is already referred to as the <u>localisation performance factor of efficiency</u>. From the above reasoning we infer that Farrel's measure S' (or P') is better called the internal technology factor of efficiency. This measure S' (= P' since $\lambda' = 1$ here) has actually been used by Arrow et al. also for comparison between two particular observations, namely Japan and United States for their statistical fit with international data. Their definitions of γ_j and γ_u (efficiency value for Japan and U.S.A.) are identical with ($\gamma S'_j$) and ($\gamma S'_u$ so that their relative measure can be written as $\frac{\gamma_j}{\gamma_u} = \frac{S'_j}{S'_u}$. Arrow et al., [1961] and Farrel [1957] had put forward their reasoning (or reasons) for their measures $\gamma S'(= \gamma P')$ and $S'(= P')$ possibly independently, without noticing the harmony in them that comes through the relation (3.31) as deduced by Pal and Saha [1981b]. Earlier work by Pal and Saha [1981a] in fact used the index like S' in their district level regional study for India. Finding the unsuitability of the index S', they later [1981b] devised the index S (or P) which seems quite appropriate for regional analysis in view of the recognition of the localisation performance factor of efficiency in it.

The actual factor intensity index $Z_1^*/Z_2^* = \frac{x_1^*}{x_2^*} = \frac{x_1}{x_2}$ is held the same as the isoquant factor intensity index $\frac{\hat{Z}_1^*}{\hat{Z}_2^*} = \frac{x_1^*}{x_2^*} = \frac{x_1}{x_2}$ in relation (3.26) which is used to deduce the measure F^* in relation (3.28). This index of factor intensity, namely

$$\phi = \frac{x_1}{x_2} = \frac{K}{L}$$

$$= \left(\frac{K'}{L'}\right)/\left(\frac{\Sigma K'}{\Sigma L}\right) \qquad \ldots \qquad (3.34)$$

is also to be treated as an internal technology character for regional analysis in addition to technical efficiency index S and its localisation performance factor L^*. The index of this index ϕ for any particular industry will reveal regional differences, if any, in the varying levels of capital intensive technology. But for the regional aggregate manufacturing production function, because of the varying industry-mixes, the index ϕ will not be of much use. We shall however examine this index for the national industrial activity function in which the question of the industry-mix does not arise. As S^* is not independent of S and L^* (i.e., S^* is derivable from S and L^*), we feel that the analysis with ϕ is more important than that of S^* in identifying internal technology character. Thus the three indices S, L^* and ϕ will be analysed in our subsequent empirical study.

3.2.5 Composite indices of concentration for manufacturing and over-all industrial activities.

The location factor of manufacturing output Y can be called the absolute concentration index of manufacturing activities M_a [Pal, 1971]. That is, we have

$$M_a = \left(\frac{Y}{A}\right) / \left(\frac{\Sigma Y}{\Sigma A}\right) \qquad \ldots \qquad (3.35)$$

with Σ extending over-all units of observation for the nation. Here we examine the manufacturing activity-wise measured by Y in relation to the geographical area A of a unit of observation under consideration. When we examine the manufacturing activity size in relation to the economically active population size of the unit of observation, then what we get is called the relative concentration index of manufacturing activities M_r. Thus we have

$$M_r = \left(\frac{Y}{D}\right)/\left(\frac{\Sigma Y}{\Sigma D}\right) \qquad \ldots \qquad (3.36)$$

where D is the economically active population.

While these two indices can be analysed separately, we shall also construct a composite index of concentration of manufacturing activities, M, following the formulae developed by Pal [1963a, 1963b, 1971] in connection with his studies on India and South India. According to him, the absolute and relative indices are generally concomitant over different units of observation (i.e., they have a high positive correlation) and only if there are a limited number of observations may there be discordance in the values of indices because of certain locational peculiarities. For example in a sparsely populated area without having the possibility of agricultural production, people may have to be dependent entirely on non-agricultural activities and in such a case its M_a value can be non-incomparably lower than the corresponding M_r value and this M_r may even be higher than such values of highly industrial areas with high density of population. In such a case, a ranking of the areal units of observation would hardly be possible by their M_a or, M_r. So there is a need for a formulation of a composite index M, moderating the values of both M_a and M_r. But before that, the statistical distributions of both M_a and M_r are to be checked and at the instances of dissimilar distributions we have to take suitably transformed indices (mathematically transformed) so that any relationship that exists between the indices can be depicted by the linear correlation coefficient of the transformed indices. Hare we have however tried to obtain an improved linear correlation coefficient with certain known transformations and that transformation on the indices is accepted whichever gave the highest value of the correlation coefficient. In fact the square root of the indices gave the best result for Nepal.

Suppose the transformed indices are denoted by

$$x_1 = \sqrt{M_a}, \quad x_2 = \sqrt{M_r}$$

the means of x_1 and x_2 by $\overline{x_1}$ and $\overline{x_2}$, the corresponding standard deviations by σ_1 and σ_2 respectively; and finally the linear correlation coefficient between x_1 and x_2 by r_{12}, then the composite index M' is given by

$$M' = \frac{\sigma_2 x_1 + \sigma_1 x_2}{\sigma_1 \bar{x}_1 + \sigma_2 \bar{x}_2}$$

which is equally correlated with the constituent variables x_1 and x_2. This common correlation is given by

$$r = \sqrt{\tfrac{1}{2}(1 + r_{12})}$$

The critical value representing the national level, of any location factor like M_a or M_r is always unity so obviously $\bar{M}' = 1$. In order to maintain this standardisation of unit critical value for our composite index of manufacturing activity M, we have chosen it to be proportional to M' where

$$M = \frac{\sigma_2 x_1 + \sigma_1 x_2}{\sigma_1 + \sigma_2} \quad \ldots \quad (3.37)$$

$$= \left(\frac{\sigma_2 \bar{x}_1 + \sigma_1 \bar{x}_2}{\sigma_1 + \sigma_2} \right) M'$$

This change retains the property of equal correlationship of the composite index M with x_1 and x_2. Thus we have

$$r = r_{Mx_1} = r_{Mx_2} = \sqrt{\tfrac{1}{2}(1 + r_{12})} \quad \ldots \quad (3.38)$$

clearly a high value of r_{12} corresponds to a still higher value of r, the common specific representativeness of any constituent variable in the composite index.

Manufacturing activities do not cover, as mentioned already in section 3.1, all industrial activities of a district. In fact all districts of Nepal do not have manufacturing activities while we learn that from the population census data of 1971 districts without any manufacturing activities do have concentrations of individual labour. In the absence of output data, the industrial activity size can best be measured by these industrial labour data, atleast partially. Thus likewise the construction of M we shall first construct the composite index of industrial labour, M^*, given by

$$M^* = \frac{\sigma_2^* x_1^* + \sigma_1^* x_2^*}{\sigma_1^* + \sigma_2^*} \qquad \ldots \qquad (3.39)$$

where,

$$M_a^* = (x_1^*)^2$$

= absolute concentration index of industrial labour

$$M_r^* = (x_2^*)^2$$

= relative concentration index of industrial labour

and, σ_1^* and σ_2^* are the standard deviations of x_1^* and x_2^*.

As the index M^* is not based on output data, we have finally constructed the composite index of over-all industrial activity, I, by the same principle on examining the relationship between M and M^*. Thus we have

$$I = \frac{\sigma_{M*} M + \sigma_M M^*}{\sigma_{M*} + \sigma_M} \quad \ldots \quad (3.40)$$

clearly, in this construction, the level of over-all industrial activity is judged not only by the concentration of industrial labour but also by the manufacturing output level.

3.3 Statistical Estimations and Tests

According to the CBS survey of 1972-73 there are about 2434 registered manufacturing factories belonging to 22 groups of industries considered (see Table 3.10) which are distributed geographically in about 38 districts (see Table 3.9). The remaining 37 districts of Nepal are not having any manufacturing activities. As the districtwise breakdowns for different industries are not made available in any published or mimeographed reports, we have been able to examine the statistical fits for the regional aggregate manufacturing production function with the available districtwise data of 38 districts. First of all we have tried out statistical fitting of estimating equations (3.17) and (3.18) of Section 3.2 developed through the help of market conditions, with and without the localisation qualifying variable Q. In these attempts the value of multiple correlation coefficient (R^2) were very low (below 0.72) and the estimates of the CES parameters σ became negative which is inconsistent on economic grounds. The incompleteness of the wage data recorded must have something to do with this kind of inconsistency. It is also possible that the assumed market condition-restricted imperfect, including perfect (refer to equation 3.15b) - does not hold good in actuality.

Then we tried to fit the CES form through equation (3.19) of Section 3.2 and the CD form (same as the equation (3.19) of Section 3.2 with $\beta = 0$), with and without the localisation performance variable Q. To decide on the choice of the surrogate of capital services, we tried with the following three alternative variables:

$K' = E + D$ (in thousand rupees)

$\bar{K}$ = invested capital (in thousand rupees)

$\hat{K}'$ = fixed capital (in thousand rupees)

The estimates of the parameters and their standard errors (inside parenthesis) are presented in Table 3.1 and Table 3.2, without and with Q respectively. A comparison of these two tables reveals that the value of R^2 are lower in Table 3.1 than the corresponding values in Table 3.2, and these departures are more pronounced with the use of K and K' as the surrogate of capital services. Again the parameter associated with variable Q, namely $\lambda^*/$, is generally significant at 5% level of chance (marginal in case of the CES fit with K'). So, we draw the inference that the localisation performance

variable is a significant explanatory variable and as such it cannot be abandoned, particularly if $\widetilde{K}$ or $\widetilde{K}'$ is to be accepted as an alternative for the surrogate of capital services. But on examination of the estimates of the parameter α, we notice inconsistencies having negative values (or very low value in one case) if $\vec{K}$ or $\vec{K}'$ is used as the surrogate variable. These inconsistent values and also the corresponding lower values of R^2 in Table 3.2 prevent us from accepting either $\widehat{K}$ or $\widehat{K}'$ as a good surrogate of capital services. The remaining variable K' does not show any such inconsistencies and also the statistical fit is found to be best in this case. So we accept K' as the surrogate variable for the capital services. Again as the value of parameter $\lambda^*\chi$ is significant with the CD form also, we cannot abandon the variable Q along with K' in relation to the statistical fit. Now as we compare the CD and CES forms the value of R^2 is slightly lower with the CD form, but the β - value is not significantly different from zero, so we should abandon the quadratic term of the equation (3.19). The fact that both $\lambda^*\chi$ and α are relatively more significant in CD form than in CES form indicates that it is all the more appropriate to choose the CD form for our localisation analysis. Also the parameter β is never significant with any of our choices of the surrogate variable.
As alrendy observed, the estimate of the CES parameter is

Table 3.1 : Different statistical estimates for the regional aggregate manufacturing production functions without the localisation qualifying variable.

Surrogate of capital services	u	Functional form	R^2	$\ln \gamma$	λ'	α	β
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$K' = E + D$	1.71	CES	0.89337	5.0908 (0.33846)	0.83448 (0.05456	0.53251 (0.18091)	-0.11175 (0.06838
		CD	0.88501	5.0183 (0.3433)	0.84319 (0.05558)	0.77104 (0.10940)	-
$\hat{K}$ (invested capital)		CES	0.75412	4.8645 (0.5087)	0.85649 (0.08410)	-0.10722 (0.28598	-0.48055 (0.26265)
		CD	0.72990	4.8598 (0.5255)	0.82564 (0.08511)	0.23091 (0.22545)	-
$\breve{K}'$ (fixed capital)		CES	0.70235	4.8301 (0.5853)	0.81694 (0.09151)	0.17599 (0.21463)	0.06221 (0.12144)
		CD	0.70005	4.9195 (0.5528	0.81066 (0.08973	0.10680 (0.16503)	-

Table 3.2 : Different statistical estimates for the regional aggregate manufacturing production functions with the localisation qualifying variable.

Surrogate of capital services	u	Functional form	R^2	ln γ	λ	α	β	λ^*/λ
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$K' = E + D$	1.71	CES	0.90425	7.0182	0.82979	0.29281	-0.05364	0.30803
				(1.0475)	(0.05254)	(0.21359)	(0.07229)	(0.15910)
		CD	0.90264	7.2959	0.83251	0.34944	-	0.35694
				(0.9719)	(0.05207)	(0.19818)		(0.14380)
$\tilde{K}$ (invested capital)	16.76	CES	0.89818	8.5983	0.83455	-0.20550	-0.18687	0.56637
				(0.6395)	(0.05503)	(0.18735)	(0.17687)	(0.08289)
		CD	0.89475	8.7370	0.82246	-0.08547	-	0.58764
				(0.6269)	(0.05391)	(0.14923)		(0.08532)
$\tilde{K}'$ (fixed capital)	5.90	CES	0.89446	8.7220	0.82569	0.04557	0.06574	0.59463
				(0.6143)	(0.05532)	(0.13081)	(0.07340)	(0.07673)
		CD	0.89189	8.8136	0.81904	-0.02745	-	0.59420
				(0.6040)	(0.05467)	(0.10200)		(0.07650)

Table 3.3: Different statistical estimates for the national industrial activity functions.

Surrogate of capital services	u	Functional form	2	ln γ	λ'	α	β
(1)	(2)	(3)	()	(5)	(6)	(7)	(8)
K' = E + D	1.71	CES	0.8443	2.3093 (0.8125)	1.08754 (0.11725)	0.52690 (0.28301)	0.03531 (0.09950)
		CD	0.8542	2.2710 (0.7865)	1.09431 (0.11300)	0.43809 (0.12899)	-
K̂ (invested capital)	16.76	CES	0.81427	1.4163 (0.9078)	1.18466 (0.13355)	0.32960 (0.20935)	0.01307 (0.08035)
		CD	0.81339	1.4104 (0.8836)	1.18339 (0.12987)	0.35149 (0.15623)	-
K̂' (fixed capital	5.90	CES	0.8052	1.4642 (0.9382)	1.18301 (0.13734)	0.28242 (0.22336)	-0.06326 (0.12232)
		CD	0.78110	1.4153 (0.9152)	1.18138 (0.13463)	0.34653 (0.18217)	-

inconsistent even when we try to estimate it through the use of market condition as in equation (3.17) or, (3.18). Therefore we can conclude with conviction that the CD form is good enough for our purpose of localisation performance analysis. Thus for our subsequent analysis we shall refer only to the CD form with the surrogate variable K' and the localisation performance variable Q. This equation is given below in (3.41), we may also

$$\hat{Y} \doteq 1474.1739\,(K^{.73477}\,L^{.26523})^{.47598}\,Q^{.35693} \qquad \ldots \qquad (3.41)$$

$R = 0.95007$, $N = 38$

$\lambda^{*} = 1.75053$ (degree of localisation economy)

contrast this equation with the one without the variable Q given below in equation (3.42) in connection

$$\hat{Y} = 151.1525\,(K^{.91443}\,L^{.08557})^{.84319} \qquad \ldots \qquad (3.42)$$

$R = 0.94075$, $N = 38$

with the measure of technical efficiency. The degree of localisation economies is estimated to be about 1.75 from the equation (3.41) which is statistically quite significant at a level of chance much less than 5 per cent.

Next, as the variable Q is not relevant for the national industrial activity function, we construct only Table 3.3

for the activity function analogous to Table 3.1. Here also the best statistical fits are obtained with the choice of K' as the surrogate variable for capital services. Table 3.3 also reveals that the β - parameters are not significant in all the cases. The value of R^2 for the CD fit may be slightly lower than its CES fit with the use of K', but the α parameter is more significant for the CD fit. As such we choose the CD fit with K' as the surrogate variable for our subsequent analysis. This equation is given below in eqn. (3.43):

$$\hat{Y} = 9.6891\,(K^{.40033}\,L^{.59967})^{1.09431} \qquad \ldots \qquad (3.43)$$

$$R = 0.92381 \quad , \quad N = 22$$

Next, we proceed to construct the regional indices of technical efficiency. As the value of λ^* is much below unity, we shall prefer to use the system (S, S^*, T^* and S') rather than the system (P, P^*, Q^* and P') as defined in the sub-section 3.2.4. To prove that S' is similar to S^* and both are widely different from S, we shall first examine the correlation matrix of ln S, ln S^* and ln S' given below in Table 3.4 which will be the same as

Table 3.4: Correlation Matrix of ln S, ln S^*, and ln S'.

ln S	ln S^*	ln S'
1.00000	.57961	.62709
.57961	1.00000	.91100
.62709	.91100	1.00000

that of ln P, ln P^* and ln P'. Denoting the Fisher's Z - statistic, $Z = \frac{1}{2} \ln \left(\frac{1+r}{1-r}\right)$, by Z, Z' and Z^* respectively for

$$r = r_{\ln S', \ln S^*},\ r_{\ln S, \ln S'},\ r_{\ln S, \ln S^*}$$

we get the following t-statistic for pairwise comparisons of correlation coefficients, i.e.,

$$t\ (Z', Z^*) = 0.44,\ t\ (Z, Z') = 5.15,\ t\ (Z, Z^*) = 4.71$$

Since $r_{\ln S', \ln S*}$ is significantly well above both the $r_{\ln S, \ln S'}$ and $r_{\ln S, \ln S*}$, and also $r_{\ln S, \ln S'}$ is not significantly different from $r_{\ln S, \ln S*}$ our inference that S' is similar to S^* and both are much away from S becomes statistically valid.

The equations (3.41) and (3.42) show very good statistical fits in terms of R and the related over-all homogeneity parameters λ and λ' are not significantly different (the corresponding t-statistic is 0.205 only). But the parameter $\lambda^*/$ is significantly different from zero (the corresponding t-statistic is 2.482) which implies that the role of the localisation performance variable Q should be explicitly considered. That means the strong relation between ln S^* and ln S' is to be expected under the above noted conditions consideration also; and if the role of Q exists, one simply measures by S' only that what S^* is supposed to measure.

So at the incidence of the localisation performance factor $T^* = Q^{\ell\lambda^*}$, the Farrel's measure S' cannot be the over-all technical efficiency index. As the measure S^* could rightly be called the internal technology factor of efficiency, the measure S' should better be termed similarly. Here comes the importance of the over-all measure of technical efficiency S as developed by Pal and Saha.

It is to be noted that the measures S, S^* and T^* are related through the linear relation (3.33) of Section 3.2. To find the relative importance between ln S^* and ln T^* in explaining the regional variation of ln S, we shall consider, next, the correlation matrix of these logarithmic variables in Table 3.5 below. If we now fit the Kendal's [1939] central

Table 3.5 : Correlation Matrix of ln S, ln S^* and ln T^*.

ln S	ln S^*	ln T^*
1.00000	.57961	.83176
.57961	1.00000	.02971
.83176	.02971	1.00000

axis which is the line of closest fit through the scatter of points (district observations) in the three dimensional space of (ln S, ln S^*, ln T^*). Then the correlation coefficients of this central axis respectively with ln S, ln S^* and ln T^*

can be estimated to be as follows:

$$r_S = 0.99995, \quad r_{S*} = 0.58774 \quad \text{and} \quad r_{T*} = 0.82615.$$

As the ln S is practically coincident with the central axis (which is expected because of the stated linear dependence), we can measure the relative importance of the factors S^* and T^* by the relative share of r^2_{S*} and r^2_{T*} in explaining the regional variation of ln S. That is, we have

$$\frac{r^2_{S*}}{r^2_{S*} + r^2_{T*}} = .33604 \quad \text{and} \quad \frac{r^2_{T*}}{r^2_{S*} + r^2_{T*}} = .66396$$

So, we can conclude that in Nepal the importance of the localisation performance factor is twice that of the internal technology factor in explaining the regional variation in the over-all technical efficiency for the aggregate of manufacturing activities. The analysis with the indices S and T^* will follow in the next section.

It should be noted here that these types of regional indices cannot be constructed for the national industrial activity function, but one can however compute indices like S' and $\emptyset$ for such function. The values of regional indices S and T^* are presented in Appendix Table (▮) but the classified values of activity indices S' and $\emptyset$ are recorded in Table 3.6.

Finally, the regional indices of manufacturing and over-all industrial activities, M and I, are constructed according to the formula given in equation (3.37) and (3.40) of Section 3.2. The empirical treatment of the regional index of industrial labour M^* was however subject to change for its regression with M needed in the construction of I. While M could be constructed over 38 districts observations, including the districts of the capital region, the corresponding values of M^* could not be meaningfully associated for one of the three districts of the capital region separately. The regression between M and M^* was thus computed for 36 observations treating the capital region as one of them. The output data used in the construction of M were collected at the factory site, while the labour data collected in the population census and used here in the construction of M^* were recorded at residences and not at working places. As the hinterland relationship is highly pronounced in the capital region, outstandingly in the national context, the intensity of activities at the work place could hardly be assessed in M^* for separate districts of the capital region. So anomalies could be noticed in these three districts on a graph between M and M^*. So the best course open to us was to treat the capital region as a single observation and compute the regression between M and M^* over 36 observations towards the construction of the composite index I from M and M^*. This regression was also used to correct the values of M^*, comparable with those of M, for the three separate districts of the capital region. Noting the actual values of M for these three districts and the departure in the value of M for the capital region from the fitted regression line between M and M^*, we made the regression estimates of M^* allowing a similar kind of departure from the regression line. These corrected estimates of M^* for the three districts will be used subsequently. Thus the empirical contents of the construction of these regional indices are as given below:

$$M = 0.34908\sqrt{M_a} + 0.65092\sqrt{M_r} \quad \ldots \quad (3.44)$$

$$r = 0.96021, \quad N = 38.$$

$$M^* = 0.27833\sqrt{M_a^*} + 0.72167\sqrt{M_r^*} \quad \ldots \quad (3.45)$$

$$r = 0.95849, \quad N = 75.$$

$$I = 0.42159M + 0.57841M^* \quad \ldots \quad (3.46)$$

$$r = 0.91323, \quad N = 36.$$

The same equation (3.46), combining M and M^* was however used to compute I for all 75 districts. In this, the corrected values of M^* were however used for the three districts of the capital region, and the value of M for any of the remaining 37 districts without any manufacturing activities was taken reasonably to be zero. We have thus checked in the following two regressions (3.47) and (3.48) that the equality criterion of the index with its constituent variables used in the equation (3.46) has not practically changed when considered over all 75 observations instead of 36.

$$M = -0.37917 + 1.23140\, I \qquad \ldots \qquad (3.47)$$

$$r_{MI} = 0.92342\ , \quad N = 75$$

$$M^{*} = 0.34906 + 0.70604\, I \qquad \ldots \qquad (3.48)$$

$$r_{M^{*}I} = 0.91372\ , \quad N = 75$$

The computed values of M are recorded in Appendix Table (9) whereas that of I are recorded in Appendix Table (10) along with other indices.

3.4 Regional Analysis of Industrialisation

As we are not in a position to examine for the regional analysis of different manufacturing activities because of the limitation of the data, we have to be content with such an analysis for the aggregate of all manufacturing activities. But before doing that we shall however examine the nature of the national activity function over the given 22 manufacturing industries, the names of which are detailed in Table 3.6. The statistical fit for this activity function is given in equation (3.43) of Section 3.3. This function tends to show an increasing return to scale ($\lambda' = 1.09431$), with the capital and labour coefficients of 0.4 and 0.6 respectively. The statistical fit is also sufficiently dependable (with the correlation coefficient R = 0.904) here. For the increasing return to scale, one could expect that the core activities (with relatively high output levels) are flourishing. To indentify the core activities, we examined the percentage value share of total national manufacturing output as generated in 1972-73 and the industries are ranked on the basis of these percentages. Both the percentages and the increasing output ranks are shown against the names of industries in Table 3.6. These values show that the cereals and oil processing industry is by far the most important industry in Nepal accounting for about 75 per cent of total national output. Now if the national activity function is fitted without this core industry of cereals and oil processing (over the remaining 21 industrial activities) we obtain the following relation (3.49) given below:

$$\hat{Y} = 15.4777\,(K^{.40727}\,L^{.59273})^{1.00160} \quad .. \qquad (3.49)$$

$$R = 0.89711,\ N = 21$$

In this relation, the return to scale parameter reduces to unity and this clearly shows that the tendency to obtain the increasing return to scale (see equation 3.43 of Section 3.3) could be mainly attributed to the core industry of cereals

Table 3.6: Classification of manufacturing industries by capital-labour intensity (ϕ) and by technical efficiency index (S').

Classification of technical efficiency (S') index	low labour intensity ($\phi > 1.0$)	moderate labour intensity ($1 \leq \phi \leq 0.5$)	high labour intensity ($\phi < 0.5$)
$S' > 1.75$ High efficiency	22. Cereals & oil processing (74.95%)	13. Bakering (1.02%) 6. Soap manufactures (0.18%) 12. Manufacture of Metallic products (0.64%)	17. Printing (1.56%) 5. Jeweller & curio manufacturing (0.16%)
$1 \leq S \leq 1.75$ Moderate efficiency	21. Mise engineering industry (7.01%) 11. Metallic vessel manufacture (0.58%) 14. Saw milling (1.09%)	-- -- --	16. Biri making (1.55%) 15. Processing of Wood product (1.20%)
$S' < 1$ Low efficiency	8. Footwear manufacture (0.25%) 2. Ice cream manufacture (0.03%) 18. Sugar refining (2.29%)	20. Jute processing (3.57%) 19. Brick & Tile manufacture (2.69)%)	10. Yarn & Textile (0.41%) 1. Cap making (0.02%) 7. Carpet making (0.20%) 9. Match manufacture (0.39%) 3. Repair works (0.06%) 4. Tea-chest manufacturing works (..15%)

N.B. - Figures within parenthesis indicate the percentage value share of total national manufacturing output in 1972-73. Increasing output ranks on the basis of the percentages are shown against the names of industries.

and oil processing. In both the equations, we have almost similar values for the capital and labour coefficients. The value of the labour coefficient is however higher than that of the capital coefficient (0.6 against 0.4). Since we have $\lambda' = \lambda'\delta + \lambda'(1 - \delta)$, we can conclude that the percentage growth in output is contributed more by the unit percentage change in labour than that in capital services indifferent industries. But if we examine the increasing output ranks denoted by ψ as referred to in Table 3.6 in relation to the capital-labour intensity index ϕ and the technology efficiency index S', we get the following relation (3.50) which tells that industries with higher outputs have higher values of ϕ and S'.

$$= 3.15085 + 3.01096\,S' + 6.04581\,\phi \quad \ldots \qquad (3.50)$$
$$\quad (2.66034) \quad (1.29548) \quad (1.53033)$$

$$R = 0.71374, \quad N = 22$$

$$r_{\psi\phi} = .61343, \quad r_{\psi S'} = .35323, \quad r_{\phi S'} = -.01887$$

In this relation, the regression coefficients of both S' and ϕ are significantly positive, though ϕ is more significant. But the regression coefficient of S' no longer remains significant if the core-industry of the cereals and oil processing is excluded from the statistical fit as shown below in relation (3.51). The contrast of equations (3.50)

$$\psi^{*} = 4.74303 + 1.88447\,S' + 5.82361\,\phi \quad \ldots \quad (3.51)$$
$$(2.48915 \quad (1.33846) \quad (1.36905)$$

$$R = 0.72086, \quad N = 21$$

$$r_{\psi\phi} = 0.68502, \quad r_{\psi S'} = 0.24444, \quad r_{\phi S'} = 0.02931$$

and (3.51) again shows that the significance of S' in explaining the increasing output ranks is only achieved with the incorporation of the core-industry of cereals and oil processing. Both the equations however tell one thing in common that higher capital-intensity has generally been concomitant with the industries having higher output levels, even though the percentage labour change has been a greater contributor to the percentage output change compared with the percentage capital services change. In other words, core industries have been more capital intensive even though labour happens to be an important explanatory variable for output variations over different industries. The details of the classification of industries by both ϕ and S' have been shown in Table 3.6. From this classification the cereals and oil processing industry is the only industry in the top class in respect of both S' and ϕ. That is, it is the most efficient capital intensive industry in Nepal.

As the cereals and oil processing industry is predominant, the regional aggregate production function that we propose for analysis of district level variations can obviously be taken to reflect predominantly the character of this core industry - see also Figure (3.1). In this figure, proportionate circles represent the total number of factories in a district and the three broad categories of industries, as given below, are represented by the sectors inside the circle:

Categories of industries (with percentage share of total national output)	Industries having output ranks numbered as in Table 3.6
Cereals and oil processing (74.95%)	22
Construction and Engineering Products (wood; bricks; metal) (13.58%)	15, 14, 4; 19; 21, 12, 11, 5, 3
Others (11.47%)	20, 18, 17, 16, 13, 10, 9, 8, 7, 6, 2, 1

The equation (3.41) of Section 3.3 gives the regional aggregate manufacturing production function. In this regional function the roles of capital services and labour are interchanged as compared to those in the national activity function. Regionally the capital services become the explanatory variable more important for output than is labour (.735 against .265). Thus the percentage increase in capital services (measured by the fuels and energy use together with the depreciation on fixed capital) between districts have contributed substantially towards the percentage change in output levels; labour has a relatively much inferior role. Here the capital services are treated as an internal technology factor; an equally important role is played by the location factor of energy use Q in explaining the variation in the output level (note that $\lambda^* \gamma = .357$ while $\lambda^* \delta = .349$). This location factor is proportional to the density of energy-use per unit of geographical area and thus the energy-use is made free from the size of the industrial concentration in the geographical area. As such it gives a locational character for industrialisation and not an internal technology character. Thus we notice that percentage increase in this locational character Q between districts has also explained substantially the percentage increase in the output level. But the over-all homogeneity parameter λ has a value less than unity ($\lambda = .833$) indicating that most industrially advanced districts should now deserve less attention. In fact, less-developed industrial districts should be given more encouragement by providing infrastructural facilities and capital facilities in order to derive gains in future through the scale effect.

In the foregoing regional aggregate production function analysis the aggregate outputs by districts were considered without examining its relationship to local people or the geographical coverage of area in which the production occurred. The relative and absolute location factors of output take care of these aspects and we have already combined them statistically in previous section to arrive at the regional manufacturing activity index M and regional industrial activity index I. These two indices do really help us in ranking the districts in terms of these two activities. In addition to these we have two other indices of regional importance namely the over-all technical efficiency index S and its component index T^* (localisation performance factor efficiency). The correlation matrix of these indices in Table 3.7 below shows very high interrelationships between pairs of such regional indices (correlation

Table 3.7: Correlation matrix of regional indices on manufacturing and industrial activities.

I	M	T^*	S
1.00000	0.89601	0.87679	0.72329
0.89601	1.00000	0.91526	0.88534
0.87569	0.91526	1.00000	0.69663
0.72329	0.88534	0.69663	1.00000

coefficients computed over 38 districts having manufacturing activities). Clearly the localisation performance factor of efficiency T^* is very high for districts with very high rank in both manufacturing (M) and Industrial (I) activities. As

T^* is a component of the over-all efficiency S, its high relationship to M is also expected. We have already evaluated the importance T^* in explaining the variation in S as about double that of the internal technology factor of efficiency S^*. In fact, S^* and also S' (computed from the production function without the incorporation of G in it) are practically unrelated to I, M and T^*. Thus we can conclude with conviction that it is the localisation performance factor T^* that plays very important role in the localisation of manufacturing or industrial activities in different districts. Thus the supply of fuel and energy for use in manufacturing activities in different districts appears to be an important determinant for industrial expansion in Nepal. We have recorded these values of these regional indices I, M, T^* and S for 38 districts, where there were some manufacturing activities in 1972-73, in Appendix Table (11) and the industrial index I for the remaining 37 districts, without having any manufacturing activity, in Appn. Table (12). In both these tables districts are arranged in descending order of values of I with their class symbols following the classification scheme as given below:

Class symbols		Value range of indices
vh (very high)	:	1.6 and more
h (high)	:	1.2 to less than 1.6
m (medium)	:	0.8 to less than 1.2
l (low)	:	0.4 to less than 0.8
vl (very low)	:	less than 0.4

In this classification scheme the critical value of unity that stands for the national level in Nepal is in the medium class and all other classes are compared relatively from the national level. This relative comparison should be kept in mind for regional analysis. Since Nepal itself cannot be considered an industrialised nation, the districts with relatively very high or high levels of industrialisation may not be internationally compared with the industrialised regions of advanced countries. As there are strong inter-relations among these indices, the regional patterns are expected to be very similar for different indices and so we mapped the classified values of I only by choropleth technique of mapping (refer to fig. 3.2) to depict the regional pattern of industrialisation. Certain minor departures that exist in the patterns of other indices can easily be observed from the values and class-symbols shown in Appendix Table 11. In figure 3.2 one can clearly identify distinct regional

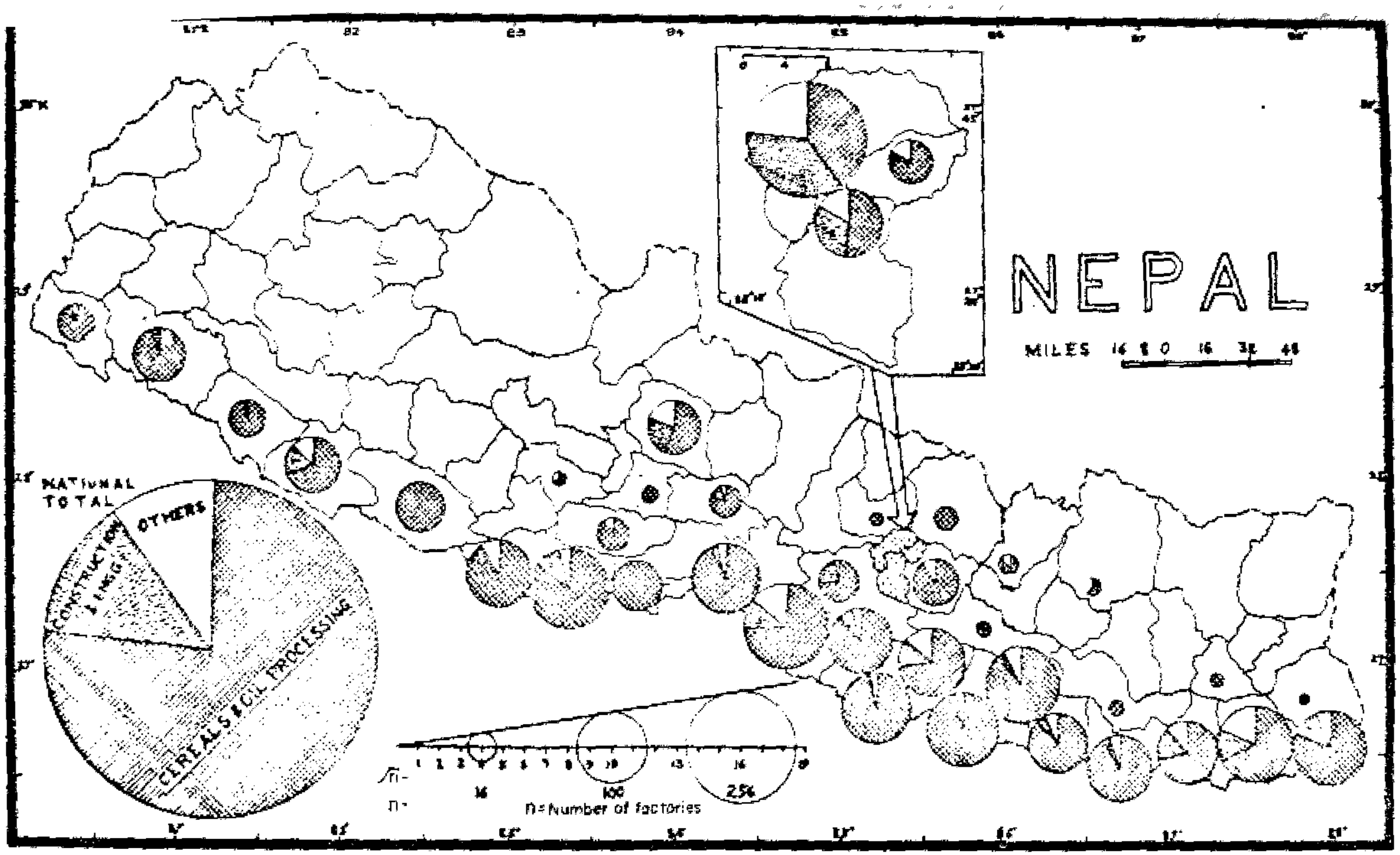


FIG-3·1: BROAD TYPES OF FACTORIES 1972-73

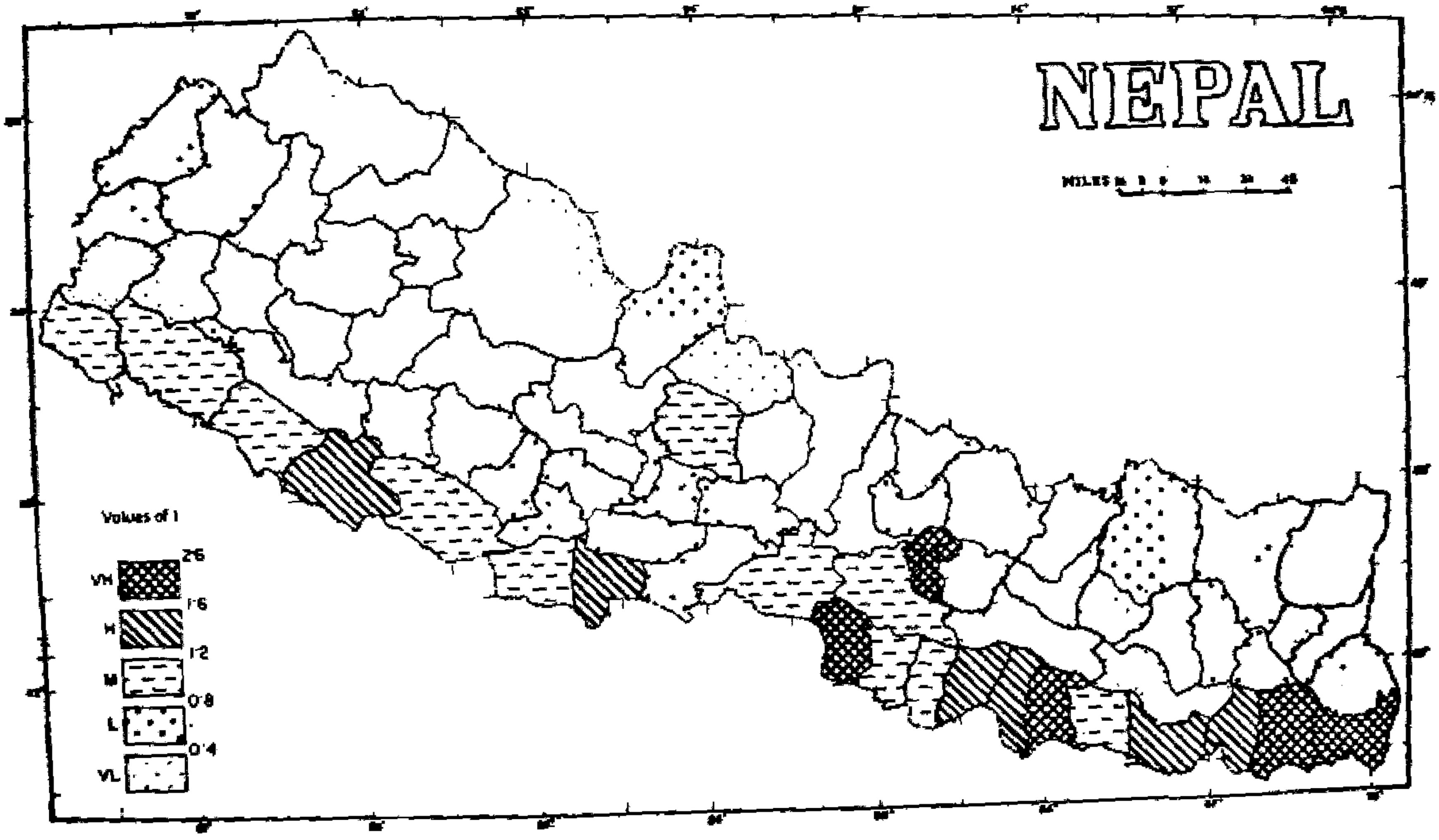


FIG-3·2 : INDEX OF OVERALL INDUSTRIAL ACTIVITIES (I) groupings of relatively industrialised districts, with very high, high and medium values, extending along the southern border districts in the Tarai. The industrialised capital region is also connected southward with this Tarai belt through districts with medium values. Except for the districts of the capital region and Kaski, with medium values, all other districts in the Hill and Mountain regions could be ranked almost as unindustrialised districts having low or very low values of I. The industrialised districts of the southern belt could also be approximately divided into two parts - the eastern and western Tarai belts. The extension of capital region districts are connected rather with the eastern Tarai belt. In fact, the eastern Tarai belt together with the capital region is the only industrialised region and all the seven relatively very highly industrialised districts are situated there. Besides, out of the six highly industrialised districts, four are also in the eastern Tarai belt, whereas only two, namely Rupandehi and Banke are in the western Tarai belt. The remaining five districts of the western Tarai belt have only medium values in I. That the western Nepal is more industrially backward than its eastern counterpart is clearly brought out by the incidence of predominant concentration of very low values of I in it. The regional distribution of I has also a strong bearing on the distribution of the localisation performance factor of efficiency T^* and the over-all efficiency factor S Thus from Appn. Table (11) very highly industrialised districts of eastern Nepal have very high or high values of T^* and S. In highly industrialised districts, one of T^* or S is high or very high, while the other does not fall below medium value. Most of the large factories, each employing more than fifty workers, are concentrated mainly in highly and very highly industrialised districts. Out of the total of 2434 factories in Nepal, only 147 factories (about 6%.) were large but they employed about 69%. of all manufacturing workers of the country. And of these large factories, moreover, about 122 factories are in highly and very highly industrialised districts where the distribution of T^* and S are also favourable. Again the medium industrialised districts have mostly low T^* values in Western Nepal including the hill district of Kaski, whereas the medium industrialisation districts in the eastern part are having mostly medium T^* values (even at times high values as in the districts of Rautahat and Siraha where manufacturing activities also are at high level). Clearly the distribution of fuel and energy has differentiated between more advanced and less advanced areas in industrialisation. Had the distribution of this infrastructure been favourable in the Western Nepal, perhaps its Tarai belt could have been as industrialised as is its counterpart in the Eastern Nepal.

Regarding the present (1972-73) concentration of industrialised districts mainly in the southern fringe of Nepal, the predominance of agro-based manufacturing activities becomes the explanatory factor. We have already noted in figure (3.1), the overwhelming share of the cereals and oil processing industry in all the Tarai districts. Only in the mountaineous districts of Solokhumbu and Dolakha, and the hilly districts of capital region, non-agro-based industry gain relatively more importance (the agro-based industries are however importantly present in the districts of the capital region), industry alone covers about 75% of the national output and if other agro-based industries like Jute, tobacco, sugar and bakery considered, then the corresponding share would increase to 83.4 percent. Naturally the distribution of agricultural resources and productivity has something to do with the present regional pattern of industrialisation which is largly agro-based in nature. In fact the 38 districts having manufacturing activities have accounted for 82 percent of the total national value of agricultural production, conversely only 18% of the total national value of agricultural production come from the remaining 37 districts having no manufacturing activities. Again the two industrial belts, as mentioned earlier, are also spread over 24 districts only having very high, high and medium values in I. These so called industrialised districts account for 97 per cent of the total national value of manufacturing output and 68 per cent of the total agricultural production. Thus a third of total agricultural production has been concentrated in 51 districts with very lettle or, no manufacturing activities. As we have already noticed in Chapter 2 that the ruggedness of the terrain is negatively related with the agricultural labour productivity. The concentration of the relatively industrialised districts mainly in the lessrugged Tarai area also explains the same kind of phenomenon. But the reason for the negative association of ruggedness with industrialisation is to be sought directly in the agro-based character of the manufacturing activities. The agricultural labour productivity is, in fact, related positively with both M and I, the regression equations of which are given below in equations (3.52) and (3.53):

$$\ln M = -0.37518 + 1.03737 \ln \zeta \quad \ldots \quad (3.52)$$

$$r = 0.787, \quad N = 38$$

$$\ln I = -0.29614 + 0.65147 \ln \zeta \quad \ldots \quad (3.53)$$

$$r = 0.718, \quad N = 75$$

where ζ stands for the index of agricultural labour productivity as defined in Chapter 2. Clearly, when the agricultural labour productivity is high, one can expect adequate agricultural surplus after home-consumption for manufacturing purposes. As such, the high relationship between M and ζ is expected because of the agro-based nature of the present (1972-73) manufacturing activities. The relationships between and M, and ζ and I would have improved further if the western industrial belt had obtained growth of agro-based industries similar to that in eastern industrial belt. The existence of non-agro-based activities in the capital region districts has also helped in reducing this relationship. The relatively neglected position of the western industrialised districts even in agro-based manufacturing activities, can be seen from the ratio estimates recorded in the last column of Table 3.8 given below. The 14 less-industrialised districts with manufacturing activities have shown, as expected, a lower ratio of the manufacturing output share to the share of agricultural production because these districts do not have adequate agricultural surplus for agro-based manufacturing. These districts mostly lie in hilly and mountainous regions. The two mountain districts of this group, namely Solokhumbu and Dolakha, do not have any cereal and oil processing activities, and the main manufacturing activities are carpet making and wool products accompanied by some other non-agro-based industries. But the cereals and oil processing industry is still predominant in the remaining 12 districts of this less-industrialised area.

Table 3.8: Comparison of manufacturing output in relation to agricultural production by industrial regions.

Coverage of districts in industrial regions	per capita share of national total: manufacturing output	per capita share of national total: value of agril production	ratio of col.(2) to col.(3)
(1)	(2)	(3)	(4)
38 manufacturing districts	100.0	82.0	1.22
24 industrialised districts (with vh, h and m values)	97.0	68.0	1.43
16 eastern industrialised districts	81.4	49.0	1.66
8 western industrialised districts	15.6	19.0	0.82
14 less industrialised districts having manufacturing activities (with l and vl values)	3.0	14.0	0.21
All 75 districts of Nepal	100.0	100.0	1.00

Though the cereals and oil processing is the most important industry in the group of 24 industrialised districts, it is worthwhile to analyse the nature of industrialisation in respect of other industries in these districts. After a preliminary analysis of the data on the districtwise concentration of different factories and their raw material resource base, we have classified these districts into 8 industrial areas as defined in Table 3.9. The specific industrial characters for these industrial areas have also been summarised in this table. The actual distribution of all factories other than cereals and oil processing has, however, been given in Table 3.10 for these industrial areas. This table reveals that the multifunctional nature of manufacturing activities exists only in the Morang and Kathmandu area. The Kathmandu area is however less-agro-based in nature, whereas the jute industry is present only in the Morang area. To the west of the Morang area we have the core-tobacco area of Dhanusha in the Eastern Tarai, while the core sugar area of Rupandehi lies in the Western Tarai. Between these two core areas and to the south of the Kathmandu area is the transitional Tabacco-sugar area of Parsa where other manufacturing activities like engineering and industries, brick-making industries, etc. are present, as they are in the Kathmandu area. The Banke area in the far Western of the Tarai has some wood, tobacco and metal product factories, while the Kailali area in the same region has practically nothing worthy of the name. The only industrialised district in the hilly area of Western Nepal is Kaski, where there are some carpet making, bakery and metal product factories. From the various data mentioned in Table 3.9, the Morang area appears to be the most industrialised area while the Kathmandu area is most multifunctional in nature.

Lastly, we shall analyse the growth of manufacturing industrialisation in various districts of Nepal over the period of two decades prior to the reference year 1972-73. We have estimated the growth pattern of factories from the given data on the year of establishment recorded in the CBS survey report, 1972-73. The limitation of this method of estimation is that it possibly does not include the few factories which existed previously but are not in operation at present; however such omissions seem negligible. On the basis of the above mentioned estimation we have depicted these estimated factories, for the years 1952-53, 1962-63, 1967-68 and 1972-73, in figure (3.3), in proportionate circles for each manufacturing district. From this figure it is clear that the industrialisation is a recent phenomenon in Nepal. These were only 86 factories in 1952-53. This figure rose to 722 in 1962-63, 995 factories in 1967-68 and it increased

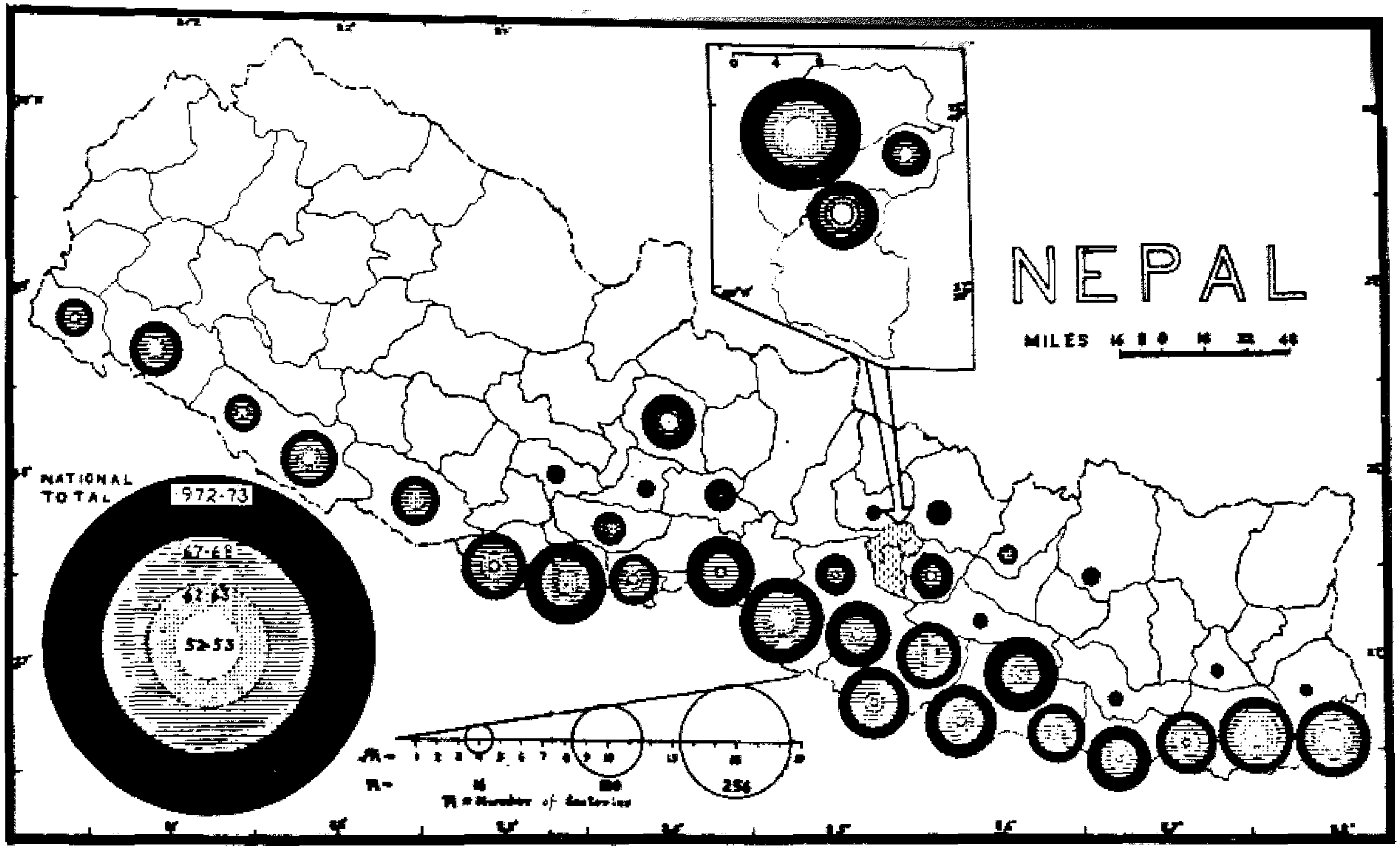


FIG-33 GROWTH OF FACTORIES 1952-53 TO 1972-73

Table 3.9: Classification of Industrial Areas Based on the Nature of Industrialisation, 1972-73.

Industrialised areas	District coverages	Percentage share of national mfg. output	No. of factories	No. of factory workers	Percentage of Large factories	Percentage of Factory workers	Percentage of Cereals & oil process industries
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Morang area	1. Morang 2. Jhapa 3. Sunsari 4. Saptari	31.2	417	14,450	13.43	78.65	77.22
2. Dhanusha area	1. Dhanusha 2. Mahottari 3. Bara 4. Siraha	18.4	406	11,893	4.43	78.23	87.68
3. Parsha area	1. Parsa 2. Chitawan 3. Bara 4. Rautahat	18.3	449	6,095	4.90	66.61	86.19
4. Kathmandu area	1. Kathmandu 2. Lalitpur 3. Bhaktapur 4. Makawanpur	13.5	475	7,365	4.84	52.74	47.16
Eastern industrialised region	16 districts	81.4	1,747	39,803	6.81	71.89	73.78
5. Rupandehi area	1. Rupandehi 2. Kapilvastu	6.6	222	3,502	5.86	66.25	84.23
6. Banke area	1. Banke 2. Bardia 3. Dang-deukhuri	4.9	142	1,897	6.34	65.42	84.51
7. Kailali area	1. Kailali 2. Kanchanpur	3.0	84	650	-	-	91.67
8. Kaski area	1. Kaski	1.1	60	677	5.00	63.18	55.00
Western industrialised region	8 districts	15.6	508	6,726	4.92	58.30	82.09
Total of industrialised districts	24 districts	97.0	2,255	46,529	6.39	69.92	75.65
Nepal	38 districts	100.00	2,434	47,706	6.04	68.87	76.42

Table 3.10: Distribution of different manufacturing factories other than cereals and oil processing by Industrial areas, 1972-73.

Unit: Number

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1. Morang area	4	12	4	17	1	5	-	-	7	4	1
2. Dhanusha area	-	3	7	7	-	-	2	-	-	-	1
3. Parsa area	-	2	4	11	-	1	4	-	6	4	2
4. Kathmandu area	1	6	49	23	13	3	12	7	40	7	-
Eastern industrialised districts (16 districts)	5	23	64	58	14	9	18	7	53	15	4
5. Rupandehi area	-	1	4	14	-	-	2	-	-	2	4
6. Banka area	-	6	-	1	-	4	-	-	2	-	-
7. Kanchanpur area	-	-	2	3	-	-	-	-	1	-	-
8. Kaski area	-	1	4	-	-	6	3	-	1	7	-
Western industrialised districts (8 districts)	-	8	10	18	-	10	5	-	4	9	4
Total of industrialised areas (24 dists.)	5	31	74	76	14	19	23	7	57	24	8
Nepal (38 manufacturing districts)	6	31	75	80	15	19	23	7	64	25	8

Note:

(1) Industrialised area
(2) Teachest mfg.
(3) Wood Saw products
(4) Wood products
(5) Bricks and Tiles
(6) Metal products
(7) Metal vessels
(8) Repair works
(9) Jewelleries and Curios
(10) Misc. Engg. industry
(11) Bakeries
(12) Sugar refineries

Contd.....

Contd..... Table No.3.10

Unit: Number

(1)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
1. Morang area	9	4	4	1	-	-	12	5	3	2	95
2. Dhanusha area	26	2	-	-	-	-	1	1	-	-	50
3. Parsa area	10	3	-	1	-	-	11	2	1	-	62
4. Kathmandu area	1	1	-	24	4	5	50	3	-	2	251
Eastern industrialised districts (16 districts)	46	10	4	26	4	5	74	11	4	4	458
5. Rupandehi area	5	-	-	-	-	-	2	-	1	-	35
6. Banka area	6	-	-	-	-	-	3	-	-	-	22
7. Kanchanpur area	1	-	-	-	-	-	-	-	-	-	7
8. Kaski area	-	-	-	-	-	4	-	-	-	1	27
Western industrialised districts (8 districts)	12	-	-	-	-	4	5	-	1	1	91
Total of industrialised areas (24 dists.)	58	10	4	26	4	9	79	11	5	5	549
Nepal (38 manufacturing districts)	58	10	4	32	5	11	80	11	5	5	574

Note:

(1) Industrialised area

(13) Tobacco industry

(14) Ice & Ice-cream mfg.

(15) Jute mfg.

(16) Yarn & Textile mills

(17) Cap making

(18) Carpet making

(19) Printing Press

(20) Soap mfg.

(21) Matches mfg.

(22) Footwear mfg.

(23) Total

:bcc:
28982

to 2434 factories in the reference year of 1972-73. Obviously, the industrial base was very poor even a decade ago compared to 1972-73. The spectacular growth of factories that took place during the period 1967-68 and 1972-73 is quite encouraging. The industrialisation has taken place at a more rapid pace in the Eastern Tarai, particularly in the corridor from the Kathmandu valley to the Indian border. In addition to those a few pockets on the eastern side, in western side the district of Rupandehi in the Western Tarai and a few less industrialised hill districts have recorded fast recent growth of factories. So from the present analysis we can conclude that Western Nepal has remained neglected in the recent industrialisation and that the industrialisation must remain agro-based unless efforts are made to diversify the industrial activities and extend them to the less industrialised areas by tapping local resources like forestry minarals and other physical resources; such efforts are lacking at present. As we have already noticed the importance of fuel and energy use in the localisation of industries, one should explore the possibility of developing indigenous sources of fuel and energy particularly hydro-electricity.

CHAPTER IV

THE SPATIAL ANALYSIS OF SUBSIDIARY ACTIVITIES AND FACILITIES

4.1 Introduction

The preponderance of agricultural activities and the meagre industrial base as analysed in the preceding two chapters suggest that other existing economic activities must be in their infancies in Nepal. Yet, in this chapter, we aim at making spatial analysis of certain subsidiary activities like (i) tertiary activities (ii) urbanisation and certain facilities like (iii) transportation infra-structure, (iv) educational level and (v) the levels of ther miscellaneous resources, mainly to examine the nature of nteractions and association of the various economic activities or activity-bases and the facilities or conditions under which the ctivities are performed or accomplished.

The low level of development of the subsidiary activities can be seen from the following facts. In 1971, the total number of persons engaged in total tertiary activities including commercial, financial, business and service activities were about 4.4 per cent of the total economically active population. Again we have already reported that there were only 16 urban centres at that time which together inhabited 461938 persons only. The total urban population accounted for merely a meagre 4 per cent of the total population of Nepal. However we believe that all district head-quarters, 75 in number, accomplish certain administrative and allied functional activities that fall into the category of central place functional activities present in urban centres. As such we shall include these administrative centres as urban centres if they are not already ranked in those 16 urban centres identified in the 1971 census. Thus, accounting in this way, we have 78 urban centres (strictly urban and administrative centres) accommodating a total of 870339 persons which account for about 7.5 per cent of total population of Nepal. Even this inflated figure certainly reflects the lop-sided nature of the non-rural or the non-agricultural activity-base in Nepal. The situation in educational background and transportation infrastructure is equally bleak. In 1975, approximately 20 per cent of the total population was literates [Ministry of Education, 1976]. Similarly in transportation side, the total lengths of the road in 1979 was around 4500 km., out of which the metalled road constituted a length of less than 2000 km in aggregate.

Regarding the miscellaneous resources our attempts have been to examine the forest, water and mineral resources and labour potentials. Unfortunately we are severely handicapped by the nonavailability of data in these attempts. Naturally we would not be able to do much of quantitative analyses and we shall have to remain content with some national estimates. However we shall put forward our idea regarding the framework of analysis that might be useful for the further analysis. In spite of having very scanty and limited information we shall try our best to derive some sensible conclusions out of it, particularly in respect of labour potentials that must be taken into consideration in any planning framework in future.

4.2 Empirical estimations of regional indices

The empirical estimations of the indices for total tertiary activities, urbanisation, transportation infrastructure and literacy level are provided in this section. In the construction of these indices we have followed more or less Pal's method [1963a] of combining absolute and relative location factors in suitably transformed forms. Here the combining weights are adjusted in such a way that the critical values (namely unity) of constituent location factors corresponded to the same critical value of unity for the combined index. This combined index, as in Pal's method [1963a], is equally related to the transformed constituent variables. The index of transportation infrastructure is however constructed in a different method which will be discussed in due course.

4.2.1 Tertiary activity index: I_t

The only spatial data that are available to measure the levels of tertiary activities by districts are the economically active population engaged in tertiary activities as compiled in the 1971 census. The relative location factor x_1 in relation to the total economically active population and also the absolute location factor x_2 (over the geographical area) have been constructed by the use of the tertiary population figures. As the absolute location factor is more skewed with a longer right hand tail compared with the distribution of the relative location factor, it has been necessary to transform x_2 to yield a comparable distribution of the transformed x_2 and the original x_1, resulting into improved linear correlation between them. The transformation of square - rooting the absolute location factor has generally yielded a high enough linear correlation with the original relative location factor for not only the present construction, but also for the two subsequent constructions of indices. The empirical estimate of the tertiary index I_t is thus given in equation (4.1):

$$I_t = 0.48008 x_1 + 0.51992 \sqrt{x_2} \; ; \; \rho = 0.981 \quad \ldots \quad (4.1)$$

4.2.2 Urbanisation index: I_u

We have already mentioned why we have included administrative centres as urban centres together with those already recognised in the 1971 census. Our urban population is thus the urban and administrative population (of district administration) residing in urban centres (strictly urban and administrative centres) that provide certain central place functions. With the use of this urban population by districts, the relative location factor

x_3 in relation to the total population and the absolute location factor x_4 (over the total geographical area by districts) have been constructed. The empirical estimate of the urbanisation index I_u is finally given in equation (4.2) below:

$$I_u = 0.54873 x_3 + 0.45127 \sqrt{x_4}, \quad \rho = 0.970 \qquad \ldots \qquad (4.2)$$

4.2.3 Literacy index: I_λ

Literacy index is also constructed in a similar way as the urbanisation index with the replacement of urban population by the literate population as recorded in 1971 census. The CBS, responsible for the census compilation, defines the literates as persons who (i) can read and write or (ii) have passed at least the 3rd grade in Schools. Here the relative location factor is denoted by x_5 and the absolute location factor by x_6. The empirical estimate of the literacy index I_λ is given below in equation (4.3):

$$I_\lambda = 0.64278 x_5 + 0.35722 \sqrt{x_6}, \quad \rho = 0.944 \qquad \ldots \qquad (4.3)$$

4.2.4 Index of transportation infrastructure: I_r

The data on metalled and non-metalled road are obtained from a report of Department of Roads [1979]. The actual linear orientation of these roads as well as of the pedestrian track was however given on a road map along with district boundaries prepared by the Department of Land Survey [1977]. This map has been used to measure, by an instrument, the road lengths under particular types in different districts. Our index of transportation infrastructure is an weighted index of road length under different types per unit area of a district. The weights have however been decided subjectively on the basis of our present notions of importance of these roads.

Let y_1, y_2 and y_3 denote the total lengths respectively of the metalled road, nonmetalled road and the pedestrian track. Our choice of weight is 4 for metalled road, 3 for nonmetalled road and 1 for the pedestrian track. The accessibility in weighted road lengths per unit geographical area in a district is then written as in equation (4.4):

$$Z_i = (4y_{1i} + 3y_{2i} + y_{3i})/A_i \qquad \ldots \quad (4.4)$$

where Z_i denote the stated accessibility measure of ith district, and A_i is the geographical area of ith district. Dividing the districtwise weighted accessibility by the corresponding national estimate, we obtain our index of transportation infrastructure which can be written as in equation (4.5):

$$I_{ri} = Z_i/(\sum_{i=1}^{75} Z_i A_i / \sum_{i=1}^{75} A_i) \qquad \ldots \quad (4.5)$$

4.3 Spatial interaction and association analysis of economic indices

Besides the indices just referred to in the previous subsections, we include other important indices developed earlier such as the agricultural and allied activity index (D), over-all industrialisation index (I) and the transformed ruggedness index $(0.4 + \tau)^{-1} = T$, say, for the spatial interaction and association analysis in this section. In order to examine the interrelationship of all these regional indices we present the correlation matrix below in Table 4.1:

Table 4.1: Correlation matrix of regional indices.

I_t	I_u	I_r	I_{λ}	I	D	T
1.0	0.95782	0.92541	0.84881	0.86426	0.40945	0.36527
0.95782	1.0	0.91284	0.83387	0.80996	0.40618	0.27926
0.92541	0.91284	1.0	0.78349	0.77315	0.40487	0.38444
0.84881	0.83387	0.78349	1.0	0.72332	0.26046	0.32480
0.86426	0.80996	0.77315	0.72332	1.0	0.62666	0.62136
0.40945	0.40618	0.40487	0.26046	0.62666	1.0	0.75249
0.36527	0.27926	0.38444	0.32480	0.62136	0.75249	1.0

In Table 4.1, two distinct groups of variables with strong relations within themselves can be seen. The first group is formed by the first five variables of the Table 4.1 namely, I_t, I_u, I_r, I_{λ} and I having each of the cell values greater than 0.62, say (infact, greater than 0.72). The relationships are however very high with first three variables, I_t, I_u and I_r, with the value of correlation coefficient as high as between 0.91 and 0.96. The other group of variables with strong inter-correlations $(r > 0.62)$ include the last three variables, namely, I, D and T. The variable I belongs to both groups with high inter-correlations. Ignoring this common variable I, any two variables belonging to the two separate groups do not have high correlation (the value of correlation coefficient is only between 0.26 and 0.41). Thus, clearly, the terrain type has best influenced the agricultural development (correlation coefficient $r_{TD} = 0.75$) and because the industrial activity is predominantly agro-based (note the correlation coefficient $r_{ID} = 0.63$), there is considerable relation between the terrain type and the over-all industrial activity index, I (correlation coefficient $r_{IT} = 0.62$). Thus the higher levels of both the agricultural development and the industrial activities have been associated with less rugged terrain. But the terrain type or the agricultural development have hardly any influence on the subsidiary activities and facilities as are considered here. As the industrial activity has the special role of having inter-connections with (i) agricultural and allied activities on the one hand, and (ii) the subsidiary activities and facilities as depicted by the first four variables in Table 4.1, we treat this variable I separately from the first group. For obvious reason D is also treated as a separate activity index related to the major group of agricultural and allied activities. The variable T is not an activity variable, but a conditioning variable affecting the major activities and thus it is also treated separately. But the first four variables on subsidiary activities and facilities are so strongly inter-connected with correlation coefficients between 0.78 and 0.96 that it seemed to be appropriate to have a composite index of subsidiary activities and facilities. After all, these variables are so parallel that there would be hardly any differences in spatial patterns that could be depicted by their separate consideration. This parallelism is however more pronounced in the correlation matrix of the variables I_t, I_u and I_r. The first two reflect miscellaneous tertiary and urban central place functional activities. Though the third variable, namely the variable on transportation infrastructure, is named here as a facility variable, it can also be taken to represent transportation activity variable since such activity is very much dependent on the transportation facility made available. As such, all these three variables can be combined to get a composite activity index of subsidiary activities and these subsidiary activities are tertiary in nature. The literacy variable is again a facility variable that can be considered as a conditing variable of non-agricultural (both tertiary and industrial) activities like-wise the variable on terrain type that conditioned agricultural activities. Thus, we can think of following two composite indices with the different combination of variables: (a) composite index of tertiary and allied activities or the Index of subsidiary activities as a combination of I_t, I_u and I_r and (b) composite index of subsidiary activities and facilities as a combination of I_t, I_u, I_r

and I_{λ}. But as we want to consider the variable I independently, we shall be more interested in the first index. The other index would not however give very different spatial picture because of the existence of three common variables in both. We shall however examine the statistical relation between them. But we shall map this index of tertiary and allied activities to understand the general combined pattern of tertiary, urbanisation and transportation activities and identify the local peculiarities in respect of any of these three constituent variables, if there are any. Such a map making needs a consideration of statistical regression of the composite index with individual constituent variables. We shall construct both the composite indices named above by the aggregate representation maximising principle of Kendall [1939]. But According to Pal [1963a, 1971, 1974], it is better to construct the composite index by the specific representations equalising principle, particularly for cartographic analysis for identifying local peculiarities of constituent variables over and above the general trend as depicted by the relevant composite index. For this reason, the index of tertiary and allied activities will be constructed by applying both the principles and a comparison will be made between the results obtained.

But before making our analysis with the composite indices, we shall examine the dependency structure of the first five variables of Table 4.1 that are strongly inter-correlated. Here the idea is to find which particular variable in this group is most dependent on the rest of the variables. To analyse this, we shall adopt the VLS procedure of regression developed by Pal and De [1979b]. In a group of n variables, each individual variable of the group will be expressed as a dependent variable under the VLS regression. Thus in n-space we are in a position to identify which dependent variable corresponds to the best VLS correlation coefficient. Again, unlike the OLS correlation coefficient, the VLS correlation coefficient does not necessarily increase with the inclusion of an additional explanatory variable. Thus the VLS correlation coefficient may even decrease in (n+1) space obtained with an additional explanatory variable, as compared to that in the n-space. The VLS and OLS correlation coefficients are however same in 2-space in which there is only one explanatory variable. Thus starting with a group of many variables we shall be able to find the space in which the best dependent variable has the maximum VLS correlation coefficient. In this way, we are in a position to limit the number of explanatory variables for explaining a dependent variable from a group of inter-related variables. This procedure of discrimination through the VLS regression has been applied below to find the best dependent variable and the most relevant associated explanatory variables. The variables which are excluded by this discrimination procedure will be called the non-conformal variables to the group finally considered. As there is no exclusion possibility of non-conformal variables, we shall start our analysis with all seven variables and show by this procedure which are non-conformal to the final group. Here, we are also in a position to understand the relative role of the industrial activity variable I in relation to the two groups identified from the correlation matrix of Table 4.1. For the present analysis we shall use the following notations for the standardised variables related to the indices of Table 4.1:

$$Z_1 = (I_t - \bar{I}_t)/\sigma_{It}, \quad Z_2 = (I_u - \bar{I}_u)/\sigma_{Iu}, \quad Z_3 = (I_r - \bar{I}_r)/\sigma_{Ir},$$

$$Z_4 = (I_\lambda - \bar{I}_\lambda)/\sigma_{I\lambda}, \quad Z_5 = (I - \bar{I})/\sigma_I, \quad Z_6 = (D - \bar{D})/\sigma_D, \quad Z_7 = (T - \bar{T})/\sigma_T$$

Table 4.2 shows the correlation coefficients, r_i's, of the central axis in different spaces with varying groups of variables of these seven. Table 4.3 is the derived VLS correlation coefficients $r_{Z_i \hat{Z}_i}$'s for the dependent variables Z_i's in different spaces.

Table 4.2 : Correlation coefficients of constituent variables with the central axis in different spaces.

Constituent variables, Z_i	Values of corr. coeff. r_i with the corresponding central axis in the						
	7-space	6-space	5-space	4-space	4-space	3-space	2-space
Z_1	0.95308	0.97435	0.98377	0.98524	0.98011	0.98378	0.98940
Z_2	0.92702	0.95775	0.96683	0.96824	0.97300	0.97947	0.98940
Z_3	0.91714	0.93355	0.94127	0.94981	0.95117	0.96799	—
Z_4	0.84993	0.87138	0.89419	—	0.90673	—	—
Z_5	0.93168	0.91302	0.88989	0.90278	—	—	—
Z_6	0.60916	0.54209	—	—	—	—	—
Z_7	0.58154	—	—	—	—	—	—

N.B. - In each column the variables not included in the respective space are shown by dashes (-).

Table 4.3: VLS correlation coefficients for a dependent variable in different spaces.

Dependent variable, Z_i	Values of VLS corr. coeff. $r_{Z_i \hat{Z}_i}$ in the						
	7-space	6-space	5-space	4-space	4-space	3-space	2-space
Z_1	0.92883	0.95922	0.97319	0.97240	0.96313	0.96293	0.95782
Z_2	0.89154	0.93381	0.94610	0.94191	0.95040	0.95346	0.95782
Z_3	0.87778	0.89803	0.90681	0.91028	0.91270	0.92900	—
Z_4	0.78906	0.81217	0.83891	—	0.84164	—	—
Z_5	0.89810	0.86877	0.83297	0.83542	—	—	—
Z_6	0.52178	0.45122	—	—	—	—	—
Z_7	0.49469	—	—	—	—	—	—

N.B. - (1) When Z_i is treated as the dependent variable, $\hat{Z}_i$ is the VLS linear function of other variables of the respective space.

(2) In each column, the variables not included in the respective space are shown by dashes (-).

From the data of Table 4.3, it can be seen that the index of tertiary activities namely Z_1 (i.e., I_t) is always the best dependent variable in all spaces considered in the table. Again this best dependent variable is best explained in the 5-space (note the highest value of the VLS correlation coefficients $r_{Z_1 \hat{Z}_1} = 0.9732$). That is other variables in this space, namely urbanisation, transportation infrastructure, literacy and industrialisation are the most relevant associated explanatory variables. This means tertiary activities did develop in different areas of Nepal with the influence of these four factors. As the next best and almost similar statistical relation ($r_{Z_1 \hat{Z}_1} = 0.9724$) is obtained in the

4-space excluding the literacy variable, the other three variables namely urbanisation, transportation infrastructure and industrialisation could be considered as sufficient to account for the spatial variation of the tertiary activities. Yet, statistically, the five variables constitute the best VLS conformal space. The variable I is connected also with the two non-conformal variables, namely D and T, we shall take these three variables together for ascertaining the best dependent variable in this group. Here also we make similar kinds of Tables 4.4 and 4.5 in 3-space and 2-space comparablo to the Tables 4.2 and 4.3.

Table 4.4: Correlation coefficients of constituent variables with the central axis in 3 and 2-spaces.

Constituent variables, Z_i	Values of corr. coeff. r_i with corresponding central axis in the		
	3-space	2-space	2-space	2-space
Z_5	0.84150	—	0.90038	0.90185
Z_6	0.90161	0.93608	—	0.90185
Z_7	0.89947	0.93608	0.90038	—

N.B. - In each column the variables not included in the respective space are shown by dashes (-).

From the data of Table 4.5 below, we notice that the VLS correlation gets improved in the 3-space by the inclusion of the industrialisation variable I along with D and T. In the 2-spaces, we are not in a position to identify the best dependent variable by this method, but in the three or more space we can always identify

Table 4.5: VLS correlation coefficients for a dependent variable in 3 and 2-spaces.

Dependent variable Z_i	Values of VLS corr. coeff. $r_{Z_i \hat{Z}_i}$ in the			
	3-space	2-space	2-space	2-space
Z_5	0.66446	—	0.62136	0.62666
Z_6	0.76554	0.75249	—	0.62666
Z_7	0.76153	0.75249	0.62136	—

N.B. - (1) When Z_i is treated as the dependent variable, $\hat{Z}_i$ is the VLS linear function of other variables of the respective spaces.

(2) In each column the variables not included in the respective space are shown by dashes (-).

the best dependent variable. This in the present 3-space case, D (agricultural development) is explained by both T (terrain type) and I (industrialisation). In other words, the spatial variation in agricultural development is explained not only by the terrain type but also by the industrialisation level, though terrain type has relatively a greater role. The VLS refression $\hat{Z}_1$ for the best dependent variable Z_1, as discussed in Tables 4.3, is given below in equation (4.6). Again the VLS regression Z_6 for the best dependent variable $\hat{Z}_6$ related to the variables of Table 4.5 is shown in equation (4.7):

$$\hat{Z}_1 = 0.278744\,Z_2 + 0.271375\,Z_3 + 0.257801\,Z_4 + 0.256562\,Z_5,$$

$$\text{VLS corr., } r_{Z_1 \hat{Z}_1} = 0.97319$$

with $g_{12} = 0.27394$, $g_{13} = 0.25965$, $g_{14} = 0.23433$, $g_{15} = 0.23208$

i.e., $\hat{I}_t = -0.599055 + 0.349184 I_u + 0.140533 I_r + 0.618918 I_l +$
$+ 0.531872 I$, $r_{I_t \hat{I}_t} = 0.97319$ ... (4.6)

$\hat{Z}_6 = 0.500079 Z_5 + 0.534529 Z_7$

VLS corr. $r_{Z_6 \hat{Z}_6} = 0.76554$

with, $g_{65} = 0.46674$, $g_{67} = 0.53326$

i.e., $\hat{D} = -0.307390 + 0.511487 I + 0.537900 T$,

$r_{D\hat{D}} = 0.76554$ ... (4.7)

The values of g_{1i}'s show the relative share of different explanatory variables i's in explaining a spatial variation of $r^2_{Z_1 \hat{Z}_1} =$ 0.9471 for the VLS regression in equation (4.6). Similarly the values of g_{6i}'s show the relative share of different explanatory variables i's in explaining a spatial variation of $r^2_{Z_6 \hat{Z}_6} = 0.5861$ in equation (4.7). The total spatial variation of the tertiary activity variable is significantly explained by the VLS regression (4.6), but the total spatial variation of agricultural development variables is not sufficiently explained here in equation (4.7). The spatial variation of the agricultural development variable has however been sufficiently explained in our 3-stage regression exercise shown already in Chapter II. The only thing that we want to add here is that the level of industrialisation has also an influence on the level of agricultural development. It is because of this association one can expect a better kind of agricultural development if industrialisation pace is stepped up in the areas of agricultural surplus. Thus it is because of this special importance of industrial activity variable in explaining both agricultural development and also the group of variables related to the subsidiary activities and facilities considered here, we treat this variable I separately from the first five variables forming the VLS conformal group.

4.4 Construction of the composite index of tertiary and allied activities and the spatial analysis.

We shall now come back to our proposal of constructing (a) the composite index of tertiary and allied activities, U, say and (b) the composite index of subsidiary activities and facilities, V, say. The last but two columns of Table 4.2 record the values of correlation coefficients of constituent variables with corresponding central axis (or the composite index under, the maximisation principle). These values of correlation coefficients, r_i's, are quite high and also fall within certain narrow range [for index U, between .968 and .984 and for index V, between .907 and 0.980]. For this narrow range of values, we do not have much need to construct the composite indices by the equalising principle. However, for the sake of illustration, we also construct by equalising principle the composite index of tertiary and allied activities and designate it by U_e. The suffix 'e' stands for equalising principle and this suffix is not used when a composite index is constructed by the maximising principle. In the present construction of each composite index we shall adjust the coefficients of constituent variables in such a way that the critical values of the constituent variables correspond to the critical value of the composite index. Thus the empirical formulation of indices U, U_e and V are as given in equations (4.8), (4.9) and (4.10):

$$U = 0.362745I_t + 0.452422I_u + 0.184833I_r,\ \rho = 0.977103 \quad \ldots (4.8)$$

= Composite index of tertiary and allied activities.

$$U_e = 0.250360I_t + 0.496278I_u + 0.253362I_r,\ \rho_e = 0.976297 \quad \ldots (4.9)$$

= Alternative composite index of tertiary and allied activities.

$$V = 0.201319I_t + 0.250364I_u + 0.101175I_r + 0.447142I_\lambda, \quad \ldots (4.10)$$

$$\rho = 0.953183$$

It should be noted, even though we have not included the literacy variable I_λ in the construction of U and U_e it is quite substantially represented in all the composite indices as is evident from the following correlation matrix as given in Table 4.6:

Table 4.6 : Correlation matrix between the composite indices and the variables.

Composite index	Composite index			Variables			
	U	U_e	V	I_t	I_u	I_r	I_λ
U	1	.99915	.99085	.98378	.97947	.96799	.84150
U_e	.99915	1	.98860	.97630	.97630	.97630	.83526
V	.99085	.98860	1	.98011	.97300	.95117	.90673

From this correlation matrix we notice that the inter-correlations among the three composite indices are so strong that they are likely to depict almost the similar spatial variations. Thus any one of them can be taken to represent the variations of the activities other than the agricultural development activity D and the industrial activity I. To make a decision as to which one we shall finally accept we examined the inter-correlations of the composite indices U, U_e and V and also their relations with the other activity indices D and I in the following Table 4.7 :

Table 4.7 : Correlation matrix between the composite indices and the activity indices.

Composite index	Composite indices		
	U	U_e	V
I	.83513	.82564	.83275
D	.41637	.41620	.39012
T	.35089	.35187	.35493

In this table, we have also shown the inter-correlation with the conditioning variable for the agricultural activity, namely the terrain type T. But, as it is not an activity variable, we have not considered its correlations with the composite indices in the proposed decision-making. From the inter-correlations among U, U_e and V, shown in Table 4.6, we find that U is most related to the other two composite indices, more than those of U_e or V. In Table 4.7, there is hardly any difference between column vectors. Yet the magnitude of correlation coefficients with I and D are highest for the composite index U. Thus we can decide finally to accept U as the composite index of tertiary and allied activities.

Figure (4.1) is a map of this composite index of tertiary and allied activities U. The classes used in mapping for this figure were ascertained by an examination of the statistical distribution of U and also the important breaks that exist in the distribution. Thus we have recognised the following classes of U as given below:

Classes of U	Class interval of U	Frequency of districts
EH (extremely high)	(2.5 to 8.5]	3
VH (very high	(1.75 to 2.5]	8
H (high)	(1.25 to 1.75]	6
M (medium)	(0.75 to 1.25]	15
L (low)	(0.25 to 0.75]	43

An examination of this figure (4.1) reveals the following spatial pattern of tertiary and allied activities:

(a) Extremely high concentration of tertiary activities can only be found in the capital region including the districts of Kathmandu, Bhaktapur and Lalitpur (actually U is between 4.5 and 8.5 in this region; see, Appendix Table 10, for details).

(b) The only contignous belt of high or very high tertiary and allied activities can be found in the eastern part of Tarai area.

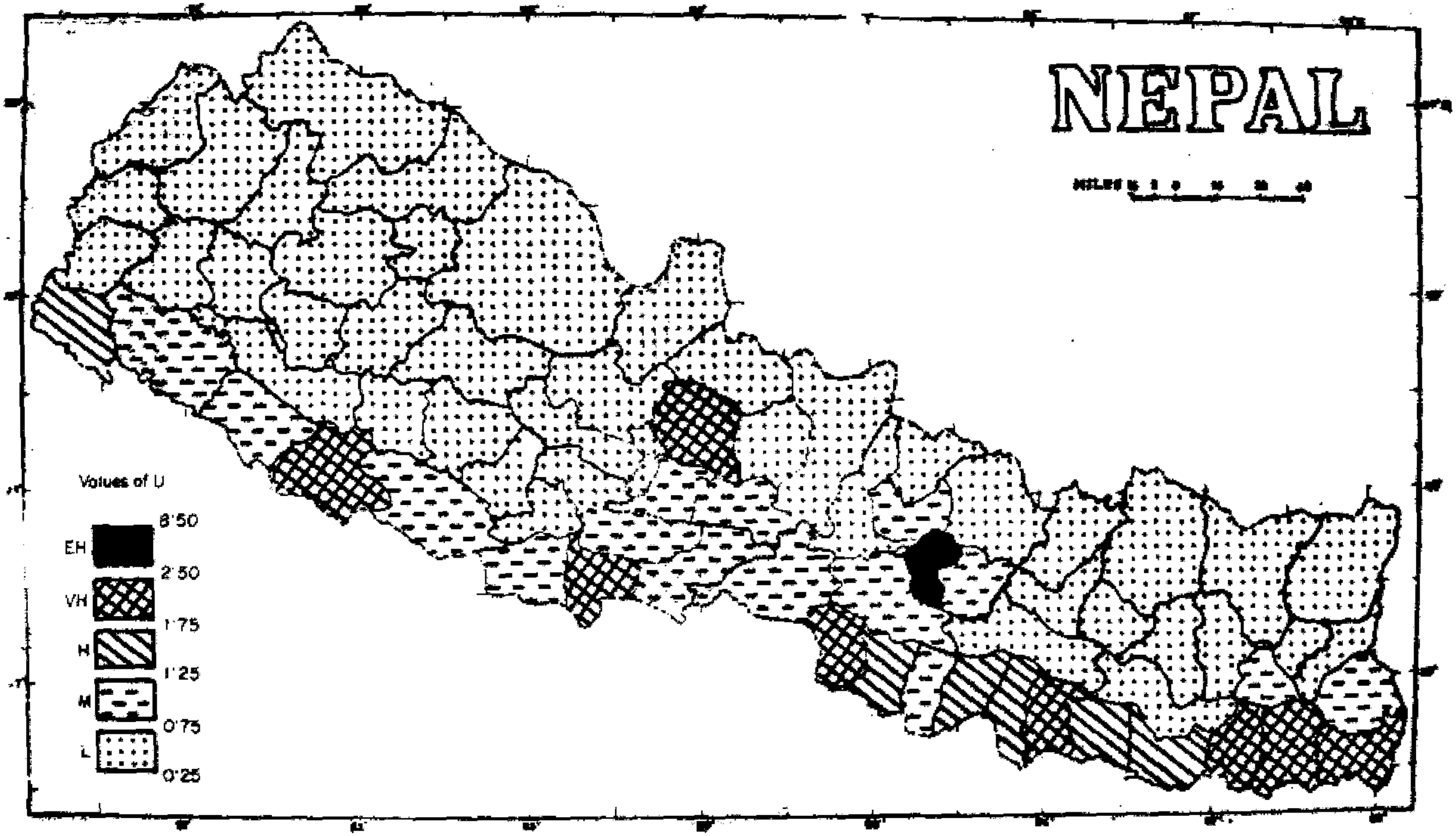


FIG-4·1: COMPOSIT INDEX OF TERTIARY AND ALLIED ACTIVITIES (U)

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(c) The above mentioned eastern Tarai belt of high or very high tertiary and allied activities extends westward in the Tarai area through medium values of U with pockets of very high values at Rupandehi and Banke districts and with high value at Kanchanpur district.

(d) Apart from the capital region of extremely high U, the only hill area where there exists very high level of tertiary activities is the district of Kaski lying to the west of the capital region. These two pockets of very high or extremely high levels of tertiary and allied activities in the hill area have medium values of U around, mostly in the southern districts which are adjoining to Tarai area also.

(e) All other hill and mountain districts, lying both in western and eastern parts of Nepal, have mostly the low level of tertiary and allied activities.

This general pattern as depicted above for the composite index U is very much reflected in the constituent variables, namely I_t, I_u and I_r. The regression equations of these constituent variables with U are given below in equations (4.11) to (4.13):

$$I_t = -0.04470 + 0.93152\,U \quad \ldots \quad (4.11)$$
$$r = 0.98378$$

$$I_u = 0.18656 + 0.74035\,U \quad \ldots \quad (4.12)$$
$$r = 0.97947$$

$$I_r = -0.36893 + 1.76994\,U \quad \ldots \quad (4.13)$$
$$r = 0.96799$$

sing these regression equation alone with the corresponding tandard errors of estimate, we are in a position to identify if the actual value of any district with reference to a particular variable I_t or I_u or I_r, is significantly higher or lower (at

5 per cent level of chance) than the computed value I_t or I_u or I_r, obtained by use of the right hand side of the corresponding regression equation. In this way, we can identify only a few local peculiarities that show significant departures from the general spatial trend as already depicted by U. These peculiar districts and the nature of peculiarities in the values of constituent variables are given below in the tabular form:

Table 4.8: Nature of regional peculiarities.

Peculiar districts	Significant departure (at 5% chance) of actual value from the regressions of U for		
	I_t	I_u	I_r
Kathmandu	higher	—	—
Bhaktapur	lower	—	higher
Lalitpur	—	higher	lower
Kaski	—	higher	—
Kanchanpur	lower	higher	—
Siraha	—	lower	higher
Nawal-Parasi	—	—	higher
Total number of peculiar districts out of total 75	3	4	4

Thus there are about seven districts which have shown some peculiarities not depicted by the general level of U. Of these seven first three districts fall in the capital region. These districts are small and very close to each other and the district boundaries in the capital region have hardly been considered as barriers to commuters' daily movements. Thus the place of residence and the place of activities might fall in different districts of the capital region and, the census count has gone by the place of residence and not by the place of work. Considering this fact of spatial complementarity in tertiary and urban activities in the capital region, it would not be unwise to treat the capital region as a whole in stead of its district breakdowns. In such a case the capital region, though has an extremely high level of U, is not a peculiar case in terms of any constituent variable. But if we want to treat them separately, the results shown in above table are also meaningful. Thus Kathmandu has a significantly higher tertiary activities. Its neighbouring district, Bhaktapur, has correspondingly lower value in tertiary activities, but higher value in transportation infrastructure. The other neighbour of Kathmandu, namely Lalitpur has higher level of urbanisation but lower level of transportation infrastructure than what is depicted by its U-value. The speciality of the Hill district of Kaski, where the value of U is very high, lies in the urbanisation character of the district which is significantly above the general level depicted by U. The Tarai district of Kanchanpur could reach only high value in U, despite its higher urbanisation-character, for its tertiary activities are significantly lower. Apart from Kanchanpur, there are two other peculiar districts in the Tarai area namely, Siraha and Nawal-Parasi. Having been in that part of Tarai area where very high levels of transportation arteries exist, these two districts have shown significantly higher level of transportation infrastructure than the levels depicted by U in them. Both Siraha and Nawal-Parasi have a significantly lower level of urbanisation than the general level depicted by U.

The above analysis on peculiar districts has a point-wise comparisons between the actual and the regression estimate (as a function of general level U) of a particular variable, I_t or I_u or I_r. But the classified values of U have been mapped in figure 4.1. To make class-wise comparisons of the values of U with those of any of the constituent variables. We have made use of the regression equations (4.11), (4.12) and (4.13) to obtain more or less comparable (broad approximations) class intervals of I_t, I_u and I_r and mapped them in figures (4.2), (4.3) and (4.4). In the distributions of I_t, I_u and I_r and also of U, the three districts of capital region have much higher values than those of others with sufficient jumps, while the distribution of I_λ did not show such jumps in value for the districts of capital region. As such the regression boundaries for the class-interval of I_λ with its regression for U or any of I_t, I_u and I_r has not been taken into account for classifying I_λ. We have examined the graph of I_λ with U for observations other than those districts of the capital region and have estimated a value of 0.3 for the class interval of I_λ corresponding the value of 0.5 chosen already for the class

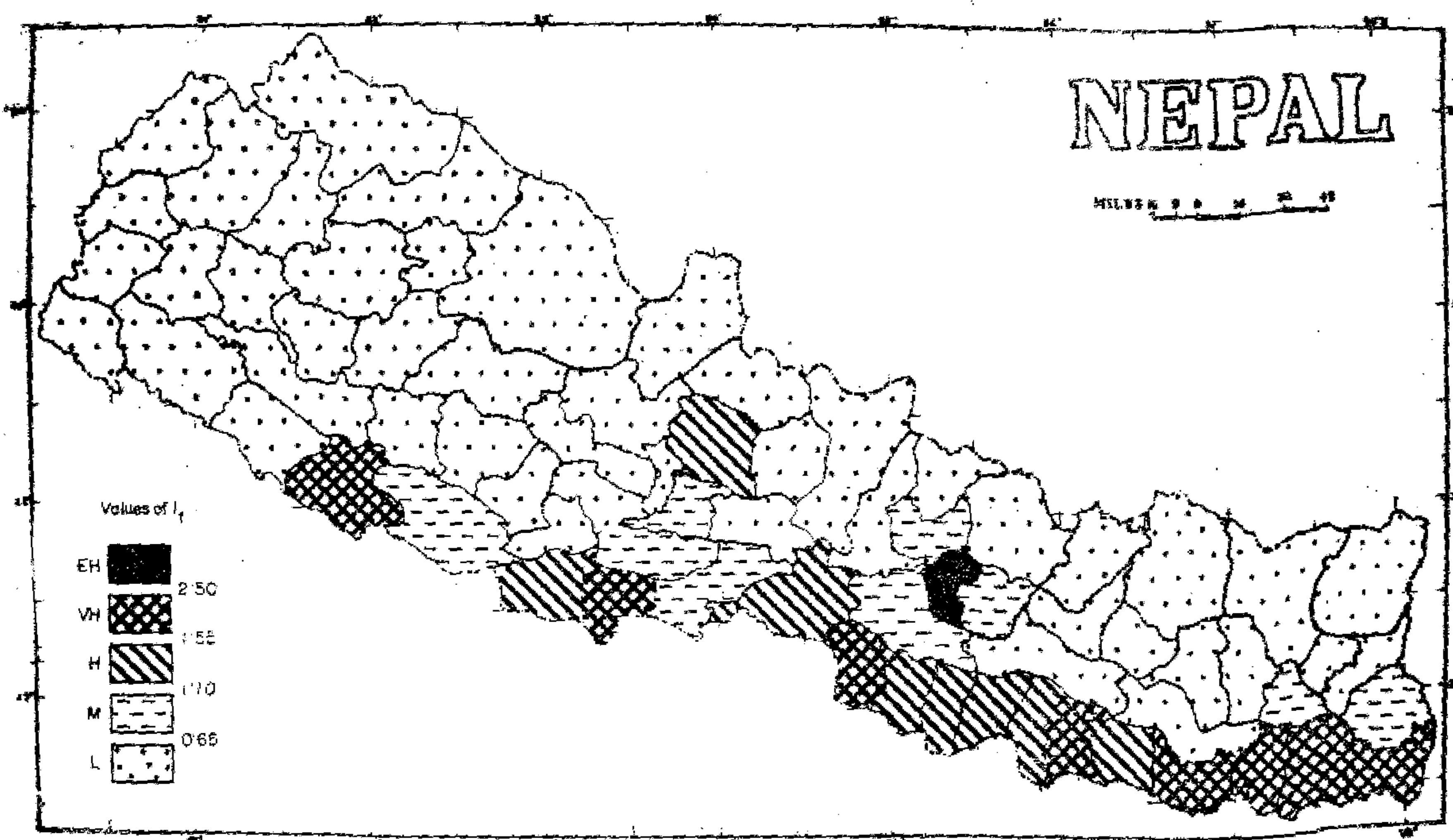


FIG-4·2: INDEX OF TERTIARY ACTIVITIES (I_t)

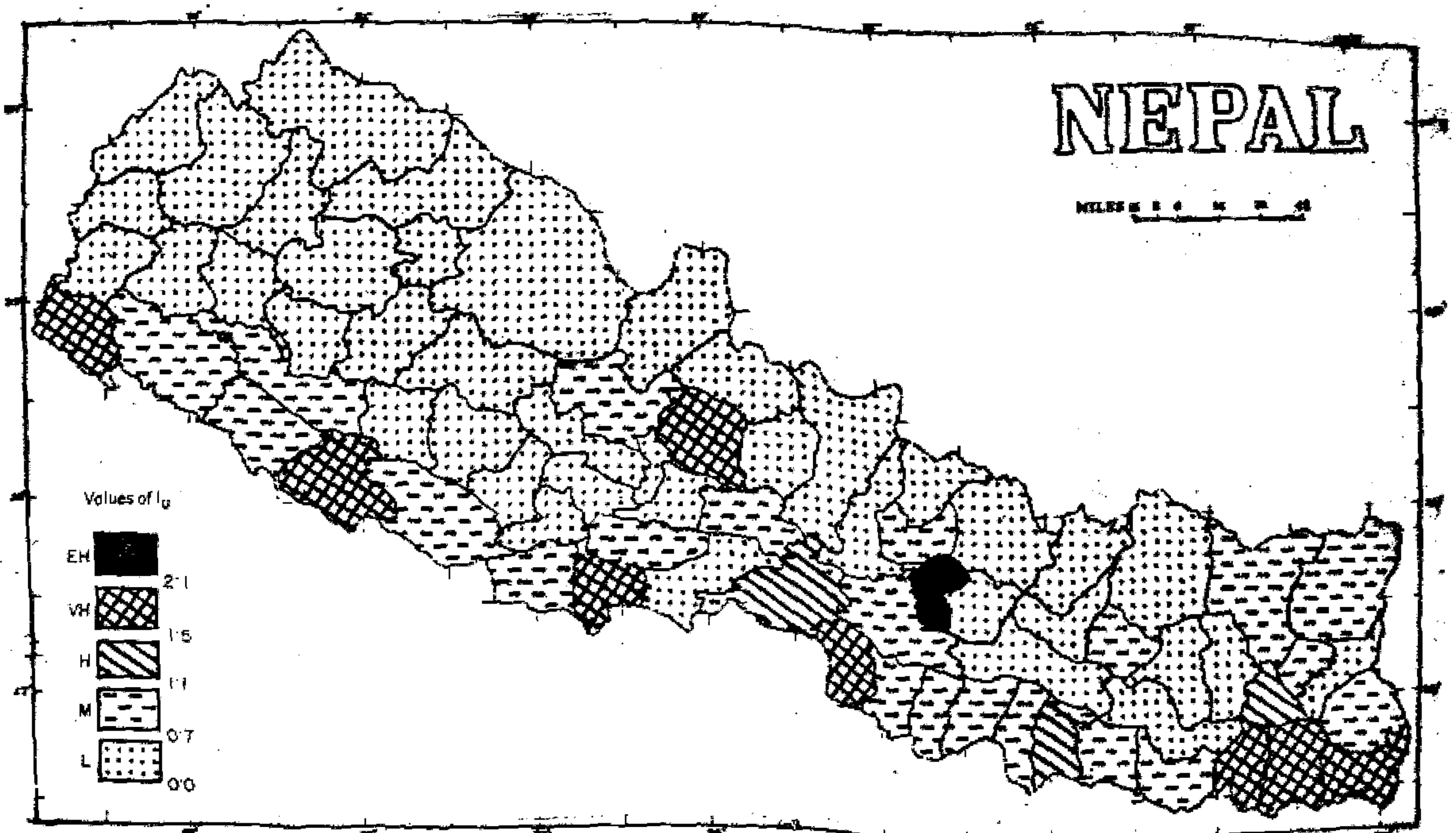


FIG-4·3 INDEX OF URBANISATION (I_u)

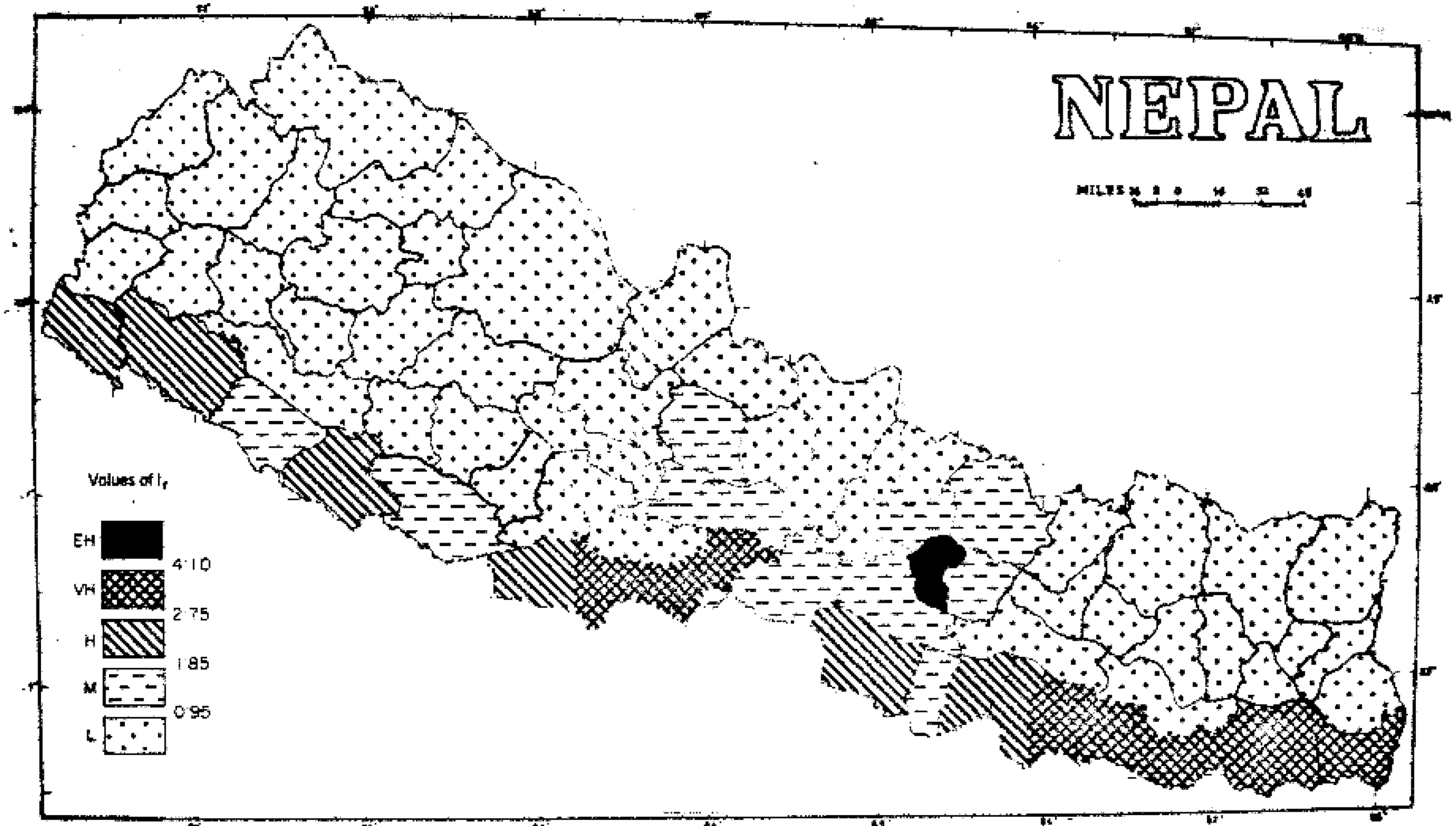


FIG-4·4 : INDEX OF TRANSPORTATION INFRASTRUCTURE (I_T)

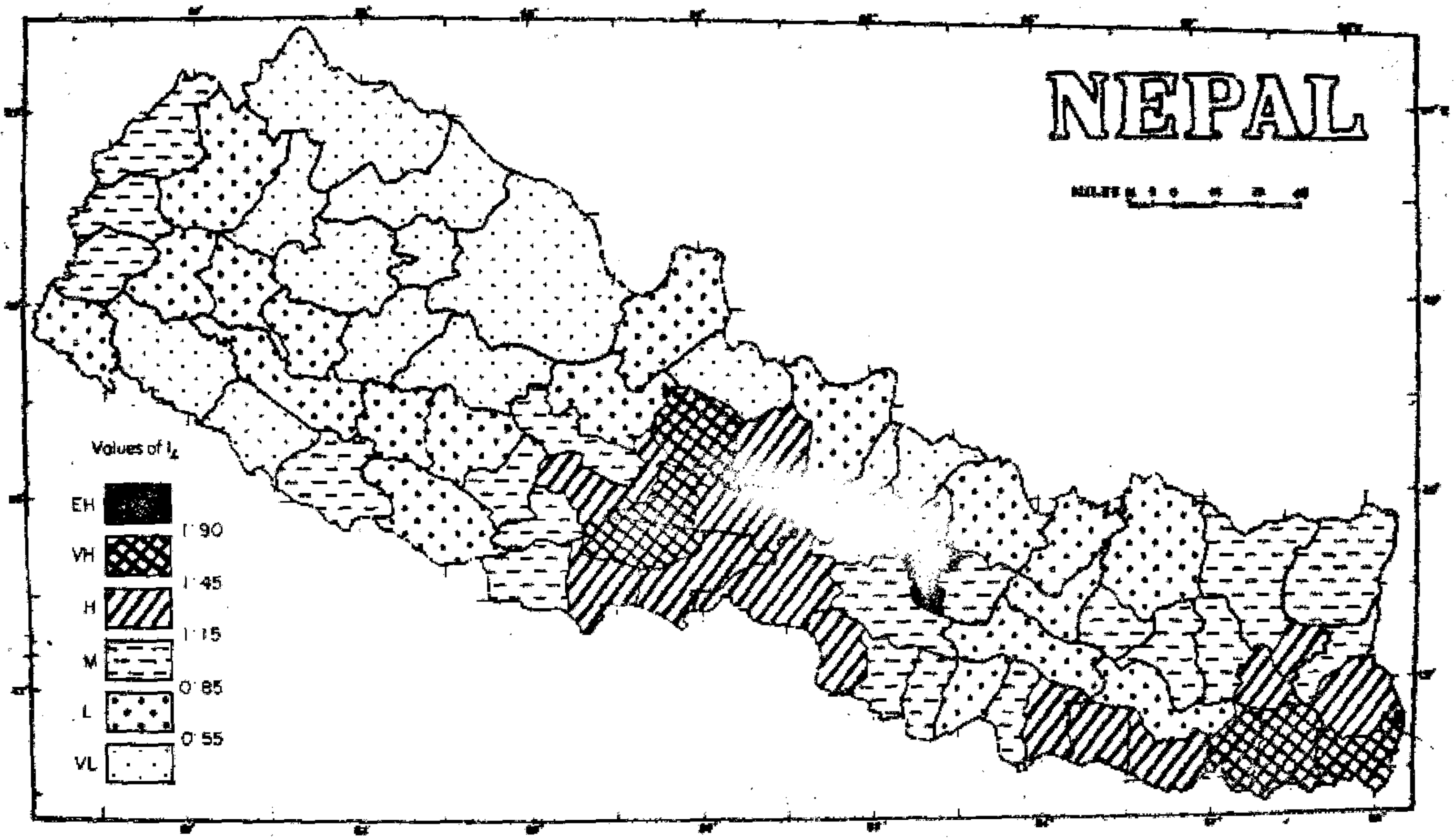


FIG-4·5: INDEX OF LITERACY RATES (I_ℓ)

interval of U. Thus a comparable mapping I_λ is obtained by using this class-interval value of I_λ around the central value of unity and shown in figure 4.5. The comparable class-boundaries for I_t, I_u, I_r and I_λ, as obtained above and used for mapping are as given below:

Between classes	boundary-value between consecutive classes for			
	I_t	I_u	I_r	I_λ
EH and VH	2.50*	2.1	4.10	1.90
VH and H	1.55	1.5	2.75	1.45
H and M	1.10	1.1	1.85	1.15
M and L	0.65	0.7	0.95	0.85
L and VL	-	-	-	0.55

N.B.-* A little higher value chosen here to match with the high gaps that exist in the right hand tails of all distributions (U, I_t, I_u and I_r).

For the peculiarities of the distribution of I_λ, (not matching with those of U, I_t, I_u and I_r) we have been forced to identify the class VL of lowest values. With the present choices of class-interval lengths the VL-class practically does not exist with substantial number of districts in it for the variables U, I_t, I_u and I_r and hence is not mapped in figures (4.1) to (4.4). But it can be seen in the figure (4.5) that the frequency of district is as high as 13 for the variable I_λ. For the sake of comparison with other maps the two bottom classes L and VL can be treated combinedly in figure (4.5).

As the correlation between U and any of I_t, I_u and I_r is quite high, it is quite natural to expect substantial similarities in spatial patterns as depicted in figures for the variable U and the constituent variables I_t, I_u and I_r. As expected (because of lower correlations), the map of I_λ does not show that closeness in spatial pattern with the maps of U, I_t, I_u and I_r. Yet in these all five maps : (a) the capital region has always the highest values, (b) the eastern Taria belt is generally more advanced with very high and high index values, (c) the western Tarai belt is generally less advanced than the eastern Tarai, (d) the southward districts of the capital region and also the central hilly district of Kaski, tend to higher values than the usual value of other hill and mountain districts (in respect of literacy, the Kaski region is as advanced as the eastern Tarai belt), (e) Apart from the capital-region and the Kaski-region, all districts in hill and mountain areas are least advanced with generally low values. In literacy, the eastern fringe and the western fringe, bordering Indian territory tends to be a little advanced with medium values in I_λ. and (f) The western Nepal is less advanced than the eastern Nepal depicted in all maps, particularly in the literacy map.

4.5 Miscellaneous Resources

In the last section we tried to identify the spatial pattern of certain subsidiary activities and facilities like tertiary activities, urban central place activities, transportation infrastructure and educational level and also the composite tertiary and allied activities. We have mentioned in earlier chapters that the agricultural production level is deteriorating, industrial base quite meagre and the population growth alarmingly rapid in Nepal.

In the absence of comparably adequate non-agricultural activities, the population pressure on land has been very severe. Its remedy lies in creation of non-agricultural activities based on resources other than agricultural so that there can be a transfer of population from agricultural to prospects of non-agricultural activities. For this we have yet to examine the existing physical resources (or facilities) such as forestry, water resources and minerals and also the additional labour potentials for whom additional jobs or activities are to be created under perspective planning considerations. However, our attempts in this connection have been severely constrained because of the lack of information and hence our analysis made on the available information is only very broad in nature.

4.5.1 Forest resources.

Besides contributing to the total exports of the country, forest has been traditionally a most important domestict source of fuel and energy in Nepal. According to one estimate fuel wood accounts for about 90% of Nepal's energy use [World Bank, 1979b]. For obvious reasons the consumption of fuel wood per capita would be higher in the areas at higher altitudes with falling temperatures. But this feature is not reflected in the estimates of fuel wood consumption per capita by Earl [1975]. According to him, the annual fuel wood consumption per capita in 1970 was at the order of 1.1 cubic meter for Tarai and 0.5 cubic meter for Hills and Mountains. For the reasons of greater biological demand for the people living in colder climate, these estimates appear to suffer from under-reporting. Particularly in the colder hilly and mountaineous areas the loss of heat due to radiation is also higher, a fact which justifies further our suspicion of under reporting in remote hills and mountains. It is because of this reason Earl's [1975] quantitative exercise towards estimating the present consumption and also predicting the future demand of fuel wood consumption has to be treated with caution. We can make a reasonable guess that if the annual consumption of fuel wood per capita could be at the order of 1.0 cubic meter for Tarai, it ought to be atleast 1.5 cubic meter for hills and mountains. With these norms, one can as well make estimates of the total demand, for the present and also for a future point of time. From a comparision of these two estimate in each area, we can get a picture of the increased demand of forest resources used as fuel. But we have not attempted here such an exercise, because the increased demand of fuel wood in various areas would then simply be a function of population growth which we shall study later. As population growth is alarmingly high, particularly in Tarai, one can easily infer that the demand for forest resources to be used as fuel wood would be equally high.

The forest has to meet the population's need for construction of residential houses, furnitures, etc., which require the use of timber, besides the industrial requirements of the country. The forest are also used for animal grazing, the leaves and twigs are lopped for cattle or livestock feed by the population. With the increase in population, the livestocks held by the people are also expected to increase in number, taxing further the forest resources. The population growth has also resulted in a pressure to expand the cultivable area by clearing forest lands. Terracing has been attempted at elevations (slopes) that were previously avoided and left to the growth and rejuvenation of forests. In the face of multi-pronged assault the forest have retreated further and further to the cores. The immediate consequences can be seen in the form of frequent land slides, soil crosions and the decreasing land productivity etc. Again, the continuing inflow of hill population into Tarai area results into a further encroachment of the Tarai forests. Infact, according to an estimate of the F.A.O. [UNDP/F.A.O., 1974] about 36000 hectares of good forests land are lost anually through squatting and no more than 818,600 hectares of forest area remain in Tarai.

If this estimate is accepted as correct, this would account for about 25% of total geographical area of the Tarai. Any further reduction of this meagre percentage of forest land in Tarai area should better be avoided. But it is also true at the moment that the economic forces of attraction are present in Tarai area that cause in migration into the area. As such forest problems ought to have been analysed in an integrated manner with the forces of economic activities. But in the absence of requisite forest resources data, we are not in a position to make analysis in this dissertation. But granting that the major use of forest resources is towards the supply of fuel and energy for human consumption, one can think of certain substitute for this source of energy. It is often said that the country has enough potentiality for expansion of hydro-electricity power [World Bank review 1979b]. In that case one can think of, as a sort of long term objective harnessing the hydro-electirc potentiality of the country towards substituting the requirements of fuel and energy. Side by side, it should be also a government policy to regulate afforestation measures in a continuing basis in order to balance the growing need of the increasing population. Pastures have also to be developed, positively with fodder crop to develope the livestock resources of the people. One should also think of forest-resource based economic activities, particularly in those area where agricultural land is limited, so that the local people have local activities and donot migrate to other areas for the economic forces existing there in.

In this respect, we have already noted that there is a greater need for the creation of more of non-agricultural activities in the areas where agricultural land is limited with considerable human habitation. Density of population is considerably high in many hill areas with limited agricultural land. One could, as such, think of developing hill forest products in hilly areas, not only for local consumption, but also for an export of those products to even Tarai area. For example, following the example of malnad (hilly area) of the Karnataka State in India, one can think of charcoal processing plants in hill areas. As charcoal is much lighter than firewood in raw form, it is easier to transport charcoal than firewood. In fact, the transportation of firewood could be quite costly beyond a certain distance over the rugged a terrain while the transformed product, namely charcoal can be transported over a long distance with much less difficulty. .The Indian example of good planning with the forest resources of Karnataka State, cited in Earl [1975], is restated below, that could be a model for in Nepalese hill forest planning.

Quoting Earl [1975], an example of a well planned joint enterprise between Industry and the Forest Department is taken from Mysore (Karnataka State) of India. A blast furnace industry with an output of 80 tonnes of iron per day, together with a ferro-silcon plant, is supplied with 40,000 tonnes of charcoal per from the surrounding forests. Formerly the charcoal was made from distillation of firewood in the plant but in 1968 it was decided to this method of manufacture on economic grounds and to buy all charcoal from the Forest Department at an agreed price negotiated each year (average US ₡ 26 per tonne in 1971-1972). Approximately 3200-4000 hectares of lightly exploited low value natural forest is cleared anually for conversion to plantation. The Forest Department which organizes and administers the whole process, receives a royalty of US ₡ 0.125 per bag (i.e., 45 ₡ 3.75 per tonne of approximately 30 bags) from the charcoal converted from the felled scrub. The operation is well organised to ensure that all the cleared land is planted with trees during the wet season when there is a temporary call in the charcoal-making operations and men are available for the task. The work takes place in various state forests and is closely tied-in with forest management requirements. The operations in Arambelli State forest near the village of Muzthinakoppa, approximately 40 kilometer, south of Bhadrawati, are typical of those carried out elsewhere. The basic organisation of the work in 1972 was as follows:

(1) Timber trees are felled and removed to the government depot, at the rate of approximately 127 cubic meters per hectare, for auction.

(2) The Forest Department calls for tenders for the manufacture of charcoal from the lop and top and all remaining trees in the demarcated area of forest, and transport to the Bhadrawati Iron and Steel works. The price is US $ 0.50 per bag i.e., US $ 15.0 per tonne ex-tax and royalty.

(3) Charcoal is made, on contract, in large earth Kilns. The contractor pays the charcoal-makers US $ 0.25 per bag stacked ready for loading on to a lorry.

(4) The amount of charcoal per hectare is about 20-25 tonnes i.e., 600-750 bags.

(5) Approximately 120 men are employed on charcoal-making in the dry season of 6-8 months and plant trees for the Forest Department at a daily rate of US $ 0.31 in the wet season, i.e., for the remaining months.

(6) 75% of the area is planted with Eucalyptus (E. tereticomis) and the remainder is planted with Teak (Tectona grandis) silky oak (Grevilleo robusta) and She oak (cabuarina species).

(7) Planting costs are about US $ 41 per hectare for Eucalyptus Planted at 1.5 x 1.5 meters spacing and Tectona 1.8 x 1.8 meter spacing.

The royalty to the Forest Department of US $ 70-90 per hectare is more than the planting costs of US $ 41 per hectare and demonstrates the important role played in developement by the use of fuel obtained as a by-product from intelligently planted forest operations.

It should however noted here that Earl [1975] does not seem to have paid much attention towards the urgently of hill forest development in Nepal. He observes "the land area which has the greatest potential contribution to solving both fuel and food problem in Nepal is the flat alluvial Tarai Plain, bordering India". It is true that the forest resources based industries are mostly located now in the Tarai area. This fact seems to be the basis for certain proposed forest fuel wood development areas spread along the northern periphery of Tarai belt in a figure presented by Earl [1975]. But there are competing uses of flat Tarai land over different economic activities to the forest resources. To add to this competition the state encouraged in-migrations are also taking place in some of the Tarai area at the cost of existing forest areas. For example, in the district of Bardia, in the Western Tarai, the Government-owned Nepal settlement company is clearing the forest and settling people at the rate of one family per holding of 2.7 hectares. Until 1974, no provision had been made for retaining forest for fuel and other basic essentials. When there is no more forest debris to burn the settlers are faced with the problem of finding fuel from the receding forest resource or obtaining alternative fuels. Eventually the settlers are forced to burn dung which is supposed to be used as manures for the agricultural land. The effects of lack of comprehensive forest resource planning is noted also in eastern Tarai area particularly around Janakpur town. Here apart from the local domestic demand for fuel wood, local tobacco industry has a great demand for this fuel. As a result, the forests in the vicinity of Janakpur is destroyed completely.

The forest staffs find it practically impossible to halt the removal of fuel wood from the nearby forest and the more serious cutting down of valuable young timber species. Thus it is clear that we have to rethink whether Tarai forests can remain as "the greatest potential contribution towards solving fuel problem" as observed by Earl, although there is hardly any doubt that other economic activities like agriculture and industry would greatly flourish in the flat Tarai land. We feel that if at all forest fuel could be developed in Tarai area, where the growth of economic activities has to be much faster in conforming to the country's highest population growth therein, the forest resources have to be allowed to develop in a mixed form with other uses in the community dwelled areas rather than in the shape of an exclusive forest area as controlled by the forest department. Following Shepherd's [1979] suggestion for community forest developement, three important points are emphasized here if the supply of fuel wood should be made available to all the rural population of the country:

(a) All non-agricultural land not immediately occupied by housing and other buildings must be made as productive as possible and protected from excessive grazing.

(b) Village people must be taught to manage their forest ás they manage their agricultural land and to harvest product, without having the stock.

(c) Rural people must be assisted to make the most economic use of the fuel wood and fodder available to them.

It seems inevitable that much more land will eventually be used for agriculture to feed the increasing population. While man-made agricultural system is being modified and managed for increased productivity through the national uses of various inputs, it is also necessary that the remaining land that is to provide the needed fuel wood and fodder etc., must have to be modified and efficiently managed. In this modification, the forests must retain a diverse character in the species-mix, instead of following a monocultural plantation approach. In otherwords, there should be a comprehensive integration of forestry into local community life. In this connection it may be appropriate to follow Jacobs [1978] "Hundred-tree Formula" prescribed for India, under which farmers are assisted to plant twenty trees per year in and around their farms for self-sufficiency for firewood and small timber requirements. Such plantings will require a great deal of liarson between Forestry department personnel and local community groups in this kind of mixed tree crops and agricultural crops farming. The community forest development is mainly being suggested for Tarai area, while non-Tarai area should try to develop forest resources in the form of protected forest areas possibly with proper planning with fast growing species. We have already suggested for examinations of the possibilities of locating charcoal processing plants in those areas.

We do not have detailed statistical information with sufficient regional breakdown on different species of forests resources for quantitative estimates of outputs. However, from a survey report on forest resources in the hill region [Dept. of Forestry, 1973], main species grown and used as industrial woods are:

Sal (Shorea robusta), Asna (Terminalia to mentosa), Khair (Acacia Catechu), Oak, Chirpine (Pinmis roxburghu) bluepine (Pinus wallichiana), Spruce (Picea morinda) Fir (Abies pindrow), Hemlock (Tsuga species) etc. Besides these there are miscellaneous species which are sources of (a) furniture and special use hardwoods, (b) Other hard woods, (c) Soft hard woods etc., [for details see, Forest Departments report 1973]. The ststistical records are provided by zones: eastern hill zone, Central hill zone and Western hill zone. Shares of commercial forest land by forest type in these zones and in the total hill region (as in 1965) are presented in Table 4.9. The dwarf free vegetation found up to 4000 meters has little commercial value. Thus mountain region has practically no commercial forest and its total forested area is estimated to be about 3.2% of the total geographical area (the residual share after accounting for Hill and Tarai region). The total commercial forest in Tarai area according to an FAO/UNDP [1974] estimate is about 818,600 hectares. But the estimate available in publications, the Agriculture statistics of Nepal [1977] estimates the commercial forest in Tarai region account for about 75% of total forest area. Using this percentage, the total forested area of the Tarai area can be estimated to be at the order of 1,090,000 hectares. From this report we have also an idea of the different types (species) of Tarai forests in terms of net saw log-volume. The net saw log-volume is defined as the volume to an eight-inch-top diameter outside bark of trees of merchantability class-one and class-two, from which exterior and interior defects have been deducted. Total defects accounted for about 7.8% of gross saw-log volume. Most of this deduction for defects occurs in merchantability class-two trees. Similar statistics for hill region forests are available in the source already quoted. The total defects as deducted from the gross saw log-volume in the Hill region accounted for only 2.5 per cent of gross volume. The higher deduction share for defects in Tarai area indicates that a higher share of merchantability class-two trees exists here as compared to those in Hill region. The total net saw log volume can be estimated to be about 5075 million cubic feet, which is distributed between Tarai and Hill regions in the shares of 46% and 54% respectively. The details of forest statistics as could be established from the above sources have been presented below in Table 4.9. In this table, we have also shown the shares of commercial forest land for three zones: Eastern Hills, Central Hills and Western Hills, of the total Hill region by the forest types. But such details are not available for the Tarai belt. The only statistics that

Table 4.9: Shares of net sawlog volume of commercial forests and area under commercial and all forests in Nepal by broad zones.

Forest types	% Share of commercial forest land				% Share of net sawlog volume							
	EH	CH	WH	Total Hill region	EH	CH	WH	Total Hill region	Total Tarai region	Hill & Tarai region	Moun-tains	All Nepal
Sal	24.95	26.45	9.39	20.70	17.5	23.2	4.7	13.7	56.7	33.5	-	33.5
Asna	-	-	-	-	-	-	-	-	15.9	7.3	-	7.3
Chirpine	9.05	14.98	26.10	16.70	3.7	17.6	26.6	16.7	0.5	9.2	-	9.2
Blue pine	0.84	0.12	5.95	2.15	0.9	-	5.7	2.7	-	1.5	-	1.5
Oak	7.34	5.42	14.09	8.68	6.7	9.7	10.6	9.1	-	4.9	-	4.9
Fir	5.94	0.91	4.18	3.41	32.9	9.4	26.1	24.0	-	13.0	-	13.0
Hemlock	2.50	0.65	0.91	1.28	12.7	5.1	5.9	7.9	-	4.3	-	4.3
Lower slope hardwood	29.34	40.87	16.20	29.79	9.6	21.6	8.2	12.2	17.3	14.5	-	14.5
Upper slope hardwood	18.44	8.91	0.73	12.28	15.2	13.1	9.6	12.3	-	6.6	-	6.6
Mixed varieties	1.60	1.69	12.45	5.01	0.8	0.3	2.6	1.4	9.6	5.2	-	5.2
All types	100.00	100.00	100.00	100.00	100.00	100.0	100.0	100.0	100.0	100.0	-	100.0
Commercial forest area (ha)	-	-	-	-	362,480	485,303	382,854	1,230,637	818,600	2,049,237	-	2,049,237
Total forest area (ha)	-	-	-	-	1,058,471	1,435,808	1,084,621	3578,900	1,090,000	4,668,900	154,100	4,823,000
Total geographical area ('000 ha)	-	-	-	-	1,927	2375	1,840	6,142	3267	9409	4799	14,208
% total forest area to geographical area	-	-	-	-	54.93	60.45	58.90	58.27	33.36	49.62	3.21	33.95
% of commercial to total forest area	-	-	-	-	34.25	33.80	35.30	34.39	75.1	43.89	0	32.86
					81	20.43	20.81	20.04	25.06	21.78	0	14.42

we can establish for certain breakdowns of Tarai belt are on the proportion of geographical area under commercial forests. The statistics on Tarai forests that are available in the publications of agricultural statistics of Nepal [1977] are truely not meant for the pure Tarai region, because the forests divisions included therein include parts of neighbouring Hill regions, also, [for this reason] the so-called Tarai forests considered by Earl [1975] is really an over-estimate for the true Tarai area. However, the CEDA [1981] gave some estimates of the percentage shares of commercial forest land to total geographical area for most of the Tarai districts (18 in number). Using them and also the local knowledge as available for different Tarai districts, we can reasonably give reliable estimates for three parts of Tarai belt, namely, eastern Tarai area (8 eastern most districts), western Tarai area (5 western most districts), and central Tarai area (7 central districts in between the above areas). These statistics are as given below in Table 4.10 :

Table 4.10 : Estimated area under commercial forest in Tarai area.

Item	Eastern Tarai (8 dists)	Central Tarai (7 dists)	Western Tarai (5 dists)	Total Tarai region
Total commercial forest area (in hectares)	121,514	320,190	376,896	818,600
Total geographical area (in '000 hectares)	1089	1157	1021	3267
% of commercial forest area to geographical area	11.16	27.67	36.91	25.06

From the estimates given above, we notice that interms of total forest land the Hill region has wider forest cover than those of Tarai region (58% in Hill region as against 33% in Tarai region), but the commercialisation of forest resources has taken place substantially in Tarai region (75%), but not so much in Hill region (only 34%). As a result the Tarai region has a higher percentage of the geographical area under commercial forests than those of Hill region (25% in Tarai region as against 20% in Hill region). The three parts of the Hill region, namely Eastern Hills, Central Hills and Western Hills do not show much variation in terms of forest-cover, nor in terms of the percentage under commercial forests. But there are wide variations among the three parts of the Tarai region, namely, Eastern Tarai, Central Tarai and Western Tarai, in terms of the shares under the commercial forest land. The Western Tarai has the maximum share of about 37%, the Eastern Tarai has the minimum share of about 11%, while the Central Tarai has a share of about 28% . The shares of total forest covers is likely to be in similarly increasing order from the Eastern Tarai towards west. Something like half of total geographical area is likely to be under forest-cover in the western Tarai, about one third in the central Tarai and about a fifth or sixth in the eastern Tarai. We have already noted that the vast Mountain region has very negligible forest cover, only 3% or so, which does not have much commercial value. Regarding the types of commercial forests as judged by the net sawlog volume, Sal is the most important species grown in Nepal which is predominantly available in Tarai region. We have alread noted much of this species is the source of export earning for Nepal. Hill region also grows this species, but only 14% of all commercial sawlog volume, while more important varieties there are Fir (24%) and Chirpine (17%). But, interestingly, the shares of commercial forest land under these species do not follow the similar pattern in the Hill region. In terms of the shares of commercial forest land in Hill region, Sal is more important than Fir (27% for Sal as against 3.4% for Fir). This shows the importance of commercial value of Fir under limited land utilization. The eastern Hills has however the maximum share of both net sawlog volume and forest land under Fir. The western Hills is next important in this respect while the central Hills is not that important in Fir production. The western Hills is most important in respect of Chirpine, while the central Hills is most important in respect of Sal. Other details are available in the Table 8. Though most commonly found timbers species in Nepal is Sal (shorea robusta) it is rather slow growing and at 80 years can be expected to have a breast height diameter of 50 centimeters. But in contrary with it Semal (Bombax malabaricum) a variety of lower slope hardwood at 40 years can be expected to reach diameter of 75 centimeters at breast height. The forest of Tarai area have been renowned for the production of high grade Sal timber which is mostly exported to India as round logs.

According to Earl's analysis [1975], exotic epecies for example, Eucalyptus tereticomis and Tectona grandis are capaple of very fast growth. Experiments can be undertaken with these kinds of fast growing species by the Forest Department. In this context, as Griffin [1979] points out "the Eucalyptus leaves can be a source of valuable oils", but this fact has not been seriously considered by the forest planners in Nepal.

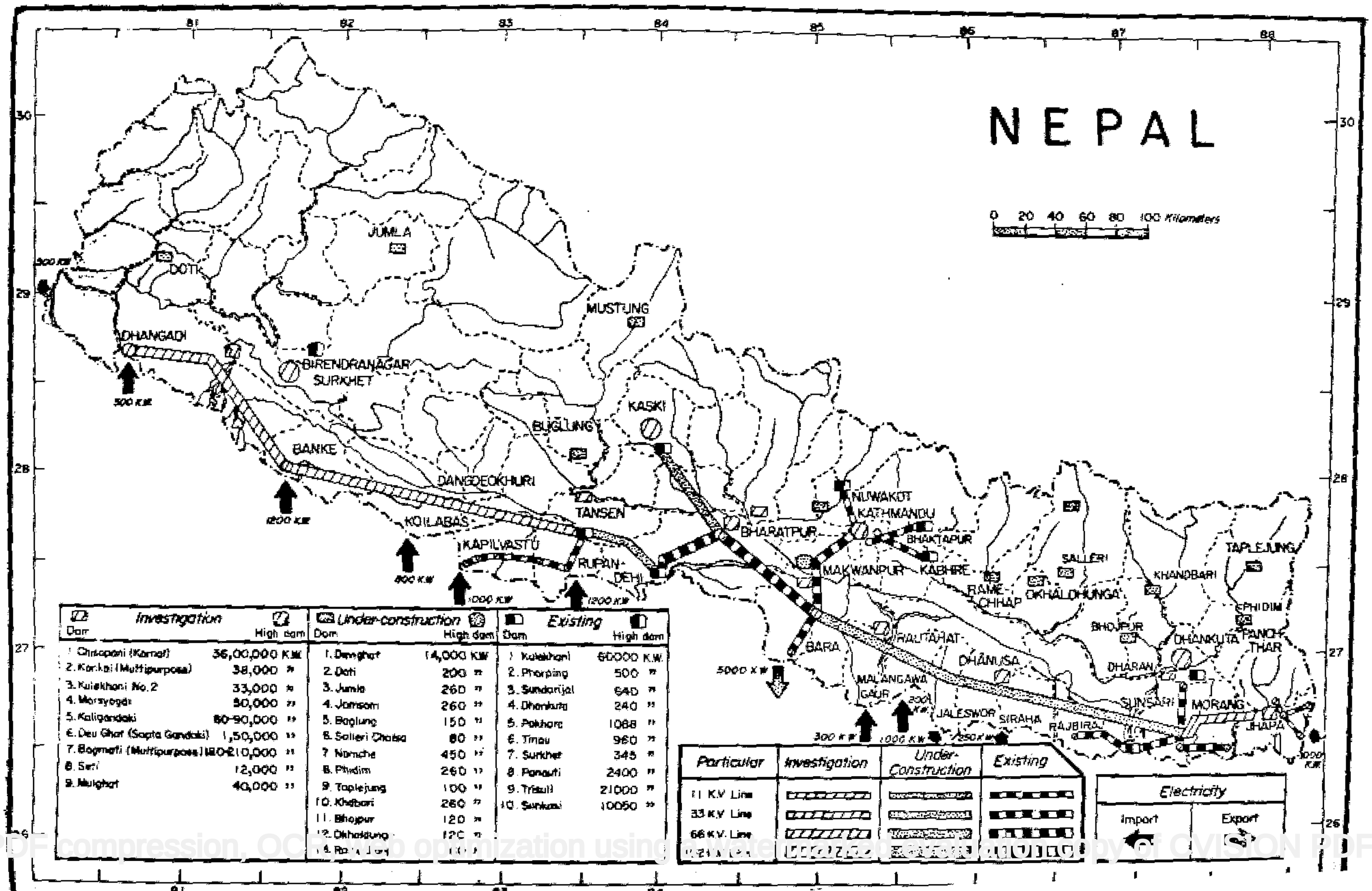
It should be kept in mind that forest fuel is renewable likewise the hydel-power. With the gradual worldwide depletion of fossil fuel, one is confronted with the problem of proper planning for renewable engergy resources. It is unfortunate that the destruction of tropical forests in developing countries like Nepal is accelerated as soon as economic growth is initiated from the stage of primitive agrarian structure. This unfortunate situation must be arrested by the institution of suitably planned economic developement with due recognition of the need for a sustained growth of renewable fuel resources, not only for the supply of energy required by the increasing number of people and their economic activities but for the maintaince of certain ecological balance of the physical environment in which the people have to live. The return to the old ecological balance will however be impossible. But even to have certain rational structure of a new ecological balance two changes seems to be essential: first, the production of forest resources must be increased and second, their utilization should become more economical.

4.5.2 Water Resources.

We have just mentioned in the last sub-section that the hydropower potentiality of the country should be exploited adequately as an alternative source of fuel and energy to meet the growing demands of the people of Nepal as a sort of a long term objective. Moreover, we have also shown in Chapter III that the extent of use of electricity and power has contributed significantly towards explaining the spatial variation in industrialisation. Thus granting that the availability of power and energy is a prerequisite towards the localisation of industries, further attempts should be made to harness the abundant water resources to produce hydel power for an enhanced industrialisation in Nepal. The entire country is full of perennial rivers, big and small, originating from the high Himalayan regions and flowing to the southern low land of Tarai region with enormous discharge of water and at places with high velocity. The Department of Electricity has estimated the hydropower potentiality of the country at 83 million kw [refer: Hydropower potentiality of Nepal, Dept. of Electricity, HMG/N, 1971].

Though the hydropower potentiality is very high, the actual power generation is at rock bottom. At present Nepal has a total power generation of only 110 megawatts computed from the data provided in World Bank [1979b] as against the estimated potential of 83 million kilowatts. Of the total hydel power generated domestically, more than 90 per cent is connected with the central distribution system (Kathmandu - Birganj - Hetauda) alone. The power demands of the border towns and industrial areas in Tarai have been met considerably with the power imported through transmission line from India under a power exchange programme. The details of the existing power development and distribution as prepared by the Dept. of Electricity is reporduced here in figure 4.6. From this figure one can notice that the transmission lines, existing or under extension, are serving mostly the central capital region and the Tarai belt. No wonder that existing industrialisation is also spread over these areas. With the foreseeable power development schemes, the World Bank report indicates that the total capacity will increase to 0.25 - 0.30 million kws. by 1990 [World Bank 1979b]. As fuelwood accounts for more than 90% of Nepal's energy use continued encroachment into the forest for fuelwood is inevitable. The only way to protect the forests and thereby reducing the landslides and soil erosion is to develop energy which can be substituted for fuelwood. At present, small scale hydropower development seems quite feasible in Nepal for local short range uses. An enhanced supply of hydroelectric power in the densely populated rural areas might be expensive, but it will releive some of the pressures being placed on the local forest resources used as fuel. If the hydelpower is to be provided as a substitute for the forest resources used as fuel the estimated generation capacity by 1990 as predicted by the World Bank [1979b] seems to be quite inadequate. So it is necessary to make investigations towards identifying the fruitful locations of hydelpower potentials and take necessary planning measures to tap this resource where it is economically feasible.

So far, we were discussing about one aspect of water resource development in Nepal namely, hydroelectric power development. Another most important aspect of it is irrigation. The potential of irrigable land area in Nepal is believed to be quite high. According to one estimate of national planning commission in 1968, as much as 90% of the present land of the Tarai can be brought eventually under irrigation by utilising the country's water resources [CEDA, 1981]. But inspite of high potentiality, the national efforts for large scale irrigation development in Nepal has not been adequate with the consequence of the stated stagnancy in agricultural production. Prior to first Five Year Plan (1956-61) some 14700 ha of land was under irrigation. During First Five Year Plan, Second Five Year Plan, Third Five Year Plan and Fourth Five Year Plan, some 17200 ha, 26500 ha, 44310 ha, and 52269 ha of land respectively were brought under irrigation. The target for the Fifth Five Year Plan period (1975-80) was to provide irrigation facilities to 146000 ha of land. Though the accomplishment of this plan period was not clear, it is believed that as of 1980 some 250,000 ha of land should have come under irrigation from government efforts. Apart from this about 157000 ha of land in the country is believed to be under year round irrigation from traditional irrigation system called kulo developed by farmers


NEPAL
0 20 40 60 80 100 Kilometers
JUMLA
DOTI
DHANGADI
BIRENDRANAGAR
SURKHET
MUSTUNG
KASKI
BUGLUNG
BANKE
DANGDEOKHURI
TANSEN
KOILABAS
KAPILVASTU
RUPAN-
DEHI
BHARATPUR
NUWAKOT
KATHMANDU
BHAKTAPUR
MAKWANPUR
KABHRE
RAME-
CHHAP
OKHALDHUNGA
SALLERI
KHANDBARI
TAPLEJUNG
PHIDIM
PANCH-
THAR
BHOJPUR
DHANKUTA
DHARAN
SUNSARI
MORANG
JHAPA
RAJBIRAJ
SIRAHA
JALESWOR
DHANUSA
RAUTAHAT
BARA
MALANGAWA
GAUR
500 KW
1200 KW
800 KW
1000 KW
5000 KW
300 KW
250 KW
Investigation
Dam
High dam
1. Chisopani (Karnali) 36,00,000 K.W.
2. Konkai (Multipurpose) 38,000
3. Kulekhani No. 2 33,000
4. Marsyagdi 50,000
5. Kaligandaki 60-90,000
6. Deu Ghat (Sapta Gandaki) 1,50,000
7. Bagmati (Multipurpose) 180-210,000
8. Seti 12,000
9. Mulghat 40,000
Under-construction
Dam
High dam
1. Devighat 14,000 K.W.
2. Doti 200
3. Jumla 260
4. Jomsom 260
5. Baglung 150
6. Salleri Chaksa 80
7. Namche 450
8. Phidim 260
9. Taplejung 100
10. Khdbari 260
11. Bhojpur 120
12. Okhaldung 120
Existing
Dam
High dam
1. Kulekhani 60000 K.W.
2. Pharping 500
3. Sundarijal 640
4. Dhankuta 240
5. Pokhara 1088
6. Tinau 960
7. Surkhet 345
8. Panauti 2400
9. Trisuli 21000
10. Sunkosi 10050
Particular
Investigation
Under-Construction
Existing
11 K.V. Line
33 K.V. Line
66 K.V. Line
Electricity
Import
Export

themselves from the time immemorial [CEDA, 1981]. This makes the irrigated land area of the country of about 17.50 per cent only of total cultivated area which is not adequate with reference to the country's needs.

As Nepal is an agricultural country, the agricultural sector has to get priority in order to enhance the economic development of the country. The production of agriculture especially foodgrain has to be increased to meet the needs of the growing population. So it becomes imperative to tap fully the irrigation potentials of the country so that it is possible to adopt the intensive methods of cultivation towards achieving agricultural prosperity. According to CEDA [1981], the irrigation potential lies basically in two different areas of the country namely, small scale or minor irrigation in the hills and mountains, and large scale or major irrigation in the Tarai. In fact the irrigation master plan 1970 states that the aboundant flow of major rivers in Nepal could be used for commanding irrigable areas by about one million hectare in Tarai and 200,000 ha in hilly regions. As less than one fourth of the cultivated area lies in hills and mountains with more than fifty per cent of the country's population, this region has been always a food deficit region. So the importance of irrigation cannot be over-looked in this region also, if feasible. In future whenever cheap hydroelectric power becomes available, there is a vast scope of irrigation of these areas by lifting water from the nearest point of a river instead of having uneconomical long stretch of canal through the risky-steep hill slopes. But in the case of high and steep mountain region a pond irrigation system can be developed by controlling numerous ponds which shall be filled with surplus monsoon run off and utilised during the dry period.

Tarai is a foodgrain bowl of Nepal. More than 70% of country's cultivated land lies in this region. If Tarai agriculture does not flourish, the people of the Hills and Mountains as well will have to suffer without the necessary supply made available from the surplus of Tarai agricultural outputs. Thus the vast potential of water resources that exists in Tarai (see fig. 4.8) have to be tapped scientifically to the full capacity to meet the water needs of the agricultural activities in Tarai. According to CEDA [1981], the following irrigation system can be thought of for Tarai : (a) simple diversion irrigation system, (b) regulated storage dam irrigation system, (c) long diversion tunnel irrigation system, (d) regulated storage dam and long diversion tunnel irrigation system, and (e) lastly, where hydropower is cheaply available and where surface water resource is either insufficient or costly to develop, ground water lift irrigation system can prove economical alternative. Some feasibility, studies have to be made right now towards developing irrigation prospects, otherwise the the country as a whole might have to face the perpetual starvations.

4.5.3 Mineral Resources

Nepal is yet to make extensive surveys to have a detailed knowledge at micro-level on the rock types and associated deposits of mineral resources. The current mining activities in the country are limited to only the infermittently worked copper mines from the olden ages, some largely primitive style mining of certain industrial minerals and some small scale mining of certain construction materials. This negligible level of mineral development is clearly reflected by the following mineral statistics in 1973-74 (see Table 4.11) at which year the highest mining revenue was realised in recent years (between 1969-70 to 1978-79).

Table 4.11: Production and revenue of minerals in 1973-74.

Minerals	Unit of measurement	Production in 1973-74
A. Metallics		
1. Copper (metal)	tonne	3.20
B. Non-Metallics (Industrial)		
1. Beryl crystal	tonne	0.14
2. Clay (white and yellow)	tonne	14.00
3. Garnet	tonne	4.00
4. Mica (crude)	tonne	4.00
5. Ochre	tonne	2.00
6. Salt	tonne	96.00
7. Talc	tonne	252.00
C. Non-Metallics (construction)		
1. Boulder and Gravels	thousand cu.m.	31.70
2. Construction Stones	thousand cu.m.	134.30
3. Limestone	thousand cu.m.	1.90
4. Marble Chips	tonne	85.00
5. Marble Craggy	sq.m.	833.00
6. Marble Slab	sq.m	14910.00
7. Paving Stone	thousand sq.m.	167.40
8. Slate	thousand sq.m.	80.40
Mining Revenue	Rs.	744,341

Source: Dept. of Mines and Geology, Kathmandu (Nepal) as referred in CEDA [1981].

Pending the detailed knowledge, the Dept. of Mines and Geology has however tried to infer on the minerals - prospects of the country by broad locations [refer CEDA 1981] which will be used below in our analysis. A map showing the locations of possible mineral deposits as worked out by the said department is also reproduced here in fig. 4.8 .

On the basis of Nepal's geological formations, its territories can broadly be divided into four divisions: (i) the great Himalayas, (ii) the middle ranges or lesser Himalayas, (iii) the Churia Hills linked with Siwaliks, and (iv) the outer Tarai belt (refer to fig. 1.1). The present knowledge of the geology of Nepal indicates that the Churia - Siwalik Hills are the product of erosion of the earlier phases in the Himalayan orogeny or mountain building process, usually of ill - consolidated sedimentary rocks and little folder by subsequent earth-movement. Lightening of the earth's crust had resulted from the massive erosion as the mountain building proceeded. There were, too, negative gravity anomolies where folded sediments of comparatively low mass had been thrust deep down below the roots of Himalaya. That is, great columns of the earth's upper crust in the long Himalayan belt had lower gravity than normal, and much lower gravity than the deep or hypabyssal rocks rich in iron, manganese and heavy metals. The combined upward force of these two factors caused 'isostatic uplift' to which the present great altitudes of the Himalayan peaks is attributed that is upward adjustment of lighter

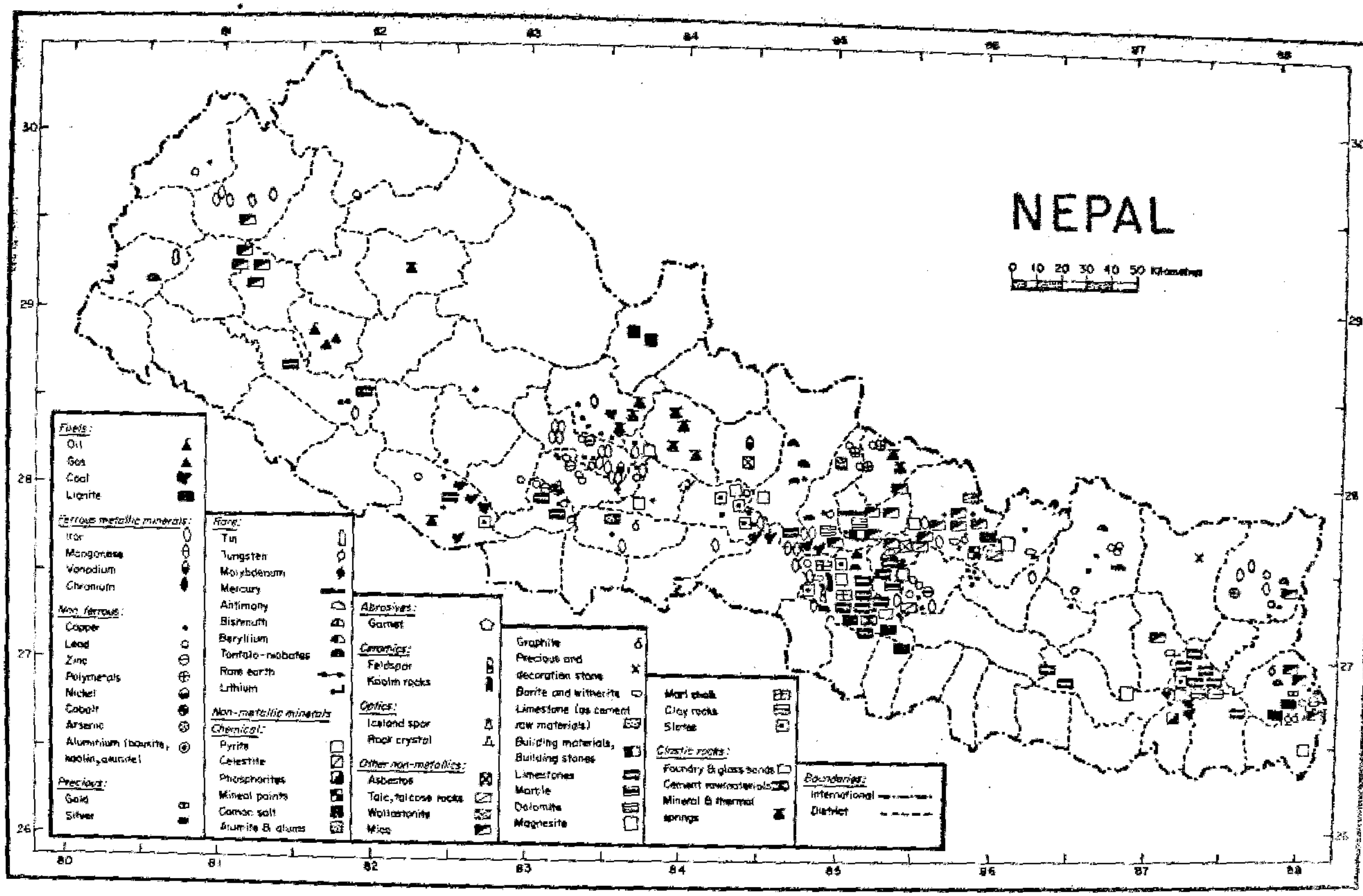


FIG- 4·7: LOCATION OF MINERALS

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columns of the earth's crust insitu (as contrasted with mountain building due to convergence of crustal plates which is thought to have dominated in the earlier phases of the orogeny). The significance of all these for mineral resource is that different minerals are to be expected in recent alluvium as in the Tarai, in lightly folded sedimentary rocks as in Churia/Siwalik Hills and in much folded rocks as in the Lesser and Greater Himalaya, especially where great heat and pressure have been generated by the earth's movements to cause metamorphosis of the rocks, or where magma (upward migrating ions) from the earth's interior have again caused metamorphosis of the Himalayan rocks. Lastly there are particular minerals associated with places where erosion perhaps in deep gorges or the like, has cutdown into the very roots of the mountains, revealing the rocks termed hypabyssal (often rich in iron and manganese and often too characterised by very large crystals on various minerals - show cooling at depth being associated with larger crystalline forms as compared, say, to lava poured out at the earth's surface and cooling quickly).

In the rest of this section, we shall try to clarify further the relationships between the four main zones noted above and the existing minaral exploitation and future potential of mineral based industry. In the key to the map (fig. 4.7) on minerals, the Department of Mines and Geology has, very reasonably, grouped the symbols such as fuels, ferrous (metallic) minerals, non-ferrous metallic minerals, precious minerals, rare minerals, non-metallic minerals of several types and so on. Given the number of symbols it is difficult to see any general pattern, if there is any, or even to make much of regional groupings that exist. Another approach that affords some insights is to regroup the mineral names in the key, and the symbols, according to the types of rocks in which they are found. Thus :

Recent alluvium - dominant in Tarai zone (but the related minerals are not shown in the fig. 4.7). The minerals available are sands, gravels (some with small to medium boulders) for road metal building purposes etc., clays for brick making, occasional impure peats and iron or bauxite in fossil soils.

Sedimentary rocks other than recent - lightly folded rocks, predominantly in the Churia/Siwalik zone and also in places in the middle Ranges and the Great Himalayas. The associated minerals are petroleum, gas, coal, lignite, aluminium minerals, low grade iron ores, pyrites, celestite, phosphorites, limestones for cement, building stones, other limestones, dolomite (magnesium limestone), foundary and glass sands, cement raw materials as a group, salt, marl chalk and clay rocks, and also some road metal (i.e., some limestones).

Metamorphic rocks - these grade from lightly folder sedimentary rocks to the roots of former and long worndown mountains ranges as in the 'oldlands', referred to in Chapter I, with Archaean (geologically very ancient) schists grading with increasing degrees of granitisation into gneisses and then granites, minerals are sometimes at contact zones between metamorphic and sedimentary rocks, or in veins in sedimentaries (though these can occur in any rock type, even in crystalline rocks like granite as a result of later mineralisation after the granites had formed). The minerals likely to occur include iron (notably high grade ores like haematite and magnetite), copper, lead, zinc, polymetals, cobalt, arsenic, gold, silver, tin, molybdenum, mercury, antimony, bismuth, garnet, feldspars, wollastonite, asbestos, mica, graphite talc, barytes, marble, magnesite and slates and also building stone and road metals.

Igneous rocks - (extrusive like lavas, but in Nepal mainly intrusive like granites, etc.). Apart from their association with vein minerals and other mineralisation in the rocks already dealt with, the main occurrences are in ornamental stone like some of the granites and gabbros, and after breaking into chips, as yielding the best road metal and aggregate for concrete.

Hypabyssal rocks - similar to igneous rocks but tending to be rich in iron and manganese minerals, and in large crystals so that very large flake-like crystal of mica, for instance, on rock crystals or feldspars are more likely to be exploitable where there are outcrops of hypabyssal rocks leading to unweathered deposits at workable depths.

Although we do not get broad regional picture of different minerals in fig. 4.7, the locations of existing and prospective mineral deposits are shown in this figure on the basis of present knowledge. But from this figure, we do not have any idea on the quantitative magnitudes of the mineral deposits. To supplement the information on the locations of occurrences with quantitative and qualitative data on mineral deposits and explorations we make the following tabular analysis in Tables 4.12 and 4.13. In Table 4.12, the known mineral resources at various stages of development have been indicated, while in Table 4.13 mine-showing and occurrences have been indicated on the basis of knowledge gained through explorations by the authorities in Nepal. In these tables, the mineral data are presented by districts occurring in the cross -sections of three geological regions like (i) Mountaints (M), (ii) Hills (H) and (iii) Tarai (T) and also the seven Food Distribution Zones (FD Zones) that have been discussed already in Chapter II; the zone numbers used are increasing from the East to West of Nepal. The use of geological regions is self-explanatory. The use of FD zones is to see how far the activities other than agriculture could be developed in each zone so that some kinds of trade relations between agricultural and non-agricultural products might possibly be developed; the logic behind this view is that the Hills and Mountains with limited agricultural prospects should have more of non-agricultural activities to develop the purchasing power needed to meet the agricultural requirements.

Table 4.12: Known mineral developments and prospects in Nepal.

Food distribution Zone	District	Mineral deposit	Remarks for minerals: Under current productions or development	Known economic deposits (near future exploitation expected)	Sub-economic deposits (further investigations needed)
(1)	(2)	(3)	(4)	(5)	(6)
Mountains					
Zone 2 (M)	Solokhumbu	Copper deposit (Wapsakhani)	-	-	1.74 million tonnes of 0.88% copper resource, 14 m wide & 270 m long.
Zone 3 (M)	Rasuwa	Zinc lead deposit (Ganesh Himal.)	469,000 tones of proved ore & 513,000 tonnes of probable ore containing 10.98% zinc, 1.53% lead & some cadmium & silver. A joint venture project to mine & mill 400 tonnes of ore per day is under implementation.	-	-
Zone 3 (M)	Sindhupalchowk	Magnesite deposit (Kharidhunga)	180 million tonnes of magnesite with 66 million tonnes of refractory grade. A joint venture project to produce 50,000 tonnes of dead burnt magnesite per year at Lamusangu followed by 20,000 tonnes of magnesite bricks at Birganj is under implementation.	-	-
Zone 3 (M)	Sindhupalchowk	Talc deposit (Kharidhunga)	303,000 tonnes of proved talc resources proposed to be extracted & marketed in conjuction with the magnesite project mentioned above.	-	-

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(1)	(2)	(3)	(4)	(5)	(6)
Hill					
Zone 1 (H)	Bhojpur	Copper deposit (Chhiriling-khola)			Tonnage not yet available, believed to be small tonnege & sub-economic grade, exploration still active.
Zone 2 (H)	Udayapur	Limestone deposit (Udayapur)	61.26 million tonnes of proven chemical grade limestone to a maximum depth of 510 m. A Nepal India joint venture to set up a 3,000 tonnes per day capacity cement plant had been decided but yet to be implemented.	-	-
Zone 2 (H)	Udayapur	Dolomite deposit (Udayapur)	-	4.84 million tonnes of proven dolomite	-
Zone 2 (H)	Udayapur	Copper deposit (Kurule)	-	-	0.30 million tonnes of 1.0% copper resource.
Zone 2 (H)	Udayapur	Magnesite deposit (Kamphu-ghat)	-	-	20 million tonnes of medium to low grade magnesite resource upto Sunkoshi river level.
Zone 2 (H)	Ramechhap	Iron ore deposit (Thosay)	-	-	8 million tonnes of 30.65% metal grade resource.
Zone 3 (H)	Kathmandu	Limestone deposit (Chobhar)	15.3 million tonnes of proved & probable limestone to a mining depth of 60 m. A 150 tonnes per day capacity cement plant is under production since 1975.	-	-

Contd.....

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(1)	(2)	(3)	(4)	(5)	(6)
Zone 3 (H)	Lalitpur	Iron ore (Phulchowki)	-	10 million tonnes of total resources (proved probable & possible) with 54-58% iron. Feasibility of 50,000 tonnes per year capacity mini steel plant has been indicated but not sufficiently established to justify capital investment decision.	-
Zone 3 (H)	Lalitpur	Marble (Godavari)	A probable reserve of 246,000 m^3 of white marble, 130,000 m^3 of brown marble & 248,400 m^3 of pink marble, presently operated.	-	-
Zone 3 (H)	Dhading	Limestone deposit (Jogimara)	0.95 million tonnes of proven & 2.65 million tonnes of probable chemical grade limestone in two sections seperated by Trisuli river being worked out.	-	-
Zone 3 (H)	Makawanpur	Limestone deposit (Bhaise-dobhan)	8 million tonnes of proven cement grade limestone to an average mining depth of 60 m. A 750 tonnes per day capacity cement plant is under construction at Hetauda(HCI).	-	-
Zone 3 (H)	Makawanpur	Limestone deposit (Okharc)		10.14 million tonnes of proven cement grade limestone as backup reserve for long term sustenance of HCI.	-

Contd.

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(1)	(2)	(3)	(4)	(5)	(6)
Zone 3 (H)	Makawanpur	Silica sand (Karrakhola)	-	About 3 million tonnes of silica sand suitable for ordinary glass making, foundry & fluxing.	-
Zone 3 (H)	Makawanpur	Copper deposit (Kalitar east)	-	-	1.12 million tonnes of 0.5% copper resource, 3 m wide & 500 m long, or 90,000 tonnes of 1.5% copper resource 1.5 m wide & 200 m long.
Zone 3 (H)	Makawanpur	Copper deposit (Kalitar west)	-	-	0.27 million tonnes of copper resource, 1.5 m wide & 350 m long.
Zone 3 (H)	Makawanpur	Lead-zinc deposit (Khairang)	-	-	1.54 million tonnes of 2 % combined lead-zinc resource, 3.8 m thick & 900 m long or 0.44 million tonnes of 4% combined lead-zinc resource, 1.1 m thick & 900 m long.
Zone 3 (H)	Makawanpur	Kaoline deposit (Daman area)	-	-	0.56 million tonnes of weathered granite averaging.
Zone 3 (H)	Makawanpur	Kaoline deposit (Tistung)	-	-	0.92 million tonnes of weathered granite averaging 11% clay.
Zone 4 (H)	Tanahu	Copper deposit (Bhutkhola)	-	-	0.21 million tonnes of 1% copper resource.
Zone 4 (H)	Tanahu	Iron ore deposit (Labdikhola)	-	-	1.08 million tonnes of 38% metal grade resource.
Zone 4 (H)	Baglung	Copper deposit (Pandav Khani & Kala Khani)	-	-	Tonnage & grade estimates not yet available, believed to be small tonnage & sub-economic grade, exploration still active.
Zone 5 (H)	Argha-Khanchi	Limestone deposit (Khanchikot)	-	8.26 million tonnes of cement grade limestone resource.	-

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(1)	(2)	(3)	(4)	(5)	(6)
Zone 6 (H)	Surkhet	Limestone deposit (Chaukune)	-	10.4 million tonnes of cement grade limestone resource under active proving.	-
Zone 6 (H)	Surkhet	Limestone deposit (Lakharpata)	-	9.5 million tonnes of cement grade limestone resource.	-
Tarai					
Zone 1 (T)	Jhapa	Copper poly-metallic pyrite deposit (Beringkhola)	-	-	3 million tonnes of pyrite resource with 0.3 to 0.7% combined copper lead-zinc & 12% sulpher; a deposit which purhaps not yet received adequate exploration.
Zone 3 (T)	Chitawan	Iron ore deposit (Jirbang)	-	-	0.8 million tonnes of iron resource of unstated grade.
Zone 3 (T)	Chitawan	Talc (Gaighat)	-	-	13,000 tonnes of Talc resources.

Source: CEDA [1981] : Development of the Himalayan Resources for Regional Co-operation and National Development, Tribhuwan University, Kathmandu (Nepal).

Table 4.13: Inventory of Mineral Explorations in Nepal.

Food distribution zone	District	Mineral deposit	Status of marginal grade mine showings and mineral occurrences: exploration active/or inconclusive	explored to the stage of drilling/or trenching	other minor occurrences and mine-showings
(1)	(2)	(3)	(4)	(5)	(6)
Mountain					
Zone 1 (M)	Taplejung	Gemstone & Garnet deposits (various)	Inconclusive	-	-
Zone 1 (M)	Sankhuwa-sabha	Beryl & Tormaline (various)	Inconclusive	-	-
Zone 2 (M)	Dolakha	Copper (Sikpasorkhani)	Inconclusive	-	-
Zone 2 (M)	Dolakha	Copper (Pandaykhani)	-	Trenching	-
Zone 2 (M)	Solokhumbu	Zinc - Lead (Pangun)	-	Drilling	-
Zone 2 (M)	Solokhumbu	Copper (Lodim Tamakhani)	-	-	Minor occurrence
Zone 3 (M)	Sindhupal-chowk	Mica (Niwangaon)	Inconclusive	-	-
Zone 3 (M)	Sindhupal-chowk	Graphite (Patibhanjyang)	-	Trenching	-
Zone 3 (M)	Rasuwa (various)	Lead-Zinc (various)	Active	-	-
Zone 3 (M)	Rasuwa	Mica (Langtang, Godikang)	Inconclusive	-	-
Zone 7 (M)	Bajhang	Lead-Zinc (Salmor velley)	Inconclusive	-	-
Zone 7 (M)	Bajhang	Mica Pegmatites (various)	Inconclusive	-	-

Contd.....

Contd..... page no.

(1)	(2)	(3)	(4)	(5)	(6)
Hill					
Zone 1 (H)	Ilam	Copper polymetallic (Siddhikhani)	Inconclusive	-	-
Zone 1 (H)	Ilam	Graphite (Parmejung)	-	Tranching	-
Zone 2 (H)	Khotang	Copper (Urleni)	-	Trenching	-
Zone 2 (H)	Sindhuli	Copper (Thapagaon)	-	Trenching	-
Zone 2 (H)	Ramechhap	Lead-Zinc (Dhaminichhap)	-	Trenching	-
Zone 2 (H)	Okhaldhunga	Copper (Jantrekhani)	-	-	Minor occurre
Zone 3 (H)	Kavrepalan-chowk	Copper-Nickel (Bhorle, Nangre & Ningre)	-	Drilling	-
Zone 3 (H)	Kavrepalan-chowk	Copper (Mahadevtar)	-	Trenching	-
Zone 3 (H)	Kavrepalan-chowk	Zinc-Lead (Koptil-Sipale)	-	Trenching	-
Zone 3 (H)	Kathmandu	Beryl Pegmatite (Jagat)	Inconclusive	-	-
Zone 3 (H)	Kathmandu Valley	Peat occurrence (Various)	Inconclusive	-	-
Zone 3 (H)	Kathmandu Valley (South)	Natural gas deposits	Active	-	-
Zone 3 (H)	Lalitpur	Lead-Zinc (Phulchowki)	-	Drilling	-
Zone 3 (H)	Lalitpur	Lead-Zinc (Salledanda)	-	Trenching	-
Zone 3 (H)	Lalitpur	Lead-Zinc (Sankhu)	-	Trenching	-

Contd.....

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(1)	(2)	(3)	(4)	(5)	(6)
Hill					
Zone 3 (H)	Nuwakot	Mica (Chindringkhola)	Inconclusive	-	-
Zone 3 (H)	Nuwakot	Beryl Pegmatite (Katigaon & Panchmane)	Inconclusive	-	-
Zone 3 (H)	Dhading	Copper (Devithan-Deurali)	-	Trenching	-
Zone 3 (H)	Dhading	Copper (Dhusa)	-	Trenching	-
Zone 3 (H)	Dhading	Lead-Zinc (Lebang)	-	Trenching	-
Zone 3 (H)	Dhading	Lead-Zinc (Bhaludanda)	-	Trenching	-
Zone 3 (H)	Makawanpur	Copper (Arkhaula,Kulikhani, Laganbas & Markhu)	-	Drilling	-
Zone 3 (H)	Makawanpur	Copper (Lamakhola-Kitbhanjyang)	-	Drilling	-
Zone 3 (H)	Makawanpur	Copper (Devrali)	-	Drilling	-
Zone 3 (H)	Makawanpur	Copper (Golkhalte)	-	Trenching	-
Zone 3 (H)	Makawanpur	Copper (Sanotar)	-	Trenching	-
Zone 3 (H)	Makawanpur	Copper, Lead-Zinc (Barghare)	-	Trenching	-
Zone 3 (H)	Makawanpur	Copper (Ipakhola)	-	Trenching	-
Zone 3 (H)	Makawanpur	Copper (Agra)	-	Trenching	-
Zone 3 (H)	Makawanpur	Copper (Likhe)	-	Trenching	-

Contd.....

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(1)	(2)	(3)	(4)	(5)	(6)
Hill					
Zone 3 (H)	Makawanpur	Lead-Zinc Antimony (Damar)	-	Trenching	-
Zone 3 (H)	Makawanpur	Lead (Kailash)	-	Trenching	-
Zone 4 (H)	Gorkha	Copper (Gyazikhani)	Inconclusive	-	-
Zone 4 (H)	Gorkha	Copper (Bhumlichok, Archanbas, Kotgaun, Rampur, etc.)	-	-	Minor occurrence
Zone 4 (H)	Tanahu	Copper (Chandauli)	-	Trenching	-
Zone 4 (H)	Tanahu	Copper (Kotthan)	-	Trenching	-
Zone 4 (H)	Tanahu	Copper Lead (Kholakhani)	-	Trenching	-
Zone 4 (H)	Tanahu	Lead-Zinc (Barchyang)	-	Trenching	-
Zone 4 (H)	Tanahu	Copper (Anpu, Bhatterai, Ghaldada)	-	-	Minor occurrence
Zone 4 (H)	Syanja	Copper (Minamkot)	-	Trenching	-
Zone 4 (H)	Myagdi	Gold Placer (Kali Gandaki)	Inconclusive	-	-
Zone 4 (H)	Myagdi	Copper (Okharbot)	-	Drilling	-
Zone 4 (H)	Baglung	Lead-Zinc (Kandebas)	-	Drilling	-
Zone 4 (H)	Gulmi	Lead-Zinc (Kolchibang)	-	Trenching	-

Contd.....

Contd..... page no.

(1)	(2)	(3)	(4)	(5)	(6)
Hill					
Zone 4 (H)	Gulmi	Cobalt-Nickel (Darling Neta, Samar-bhamar & Tamghas)	-	Trenching	-
Zone 5 (H)	Rukum	Copper (Rukumkot)	Inconclusive	-	-
Zone 7 (H)	Dadeldhura	Copper-Tungsten (Melmura-Bamengaon)	Active	-	-
Zone 7 (H)	Dadeldhura	Tin (Medi)	Active	-	-
Zone 7 (H)	Doti	Mica Pegmatites (Various)	Inconclusive	-	-
Tarai					
Zone 1 (T)	Sunsari	Phosphorite (Barahachhetra)	-	Trenching	-
Zone 3 (T)	Chitawan	Zinc-Lead (Darechok-Geolbang)	-	Trenching	-
Zone 3 (T)	Chitawan	Lead-Zinc (Adhamara)	-	Trenching	-
Zone 3	Chitawan	Copper (Dumariya & Sairaling)	-	-	Minor occurrence
Zone 5 (T)	Dang-Deokheri (Dang Valley Tertiary)	Coal occurrence	-	Trenching	-
Zone 5 (T)	Tarai & Lesser Himalayas	Oil & Natural Gas	Active	-	-

Source: CEDA [1981]; Development of the Himalayan Resources for Regional Co-operation and National Development, Tribhuwan University, Kathmandu (Nepal).

From the tabular analysis provided in Table 4.12, it is clear that the known mineral developments and proven prospects are showing mainly in the Hills of Zones 2 and 3. This shows that the past attentions towards developing mineral industries were concentrated in the areas around the capital city of Kathmandu. Even in the recorded inventory of recent mineral exploratory works as shown in Table 4.13, we notice the predomince of similar kind of attentions around the capital. While there are reasons for this choice, it does not corroborate with the regional principle of identifying the entire mineral resource endowment of the country. Thus we may safely conclude that though there are promising occurrences of minerals in the limited area already explored around the capital, much more has yet to be done towards making detailed investigations (possibly with advanced worldwide knowledge and tools) on minerals for a possible development and growth of mineral-based industries. The Tables 4.12 and 4.13 indicate the possible minerals that may have the promise towards this direction. But we do not yet have the fuller knowledge on the mineral resource endowments which can be commercially exploited in different zones over the entire country. Our preceding analysis is only to provide certain guidelines towards further investigations for developing feasible mineral-based industries, so that more and more non-agricultural activities could be created to release labour pressure on arable land. The existing mineral based industries are negligible and they were mainly based on certain purely chance discoveries of minerals in the past [ref. to Karan and Jenkins, 1960]. We learn that some recent investigations are going on in discovering petroleum oil and gas deposi in certain selected locations. The details of which could not b indicated in Table 4.13. However, more of systematic exploratory efforts should now be made in order to understand the real position of Nepal's mineral wealth on which to base possible industrialisation. Nepal is stated to have little known reserves of minerals as observed in the World Bank report [1979a]. But on the basis of our analysis made on the geological formations, the possible associated minerals, the known mineral development and proven prospects (Table 4.12) and also the inventory recorded in Table 4.13 on recent mineral explorations that are going on, one should be more optimistic than what pessimistic conclusions were drawn earlier on the basis of incomplete or yet unexplored information on Nepal's true position of mineral wealth.

4.5.4 Labour Potential

From the 1971 census estimates, we can derive the share of economically active population by districts. For the nation as a whole this share works out to be 48 per cent. The district values of this shares are varying within certain narrow range around the national value, depending upon demographic and economic factors. We shall call the economically active population as the working force or, alternatively, labour force. As population is growing over a time period, the working force will also be growing, maintaining more or less a similar share of labour force to population. If we grant the hypothesis that the share of labour force would remain same over a time horizon under consideration by districts, the increase in labour force is simply a function of population growth rate under the 'ceteris paribus' assumption on demographic and economic factors. It is by this principle we have attempted below for the estimates of the addition to labour force over the time period between 1977-78 and 1989-90 by districts. We have already used the midterm population growth rates (obtained from the district wise populations of the 1971 census and the 1976 survey estimates called the mid-term census) for the purpose of population projections by districts. It is quite a reasonable extrapolation of population for 1977-78, our base year in the chosen time-horizon, obtained by use of the corresponding mid-term rate of growth. If we use the mid-term rates of growth further for 1981 (i.e., 1980-81 year end) for districtwise estimates of population, the aggregate population for Nepal works out to be about 14209 thousands which corresponds to an annual growth rate (geometric) of about 2.1%. But actual 1981 census estimate (provisional) gives a figure of 15020 thousand persons which corresponds to a higher annual growth rate of 2.7% approximately. This higher rate of growth of population can be explained substantially by the immigration of mostly Indian nationals particularly Indian Nepalese during the period: 1978-81, when the question of foreign national issue has been firmly raised by the local people of the far-eastern Indian states. The question of a slight under-estimation of the mid-term rate is not however entirely ruled out. Yet we feel that on the face of attentions now being taken on the family planning measures by the government, the mid-term rates were thought to be good enough for a further projection of population by districts upto the end point of our time horizon chosen, namely 1990 (i.e., 1989-90 year end). Thus our estimate for the population aggregate of Nepal works out to be about 17263 thousands which corresponds to an annual growth rate (geometric) of about 2.3% over the time horizon between 1977-78 and 1989-90. This percentage rate falls in between the two rates of 2.1% and 2.7% obtained earlier. A slightly higher rate of 2.3% than the mid-term rate for the country as a whole takes care of the possible under-estimation of the mid-term rate. This has been possible because of the enhanced multiplier effect of higher geometric growth rates used over longer time-horizon as present in certain Tarai districts of Nepal. Anyway, the population growth rate of 2.3% for Nepal as a whole over our time-horizon seems to be quite reasonable. Now, granting that the 1981 census estimate of population is correct and also that there has been a significant population influx during a short period prior to the 1981 census, in varying magnitudes in different Tarai districts mainly, we have made the necessary adjustments in estimating labour force by districts for 1990. Such an estimate, worked out for each of 75 districts of Nepal, is based on the following algebraic formulations:

Let P_{78}, P_{81} and P_{90} denote the estimates of population for the district under consideration in 1978, 1981 and 1990 respectively. Also let L_{78}, L_{81} and L_{90} represent the corresponding labour forces estimated on the basis of the share of labour force to population, s, as calculated from the 1971 census estimates. Thus we have $L_{78} = sP_{78}$, $L_{81} = sP_{81}$ and $L_{90} = sP_{90}$. If g represents the percentage annual mid-term rate of growth of population, the corresponding annual multiplier of population, m, is then given by: $m = 1 + 0.01g$. Note that we have $m^{12} = \frac{P_{90}}{P_{78}} = \frac{L_{90}}{L_{78}}$ and $m^3 \doteq \frac{P_{81}}{P_{78}} = \frac{L_{81}}{L_{78}}$. If P^*_{81} denotes the actual 1981 census estimate of population, we have the estimate of adjusted labour force of 1990, L^*_{90}, given by: $L^*_{90} = sm^9 P^*_{81}$ Then we shall have $\frac{L^*_{90}}{L_{90}} = \frac{sm^9 P^*_{81}}{sm^9 P_{81}} = \frac{P^*_{81}}{P_{81}}$.

If g^* denotes the adjusted percentage annual growth rate and $m^* = 1 + 0.01g^*$, the corresponding multiplier, we have $(m^*)^{12} = \frac{L^*_{90}}{L_{78}} = \frac{L_{90}}{L_{78}} \times \frac{L^*_{90}}{L_{90}} = m^{12}\left(\frac{P^*_{81}}{P_{81}}\right) = (m\epsilon)^{12}$ (say). Where ϵ is the adjustment factor given by $\epsilon^{12} = \frac{P^*_{81}}{P_{81}}$ Thus $m^* = m\epsilon$

So our mid-term annual multiplier m for each of the districts has been multiplied by the corresponding adjustment factor ϵ for the purpuse of calculation of, L_{90}^{*}. The addition to labour forc during the time horizon ΔL, is given by $\Delta L = L_{90}^{*} - L_{78}$.

It must be mentioned that only the provisional estimates of 1981 census population were made available to us by the courtesy of the Central Bureau of Statistics in March 1982. A comparison of data revealed that the district boundaries as we have been referring to in our study (and in use before 1976) were not followed in reporting the districtwise populations of 1981 census count. As such we had to make the necessary adjustment in these population estimates to tally our district boundaries with the knowledge of area transfers between districts; the aggregate population of Nepal would however remain invariant by this internal adjustment for district boundaries. Thus only after obtaining the comparable population estimate for a district, we have calculated the corresponding labour force adjustment factor ϵ due to population influx. We have recorded in Appendix Table 11 the values of ϵ for all districts only to have an idea in which district a significant population influx has taken place. We have also presented in this table the values of m*, L_{78}, and ΔL. We have mapped m* and the densities of L_{78} and L_{90}^{*} per sq. km. of 1978 gross-cropped area in figures (4.8), (4.9) and (4.10). On the map of m* we have noted the districts by asterisks where significant population influxes are detected through the values of ϵ It should be noted that the value of as estimated for

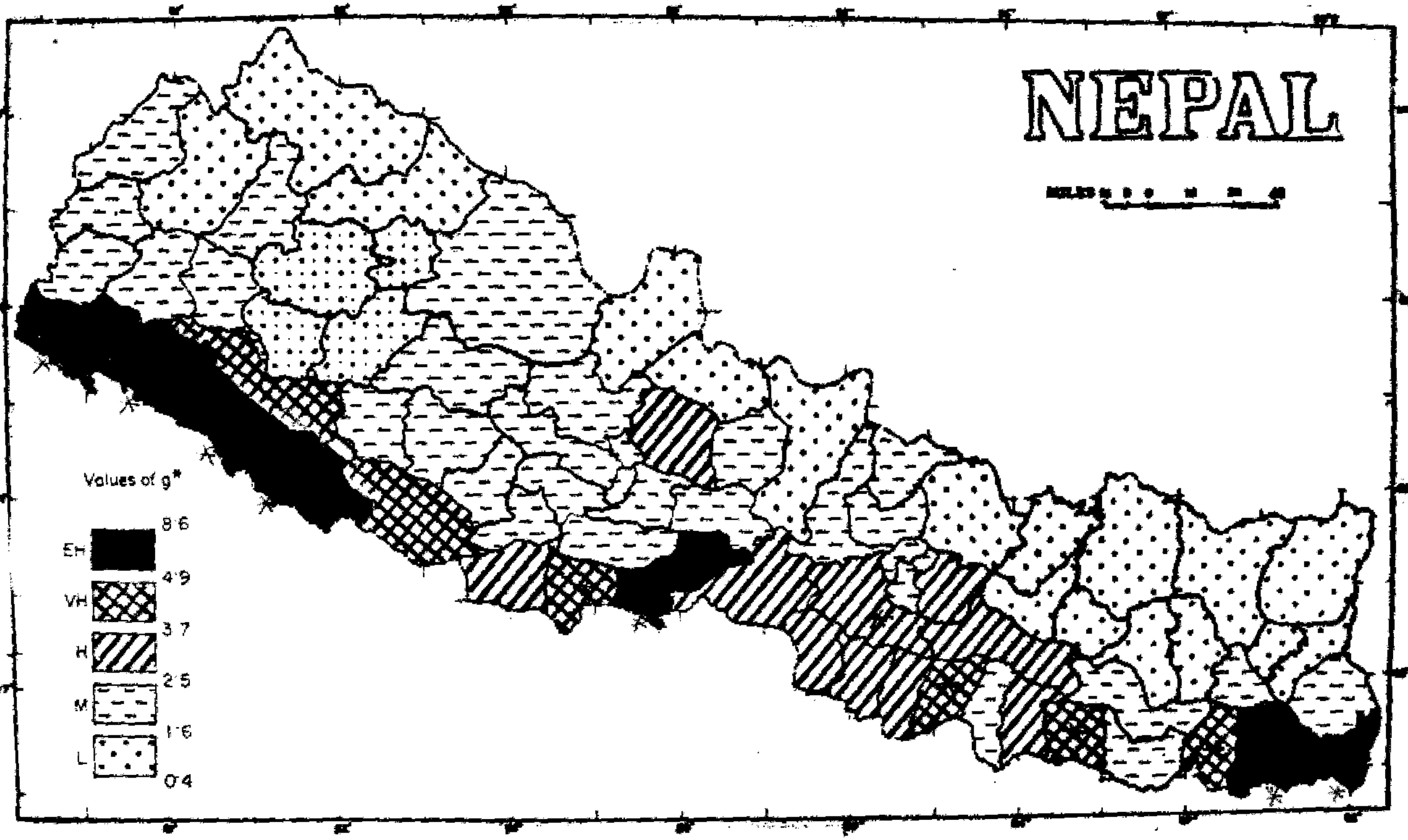

FIG-4·8: PERCENTAGE ANNUAL RATE OF INCREASE OF LABOUR FORCE IN THE PERIOD 1977-78 TO 1989-90 (g*)

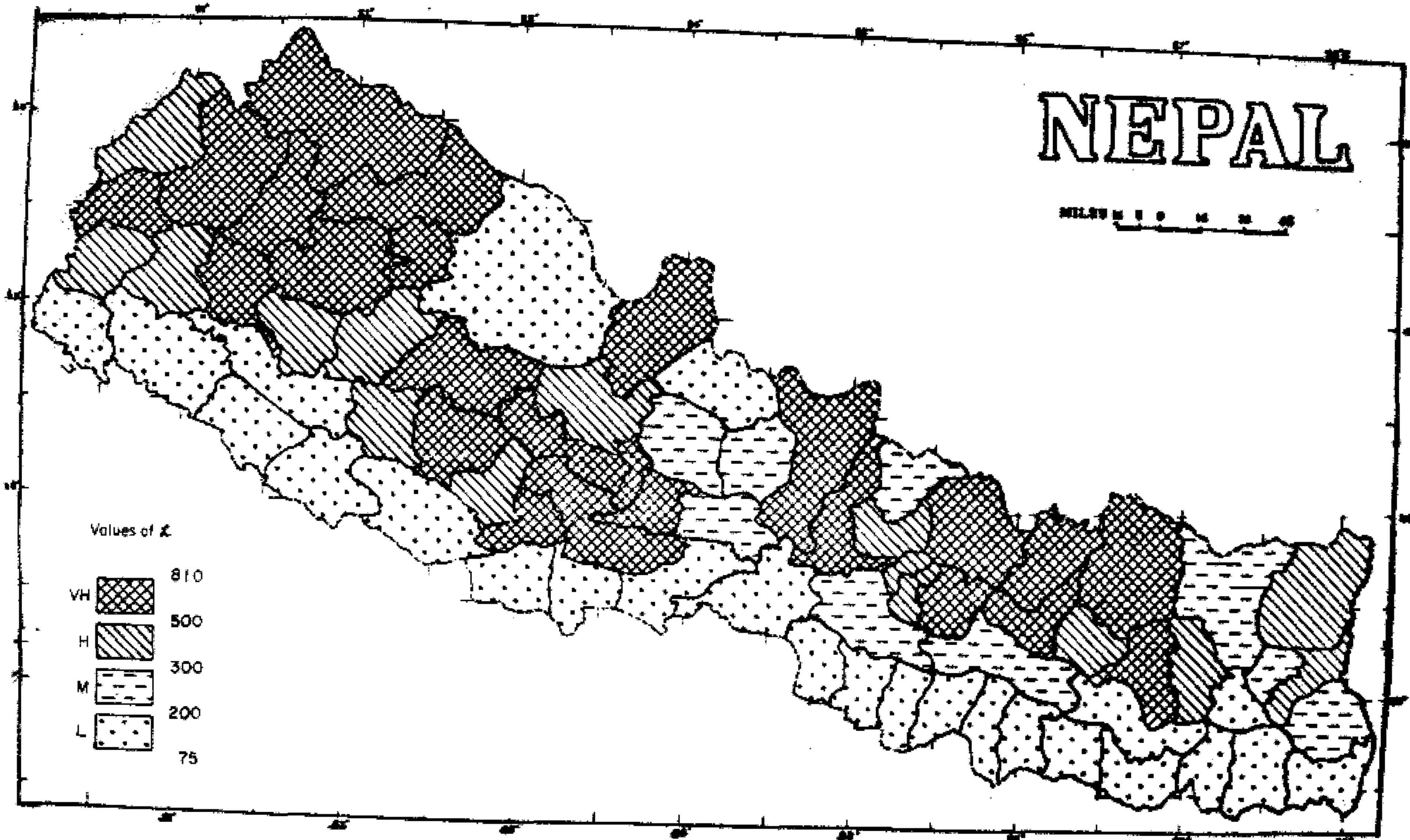

FIG-4·9: ECONOMIC ACTIVE POPULATION PER SQ. KM.
OF GROSS CROPPED AREA IN 1977-78, (∠)

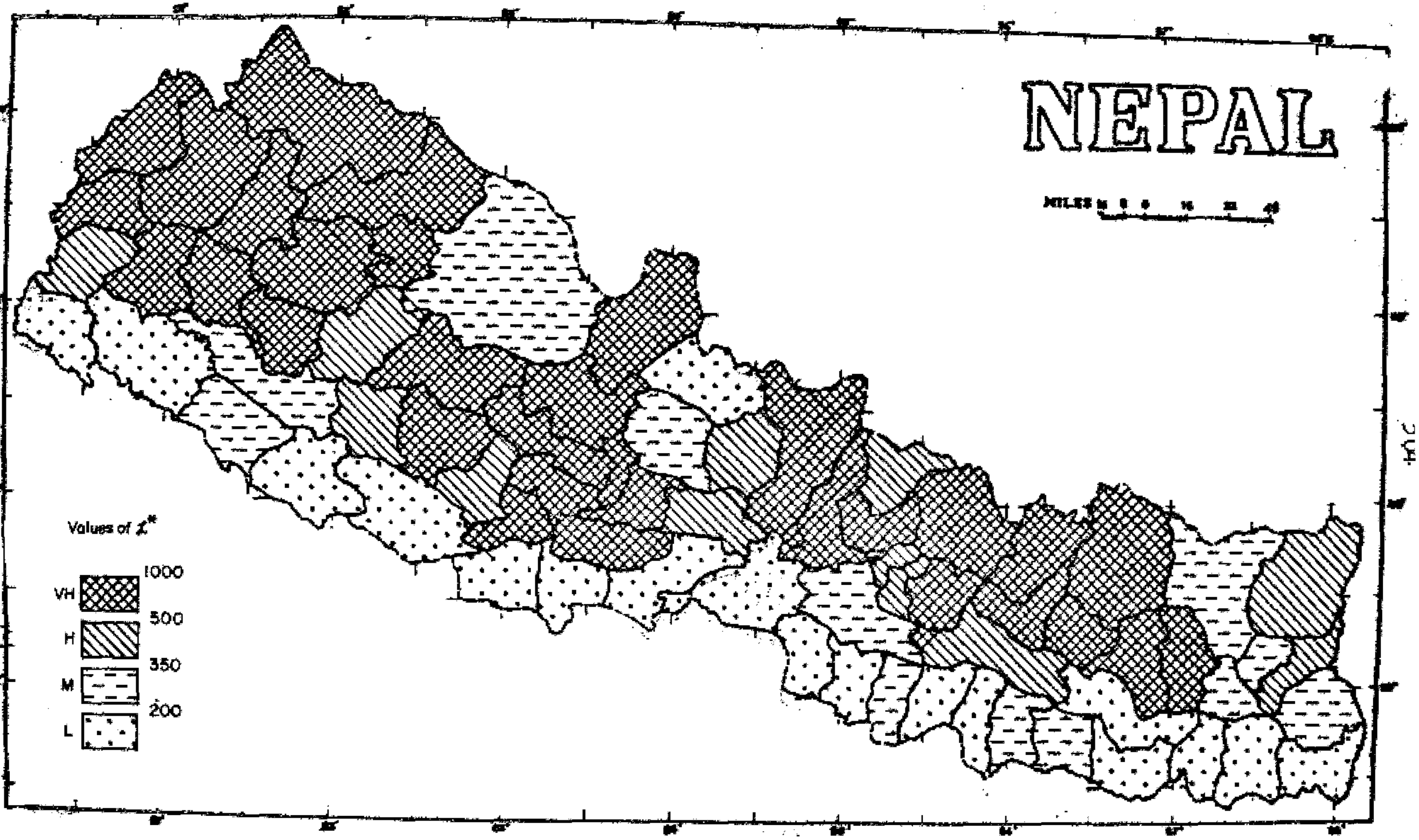

FIG-4·10: ECONOMIC ACTIVE POPULATION (ADJUSTED) OF 1989-90 PER SQ. KM. OF 1977-78 GROSS CROPPED AREA (ℓ^*)

national aggregate is about 1.00464 (or 1.005 approximately). Allowing a margin for possible in migrations of minor nature within Nepal, a value of ϵ above 1.01 is considered as significant, such values have occurred only in thirteen districts in the whole of Nepal. All other districts have the values of ϵ within the small range between 0.99 and 1.01. The districts with values of ϵ less than 1 might have incidences of minor emigration. It is noted that the use of the labour force adjustment factor ϵ over the mid-term rate m has inflated the estimated growth rate of labour force g^* to a value of 2.7% per annum when the estimated population growth rate has been $g = 2.3\%$ approximately. This obviously has inflated marginally the share of labour force to population by 1990. As the influx of population has taken place, it is quite reasonable to take planning measures on the creation of new activities based on the upward margin of 2.7%. (which is also the annual rate of population growth in the period 1971-81) rather than tallying it with the visualised population growth rate of 2.3%.

Following observations can now be high-lighted on the basis of our analysis from figures (4.8), (4.9) and (4.10) and also the data recorded in Appendix Table 11.

(a) Extremely high growth rate g^* is observed only in Tarai - in the two extreme estern districts, in the four extreme western districts and also in Chitwan in the central Tarai. The very high growth rate is observed mainly in Tarai (five districts) and in hill Surkhet district to the north of the western Tarai of extremely high growth rate. The high growth rate observed mainly in the districts of central Tarai and the adjoining Hill districts around the capital region and also in Kaski district (Hills).

(b) Northern districts lying both in Mountain and Hill areas, showed low growth rate g*. But medium values occurred mostly in the western part of Nepal over major area, while such values had limited occurrences in the eastern part. The incidence of some medium values could be observed in eastern Tarai districts.

(c) The population influx was significant in all districts with extremely high and very high values of g*, except the district of Dang-Deokheri. The district of Makwanpur, flanked between the capital region and the central Tarai districts seemed to have significant population influx even though its growth rate is not that high as in other districts of high population influx.

(d) The labour pressure on arable land is observed to be low in all Tarai districts and in a few adjoining hilly districts. The very rugged Mountain districts of Dolpa and Manang also recorded low values. This was the position in the base year (1977-78) of our time-horizon under consideration and this position has practically not changed in the target year (1989-90) despite higher growth rates of labour force in Tarai districts. A few medium values that have occurred in Tarai area in 1989-90 are just at the boundary value of the low class chosen in the figures (4. 9) and (4.10).

(e) Obviously the labour pressure on arable land was higher in the Hills and Mountains with very high values in major areas which has extended in the target year. The absolute magnitude of the additional to labour force, ΔL, as tabulated in Appendix Table (11) is not however predominant in Hills and Mountains, as compared to that of Tarai area in view of lower growth rate g* in the former.

(f) The density of labour force for the nation as a whole worked out to be 220 only in 1977-78, in which year Nepal could still generate national surplus in foodgrains with the existing primitive mode of cultivation. All Tarai districts in 1989-90 have lower values than this density figure, while labour pressure on arable land has been alarmingly high in many non-Tarai districts. Though government is not discouraging population in-migration to Tarai area (for example, the Government owned Nepal Settlement Company has been responsible in settling people in many Tarai districts, such as Bardia and Kanchanpur in recent years), there are expressions of sentiments aired by the planning authorities against this encouragement of in-migration into Tarai area on grounds of disturbing the ecological balance therein. But keeping in view the alarming labour pressure on arable land as observed above, there is no reason to discourage in-migration into Tarai area with proper type land use planning therein.

(g) Lastly, the values of ΔL should be kept in mind by the regional planners of Nepal while formulating regional policies, on the basis of which new activities should be generated particularly in the non-agricultural sector.

CHAPTER V

SYNTHETIC REGIONAL ANALYSIS

5.1 Introduction

In the preceding chapters, we have made regional analysis on individual activities and tried to explain their regional variations by certain important factors. In Chapter II, we have dealt, in considerable details, with the agricultural and allied aspects and the corresponding development index D has been constructed to rank the districts in respect of agricultural development. Similarly in Chapters III and IV, we have constructed the index of over-all industrial activities, I, and the composite index of tertiary and allied activities, U, and analysed the regional patterns in respect of individual indices. In this chapter we would attempt for the synthetic regional analysis combining all important activities and other aspects of regional economics. In doing so, we have to duly recognise the fact that agricultural activities provide the predominantly major part of people's occupations, while other non-agricultural activities are yet insignificant. Thus our development index of agricultural and allied activities D remains still important. For a synthetic ranking of districts there is a need to contrast the agricultural development with the non-agricultural development and also to formulate a combined index of both agricultural and non-agricultural developments. It has been already noted in Chapter IV that there is a strong inter-dependence between the two major counterparts of non-agricultural activities, namely, the indices of industrial and tertiary activities I and U. But the agricultural index D is not much associated with U and even with I. As such it seems appropriate to construct a non-agricultural development index statistically by combining I and U in the usual way and then combine the agricultural and non-agricultural indices by some suitable methods in which the importance of agriculture is retained. Our statistical methods would not be appropriate here and we have to take resort to the economic principles of index formulation for a combined development index of both agricultural and non-agricultural activities. The actual synthetic for such an index and the corresponding regional analysis are discussed in the next subsection.

Further, in Chapter II, we have made demand projections for cereals and suggested the corresponding production tasks needed to achieve the consistent targets prescribed for 1989-90. We have also dealt with the distributional aspects between the deficit and the surplus areas on zonal basis (named as food distribution zones) in that chapter. In the following subsection 5.2, we would make further analysis on the consumer demands on different items of consumption through the expenditure elasticity analysis to be done from certain sample data on family budget surveys referred in Chapter II. With the use of these data we would try to predict the future pattern of total consumption expenditure by zones and sub-zones and also the possible growth of income (GDP) for Nepal as a whole.

Further synthetic analysis and concluding observations will be made in the following subsection 5.3 with the results obtained earlier. The chapter will be concluded with a summary and conclusion on our main findings.

5.2 Combined Development Index of All Activities and the Regional Analysis:

Of the three major activity indices, D, I and U, it is already noted that the relation between I and U is highest (corr. coeff. = 0.835) and that between D and U is lowest (corr. coeff. = 0.416). This reflected the fact that the tertiary activities prospered with the industrial activities and not with the predominant agricultural activities spatially in Nepal. In fact, the relation between I and U can be better depicted if a relatively more skewed statistical distribution of U is made comparable to that of I by a suitable mathematical transformation of U. As the index I is more related to D (corr. coeff. = 0.627) than with U, the distribution of I is kept undisturbed and the mathematical transformation is applied on U to make the statistical distribution of the transformed variable comparable to that of I. Thus taking the square root of U as the transformed tertiary activity index, the improvement is noticed not only in its correlation with I but also with D. ($r_{\sqrt{U}, I} = 0.90439$, $r_{\sqrt{U}, D} = 0.55869$).

With so much high spatial association between I and $\sqrt{U}$, these two indices need not be treated separately and we have combined them statistically to form the development index of non-agricultural activities, N, as given below in equation (5.1):

$$N = 0.419365I + 0.580635\sqrt{U}, \qquad \rho = 0.97581 \qquad \ldots \qquad (5.1)$$

The index N is so formulated that its critical value (national value) corresponds to unity.

The correlation between the development indices of agricultural and non-agricultural activities is still not high (r_{ND} = 0.60737). This is not a very happy state of affair that the agricultural development has not gone, side by side, with the non-agricultural development over space in Nepal. But it is interesting to note that the concentration index of cultivated land I_{CG} which is strongly related to an inverse of ruggedness index $[T = (.4 + \tau)^{-1}]$, has also a substantial relation with N and I (corr. coeffs. = 0.7912 and .7984 respectively) and this relation is even better than that of D with I_{CG} $\{r_{DI_{CG}} = 0.7121\}$. Thus it can be inferred that the non-agricultural activities have certain spatial association with the concentration of cultivated land, but the performance in agricultural activities has not been so satisfactory as to be concomitant with the levels depicted by I_{CG} and N. In combining D and N for a combined Development index, the performance as actually depicted by D by a predominant sector of population has to be recognised. This cannot be done in a statistical combination as used earlier, since in that the population weights to sectors do not figure in the empirical formulation. Had the correlation coeff. r_{ND} been high enough, this problem would not have arisen, since in that case the statistically combined index and also its constitutent indices N and D would have been almost parallel, as a result of which the population weights to sectors would not have mattered much. Thus we abandon the use of statistical methods and take certain economic aspects into account to combine D and N for a combined development index of all activities, say, Δ. Following Pal's [1968, 1974, 1975] procedure, the formulation of Δ has been done as given in equation (5.2) below:

$$\Delta_j = w_{aj}(\lambda_a D_j) + w_{nj}(\lambda_n N_j) \quad \ldots \quad (5.2)$$

where, λ_a = ratio of agricultural labour productivity to all labour productivity for Nepal.

$$= \frac{\text{share of agricultural GDP to total GDP}}{\text{share of agricultural labour to all labour}}$$

λ_n = ratio of non-agricultural labour productivity to all labour productivity for Nepal.

$$= \frac{\text{share of non-agricultural GDP to total GDP}}{\text{share of non-agricultural labour to all labour}}$$

w_{aj}, w_{nj} = shares of agricultural labour and non-agricultural labour to all labour in jth district with $w_{aj} + w_{nj} = 1$.

The logic of above formulation is as follows. The critical values (national values) of D and N are unity. The index D is really proportional to agricultural labour productivity. Taking index N as proportional to non-agricultural labour productivity, the index Δ_j is so formulated as to be proportional to the total labour productivity with its critical value set at unity. The role of λ_a and λ_n is to make D and N additive with a common denominator of all labour productivity in both, instead of individual labour productivities. The role of w_{aj} and w_{nj} in each jth district is to recognise the due labour shares to sectors for deriving the total labour productivity of the district. As the urbanisation activities are included in our formulation of N, we have treated the urban labour as non-agricultural labour in addition to the estimated rural non-agricultural labour in our calculation of Δ by the formula (5.2). With such a treatment, the labour shares to agricultural and non-agricultural activities for Nepal as a whole turn out to be 0.87465 and 0.12535 respectively. With the estimate on the share of agricultural GDP to total GDP for Nepal [APROSC, 1978b], we can get the following estimates for 1971-72 : $\lambda_a = 0.783395$ and $\lambda_n = 2.511460$. These estimates reflect the fact that the non-agricultural labour productivity is about 3.2 times more than the agricultural labour productivity. This shows the need for a creation of more of non-agricultural activities, if feasible, for a speedier economic development of the people of Nepal. With the varying agricultural and non-agricultural labour shares in different districts, we finally computed the index Δ for all districts of Nepal and recorded them along with the values of other important indices like N, D, etc. in Appendix Table 13 .

A synthetic regional analysis is attempted below with the help of a correlation matrix and also, with the mapping of Δ and N. In the correlation matrix we shall also include other major activity indices and also the conditioning factors like the ruggedness of terrain or the literacy rate. First we examine the following correlation matrix given in Table 5.1:

Table 5.1: Correlation matrix of major activity indices and conditioning factors.

	Δ	D	N	I	$\sqrt{U}$	T	I_{λ}
Δ	1.00000	0.70648	0.92826	0.88313	0.92846	0.50035	0.72245
D	0.70648	1.00000	0.60737	0.62666	0.55869	0.75249	0.26044
N	0.92826	0.60737	1.00000	0.97580	0.97580	0.58465	0.79738
I	0.88313	0.62666	0.97580	1.00000	0.90439	0.62135	0.72331
$\sqrt{U}$	0.92846	0.55869	0.97580	0.90439	1.00000	0.51965	0.83286
T	0.50035	0.75249	0.58465	0.62135	0.51965	1.00000	0.32479
I_{λ}	0.72245	0.26044	0.79738	0.72331	0.83286	0.32479	1.00000

As the index Δ has not been constructed statistically from the indices D and N, the difference in the relations of Δ with D and N are meaningful. From the correlation matrix given in Table 5.1, we can clearly notice that inspite of low labour share in non-agricultural activities than in agricultural activities, the over-all labour productivity as depicted by Δ has much better

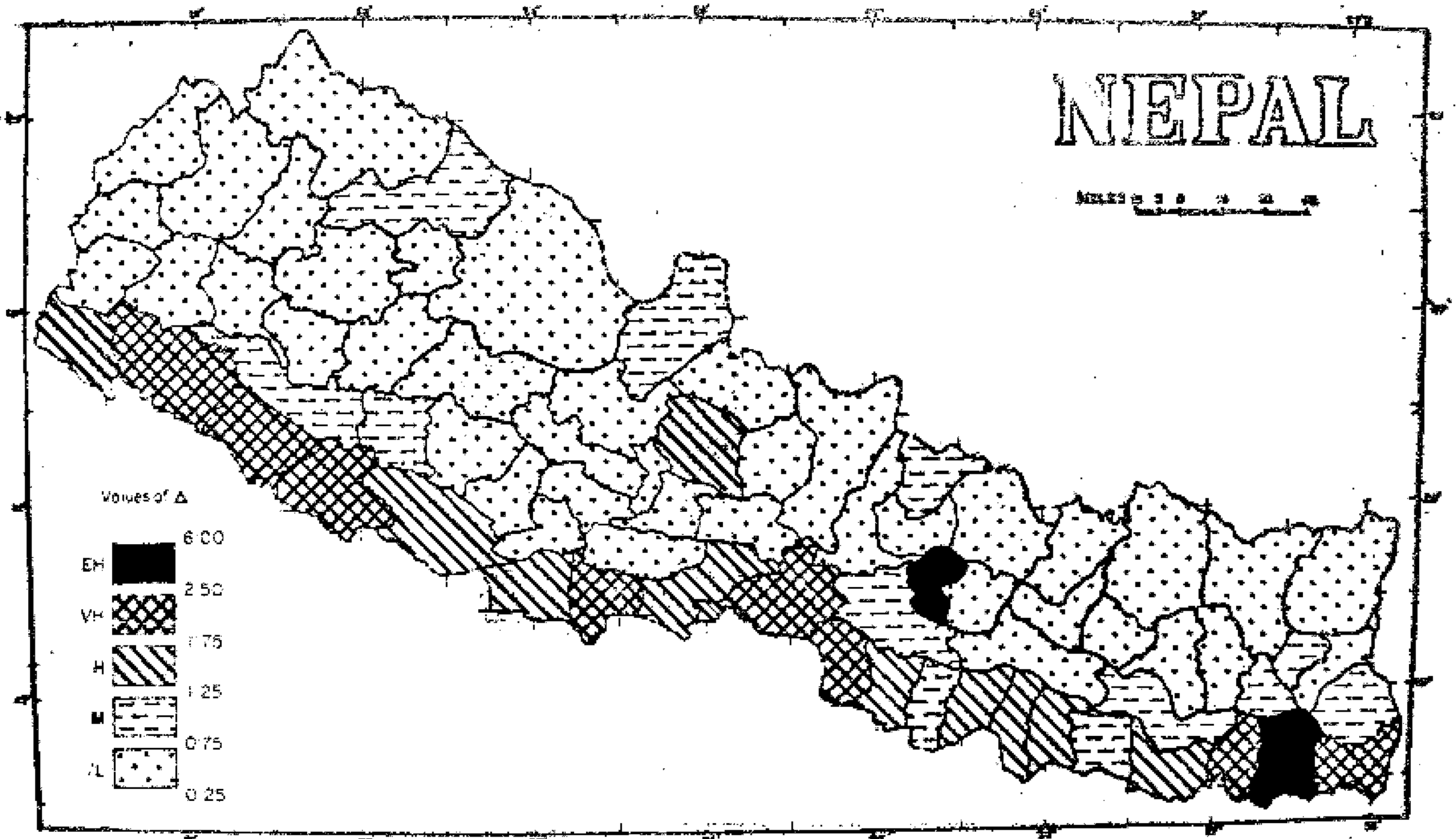

FIG-5.1: COMPOSITE DEVELOPMENT INDEX OF OVERALL ACTIVITIES (Δ)

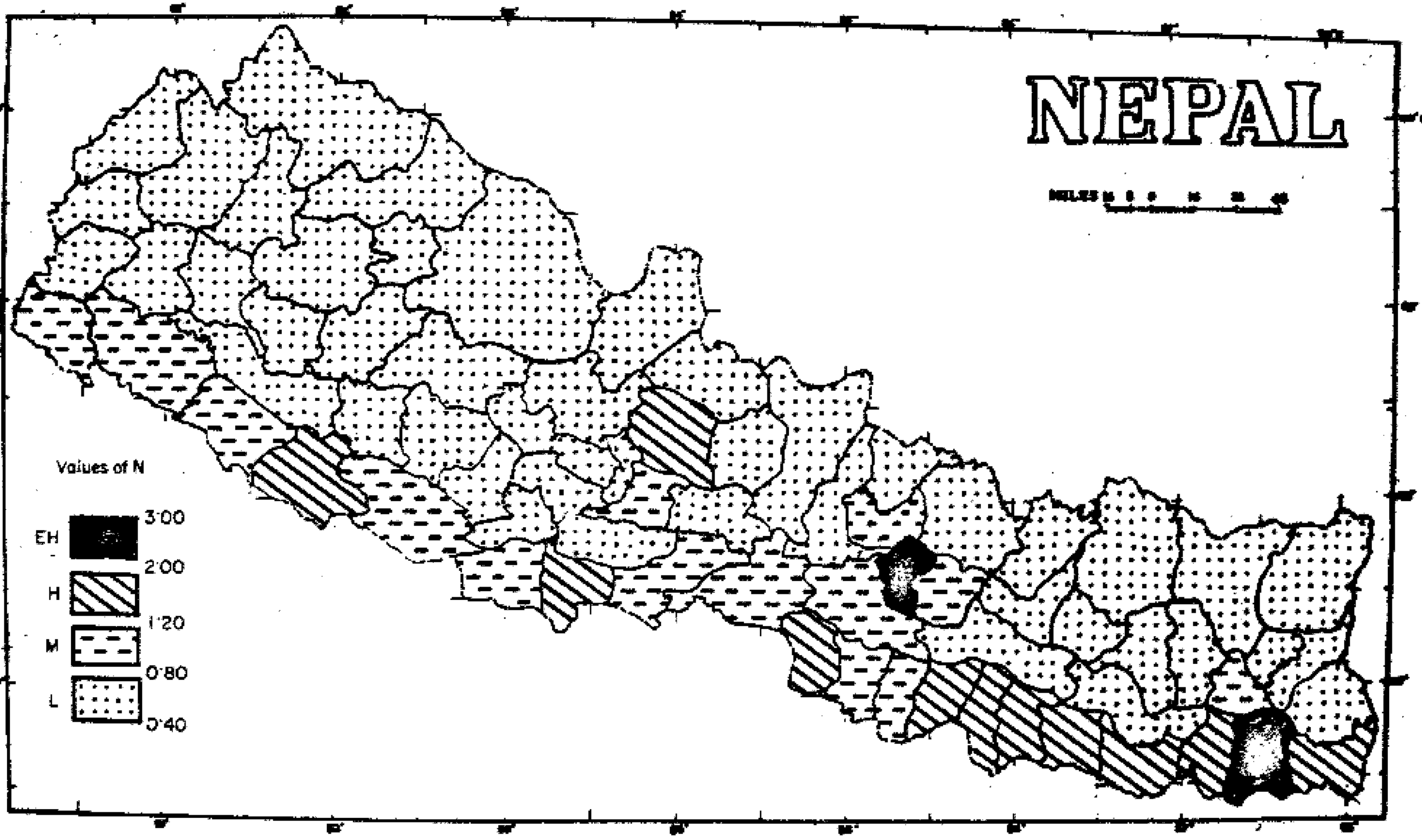

FIG-5·2: COMPOSITE INDEX OF NON-AGRICULTURAL ACTIVITIES (N) spatial association with the non-agricultural development index N ($r_{\Delta N}$ = 0.9285) than with the agricultural development index D ($r_{\Delta D}$ = 0.7065). As the index N is almost the parallel variable to its constituent indices $\sqrt{U}$ and I ($r_{N, \sqrt{U}}$ = 0.9758 = r_{NI}), the over-all development index Δ has also strong relations with $\sqrt{U}$ and I. The conditioning factor of educational level measured by index I_{ℓ} has best influenced the tertiary activities, a constituent of the non-agricultural activities ($r_{\sqrt{U}, I_{\ell}}$ = 0.833, $r_{NI_{\ell}}$ = 0.797) and it has also moderate relations with I and Δ ($r_{II_{\ell}}$ = 0.723, $r_{\Delta I_{\ell}}$ = 0.722), but it has practically not influenced the agricultural activities ($r_{DI_{\ell}}$ = 0.260). On the other hand, the conditioning factor of ruggedness of terrain has best influenced the agricultural development (r_{DT} = 0.752, where $T = (0.4 + \tau)^{-1}$). The ruggedness factor has however influenced a little the industrial activities (r_{IT} = 0.621), because the flatness of terrain has been in some way advantageous to the industrial activities.

It should be noted here that among the broad indices discussed above, the index of tertiary and allied activities U is best associated spatially with the population concentration index I_{PG} ($r_{UI_{PG}}$ = 0.904, $r_{\sqrt{U}\, I_{PG}}$ = 0.852). The index I_{PG} has also moderate relation with the index of industrial activities ($r_{II_{PG}}$ = 0.727), but, as noted already, it did not show practically any relationship with the broad agricultural development index D ($r_{DI_{PG}}$ = 0.1879). Thus the moderate relationship that the index I_{PG} shows with the over-all development index Δ ($r_{\Delta I_{PG}}$ = 0.734) comes as a result of its substantial relationship with the non-agricultural development index ($r_{NI_{PG}}$ = 0.809). In Chapter II, we have however noted that separate cropped-area indices of maize, paddy and wheat explained together a substantial amount of spatial variation of I_{PG} likewise the index U. Thus one can notice that along with the crop output indices, the index of tertiary and allied activities had been the main factors for the spatially varying population concentration in Nepal. The crop factors were however influenced much by ruggedness of terrain, but not the factor U. Again because of a strong spatial association between U and I_{λ}, the educational level appeared to be better in the areas of higher population concentration ($r_{I_{\lambda}, I_{PG}}$ = 0.823). It seems rural areas with predominant agricultural population had remained neglected in respect of educational facilities.

The spatial patterns of over-all development, measured by, index Δ and the non-agricultural development, measured by, N could be easily comprehended from figures (5.1) and (5.2). In mapping the data of Δ and N for these figures, we have made the classifications comparable to those of index D (ref. to figure 2.1). The class interval length of D around the critical value has been taken as 0.50. Deflating by the standard deviation ratio σ_N/σ_D, the corresponding class interval length of N turns out to be 0.40. Applying the procedure as used in the formula (5.2) for Δ with the use of national labour shares in the two sectors, the corresponding class interval length of Δ has been estimated to be 0.47 which has been rounded off to the value of 0.5 in our classification for figure (5.1). The synthetic regional patterns of development as emerge from these figures are summarized below:

(a) The broad regional patterns of development are, in many ways, similar in all the three maps for (i) over-all development, (ii) non-agricultural development and (iii) agricultural development with generally higher levels in the Tarai area and the Kathmandu Valley and with mostly low values in other non-Tarai area.

(b) Extremely high values of over-all development are noticed only in the Kathmandu Valley and Morang district in the eastern Tarai. This extremely high development could be accounted more by non-agricultural development than by agricultural development. In fact, the Kathmandu Valley has only "high" agricultural development and Morang district "very high", while the level of non-agricultural development has been extremely high in these areas and nowhere else. Even these areas stand much above other districts in respect of non-agricultural development which could be observed by the absence of any district in the very high class in figure (5.2).

(c) Very high values of over-all development are noticed in (i) two districts on either side of Morang district, (ii) three districts in central Tarai and (iii) three districts in western Tarai. Very high agricultural development in most of these districts is mainly responsible for the very high over-all development, though quite high non-agricultural development has been attained in the two districts on either side of Morang, in the districts of Parsa and Rupandehi in the central Tarai and also in Banke district in the western Tarai.

(d) High values of over-all development are noticed in all other districts of Tarai area except Rautahat and Siraha and also in the Hill district of Kaski. Generally these districts to the west of Rautahat in the Tarai have very high agricultural development and medium non-agricultural development while other Tarai districts to the east of Rautahat have high values in both non-agricultural and agricultural developments. The high over-all development of Kaski is however associated with the high non-agricultural development and medium agricultural development. Thus one sees that the eastern part of Tarai is more developed non-agriculturally while the western part of Tarai is developed agriculturally, generally in labour productivity measure.

(e) Medium values of over-all development occur only in some of the districts to the northern fringe of Tarai and also in three mountain districts in the north wherein the population concentration has been very negligible.

(f) In all other districts (in 41 districts) of Hills and mountains, the level of over-all development is low. In this broad area of low development, neither the non-agricultural activities, nor the agricultural activities have prospered. The ruggedness of terrain is however highly pronounced in this area.

5.3 Regional Analysis of Demands and the prediction of different items of consumption.

5.3.1 The data for demand predictions and the estimation of expenditure elasticities:

Much of our preceding analysis has been devoted to the spatial analysis of productive activities. The only demand or requirement analysis that we have attempted is for foodgrains (or cereal food) in Chapter II. But there we have made the predictions of foodgrains by regional per capita norms which could be taken to have limited variation for biological reasons over a short period of time (our time horizon is only of twelve years length between 1977-78 and 1989-90). There has been also some reasonable stability in the values of these regional norms despite considerable variations in the economic and the environmental conditions in Nepal. The variations in the total consumption expenditure have been partly due to the price variations in areas with different degrees of ruggedness. But as the general price level is usually reflected in the food price level, there has been a marked stability in the proportion of total consumption expenditure spent on cereal food in different regions of Nepal for which we have the family budget data obtained from the surveys conducted by the Nepal Rashtra Bank in early seventees. [Nepal Rashtra Bank, 1977 to 1980]. It should however be noted that though the sample surveys conducted by the Nepal Rashtra Bank are distributed over different locations covering the length and the breadth of the country we do not have adequate samples for different zones (food distribution zones) with Tarai and non-Tarai breakdowns to expect very reliable sub-zonal estimates. We have however attempted to use them in our demand analysis. In the absence of more reliable data, the rates of growth calculated below for different items of consumption on the basis of Engel's elasticity concept [for details see Pal 1965, for example] could be considered the best at the moment to clarify our visions for the future productive planning on the consumer items. The importance of demand predictions for the purpose of planning should have to be appreciated at least, even though the results obtained here could be considered as tentative on grounds of the coverage in the family budget survey.

Because of the reasonable stability or the limited variation in the proportion of total consumption expenditure spent on cereals or foodgrains, we have ventured to use these data for predictions of total consumption expenditure that would be compatible with our previous predictions of cereals requirements, made in Chapter II. The predictions have been made by sub-zones and then aggregated for Nepal, where possible. Here we have followed our food distribution zones referred to earlier in Chapter II. As the mountain districts have not been covered by the survey made by Nepal Rashtra Bank, the hill and the mountain districts have been treated together as non-Tarai districts. Again we do not have adequate samples to treat zones 6 and 7 separately. The Kathmandu valley of the non-Tarai area of zone 3 has also been treated separately from other non-Tarai area of this zone for obvious reasons. Thus with Tarai and non-Tarai breakdowns in each zone (in all six zones, treating zones 6 and 7 together), we have altogether thirteen sets of sub-zonal estimates that have been established from the locational data of eighteen districts. In some sub-zones, two or three locational estimates have been available which are aggregated by us on the basis of appropriate population weights. Any further aggregation, if attempted, has again been done on the basis of appropriate population weights. But the Engel's expenditure elasticities used for demand predictions of different items of consumption have been computed only for the sub-zones.

It is well known that the consumers' demand for an item of consumption or a commodity is not only a function of consumer income, but also of relative prices of commodities and of individual consumers' tastes, needs and environment. But with the present data position in Nepal, the effects of changes in relative prices and in individual consumers' preference have been ignored in the present study. Again the available family budget data furnish the information on total consumption expenditure, not the income. Naturally, while making use of these data, we have to take resort to total expenditure instead of income for the calculation of elasticity of demand for a commodity or an item. Thus the elasticities calculated below are really the expenditure elasticities and not the usual Engel's income elasticities. In the present study constant elasticity curves are fitted by sub-zones. Analytically speaking if y_{ri} is the per capita value of consumption for ith item in rth sub-zone and if y_{ro} is the per capita total consumption expenditure in rth sub-zone, the coefficient of elasticity is given by the constant B_{ri}:

$$B_{ri} = \frac{y_{ro}}{y_{ri}} \cdot \frac{dy_{ri}}{dy_{ro}} ,$$

which, on integration, becomes

$$\log y_{ri} = \log A_{ri} + B_{ri} \log y_{ro} \qquad \ldots \qquad (5.1)$$

$$\text{i.e., } y_{ri} = A_{ri} \, y_{ro}^{\;B_{ri}} \qquad \ldots \qquad (5.2)$$

The elasticity parameters B_{ri} are determined by the usual weighted (population share weighted) least square regressions as applied to the data of nine different class intervals of total household consumption expenditure given in the published reports of the Nepal Rashtra Bank. The classification by per capita total consumption expenditure would have been more appropriate in the present context, instead of the given household expenditure classification. In the absence of data by per capita expenditure classification, we are compelled to use the data by household expenditure classification. The family or household size and the share of total number of households have however been given for the household expenditure classes. The recorded data on the family size show wide variations and the calculation of household expenditure elasticities could not be used meaningfully. The data on family size have been used to determine the per capita expenditures on different items of consumption by household expenditure classes. These data have been used to estimate per capita expenditure elasticities. The population share weights that are used in the weighted regression could also be estimated from the data on family size and household distribution by classes. Suppose w_{rij} is the population share weight in jth expenditure class for ith item in rth sub-zone with $\sum_j w_{rij} = 1$, the geometric mean y^*_{ri} and arithmetic mean y_{ri} of per capita expenditure on ith item in rth sub-zone can be written as follows:

$$\log y^*_{ri} = \sum_j w_{rij} \log y_{rij}$$

and

$$y_{ri} = \sum_j w_{rij} \; y_{rij}$$

The share of consumption expenditure spent on ith item in rth sub-zone, say, s_{ri}, the data of which are recorded in Tables 5.3 and 5.4 really based on the arithmetic means, i.e., $s_{ri} = y_{ri}/y_{ro}$, while geometric means enter in the regression model given in equation (5.1) for estimating the parameter A_{ri}. Thus the model of regression equation (5.1) can be rewritten for jth expenditure class as given in equation (5.3):

$$\log (y_{rij}/y^*_{ri}) = B_{ri} \log (y_{roj}/y^*_{ro}) \quad \ldots \quad (5.3)$$

It should be noted that this curve with the variations of expenditure classes is assumed to pass through the point of geometric means (y^*_{ri}, y^*_{ro}) in the usual weighted least square regression fit. But these expenditure elasticity equations, fitted with household expenditure classes, are to be used for predictions of data of all classes given by the weighted arithmetic means y_{ri}'s over a time horizon. For this reason it is meaningful to take the curve pass through the point of arithmetic means (y_{ri}, y_{ro}) instead of the usual point of geometric means. As such our revised model for the regression fit is given in equation (5.4) in which arithmetic means are used instead of geometric means.

$$\log (y_{rij}/y_{ri}) = B_{ri} \log (y_{roj}/y_{ro}) \qquad \ldots \qquad (5.4)$$

It could be easily proved that the estimates of B_{ri} and the correlation coefficients remain invariant by this change in average conditions, but the estimates of A_{ri} gets changed and are now given in relation (5.5):

$$A_{ri} = y_{ri}/y_{ro}^{B_{ri}} = s_{ri}\, y_{ro}^{(1-B_{ri})} \qquad \ldots \qquad (5.5)$$

In the usual regression fit, the corresponding estimate, denoted by A^*_{ri}, is given by

$$A^*_{ri} = y^*_{ri}/(y^*_{ro})^{B_{ri}} ,$$

So that $A_{ri} = A^*_{ri}\, F$, where $F = \left(\frac{y_{ri}}{y^*_{ri}}\right)\left(\frac{y^*_{ro}}{y_{ro}}\right)^{B_{ri}}$

The multiplying factor F is usually not unity and as such we have allowed a little departure from the usual estimate of A_{ri} only to allow the elasticity curve pass through the representative values of all classes together. From the relation (5.5) it is clear that, given the estimates of s_{ri} in addition to the estimates of y_{ro} and B_{ri}, the parameter A_{ri} can be easily computed. As the estimates s_{ri} are more useful for our purpose, we have recorded the estimates of s_{ri}, along with those of y_{ro} and B_{ri}, and have not felt the need for the computation of A_{ri}. It should be noted later that we have hardly used the parameter A_{ri} in our predictions on items of consumption. So, whether we use A_{ri} or A^{*}_{ri}, our predicted values would remain unchanged.

It should be noted that even though we have calculated the constant expenditure elasticities B_{ri} for all items of consumption, all the coefficients of elasticity cannot be assumed to be constant when the question of balancing the aggregate of itemwise expenditure with the corresponding total arises. This happens because of the non-linear nature of the expenditure elasticity curves. Thus, the total consumption expenditure having been the sum of food and non-food totals, the coeffs. of elasticity for both food total and non-food total can not remain constant. Because the non-food total is a less essential item than the food total, it would be reasonable to assume the constancy of the coeff. of elasticity for food total and take that of non-food total as variable with the expenditure level. But we have not calculated an appropriate elasticity coeff. for non-food total, rather the constant elasticity coeffs. have been shown here for both food and non-food totals in Table 5.4 for the sake of comparison of magnitudes between the two elasticity coefficients. Like the non-food total, the items like "other food" and "miscellaneous non-food" are residuals in the corresponding group totals over other specific items of their respective groups. In view of the stated balancing problem, we have not calculated the constant elasticity coefficients for these two residual items. Again, as in the balancing of the aggregate of itemwise expenditures with the corresponding total in a sub-zone, there should be a balance of the aggregate of sub-zonal total expenditures for a particular commodity with the corresponding national estimate or the like. For this reason, sub-zonal values of the coefficient of elasticity of a particular commodity and the corresponding national coefficient estimated directly can not hold good simultaneously, while one is making a demand projection of that commodity. In our approach the national projection, if made, has been derived from the appropriate aggregation of sub-zonal projections. Thus, as the national estimates of the coefficient of elasticities are not of much use in projection when one has the corresponding sub-zonal estimates, we have only computed the sub-zonal estimates of elasticity coefficients and not the national estimates. These sub-zonal estimates of elasticities are given in Tables 5.4 and 5.5, while the corresponding correlation coeffs. are shown in Tables 5.6 and 5.7.

Table 5.2: Percentage share of total consumer expenditure on food items.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
		Percentage share of total consumer expenditure on items									
Zone 1: Total	1315.75	34.33	2.88	7.44	3.34	5.13	4.41	1.68	1.10	64.15	35.85
Tarai	1378.42	30.83	3.52	8.00	3.11	4.72	4.46	1.88	0.87	62.01	37.99
non-Tarai	1237.71	39.16	2.00	6.69	3.66	5.70	4.37	1.40	1.41	67.11	32.89
Zone 2: Total	1392.85	36.15	2.33	7.54	3.06	4.16	3.71	0.76	0.46	64.07	35.93
Tarai	1468.15	31.39	3.24	6.67	2.66	3.05	3.15	0.65	0.34	58.85	41.15
non-Tarai	1298.74	42.55	1.11	8.72	3.59	5.66	4.47	0.92	0.62	71.09	28.91
Zone 3: Total	1485.72	34.44	3.16	7.85	3.66	4.48	3.40	1.28	0.95	63.40	36.60
Tarai	1647.20	32.53	3.92	7.33	3.86	3.90	3.61	1.26	0.89	62.35	37.65
non-Tarai	1392.08	35.61	2.70	8.17	3.54	4.83	3.27	1.29	0.99	64.04	35.96
Kathmandu valley	1434.97	33.44	2.18	8.75	3.37	3.26	3.07	1.79	1.14	60.21	39.79
Other non-Tarai	1366.24	36.96	3.02	7.82	3.65	5.80	3.39	0.98	0.89	66.41	33.59
Zone 4: Total	1558.06	36.88	3.03	6.77	3.46	5.04	4.72	2.19	0.86	66.94	33.07
Tarai	1019.53	38.53	5.19	7.54	4.17	3.18	4.46	2.54	1.09	69.99	30.01
non-Tarai	1685.01	36.46	2.48	6.57	3.28	5.52	4.79	2.10	0.80	66.15	33.85
Zone 5: Total	1164.49	40.31	2.60	6.48	2.97	5.33	4.06	1.65	0.82	68.39	31.61
Tarai	978.48	41.35	3.50	7.30	3.33	4.21	2.90	1.15	1.19	69.00	31.00
non-Tarai	1274.19	39.65	2.00	5.94	2.73	6.07	4.84	1.98	0.58	67.98	32.02
Zone 6 & 7 Total		39.80	3.85	6.22	2.78	5.85	4.56	0.96	0.93	67.68	32.32
Tarai		34.43	4.85	7.81	2.44	7.47	3.49	1.65	0.81	65.02	34.98
non-Tarai		42.19	3.40	5.51	2.93	5.13	5.03	0.66	0.99	68.87	31.13
Nepal: Total	1418.93	36.31	2.93	7.74	3.27	4.40	3.84	1.62	0.94	64.98	35.02
Tarai	1380.63	33.01	3.91	7.59	3.18	4.48	3.96	1.57	0.82	63.19	36.81
non-Tarai	1442.92	38.56	2.26	7.85	3.34	4.34	3.76	1.65	1.02	66.20	33.80

Note: (1) Zone/area (2) Percapita annual cons. expd. in Rs. (3) Cereals (4) Pulses

(5) Fruits, Vegetables & Spices (6) Meat & Eggs (7) Milk & Milk Products

(8) Oils & Fats (9) Sugar & Sweets (10) Beverages (11) Total food

Table 5.3: Percentage share of total consumer expenditure on non-food items

	percentage share of total consumer expenditure on items										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Zone 1: Total	2.18	7.68	1.14	5.23	4.66	1.36	3.07	1.26	1.96	1.06	5.37
Tarai	2.43	7.92	0.94	4.15	5.51	1.44	4.04	1.54	2.21	1.54	5.54
Non-Tarai	1.83	7.36	1.42	6.73	3.49	1.25	1.74	0.87	1.62	0.40	5.14
Zone 2: Total	1.97	7.44	0.87	6.03	5.22	1.61	2.77	1.17	2.01	0.90	4.73
Tarai	2.20	7.68	0.75	4.99	6.90	2.40	3.54	1.61	2.68	1.44	5.41
Non-Tarai	1.65	7.12	1.04	7.43	2.95	0.54	1.73	0.57	1.12	0.38	3.82
Zone 3: Total	2.60	6.78	0.99	3.96	5.74	1.64	3.42	1.18	2.74	1.88	4.56
Tarai	2.17	6.38	0.69	3.55	6.40	1.98	4.56	1.19	2.62	1.75	5.01
Non-Tarai	2.86	7.02	1.17	4.22	5.34	1.43	2.72	1.17	2.82	1.96	4.29
Kath. valley	2.79	7.83	1.52	5.54	4.95	2.17	3.39	0.95	3.27	3.05	3.57
Other Non-Tarai	2.91	6.53	0.96	3.41	5.58	0.97	2.30	1.31	2.54	1.28	4.72
Zone 4: Total	2.58	7.20	1.02	4.73	4.75	1.74	3.03	0.81	1.89	0.92	3.27
Tarai	2.64	5.94	0.93	4.77	4.23	1.25	3.05	1.34	1.93	0.43	3.22
Non-Tarai	2.57	7.52	1.04	4.72	4.88	1.86	3.03	0.68	1.88	1.05	3.28
Zone 5: Total	2.53	9.41	0.96	5.84	3.77	0.54	1.93	0.89	1.59	0.75	2.79
Tarai	2.64	10.94	1.22	4.25	3.88	0.67	1.38	1.11	1.08	0.31	3.20
Non-Tarai	2.45	8.40	0.78	6.90	3.70	0.46	2.30	0.74	1.93	1.05	2.51
Zone 6: Total	2.44	10.54	1.54	4.70	4.51	1.25	1.96	0.81	0.96	0.59	2.11
Tarai	2.85	9.35	1.13	4.42	5.19	2.31	3.07	1.02	1.22	1.53	1.64
Non-Tarai	2.26	11.07	1.73	4.82	4.20	0.78	1.46	0.71	0.85	0.17	2.32
Nepal: Total	2.41	7.52	1.11	4.81	4.84	1.63	3.07	1.03	2.25	1.65	3.80
Tarai	2.44	7.81	0.90	4.33	5.62	1.71	3.67	1.36	2.11	1.36	4.50
Non-Tarai	2.39	7.33	1.26	5.14	4.30	1.58	2.66	0.81	2.35	1.85	3.33

Note: (1) Zone/area (2) tobacco & products (3) clothing & cloth
(4) footwear (5) fuel & light (6) other housing
(7) transportation (8) medical care (9) personal care
(10) education (11) recreation (12) social expense

Table 5.4: Estimate of total expenditure elasticities for food items

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Zone 1: Tarai	0.40092	0.55028	0.61561	0.77159	2.04682	1.35233	1.67201	1.71169	0.62687	1.60095
Non-Tarai	0.52139	0.65500	0.42121	0.62832	1.81786	0.69659	1.95798	0.52627	0.66395	1.66706
Zone 2: Tarai	0.50066	0.55850	0.86274	1.25180	2.81319	1.32419	1.80067	1.02894	0.60824	1.54429
Non-Tarai	0.57936	0.62532	0.55117	0.77328	1.17738	0.83542	2.26677	0.92073	0.72208	1.70517
Zone 3: Tarai	0.37603	0.79050	0.81596	0.68524	1.93542	1.27372	1.49139	1.05630	1.60300	1.60559
Kathmandu valley	0.30706	0.81980	0.55253	1.26258	1.73278	0.93483	1.62054	1.41176	0.58015	1.73468
Other Non-Tarai	0.50371	0.86947	0.40061	1.03953	1.51692	0.63761	2.67132	0.74733	0.65340	1.64237
Zone 4: Tarai	0.55986	0.53315	0.66497	1.26308	1.96045	1.09767	1.14102	1.42837	0.73292	1.54904
Non-Tarai	0.37476	0.55552	0.58252	1.63773	1.44080	0.45537	1.89808	1.55480	0.58866	1.74653
Zone 5: Tarai	0.40933	0.59588	0.68871	1.07261	1.69946	0.70087	1.88921	1.56482	0.58748	2.11311
Non-Tarai	0.49563	0.50953	0.53144	1.19135	1.41595	0.67750	1.76074	1.13899	0.58274	1.97324
Zone 6 & 7: Tarai	0.45972	0.44002	0.53385	0.82478	1.45036	1.51047	1.87214	0.87287	0.63430	1.68599
Non-Tarai	0.52148	0.50756	0.55398	1.76267	1.41202	0.84591	2.38680	0.88346	0.71561	1.57571

Note: (1) Zone/area (2) Cereals (3) Pulses (4) Fruits, Vegetables & Spices (5) Meat & Eggs (6) Milk & Milk products (7) Edible Oil & Fats (8) Sugar & Sweets (9) Beverages (10) Total food (11) Total non-food

Table 5.5 : Estimate of total consumer expenditure elasticities for non-food items

	total expenditure elasticity of consumption for items										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Zone 1: Tarai	0.49077	1.75761	2.00546	0.47290	0.94355	2.47087	2.75346	0.69577	3.36344	1.96341	2.65425
Non-Tarai	0.77935	2.13751	2.15544	0.27019	1.50179	3.06558	2.08557	1.45310	2.83437	3.55946	2.10867
Zone 2: Tarai	0.39276	2.35757	1.87227	0.49479	1.03349	2.58140	2.20064	1.10352	2.89112	1.90504	1.33660
Non-Tarai	0.77835	2.82386	2.68761	0.21625	1.59262	2.81766	2.44192	1.80184	2.10067	3.25604	2.29852
Zone 3: Tarai	0.57291	1.48610	0.78355	0.76294	1.41201	2.62653	1.93785	1.29689	2.99570	2.02008	1.24581
Kathmandu valley	0.80084	2.35276	1.82035	0.62103	1.29549	2.68807	2.16980	1.51286	2.91403	2.33486	1.71539
Other Non-Tarai	0.68810	1.91391	1.68921	0.45184	1.33510	2.99098	1.83502	1.24971	3.30334	2.25930	2.28372
Zone 4: Tarai	0.90550	1.81952	1.37562	0.50091	1.22184	1.68001	3.19558	1.32755	3.57820	3.59988	2.00198
Non-Tarai	0.58074	2.11916	1.96701	0.38238	1.33765	2.34384	3.36318	1.92265	3.17569	3.34967	3.63383
Zone 5: Tarai	0.85069	1.81210	1.96125	0.74162	1.42491	2.85474	2.79084	1.77877	3.29144	3.62437	2.96878
Non-Tarai	0.57814	2.77018	2.32002	0.28052	1.64482	3.64429	2.86746	1.95790	2.30947	3.25425	2.52454
Zone 6: Tarai	1.01323	2.10516	1.56030	0.65289	1.27604	3.12526	2.47441	1.07921	2.15594	3.26627	1.96336
Non-Tarai	0.60932	2.35238	1.86131	0.26103	1.63803	3.95733	3.75942	1.66606	3.39810	3.48821	3.69214

Note: (1) Zone/area (2) tobacco & products (3) clothing & cloth (4) footwear (5) fuel & light (6) other housing (7) transportation (8) medical care (9) personal care (10) education (11) recreation (12) social expenses

Table 5.6: The correlation coefficients of the total expenditure elasticities for food items.

	Correlation coefficients of the total expenditure elasticities for items									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Zone 1: Tarai	0.96014	0.94645	0.97040	0.79504	0.90730	0.98485	0.92146	0.91385	0.99040	0.99591
Non-Tarai	0.94441	0.95356	0.85767	0.61384	0.84345	0.75198	0.89337	0.79311	0.97718	0.98190
Zone 2: Tarai	0.87772	0.95549	0.95069	0.72066	0.91057	0.96721	0.93406	0.56158	0.99019	0.99576
Non-Tarai	0.99008	0.95185	0.93184	0.87435	0.78957	0.96908	0.83146	0.79053	0.99861	0.99885
Zone 3: Tarai	0.97727	0.98449	0.96336	0.74201	0.89006	0.95598	0.86235	0.89304	0.98893	0.99925
Kathmandu valley	0.94671	0.97825	0.92722	0.99194	0.93351	0.98389	0.93894	0.93929	0.99751	0.97490
Other Non-Tarai	0.97192	0.95596	0.88788	0.94199	0.83398	0.94764	0.95606	0.76443	0.98504	0.99570
Zone 4: Tarai	0.87372	0.84610	0.88872	0.74846	0.90937	0.96493	0.92504	0.82606	0.98912	0.98669
Non-Tarai	0.73532	0.87084	0.76922	0.89789	0.89047	0.61798	0.91061	0.72151	0.98524	0.99741
Zone 5: Tarai	0.97945	0.96314	0.97973	0.95121	0.56400	0.82158	0.67548	0.67256	0.90245	0.99237
Non-Tarai	0.92879	0.80091	0.77903	0.94036	0.86113	0.68232	0.77652	0.69500	0.99205	0.99512
Zone 6: Tarai	0.97896	0.85110	0.95922	0.92916	0.93824	0.90010	0.95523	0.77275	0.99934	0.99816
Non-Tarai	0.94288	0.80118	0.72792	0.79614	0.82227	0.93176	0.97182	0.66748	0.97820	0.98742

Note: (1) Zone/area (2) Cereals (3) Pulses (4) Fruits, Vegetables and Spices (5) Meat and Eggs (6) Milk and Milk-products (7) Oils and fats (8) Sugar and Sweets (9) Beverages (10) Total food (11) Total non-food

Table 5.7: The correlation coefficients of the total cunsumer expenditure elasticities for non-food items.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Zone 1:											
Tarai	0.8734	0.8826	0.8440	0.8569	0.9310	0.9170	0.9287	0.9437	0.9262	0.9334	0.9344
Non-Tarai	0.8527	0.8300	0.8653	0.8276	0.8950	0.8188	0.6243	0.8590	0.8716	0.2322	0.8719
Zone 2:											
Tarai	0.7340	0.9471	0.8161	0.8740	0.7917	0.9247	0.9318	0.9044	0.9057	0.7983	0.9007
Non-Tarai	0.9762	0.9883	0.9282	0.8039	0.9830	0.5600	0.9180	0.9652	0.9026	0.9486	0.9611
Zone 3:											
Tarai	0.8484	0.8830	0.8544	0.9665	0.9406	0.9426	0.9535	0.9577	0.9865	0.8788	0.8327
Kath.valley	0.9393	0.9067	0.9309	0.9183	0.9283	0.9733	0.8979	0.9500	0.9230	0.9412	0.9278
Oth.N-Tarai	0.7441	0.9902	0.9746	0.8510	0.9464	0.9184	0.8665	0.9894	0.9796	0.9524	0.9465
Zone 4:											
Tarai	0.6941	0.6611	0.7595	0.9827	0.8484	0.8696	0.8162	0.8384	0.9235	0.3520	0.3599
Non-Tarai	0.7201	0.9197	0.7757	0.8214	0.8477	0.8594	0.7577	0.9605	0.9606	0.7695	0.9149
Zone 5:											
Tarai	0.9672	0.9786	0.9191	0.9808	0.9572	0.9411	0.6505	0.9016	0.8511	0.9051	0.9644
Non-Tarai	0.6584	0.9503	0.9147	0.8314	0.9944	0.8965	0.6959	0.9401	0.7514	0.8453	0.7648
Zone 6 and 7:											
Tarai	0.9711	0.9654	0.9651	0.9871	0.9886	0.9563	0.9458	0.9625	0.9331	0.9396	0.9835
Non-Tarai	0.8134	0.9386	0.8709	0.7827	0.7860	0.7434	0.8932	0.9293	0.9313	0.5662	0.9471

Note: (1) Zone/area (2) tobacco and products (3) clothing and cloth (4) footwear (5) fuel and light (6) other housing (7) transportation (8) medical care (9) personal care (10) education (11) recreation (12) social expenses

5.3.2 Spatial distribution of total consumption expenditure.

Now we are confronted with the problem of estimations of total consumption expenditure by sub-zones for both 1977-78 and 1989-90, the two terminal points of our chosen time horizon. These estimates are essential for item wise demand predictions through the use of elasticity coefficients. As the family budget surveys conducted by the Nepal Rashtra Bank refer to a reference year in early seventies, the available per capita consumption expenditure data do not relate to the year 1977-78. In the absence of any time series data on consumption expenditure it is rather problematic to make required estimations by trend analysis. Again the distressing agricultural output trend as analysed in Chapter II, does not give us any promise of a healthy economic trend in recent years that can be accepted for making decisions on the regional or spatial growth perspectives for 1989-90. To overcome this problem, we have made use of the consistent estimates of cereal food as obtained already in Chapter II and also the stated fact of reasonable stability (or the limited variation) in the proportion of total consumption expenditure spent on cereal food. An examination of the percentage shares of total consumption expenditure given in Table 5.2 under the column for cereals supports this fact. Using the suffix 1 for cereal food, if we denote

V_{r1} = price of cereals in rth sub-zone,

Q_{r1} = quantity of the total requirement of cereals in rth sub-zone,

s_{r1} = proportionate share of total consumption expenditure spent on cereal food in rth sub-zone,

we have the total consumption expenditure C_{ro}, given by the relation (5.6):

$$C_{ro} = (V_{r1}\ Q_{r1})/s_{r1} \qquad \ldots \qquad (6.6)$$

and with the estimates of population P_r, given already in Chapter II, we can deduce the corresponding per capita estimate

$$y_{ro} = C_{ro}/P_r .$$

The estimates of s_{r1} are already given in Table 5.2. The estimates of Q_{r1} for 1977-78 and also for 1989-90 under two alternative hypotheses 1 and 2 are available in Chapter II.. Note that the per capita quantity of consumption of cereals is same for both 1977-78 and 1989-90, Alt. 1, but it is a little higher for 1989-90, Alt. 2 . The relation (5.6) will be used to estimate C_{ro} for 1977-78 and 1989-90, Alt.1, only and the elasticity coefficients for cereals will be used to estimate C_{ro} for 1989-90, Alt. 2. To use the relation (5.6), we have still to estimate the price data of cereals V_{r1} for different sub-zones. In the family budget reports, the consuming shares of the quantities of different cereals have been given. The sub-zonal price data (retail prices) of different cereals for 1977-78 are available in the price bulletin of DFAMS [1980]. Using the data on consuming shares and the prices, we are in a position to obtain 1977-78 prices of cereals V_{r1}. As we will be using these prices, it is understood that all our value estimates are to be treated at constant 1977-78 prices. It is also to be understood that the estimates of C_{ro} really refer to total private (household) consumption expenditure; the government consumption expenditure which is negligible as compared with C_{ro} has not been included in our estimates of total consumption expenditure C_{ro}.

With a view to have a check on the reliability of our estimation procedure of C_{ro}'s, the national aggregate $\sum_r C_{ro} = C_o$, say for 1977-78 have been contrasted with such national estimate as could be obtained from other sources. This kind of check at the national level has also been done in estimating the requirements of cereal food for 1977-78. From the national data on (i) total GDP for 1977-78 at 1976-77 prices as given in a report of ISC [1980], (ii) consumer price indices for 1976-77 and 1977-78 as given in a price bulletin of DFAMS [1979] and (iii) share of consumption and saving as given in World Bank Report [1979b], we could establish that the total national GDP or income and the total consumption expenditure for 1977-78 were at the order of N Rs.19603 million and M Rs.18601 million at 1977-78 prices respectively. Our initial estimate of C_o as aggregated from C_{ro}'s of 1977-78 gave a higher estimate, about 1.12618 times more than the direct national estimate of total consumption expenditure, just given above. Considering the fact that the estimates of the same data obtained from sources might have used different price data, a difference of only 12.62 per cent is not very significant. We have however deflated our initial estimates of all sub-zones for 1977-78 by the same ratio to arrive at the final estimates of C_{ri} for 1977-78, so that $C_o = \sum_r C_{ri} = 18601$ N Rs. million (the direct national estimate). The corresponding final per capital estimates y_{ro}'s for 1977-78 are recorded in Table 5.2 along with the share values. But such a deflation has been avoided for the estimates of C_{ro} for 1989-90, Alt. 1, for the following reason. As the per capita cereals consumption norms are same in both 1977-78 and 1989-90, Alt. 1, such a deflation at both the years would have corresponded to growth rates of total consumption expenditure exactly identical with the population growth rates. In a developing economy with the objective of an improvement in peoples' level of living, the growth rate of consumption expenditure at the order of merely the population growth rate is hardly desirable;percentage annual growth rate of population in our time horizon is at the order of 2.3 per cent. By avoiding the stated deflation also for 1989-90, Alt. 1, we are allowing an additional growth rate of about 1 per cent per annum. Thus the annual growth rate of total consumption expenditure of about 3.3 per cent seems to be quite a reasonable developmental perspective (under Alternative 1). When the population growth rate is at the order of 2.3 per cent (for the nation as a whole).

For making the estimates of total consumption expenditure for 1989-90, Alt. 2, we shall make use of the elasticity coefficients for cereals B_{r1}. To indicate the variables for 1989-90, Alt. 1, and 1989-90, Alt. 2, we shall use suffices (1) and (2) to the variables already designated. Using the elasticity equation for cereals, we can write

$$\frac{y_{r1}(2)}{y_{r1}(1)} = \left[\frac{y_{ro}(2)}{y_{ro}(1)}\right]^{B_{r1}} .$$

from which we can deduce

$$C_{ro}(2) = C_{ro}(1) \left[y_{r1}(2)/y_{r1}(1)\right]^{1/B_{r1}} \quad \ldots \quad (5.7)$$

As the estimates $C_{ro}(1)$ are known and also the quantity ratios under two alternatives for cereal food, we can estimate total consumption expenditure $C_{ro}(2)$ for 1989-90, Alt. 2. The national aggregate established from the aggregation of $C_{ro}(2)$'s over sub-zones r's would now correspond to a percentage annual growth rate of about 4.2 per cent during the time horizon chosen. It may be recalled that after our programming exercises for cereal food distributions in Chapter II, we arrived at a sensible decision that our total requirement for cereal food should better be matched with the corresponding estimate for 1989-90, Alt. 1, while our production task should better be geared to estimate of 1989-90, Alt. 2, so that there is a generation of certain national exportable surplus in cereal food grains. Thus the total consumption expenditure estimated above for 1989-90, Alt. 2, based

Table 5.8: Estimates of Total and Percapita consumption expenditure for 1977-78 and for 1989-90 under two alternatives and the related Growth rates (values at const. 1977-78 prices).

	1977-78		1989-90 - Alternative 1			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Zone 1: Total	2926.142	1315.75	4162.699	1483.06	2.9809	1.0025
Tarai	1700.190	1378.42	2524.799	1550.50	3.3501	0.9852
non-Tarai	1225.952	1237.71	1637.900	1389.87	2.4435	0.9709
Zone 2: Total	3258.232	1392.85	4791.018	1571.69	3.2652	1.0117
Tarai	1908.004	1468.15	2894.529	1654.58	3.5341	1.0012
non-Tarai	1350.228	1298.74	1896.489	1460.05	2.8715	0.9804
Zone 3: Total	4421.452	1485.72	6687.929	1673.04	3.5088	0.9944
Tarai	1799.328	1647.20	2805.545	1849.13	3.7709	0.9683
non-Tarai	2622.124	1392.08	3882.384	1565.32	3.3246	0.9822
Kathmandu Valley	1016.295	1434.97	1530.427	1612.99	3.4704	0.9793
Other non-Tarai	1605.829	1366.24	2351.957	1535.78	3.2312	0.9796
Zone 4: Total	3715.444	1558.06	5418.005	1742.72	3.1935	0.9378
Tarai	463.776	1019.53	728.516	1146.70	3.8351	0.9844
non-Tarai	3251.668	1685.01	4698.489	1895.80	3.0983	0.9871
Zone 5: Total	1396.232	1164.49	2124.962	1300.94	3.5618	0.9276
Tarai	435.234	978.48	717.881	1099.43	4.2583	0.9760
non-Tarai	960.998	1274.19	1407.081	1435.14	3.2285	0.9962
Zone 6: Total	1332.190	1476.52	2045.084	1643.62	3.6363	0.8975
Tarai	362.496	1277.22	659.149	1436.75	5.1090	0.9856
non-Tarai	969.694	1567.98	1385.935	1764.45	3.0210	0.9886
Zone 7: Total	1550.953	1430.96	2280.310	1602.37	3.2642	0.9473
Tarai	300.963	1256.51	513.788	1414.65	4.5577	0.9928
non-Tarai	1249.990	1480.45	1766.522	1666.70	2.9242	0.9924
Nepal: Total	18600.645	1418.93	27510.007	1593.64	3.3150	0.9723
Tarai	6969.991	1380.63	10844.207	1548.01	3.7522	0.9581
non-Tarai	11630.654	1442.92	16665.800	1624.81	3.0430	0.9943

Note: (1) Zone/area
(2) Total cons. expd. Rs. million
(3) Percapita annual cons. expd. in Rs.
(4) Total cons. expd. in Rs. million
(5) Percapita annual cons. expd. in Rs.
(6) % annual growth rate of total cons. expd.
(7) % annual growth rate of percapita cons. expd.

Contd.....

Contd..... Table No.5.8

1989-90 - Alternative 2

(1)	(2)	(3)	(4)	(5)	(6)
Zone 1: Total	4587.690	1634.47	3.8185	1.8240	1.9588 %
Tarai	2807.172	1723.91	4.2672	1.8813	2.3418 %
non-Tarai	1780.518	1510.89	3.1588	1.6759	1.4584 %
Zone 2: Total	5183.008	1700.28	3.9441	1.6759	2.2309 %
Tarai	3141.911	1795.99	4.2440	1.6938	2.5078 %
non-Tarai	2041.097	1571.37	3.5034	1.6006	1.8728 %
Zone 3: Total	7482.460	1871.80	4.4816	1.9437	2.4896 %
Tarai	3161.351	2083.64	4.8086	1.9780	2.7757 %
non-Tarai	4321.109	1742.21	4.2506	1.8872	2.3196 %
Kathmandu velley	1764.953	1860.17	4.7071	2.1863	2.4669 %
Other non-Tarai	2556.159	1669.12	3.9499	1.6826	2.2297 %
Zone 4: Total	6038.815	1942.41	4.1306	1.8544	2.2348 %
Tarai	786.543	1238.03	4.5004	1.6313	2.8230 %
non-Tarai	5252.272	2123.31	4.0767	1.9454	2.0906 %
Zone 5: Total	2329.930	1426.43	4.3595	1.7051	2.6099 %
Tarai	799.265	1224.07	5.1955	1.8837	3.2506 %
non-Tarai	1530.665	1561.19	3.9553	1.7072	2.2103 %
Zone 6: Total	2225.684	1788.77	4.3698	1.6115	2.7145 %
Tarai	724.108	1578.34	5.9355	1.7797	4.0831 %
non-Tarai	1501.576	1911.67	3.7113	1.6653	2.0125 %
Zone 7: Total	2476.226	1740.04	3.9759	1.6430	2.2951 %
Tarai	562.996	1550.14	5.3576	1.7655	5.5298 %
non-Tarai	1913.230	1805.11	3.6108	1.6660	1.9129 %
Nepal: Total	30323.813	1756.65	4.1569	1.7951	2.3201 %
Tarai	11983.346	1710.62	4.6194	1.8020	2.7675 %
non-Tarai	18340.467	1788.08	3.8685	1.8033	2.0286 %

Note: (1) Zone-area
(2) Total cons. expd. in Rs. million
(3) Percapita annual cons. expd. in Rs.
(4) % annual growth rate of total cons. expd.
(5) % annual growth rate of percapita cons. expd.
(6) % annual growth rate of popn. in 1977-78 to 1989-90

on requirement data is not the recommended consumption norm. Considering the past performance of the nation, an annual growth of about 4.2 per cent for total consumption expenditure (as related to the 1989-90, Alt. 2), seems to be on the higher side. Yet we have recorded all demand predictions for both alternatives only to give a comparative picture of how high would have been the different predictions under second alternative. Compared with those of the recommended first alternative for 1989-90. The estimates of total and per capita consumption expenditure by sub-zones for 1977-78 and also for 1989-90 under the two alternatives and the related growth rates are recorded in Table 5.8.

5.3.3 Derivation of growth rates and demand predictions for different items of consumption.

Having obtained the estimates of per capita total consumption expenditures and the elasticity curves given in equation (5.2), it is now easy for us to derive the growth rates of item-wise total consumption by sub-zones. The growth rates of the total consumption of cereals, as determined by normative predictions in Chapter II have been already used to have the compatible estimates of the growth rates of total consumption expenditure. As such the present derivations are meant for other items of consumption except cereals. As noted already, the variables for 1989-90, Alt. 1, and 1989-90, Alt. 2, have been distinguished by attaching the suffices (1) and (2) to the variables. When we mean to refer to either of these two alternatives, we will attach (k). The variables without any such attachment of symbols will refer to the year 1977-78. The notation $P_r(t)$ will however be used for the population estimate in the target year of 1989-90 for rth sub-zone, while P_r will refer to such estimate for the year 1977-78. While the per capita consumption items are denoted by y_{ri}, the corresponding total item will be denoted by C_{ri} which equals the product $P_r\, y_{ri}$. Now using the elasticity equations, we can derive below the relation (5.8) that has been used for estimating the percentage annual growth rate of total consumption of ith item in rth sub-zone, denoted by g_{ri}. Thus we have

$$\frac{y_{ri}^{(k)}}{y_{ri}} = \left[\frac{y_{ro}^{(k)}}{y_{ro}}\right]^{B_{ri}} , \quad k = 1,2 \text{ and } i \neq 0,1$$

or, $$\frac{C_{ri}^{(k)}}{C_{ri}} = \left[\frac{P_r^{(t)}}{P_r}\right]\left[\frac{y_{ro}^{(k)}}{y_{ro}}\right]^{B_{ri}}$$

so that, we have

$$\left[1 + 0.01\, g_{ri}^{(k)}\right]^{12} = \left[\frac{P_r^{(t)}}{P_r}\right]\left[\frac{y_{ro}^{(k)}}{y_{ro}}\right]^{B_{ri}} \quad \ldots \quad (5.8)$$

Thus with the knowledge of population growth, per capita total consumption expenditure growth and the itemwise coefficient of elasticity, we are in a position to estimate the corresponding growth rates $g_{ri}^{(k)}$; k = 1, 2. These rates along with the pre-determined growth rates for cereals and total consumption expen-

Table 5.9: Percentage annual growth rate of total demand for different items: 1977-78 and 1989-90.

Item of consumption		Tarai Zone						
		1	2	3	4	5	6	7
all items	Alt.I	3.3501	3.5341	3.7709	3.8351	4.2583	5.1090	4.5577
	Alt.II	4.2672	4.2440	4.8086	4.5004	5.1955	5.9355	5.3576
all food items	Alt.I	2.9727	3.1308	3.3747	3.5639	3.8414	4.7327	4.1806
	Alt.II	3.5446	3.5604	3.9968	4.0497	4.3888	5.2543	4.6855
all non-food items	Alt.I	3.9607	4.0970	4.3783	4.3951	5.3915	5.8186	5.2686
	Alt.II	5.4416	5.2014	6.0592	5.4329	7.4035	7.2253	6.6301
cereals	Alt.I	2.3415	2.5237	2.7588	2.8222	3.2416	4.0832	3.5373
	Alt.II	2.7047	2.8751	3.1440	3.1905	3.6205	4.4587	3.9007
pulses	Alt.I	2.8954	3.0797	3.5616	3.3614	3.8499	4.5333	3.9808
	Alt.II	3.3969	3.4739	4.3794	3.7139	4.4052	4.8942	4.3302
fruits, vegs. and spices	Alt.I	2.9613	3.3926	3.5870	3.4949	3.9436	4.6296	4.0773
	Alt.II	3.5229	4.0040	4.4315	3.9354	4.5862	5.0680	4.5016
meat and eggs	Alt.I	3.1189	3.7941	3.4566	4.1031	4.3319	4.9285	4.3768
	Alt.II	3.8242	4.6858	4.1644	4.9462	5.3382	5.6086	5.0350
milk and products	Alt.I	4.4161	5.4212	4.7105	4.8167	4.9690	5.5743	5.0239
	Alt.II	6.3215	7.4676	6.7466	6.1372	6.5776	6.7805	6.1913
edible oils	Alt.I	3.7076	3.8690	4.0450	3.9345	3.9559	5.6366	5.0862
	Alt.II	4.9541	4.8132	5.3720	4.6657	4.6099	6.8938	6.3031
sugar and sweets	Alt.I	4.0332	4.3632	4.2635	3.9787	5.1626	6.0120	5.4624
	Alt.II	5.5813	5.6554	5.8222	4.7391	6.9557	7.5780	6.9780
beverages	Alt.I	4.0736	3.5639	3.8272	4.2718	4.8318	4.9780	4.4264
	Alt.II	5.6595	4.2947	4.9242	5.2273	6.3102	5.6982	5.1235
tobacco products	Alt.I	2.8354	2.9096	2.3447	3.7391	4.1072	5.1227	4.5713
	Alt.II	3.2823	3.1862	3.9355	4.3407	4.9028	5.9603	5.3820
clothing and cloth	Alt.I	4.1205	4.9438	4.2581	4.6721	5.0839	6.2546	5.7054
	Alt.II	5.7499	6.6483	5.8112	5.8954	6.8019	8.0211	7.4152
footwear	Alt.I	4.3738	4.4376	3.5547	4.2179	5.2362	5.6882	5.1380
	Alt.II	6.2396	5.7825	4.3652	5.1375	7.0996	6.9878	6.3958

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Item of consumption		Tarai Zone						
		1	2	3	4	5	6	7
fuel and light	: Alt.I	2.8174	3.0143	3.5341	3.3288	3.9970	4.7518	4.1997
	: Alt.II	3.2479	3.3632	4.3231	3.6598	4.6895	5.2888	4.7196
other housing	: Alt.I	3.2929	3.5686	4.1837	4.0610	4.6895	5.3940	4.8432
	: Alt.II	4.1575	4.3027	5.6578	4.8762	6.0330	6.4926	5.8678
transportation	: Alt.I	4.8511	5.1780	5.4102	4.5291	6.1534	7.3230	6.7760
	: Alt.II	7.1651	7.0500	8.2014	5.6566	8.9003	9.9825	9.3500
medical care	: Alt.I	5.1420	4.7798	4.7130	6.0925	6.0876	6.6401	6.0917
	: Alt.II	7.7310	6.3676	6.7516	8.2798	8.7705	8.7270	8.1115
personal care	: Alt.I	3.0423	3.6409	4.0682	4.1688	5.0499	5.1907	4.6395
	: Alt.II	3.6776	4.4254	5.4198	5.0557	6.7355	6.0837	5.5038
education	: Alt.I	5.7726	5.5031	5.7859	6.4909	6.6046	6.3075	5.7584
	: Alt.II	8.9628	7.6083	8.9866	8.9523	9.7914	8.1179	7.5107
recreation	: Alt.I	4.3308	4.4717	4.7960	6.5135	6.9499	7.4715	5.9249
	: Alt.II	6.1563	5.8408	6.9237	8.9905	10.4756	10.2565	9.6202
social expenses	: Alt.I	5.0398	3.8818	4.0170	4.8593	6.2710	6.1069	5.5574
	: Alt.II	7.5320	4.8351	5.3144	6.2085	9.1323	7.7512	7.1489

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Table 5.10 : Percentage annual growth rate of total demand for different items : 1977-78 and 1989-90.

Item of consumption		Non-Tarai Zone							
		1	2	3 KV	3 other than KV	4	5	6	7
all items	: Alt.I	2.4435	2.8715	3.4704	3.2312	3.0983	3.2285	3.0210	2.9242
	: Alt.II	3.1588	3.5034	4.7071	3.9499	4.0767	3.9553	3.7113	3.6108
all food items	: Alt.I	2.1114	2.5930	3.0479	2.8829	2.6826	2.8024	2.7329	2.6353
	: Alt.II	2.5042	3.0476	3.7607	3.3504	3.2551	3.2235	3.2248	3.1245
all non-food item	: Alt.I	3.1059	3.5817	4.2139	3.8796	3.8571	4.2292	3.6061	3.5110
	: Alt.II	4.3087	4.6689	6.3841	5.0701	5.5844	5.6821	4.7021	4.6011
cereals	: Alt.I	1.4439	1.8683	2.4598	2.2249	2.0929	2.2207	2.0154	1.9196
	: Alt.II	1.8126	2.2304	2.8343	2.5828	2.4549	2.5768	2.3713	2.2736
pulses	: Alt.I	2.1026	2.4962	3.2888	3.0999	2.6492	2.8093	2.5231	2.4250
	: Alt.II	2.5689	2.8894	4.2998	3.7237	3.1891	3.2354	2.8712	2.7711
fruits, vegs. and spices	: Alt.I	1.8722	2.4221	3.0202	2.6297	2.6764	2.7501	2.5700	2.4719
	: Alt.II	2.1712	2.7683	3.6987	2.9154	3.2428	3.1339	2.9501	2.8500
meat and eggs	: Alt.I	2.0763	2.6442	3.7355	3.2709	3.7461	3.4245	3.7968	3.7023
	: Alt.II	2.5235	3.1314	5.3034	4.0184	5.3633	4.2925	5.0259	4.9247
milk and products	: Alt.I	3.2563	3.0497	5.5753	3.7526	3.5457	3.6550	3.4394	3.3439
	: Alt.II	4.5705	3.7953	6.3797	4.8503	4.9643	4.6898	4.4194	4.3185
edible oils	: Alt.I	2.1436	2.7065	2.4047	2.8671	2.5482	2.8991	2.8649	2.7678
	: Alt.II	2.6399	3.2332	4.5596	3.3232	2.9902	3.3894	3.4477	3.3473
sugar and sweets	: Alt.I	3.3962	4.1508	4.0980	4.9267	4.0118	4.0099	4.4361	4.3434
	: Alt.II	4.8143	5.6065	6.1218	6.8896	5.8932	5.3026	6.1141	6.0123
beverages	: Alt.I	1.9757	2.7920	3.8864	2.9772	3.6617	3.3706	2.9030	2.8059
	: Alt.II	2.3497	3.3732	5.6437	3.5125	5.1951	4.2001	3.5119	3.4114

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Item of consumption		Non-Tarai Zone							
		1	2	3 KV	3 other than KV	4	5	6	7
tobacco and products	: Alt.I	2.2253	2.6493	3.2698	2.9177	2.6746	2.7977	2.6258	2.5279
	: Alt.II	2.7811	3.1397	4.2571	3.4103	3.2393	3.2155	3.0443	2.9441
clothing and cloth	: Alt.I	3.5757	4.7184	4.8435	4.1549	4.2379	5.0558	4.4000	4.3080
	: Alt.II	5.1275	6.5449	7.8157	5.5472	6.3452	7.1175	6.0538	5.9520
footwear	: Alt.I	3.5936	4.5793	4.3009	3.9270	4.0822	4.5881	3.8976	3.8034
	: Alt.II	5.1588	6.3146	6.5814	5.1522	6.0339	6.3043	5.1971	5.0958
fuel and light	: Alt.I	1.7237	2.0879	3.0889	2.6810	2.4747	2.4949	2.2748	2.1759
	: Alt.II	1.9151	2.2232	3.8524	3.0034	2.8455	2.6968	2.4532	2.3534
other housing	: Alt.I	2.9414	3.4681	3.7688	3.5689	3.4408	3.8904	3.6697	3.5748
	: Alt.II	4.0226	4.4820	5.3784	4.5327	4.7559	5.0962	4.8099	4.7088
transportation	: Alt.I	4.5086	4.7121	6.2168	5.2542	4.4682	5.9701	6.0622	5.9743
	: Alt.II	6.7616	6.5344	10.9747	7.4613	6.8066	8.7143	8.9026	8.7993
medical care	: Alt.I	3.5237	4.3290	4.6567	4.0748	5.5194	5.1572	5.8559	5.7674
	: Alt.II	5.0368	5.9006	7.3899	5.4084	8.9249	7.2940	8.5472	8.4441
personal care	: Alt.I	2.8930	3.6795	3.9888	3.4827	4.0369	4.2133	3.6982	3.6034
	: Alt.II	3.9385	4.8297	5.8749	4.3839	5.9433	5.6546	4.8585	4.7573
education	: Alt.I	4.2754	3.9822	5.4185	5.5752	5.3253	4.5772	5.4803	5.3907
	: Alt.II	6.3521	5.3283	9.1324	8.0228	8.5322	6.2853	7.9014	7.7986
recreation	: Alt.I	5.0085	5.1609	4.8252	4.5062	5.5054	5.5611	5.5739	5.4845
	: Alt.II	7.6415	7.2786	7.7740	6.1573	8.8966	7.9988	8.0621	7.9592
social expenses	: Alt.I	3.5468	4.1831	4.1943	4.5310	5.8003	4.6965	5.7859	5.6972
	: Alt.II	5.0771	5.6597	6.3397	6.2005	9.4944	6.4926	8.4266	8.3236

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diture are presented for different Tarai and non-Tarai sub-zones in Tables 5.9 and 5.10. It should be noted that the growth rate for cereals under alternative 1 would correspond to the population growth rates.

After having obtained the rates of growth for all enlisted items of consumption we have made attempts for estimations of total demand for 1977-78 for some selected food items and the nonfood item of tobacco product for which per capita quantities of annual consumption are available in the family budget survey reports of the Nepal Rashtra Bank. As we have no way of cross-checking these 1977-78 quantitative estimates of consumption for these selected items except the cereal food, we have to treat them as tentative estimates. Granting that these estimates provide us with certain possible magnitudes of demand we can easily derive the corresponding estimates for these items for 1989-90 under the two alternatives, by use of the growth rates already calculated and recorded in Tables 5.9 and 5.10. In these calculations certain rates meant for a group of items has been applied on individual items of the group. The results of these exercises on demand predictions are presented in Tables 5.11, 5.12 5.13 for 1977-78, 1989-90 (Alt. I) and 1989-90 (Alt.II) respectively.

Table 5.11: Estimated total demand of different items of consumption in 1977-78.

(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Zone 1:	Total	22183	55668	4967	88977	11097	10634	80062	12182	58084	12299
	Tarai	14061	38730	2590	44404	5550	3700	44404	7031	28369	8634
	Non-Tarai	8122	16938	2377	44573	5547	6934	35658	5151	29715	3665
Zone 2:	Total	22951	74752	3223	77715	12554	11696	81094	10761	43146	5406
	Tarai	18584	50944	1560	29891	6108	6498	41587	7018	28591	3639
	Non-Tarai	4367	23808	1663	47824	6446	5198	39507	3743	14555	1767
Zone 3:	Total	31020	80708	3873	86477	22284	21179	84977	13250	74588	12156
	Tarai	14419	37031	1092	24032	7756	3277	27309	5243	21847	4260
Kathmandu valley		6728	22168	1841	35412	5595	8499	17706	3541	19831	4958
Other Non-Tarai		9873	21509	940	27033	8933	9403	39962	4466	32910	2938
Zone 4:	Total	27271	53412	3634	35770	12764	14873	94352	13026	72450	12968
	Tarai	8552	14238	546	6823	2729	1365	11372	3184	14557	2547
	Non-Tarai	18719	39174	3088	28947	10035	13508	82980	9842	57893	10421
Zone 5:	Total	11406	22006	1442	17985	5897	5415	45368	4957	30904	4879
	Tarai	5071	5338	311	6672	1824	890	10675	2091	9786	1334
	Non-Tarai	6335	16668	1131	11313	4073	4525	34693	2866	21118	3545
Zone 6:	Total	15085	11062	665	14953	3409	2372	22738	4381	17740	2143
	Tarai	5932	8032	170	5676	1306	1135	8514	1845	9082	1277
	Non-Tarai	9153	3030	495	9277	2103	1237	14224	2536	8658	866
Zone 7:	Total	15993	9478	1082	15539	3422	1799	33791	4684	18767	1952
	Tarai	3497	5341	407	2874	551	110	14371	1222	6946	770
	Non-Tarai	12496	4137	675	12665	2871	1689	19420	3462	11821	1182
Nepal:	Total	145909	307086	18886	337416	71427	67968	442382	63241	315679	51803
	Tarai	70116	159654	6676	120372	25824	16975	158232	27634	119178	22461
	Non-Tarai	75793	147432	12210	217044	45603	50993	284150	35607	196501	29342

Note: (1) Zone/area (2) Pulses (tonne) (3) Vegetables (tonne)
(4) Spices (tonne) (5) Fruits (000 no.) (6) Meat & Fish (tonne)
(7) Eggs (000 no.) (8) Milk (000 litre.) (9) Edible oils & Ghee (000 litre.)
(10) Cigarettes (000 packets) each of 20 sticks (11) Sugar & Sakkar (tonne)

Table 5.12: Estimated total demand of different items of consumption in 1969-90 (Alt. I).

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Zone 1: Total	30231	76133	6646	118710	15121	14222	126961	17527	78376	19348
Tarai	19805	54972	3676	63025	8023	5349	74582	10883	39679	13876
Non-Tarai	10426	21161	2970	55685	7098	8873	52379	6644	38697	5472
Zone 2: Total	32614	107755	4544	108342	18366	17269	135015	16224	60257	8954
Tarai	26743	76027	2328	44608	9549	10159	78360	11067	40337	6075
Non-Tarai	5871	31728	2216	63734	8817	7110	56655	5157	19920	2879
Zone 3: Total	46105	117573	5581	124202	33493	31961	143575	20000	108073	20291
Tarai	21944	56523	1666	36682	11661	4927	47445	8438	32423	7031
Non-Tarai	24161	61050	3915	87520	21832	27034	96130	11562	75650	13260
Kath. valley	9920	31680	2631	50608	8688	13198	33952	5292	29176	8028
Oth.Non-Tarai	14241	29370	1284	36912	13144	13836	62178	6270	46474	5232
Zone 4: Total	38335	75285	5065	50046	20023	23214	146053	18370	102080	20775
Tarai	12717	21502	825	10304	4421	2212	19999	5059	22614	4068
Non-Tarai	25618	53783	4240	39742	15602	21002	126054	13311	79466	16707
Zone 5: Total	16813	31573	2061	26279	9135	8258	72476	7369	45270	8123
Tarai	7979	8491	495	10613	3034	4480	19103	3331	15863	2441
Non-Tarai	8834	23082	1566	15666	6101	6778	53373	4038	29407	5682
Zone 6: Total	22442	17934	964	22349	5615	3957	37667	7122	28357	4031
Tarai	10099	13825	293	9770	2326	2022	16324	3563	16540	2573
Non-Tarai	12343	4109	671	12579	3289	1935	21343	3559	11817	1458
Zone 7: Total	22245	14174	1562	21620	5362	2797	54697	7020	27826	3427
Tarai	5586	8628	657	4643	921	184	25879	2216	11876	1458
Non-Tarai	16659	5546	905	16977	4441	2613	28818	4804	15950	1969
Nepal: Total	208785	440427	26423	471548	107115	101678	716444	93632	450239	84949
Tarai	104873	239968	9940	179645	39935	26333	281692	44557	179332	37522
Non-Tarai	103912	200459	16483	291903	67180	75345	434752	59085	270907	47427

Note: (1) Zone/area (2) Pulse (tonne) (3) Vegetables (tonne)
(4) Spices (tonne) (5) Fruits (000 no.) (6) Meat & Fishes (tonne)
(7) Eggs (000 no.) (8) Milk (000 litre.) (9) Edible oil & Ghee (000 litre.)
(10) Cigarattes (000 packets each of 20 sticks
(11) Sugar & Sakker (tonne)

Table 5.13: Estimated total demand of different items of consumption in 1989-90 (Alt. II).

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Zone 1: Total	32006	80597	7000	124953	16188	15156	153619	19603	83097	23011
Tarai	20994	58679	3924	67275	8707	5805	92656	12561	41798	16568
Non-Tarai	11012	21918	3076	57678	7481	9351	60963	7042	41299	6443
Zone 2: Total	34144	114640	4807	114246	19914	19302	160467	17820	62749	10442
Tarai	27997	81601	2499	47878	10582	11777	98693	12337	41657	7042
Non-Tarai	6147	33039	2308	66368	9332	7525	61774	5483	21092	3400
Zone 3: Total	50576	126951	6011	133356	37389	36235	167518	22481	116637	25050
Tarai	24116	62308	1837	40436	12655	5347	59780	9824	34718	8401
Kath.valley	11150	34277	2847	54756	10402	15801	37190	6046	32705	10115
Oth.Non-Tarai	15310	30366	1327	38164	14332	15087	70548	6611	49214	6534
Zone 4: Total	40530	80080	5397	53297	23655	27721	171655	19519	109111	25157
Tarai	13247	22626	868	10843	4871	2436	23241	5503	24239	4440
Non-Tarai	27283	57454	4529	42454	18784	25285	148414	14016	84872	20717
Zone 5: Total	17790	33281	2171	27810	10150	9154	83058	7867	48254	9580
Tarai	8507	9143	533	11427	3405	1661	22928	3591	17380	2990
Non-Tarai	9283	24138	1638	16383	6745	7493	60130	4276	30874	6590
Zone 6: Total	23381	18832	1010	23423	6302	4413	42608	7915	30601	4833
Tarai	10525	14537	308	10273	2514	2185	18708	4106	18193	3068
Non-Tarai	12856	4295	702	13150	7388	2228	23900	3809	12408	1765
Zone 7: Total	23163	14855	1636	22619	6105	3205	61804	7684	29774	4112
Tarai	5816	9059	690	4875	993	198	29550	2545	13030	1730
Non-Tarai	17347	5796	946	17744	5112	3007	32254	5139	16744	2382
Nepal: Total	221590	469236	28032	499704	119703	115186	840729	102889	480223	102185
Tarai	111202	257953	10659	193007	43727	29409	345556	50467	191015	44239
Non-Tarai	110388	211283	17373	306697	75976	85777	495173	52422	289208	57946

Note: (1) Zone/area (2) Pulses (tonne) (3) Vegetables (tonne)
(4) Spices (tonne) (5) Fruits (000 no.) (6) Meat and Fishes (tonne)
(7) Eggs (000 no.) (8) Milk (000 litre.) (9) Edible oil and Ghee (000 litre.)
(10) Cigarettes (000 packets) each of 20 sticks.
(11) Sugar and Sakker (tonne)

5.3.4 Associated income generation at the national level.

On the basis of the present cereal food requirement norms and the expenditure shares on cereal food and also the population growth path, we have predicted the growth rate of total consumption expenditure. For reasons stated earlier, the growth rate of about 3.2 per cent per annum under alternative 1 is more feasible and the estimations under alternative 2 are presented here in order to show how enhanced would be the planning tasks if people switch over to the higher cereal food requirement norms of the early seventy (1971-72) instead of late seventy (1977-78). To avoid that situation, national efforts for resource mobilisation from peoples' saving share and also the export potential for the surplus foodgrain production must have to be strengthened. Now having the target set on thegrowth rate of total consumption expenditure, it is natural to question what would be the possible growth path of national income to be associated with the growth path of consumption. Obviously national income growth path has to be higher than the corresponding consumption expenditure growth path, but it is difficult to answer how higher it ought to be. We can only examine the alternative possibilities and make some assessment on the basis of the feasibility of saving rate generation.

If we assume that the national GDP, denoted by Z, is distributed between consumption and saving, denoted by C and S respectively, the income elasticity of consumption, denoted by E, can then be written as follows:

$$E = \frac{dC}{dZ} \cdot \frac{Z}{C} = \left(\frac{dZ - dS}{dZ}\right)/\left(\frac{Z - S}{Z}\right)$$

$$= (1 - S_m)/(1 - S_a) \qquad \ldots \qquad (5.9)$$

where $S_m = \frac{dS}{dZ}$ = marginal share of saving, and $S_a = \frac{S}{Z}$ = average share of saving. For a healthy growth path of national economy, the income elasticity of consumption E should be considerably below unity. That is for a one per cent rise in national income, the rise in consumption should be considerably below one per cent. It has been noted that the average saving share of Nepal, S_a, was at the order of 5.1 per cent in 1977-78 and from the evidences of recent past, we believe that this share remained almost stagnant. In the fifth five year planning document [reported in the World Bank Report, 1979b] this average saving share was expected to rise to a value in between the minimum of 6.4%. and the maximum of 7.9%. by 1980. The associated marginal share M_s postulated has been in between the minimum of 27.8%. and the maximum of 37.4%.. But if the average saving share did not improve at all by 1977-78, the postulated average saving rate and the associated marginal saving rate would have hardly attained by the target year 1980 of the fifth five year plan of Nepal. Under these circumstances one cannot be over optimistic on the saving generation possibilities and hence on the growth path of income in our chosen time horizon. With the knowledge of Z and C at 1977-78 and 1989-90, and also the postulated values of either S_m or S_a at selected intervals (including those attained or postulated in the fourth five year plan document), we have calculated in the Tables 5.14 and 5.15 for alternatives 1 and 2, giving the associated estimates of the income elasticity of consumption and also the growth path of per capita income, total income and total saving. In the first ten rows in each of these Tables, the selected values are those of S_a given in the first column and all other values in those rows are derived ones. Whereas in the last ten rows of those Tables, the selected values are those of S_m given in the second column and all other values of those rows are derived ones. From among those values calculated one can try to make judgements on a feasible growth path of income on the basis of certain possible saving mobilisation. It should be emphasised at the outset that mere algebraic calculations do not put the nation at a desired growth path. Productive activities must have to be geared according to the associated demand predictions for commodies and also the resource mobilisation and the export generation efforts must have to be strengthened in order to have a desired income growth path.

In 1977-78, overage saving share was about 5.1%. Calculations according to this value and also the minimum and the maximum average saving shares as postulated in the fifth five year plan are presented in the first three rows of Tables 5.14 and 5.15. If 1977-78 average saving share continues to follow, the income elasticity of total consumption would likely to be unity and the growth rates for total income, total consumption and total saving would be the same 3.3 per cent per annum in the period under consideration under alternative 1. Under alternative 2, the growth rates for total income and total consumption and total saving would again be the same 4.15% or so. If the postulated average saving shares of the fifth plan could be attained the total income growth rate would be a little higher than the total consumption growth rate, while the total saving growth rate has to be considerably higher. In that case the income elasticity of consumption has to be a little less than unity in both alternatives. Even then it would not be difficult to attain this saving rates. But the calculations made on the basis of the postulated marginal saving shares of the fifth plan seem to be quite beyond the limits of possibilities in the economy with poor activity bases. These estimates are given in the rows (11), (13) and (12) for the postulated minimum S_m, maximum S_m and their average respectively. Under those postulated range, the total saving growth rate has to be between 13.2% and 16.6% per annum under alternative 1 and between 15.3% and 18.9% per annum under alternative 2. This also means that the average saving share and the income elasticity of total consumption have to change from the respective initial value of 5.1% and 1.0% to the values in the range of 13.9% to 18.7% and the range of 0.84 to 0.77 under alternative 1. Similar kinds of changes can be noticed under alternative 2 also. These changes in the values within a span of only twelve years seem to be not possible. Because the fifth plan time horizon was of only the five years length, the calculations of the postulated S_m were possibly the result of the short time horizon therein in the hope of achieving the postulated average saving share. Definitely, the postulated marginal shares were over optimistic under the economic situations prevailing in Nepal. We have given other calculations on basis of either S_a [rows (4) to (10)] or S_m [rows (14) to (20)] chosen at regular intervals. We feel that difficult to expect a target year saving share that could be more than doubled within a span of only twelve year. In order to achieve an average saving share of 10 per cent, one has to have a total saving growth rate of about 9.7 per cent under alternative 1 and 10.6 per cent under alternative 2. With efforts, a ten per cent rise in saving should not be difficult. This means that the income elasticity of total consumption should not go below 0.9 which also seems to be within reasonable limit. But a growth rate of saving over 10 per cent per annum could be hardly achieved under the prevailing situations in saving generation. Thus we feel that would possibly be within limit to expect a total income growth rate of about 3.77 per cent per annum for which average saving share has to be 10 per cent under alternative 1. At any

Table 5.14: Income generation possibilities and the income elasticity of total consumption as associated with selected average or marginal saving shares: 1977-78 to 1989-90 (values at constant 1977-78 prices)

(Alternative I)

Sl. No.	S_a = average saving share in %	S_m = marginal saving share in %	E = income elasticity of total consumption	GDP in Rs. million in 1989-90	Per-capita income in 1989-90 Rs.	% annual growth rate: per-capita income	Total income	Total saving
1	5.10	5.07	1.0003	28988.4	1679.29	0.971	3.314	3.292
2	6.40	8.98	0.9725	29391.0	1702.61	1.087	3.433	5.386
3	7.90	13.22	0.9422	29869.7	1730.34	1.224	3.572	7.396
4	5.00	4.76	1.0025	28957.9	1677.52	0.962	3.305	3.112
5	7.50	12.12	0.9501	29740.5	1722.86	1.187	3.535	6.893
6	10.00	18.74	0.9029	30566.7	1770.72	1.418	3.771	9.737
7	12.50	24.73	0.8602	31440.0	1821.31	1.657	4.015	12.059
8	15.00	30.19	0.8213	32364.7	1874.88	1.903	4.267	14.050
9	17.50	35.17	0.7858	33345.5	1931.69	2.156	4.526	15.812
10	20.00	39.74	0.7533	34387.5	1992.06	2.419	4.795	17.409
11	13.88	27.80	0.8384	31942.8	1850.44	1.791	4.153	13.189
12	16.18	32.60	0.8041	32821.6	1901.35	2.022	4.389	14.908
13	18.69	37.40	0.7699	33835.2	1960.06	2.281	4.654	16.593
14	8.56	15.00	0.9296	30084.6	1742.78	1.284	3.634	8.178
15	10.51	20.00	0.8940	30739.7	1780.74	1.466	3.820	10.242
16	12.62	25.00	0.8583	31482.1	1823.75	1.668	4.027	12.159
17	13.74	27.50	0.8405	31891.8	1847.48	1.778	4.139	13.080
18	14.91	30.00	0.8227	32330.7	1872.90	1.894	4.258	13.983
19	16.13	32.50	0.8048	32802.1	1900.21	2.017	4.383	14.873
20	17.41	35.00	0.7870	33309.7	1929.62	2.147	4.517	15.753

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Table 5.15: Income generation possibilities and the income elasticity of total consumption as associated with selected average or marginal saving shares: 1977-78 to 1989-90 (values at constant 1977-78 prices).

(Alternative II)

Sl. No.	S_a = average saving share in %	S_m = marginal saving share in %	E = income elasticity of total consumption	GDP in Rs. million in 1989-90	Per-capita income in 1989-90 Rs.	% annual growth rate: per-capita income	Total income	Total saving
1	5.10	5.08	1.0002	31953.4	1851.05	1.794	4.156	4.133
2	6.40	8.37	0.9789	32397.2	1876.76	1.911	4.276	6.244
3	7.90	12.00	0.9555	32924.9	1907.33	2.048	4.416	8.271
4	5.00	4.82	1.0019	31919.8	1849.10	1.785	4.147	3.952
5	7.50	11.05	0.9616	32782.5	1899.08	2.012	4.378	7.764
6	10.00	16.80	0.9245	33693.1	1951.83	2.245	4.617	10.631
7	12.50	22.12	0.8901	34655.8	2007.60	2.485	4.863	12.972
8	15.00	27.06	0.8581	35675.1	2066.64	2.733	5.116	14.979
9	17.50	31.66	0.8284	36756.1	2129.27	2.989	5.378	16.756
10	20.00	35.95	0.8007	37904.8	2195.81	3.253	5.649	18.366
11	15.39	27.80	0.8533	35840.1	2076.20	2.772	5.157	15.271
12	18.04	32.60	0.8224	36996.4	2143.19	3.045	5.435	17.113
13	20.89	37.40	0.7913	38330.1	2220.45	3.349	5.747	18.905
14	9.20	15.00	0.9361	33395.0	1934.56	2.169	4.539	9.780
15	11.48	20.00	0.9038	34257.0	1984.49	2.386	4.762	12.067
16	13.94	25.00	0.8715	35233.9	2041.09	2.626	5.007	14.158
17	15.23	27.50	0.8553	35772.9	2072.31	2.756	5.140	15.153
18	16.58	30.00	0.8391	36350.4	2105.76	2.894	5.281	16.124
19	17.98	32.50	0.8230	36970.7	2141.70	3.039	5.429	17.076
20	19.43	35.00	0.8068	37638.6	2180.39	3.193	5.587	18.014

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rate, one cannot expect to exceed 4 per cent growth rate of total income per annum with even over ambitious expectations on the rate of saving (12% per annum under alternative 1) and the average saving share (12.5% under alternative 1). We abandon the alternative 2 which requires the gearing of our productive activities at a much higher levels of demand predictions. Even with alternative 1, foreign financial resources might even be necessary for an appropriate gearing of productive activities. According to the fifth plan document [reported in the World Bank report 1979b], only half of total national investment for planning comes from domestic saving. Therefore even to start certain basic productive activities, Nepal might have to seek international collaborations.

5.4 Synthetic Analysis and Concluding Observations.

Detailed regional analysis have been already made for various productive activities in preceding chapters, with district level data. Though productive activity is expected to be broadly related to people's level of living, they are often not identical because of the openness of regional economies caused by the mobilities of people, goods and funds. District level data on people's level of living can hardly be obtained. The only data that we have at the moment are those of sub-zonal estimates of total consumption expenditure as reported in the last sub-section. These estimates of per capita total consumption expenditure have been calculated at the local prices. In order to compare the level of living in real terms, the estimates of per capita expenditure have to be deflated, by the consumer price index. But we do not have readily the sub-zonal consumer price indices. What we have is the cereals food price indices as we have established for the purpose of demand predictions. Assuming that the regional variations in the general consumer prices are reflected in the cereal food prices, we have deflated the per capita consumption expenditure by the cereal food price index. Again to have a comparative study between the level of living thus obtained and the major activity indices, namely (i) the over-all development index A, (ii) the agricultural development index D and (iii) the non-agricultural development index N, we have aggregated the district level values in each of these activity indices by the respective population shares of districts to arrive at the sub-zonal estimates and other aggregates. All these sub-zonal or regional estimates are recorded in Table 5.16. The variations between Tarai and non-tarai areas are depicted also in the level of living index as in the activity indices, but as expected the variations are not that contrasting with the level of living index as in the activity indices. This shows that the non-Tarai areas have quite depressed activity bases well below the national level compared with the level of living index. On the contrary Tarai areas and Kathmandu valley have highly advanced activity bases well above national level than what they have in respect of the level of living index. Obviously these relative contrasts

Table 5.16: Regional indices of level of living and development activities.

Region	Cereal food price index 1977-78	Level of living index 1977-78	Activity indices of development: Δ = over-all	D = agricultural	N = non-agricultural
Zone 1: Total	0.9228	1.0049	1.4702	1.3752	1.5093
Tarai	0.8646	1.1236	2.1294	1.9649	1.7127
Non-Tarai	0.9961	0.8757	0.6805	0.7826	0.6745
Zone 2: Total	0.9605	1.0220	0.9694	1.0431	1.1507
Tarai	0.9069	1.1409	1.3336	1.4117	1.3957
Non-Tarai	1.0235	0.8943	0.5298	0.6202	0.5610
Zone 3: Total	0.9254	1.1315	1.9567	1.1138	2.2510
Tarai	0.8949	1.2972	1.5567	1.6929	1.2954
Non-Tarai	0.9456	1.0375	2.1829	0.7091	2.4759
Kathmandu valley	0.9165	1.1034	4.9358	1.4005	2.7408
Other Non-Tarai	0.9632	0.9997	0.5475	0.5615	0.8448
Zone 4: Total	1.1544	0.9512	0.7920	0.7929	1.0297
Tarai	0.7669	0.9369	1.7866	1.8845	1.4045
Non-Tarai	1.2495	0.9504	0.5667	0.5666	0.8522
Zone 5: Total	0.9058	0.9063	0.8761	0.9839	0.8455
Tarai	0.7447	0.9260	1.4955	1.7428	1.0385
Non-Tarai	1.0089	0.8901	0.5303	0.5791	0.6660
Zone 6: Total	1.1693	0.8899	1.1086	1.1946	1.0074
Tarai	0.8465	1.0634	2.3089	2.5680	1.3410
Non-Tarai	1.3233	0.8351	0.6163	0.7253	0.5283
Zone 7: Total	1.0922	0.9234	0.7621	0.8575	0.7654
Tarai	0.6733	1.3152	1.8077	2.1345	1.0078
Non-Tarai	1.2443	0.8385	0.4902	0.5633	0.5673
Nepal: Total	1.0000	1.0000	1.0000	1.0000	1.0000
Tarai	0.8512	1.1431	1.7077	1.7609	1.4495
Non-Tarai	1.0981	0.9261	0.9489	0.6430	1.7353
Non-Tarai except Kathmandu valley	1.1162	0.9115	0.5745	0.6175	0.7210

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are suggestive of the fact that the saving generation possibilities are practically limited in the non-Tarai areas (except Kathmandu valley) unless concerted efforts are made by the government to create certain minimum of activity bases for the sustainance of living standards in the future time horizon. It should be recalled that our previous analysis gives an impression that the activities in the non-Tarai areas could possibly, be centered around (i) forest resource based industries, (ii) wollen industries on cooperative basis, (iii) mineral developments with proper attention for mineral prospective in all feasible non-Tarai areas, (iv) horticultural development where feasible, (v) hydel power generation, where possible, etc.. On the other hand, saving generation possibility is much better in the Tarai areas and Kathmandu valley than the major non-Tarai areas. As these areas are also more productive, according to some theorems proved by Rehman [1963], planning investments for productive activities have to be made in Tarai areas for an optimisation of national income. This optimisation aspect is often not concomitant with the distributional aspect to be considered under welfare consideration. The best compromise one can suggest in the present context is to (i) earmark planning investment funds into two categories: (a) productive activity improvement fund and (b) welfare promotion fund, (ii) allocate the productive activity improvement fund on the basis of dimensions of productive tasks assessed by sectors of activities and (iii) distribute the welfare promotion fund, with the motive for a creation of productive bases towards sustainance of peoples' welfare, on the basis of some kind of inverse function of over-all development level by regions. For such allocations and distributions of planning investment funds, the development activity indices and dimensions of various productive tasks that we have evaluated in different chapters can be of immense help to the planners of the national planning commission.

Another important feature that is well brought out from the estimates of cereal food price indices recorded in Table 5.13 is that the variation in prices between Tarai and non-Tarai areas are sharper in the western part of Nepal than that in the eastern part. True that because of a relatively more rugged terrain in non-Tarai area than in Tarai area, the prices are bound to be at a higher level in the non-Tarai areas than in their southern flat counter part. But the wider price variation in the western part is suggestive of relatively more neglected condition of transportation arteries and links between a Tarai area and its northern non-Tarai area. Unless the accessibility condition is improved in the western part, any exploratory work that has to be undertaken to assess the productive potentials of non-Tarai areas, particularly in the western part, will be greatly hampered and as such those areas would very likely remain neglected. While launching efforts for any improvement of accessibility conditions, one has always to keep in mind the possible areas of productive potentials and resource endowments to be assessed.

We shall conclude this section by adding our observations on the relationship between productive activities and the consumer demands as depicted by the estimated coefficients of elasticities presented in Tables 5.4 and 5.5 in previous section. The main purpose of calculations of elasticities in the previous section has been the growth rate evaluations and demand predictions of different items of consumption with varying elasticities. We have noticed already in the relation (5.8) that the coeff. of elasticity has an important role in moderating or enhancing the growth rates of consumption item. When the coeff. of elasticity is lower than unity for a commodity, its future growth rate is likely to be lower than the total consumption growth rate according to formula (5.8) and it would reverse when the coeff. of elasticity of an item is higher than unity. Assuming that the consumer behaviour does not change within a short span of time as our chosen time horizon is, our productive efforts must have to be matched with the demand predictions to avoid the economies of shortages and imbalances and also to achieve the desired growth path of the economy in the time horizon. It could be noticed generally and also supported by our present data on the elasticity coefficients that basic food items are having lower values of elasticity coefficients than unity, while many of the non-food items have such values higher than unity. Infact, items with elasticity coefficients lower than unity are called essential items of consumption, while the items with elasticity coefficients above unity are called luxurious items. Though most of the food items are likely to be essential, all of them do not behave like essential items in respect of values of elasticity coeffs. particularly in an under-developed economy. For example, though "milk" is considered to be an essential food item, in fact, it is so in a developed economy, this item behaved like a luxurious item in Nepal in all regions considered. In fact, Tarai areas have generally higher values of elasticity coeff. for milk and milk products than those in non-Tarai areas. It appears that non-Tarai areas are more productive in milk; this is also supported by the higher magnitudes of livestocks maintained by people of non-Tarai areas. Similarly the food item of sugar and sweets shows values higher than unity for elasticity coefficients in all regions and it shows the lowest value expectedly in the sugar producing Tarai area of zone 4. Though other sugar producing areas in Tarai do not show similar kind of low values, all Tarai areas are having lower values than those of non-Tarai areas; nearness to sugar producing areas (both of Nepal and India) is the reason for this situation. The values of elasticity coeffs. are on either side of unity in different regions for food items like (i) meat and eggs, (ii) oils and fats, and (iii) beverages. But, as expected, the values of elasticity coeffs. are always considerably below unity for essential food items like (a) cereal (b) pulses, (c) fruits, vegetables and spices and also for (d) the food total. Among the nonfood items, generally (i) fuel and light and (ii) tobacco and products behaved as the essential items generally with values of elasticity lower than unity. In fact, for the cold climatic condition, the item of fuel and light behaved as the most essential item practically in all non-Tarai areas. The corresponding elasticity coeffs. are very often less than those of cereal food even. Non-food items like (a) education, (b) transportation, (c) recreation, (d) medical care, behaved like the most luxurious items of consumption in all regions with values of elasticity coefficient substantially above unity. Even "clothing and cloth" behaved like quite a luxurious item, though it must be considered very essential item in such a cold country as Nepal. All these reflect generally the distressing conditions of the people in all regions. No wonder why the education level is at the rock bottom in Nepal, particularly with the predominant sector of agricultural population. The non-food total has expectedly the higher values of elasticity coefficients than unity in every region.

The higher or lower than unity values of elasticity coefficients have the differential implications not only in growth rate calculations, but also in the multiplier effect of growth of regions [Krutilla 1958, Pal 1974]. Note that the elasticity coefficient as estimated here are expenditure elasticities. The corresponding income elasticities are connected with the expenditure elasticities by the following relations:

$$\frac{\partial \log y_{ri}}{\partial \log Z_r} = \frac{\partial \log y_{ri}}{\partial \log y_{ro}} \cdot \frac{\partial \log y_{ro}}{\partial \log Z_r} ,$$

where, $\frac{\partial \log y_{ri}}{\partial \log Z_r}$ = the income elasticity of ith consumption item,

$\frac{\partial \log y_{ri}}{\partial \log y_{ro}}$ = the expenditure elasticity of ith consumption item,

and, $\frac{\partial \log y_{ro}}{\partial \log Z_r}$ = the income elasticity of total consumption expenditure.

As the income elasticity of total consumption expenditure is generally lower than unity, the values of income elasticity of an item is lower than the corresponding expenditure elasticity. This means that commodities with below unity expenditure elasticities will likely to have still lower values of income elasticities. Now the regions which have the industries based on such commodities as have the below unity values of income elasticity will relatively be less and less developed as compared with other regions which have industries based on commodities that have the above unity values of income elasticity. This happens because when income is rising by one per cent the demand for the commodity with below unity value of elasticity rises by less than one per cent, while the demand for the commodity with above unity value of elasticity rises by more than one per cent. As the economic growth of a region implies the growth of activities in conformity with the demand for such activities, the region is likely to be relatively less and less developed as compared with the average national growth path if the region's productive activities are engaged in the production of commodities with below unity value of income elasticity of demand. It is often for this reason one of the strategies of developing a less developed region is to concentrate the production activities of such commodities as have the above unity value of income elasticity of demand. This should be kept in mind for developing the relatively less developed non-Tarai areas. As for the present situation in Nepal, the industries, mostly concentrated in Tarai belt and the Kathmandu valley, are agro-based. The related commodities are mostly foodgrains, sugar, tobacco, edible oils, etc.. As between tobacco and sugar, for example, tobacco has the below unity value of income elasticity of demand, while sugar has in all probability the above unity value of income elasticity of demand. The Tarai sub-zone 2 and partly the Tarai sub-zone 3 have the concentrations of tobacco industries, while Tarai sub-zone 4 has the substantial concentration of sugar industry. From the Table 5.16, if could be noticed that the core tobacco-region of Tarai sub-zone 2 has the lowest value of the over-all development index, among all Tarai sub-zones, while the sugar producing region of Tarai sub-zone 4, for example has a much higher value of the over-all development index. This fact corroborates with our arguments put forward earlier.

This being so, it should be a reasonable strategy to develop such industries which have above unity value of income elasticity of demand for their products. We have noticed earlier in Chapter III that about 75% of manufacturing industries of Nepal are only cereal food processing industries while the income elasticity of cereal food demand have always remained considerably below unity. With such an industrialisation pattern, the industries themselves do not appear to be growth-promoting unless one brings in such industries as have higher growth-promoting effect in the light of above arguments. For example, sugar industry has a higher growth promoting effect and with our estimation of demand prediction for sugar which showed a much higher rate than the feasible income growth rate or the total consumption expenditure growth rate, there is no reason why should we not accelerate the growth of sugar industries and avoid future imports of sugar. With below unity value of income elasticity for tobacco, the tobacco industry does not seem to be effectively growth-promoting. But it is seen that much of cloth and clothing requirements are met through imports. This situation of over-dependence on other nations even for a basic need as clothing should be avoided, if necessary by government pressure. But before taking that step, the countrt has to be made self-sufficient in the productive activities for clothing industries. The promise of wollen clothing is definitely there in Nepal. Only it is required that proper production planning and government involvement must be stepped up.

Further, instead of importing cotton and other varities of clothings and cloth, it may be better to start such industries in Nepal on the basis of even imported raw materials, if their indegeneous production is not feasible. That would at least provide job opportunities of Nepal's even increasing labour force. It is emphasised here that the income elasticity of demand for clothing and cloth has a value much above unity. As such, if this industry could be properly developed in Nepal, the country would likely to have a speedier income growth path. There are other items for consideration. For example, noting the very high value of the income elasticity of demand for medical care, one is tempted to think that this country has a great promise in medicine industry and, in general, in chemical industries.

Again it should be noted that if the country's productive activities are not geared to meet the rising demand of certain commodities irrespective of its income elasticity coefficient, there will likely be an imbalance between demand and supply and the result will be the price inflation and increase in the value of its income elasticity of demand causing hardship to people in the lower levels of income. So, in order to avoid this situation, productive planners should have sufficient vision on the future demand of commodities which have rising trend nationally. It is for this reason demand predictions are so important for production planning and our exercises in the preceding section is meant to help in that direction. Thus one should notice that even though the cereal food has a low income elasticities of demand, the productive activities for the cereal food productions must have to be geared with the rising trend of cereal food which must follow in view of the rising population trend. If this is not done, the income elasticity will no longer remain below unity even for this fundamentally essential item and national crisis will follow. It is for this reason we considered cereal food as the key item of demand the requirement prediction of which has been done first in Chapter II and all other demand and growth rate prediction of different items have a strong bearing on the prediction of the key item.

We have also made other related predictions, such as the prediction of fertiliser inputs required relative to production tasks of cereal food in Chapter II. If the production tasks of agricultural commodities are expected to be accomplished mainly through the intensification of agricultural activities, the production of required fertiliser inputs gains importance. Though we do not have any estimate of the income elasticity of demand for fertiliser to assess its growth promoting aspect, the importance of this input commodity in view of the related agricultural outputs can readily be realised. So by all means planning decisions must have to be made to meet the future rising demand of fertiliser. Here decision has to be made how best we could produce fertiliser indigenously. Meeting the rising demand of fertiliser in future through imports would certainly not be at all conductive for a healthy economic growth of Nepal.

By all the above discussions and findings we want to drive home the fundamental point that Nepal's growth and development prospects lies in the creation of proper kind of productive activities with the full utilisation of its increasing human labour resources. For this a right kind of choice of industrialisation path that assures the growth promoting or growth-sustaining aspects has to be made. If a right kind of industrialisation path for productive activities are not followed, Nepal's ever-increasing human labour force is going to face serious unemployment crisis. All our regional analyses made earlier have been oriented with the emphasis on the diagnosis of regional problems and the assessment of production tasks so that proper regional planning decisions can be made on the basis of our findings to avert such a crisis.

5.5 Summary and Conclusions

The main objective of this study has been the statistical analysis by the use of those statistical and quantitative tools that could be considered appropriate for applications in an underdeveloped economy, where in usually lies sufficient data and information gaps, towards a proper diagnosis of the problems and prospects of economic activities in its diversified regional environments. This study is conducted with reference to an underdeveloped country, Nepal, where detailed regional analyses have hardly been attempted earlier, to evaluate the regional structures of economic activities for the purpose of clarifying our visions for a proper kind of regional planning. Though Nepal is a small country, the variations in its topographical features are so pronounced that wide diversities in economic activities have been resulted, shaping the destiny of the people at different regional settings. In the absence of appropriate statistical analysis for the evaluation of detailed regional structures, the national plans of Nepal, despite all good intentions for regional developments expressed in the plan documents, have hardly been successful towards improving the economic conditions of people, in general, and also reducing the ~~general~~ regional disparities in developmental activities in particular.

The statistical and quantitative tools that have been applied with success in this dissertation can be broadly summarised as follows:

(a) Because of the poor reliability of data and data-base as exist in Nepal, we have often relied on more than one measures for every economic activity considered and relevant regional indices have been formulated for those activities by various applications of multivariate statistical methods and these regional indices have been used for the depictions of diversified regional structures. Some of the main regional indices thus formulated are: (i) development index of agricultural and allied activities, (ii) composite index of industrial activities, (iii) composite index of tertiary and allied activities, (iv) development index of non-agricultural activities, (v) the over-all development index of all activities etc.

(b) As the theme of the study falls in the inter-disciplinary field of Regional Science - involving mainly Statistics, Geography and Economics in our case - it has been necessary for us to quantify some of the qualitative geographical features for making them amenable to statistical analysis with other quantitative variables. Here also the dependability of our quantifications have been enhanced by the use of the multivariate statistical approach and thus we have constructed, for example, a very important index like "the index of ruggedness" that has been shown to influence major economic activities such as those based on soil resources (like arable cropping) or those affected by terrain types (like transportation activity), etc.

(c) Various multivariate regression analyses have been used to identify relationships between different activities of development and their explanatory factors. In this way, we could identify the factors responsible for regional variations in developmental levels, growth of activities, population concentration, etc. At times we have determined conditional global regressions with the use of appropriate dummy variables when free global relations could not be depicted for the varying nature of terrains present in the country.

) Analysis on the growth of certain important activities have been attempted through various quantitative tools. Particularly, for the regional growth analysis of agricultural production, a quantitative model for the decomposition of growth by components has been used and the relative importance of those components in explaining the varying regional growth rates have been evaluated by use of certain advanced regression techniques.

e) Linear Programming Techniques have been used to identify optimal transportation tasks and their changes over time in relation to the distributions of foodgrains between surplus and deficit areas (districts) within different zones and also those between different zones in Nepal. In applying these techniques the prevalent transportation orientations under the diversified ruggedness conditions of terrains have been given a due consideration.

(f) Analytic tools have been used for the regional production function analysis of the over-all manufacturing activities. Modified production models have however been used to suit our regional analysis, especially with the evaluation of technical efficiency. Unlike the usual analysis, we have evaluated the technical efficiency considered as to be constituted not only of (i) the internal technology factor of efficiency alone, but also of (ii) the localisation performance factor of efficiency.

(g) Quantitative methods have also been used for (i) the regional demand predictions through the analysis of norms and expenditure elasticities of various consumer items (ii) the regional prediction of the addition to labour force expected in future in various regions and also, (iii) the evaluations of the possible expenditure and income growth paths.

Our approaches and principles for the regional analysis have been the (i) examinations of regional variations of different economic activities, resources and facilities, and also the factors that influence them, with mostly the district level data (all 75 districts) in order to identify the existing regional patterns of economic activities, (ii) setting the prospective patterns of regional economic activities, over a chosen time horizon, as should be desired or could be predicted on the basis of detailed analysis of requirements for the spatially varying growing population, and (iii) determination of the enhanced tasks of productive and welfare activities on the basis of which our visions for regional development planning measures could be clarified and thereby the detailed decisions on planning measures could be chalked out on a firm footing.

Along these lines the regional studies on economic activities were made in this dissertation some of our main findings and observations in different chapters are briefly highlighted below:

(1) Diverse topographical feature of the country has been identified by use of specially developed index measuring the ruggedness condition. The inverse of ruggedness index is seen to have strong positive relation with both (i) the extent of cultivated land and (ii) the agricultural labour productivity. That means the less rugged Tarai area has the higher concentration of cultivated land and also the higher labour productivity as compared with more rugged Hill and Mountain areas. There is as such no free

global relation to explain the spatial variation in labour productivity on the basis of soil productivity. This apparent paradox could however be explained by a statistical fit of an appropriate conditional global relation by use of a suitable dummy variable based on differential ruggedness conditions of Tarai and non-Tarai areas. The dummy factor as introduced artificially for Tarai districts could be explained by two factors, namely, the higher extent of cultivated land and the concentration of cash cropped areas occurring predominantly in the Tarai. The labour productivity index for agricultural and allied workers has been taken as the agricultural development index. The spatial variations of which could finally be explained by (i) the soil productivity, (ii) concentration of cultivated land (in quadratic form indicating diminishing return when the extent of cultivated land increases beyond certain level), and (iii) a combination of (a) the concentration of cash cropped area, and (b) the concentration of livestock relative to population. It is to be noted that areas with limited cultivated land are having higher levels of livestock holding. Thus the higher agricultural development of Tarai area could be accounted more by the extensive mode of agricultural practices rather than intensive mode and also by the production of cash crops. On the otherhand a relatively better intensification of agricultural practices have been followed in non-Tarai area with the limited availability of agricultural land and the higher levels of livestock holdings. The promise of further agricultural development in Tarai area rests more on the intensive mode of agricultural practices rather than the extensive mode (because of the quadratic relation with the concentration index of cultivated land). On the basis of above indices, the regionalisation of agricultural and allied activities has been done.

(2) Although an overwhelming high proportion of population (about 88%) depend on agricultural activities the broad agricultural development patterns or the ruggedness conditions, that constrain the availability of total arable land, do not practically account for the complex regional patterns of population concentration relative to geographical area. The detailed cultivation patterns of three major cereal crops paddy, maize and wheat however explain substantially the regional variation in the population concentration. Maize seems to be the universal crop in Nepal capable of overcoming the ruggedness barrier and it explains much of the complex phenomenon of population concentration in more rugged areas. Although the cultivation of major cereals has been responsible for the population concentration, peoples prosperity as depicted by the agricultural development index is however seen to depend upon the intensive and extensive agricultural practices and also by the cash crop cultivation and the livestock raising.

(3) Although sharp regional patterns emerge for agricultural productive activities, there is practically no time-series trend in the over-all agricultural production level almost everywhere. In fact in the decade ending 1977-78 most of the districts of Tarai area and Kathmandu valley have shown a marginal improvements in agricultural production, while the majority of the Hill and Mountain districts have exhibited deteriorating agricultural production. The spatial variation in the rate of change of agricultural production has been explained mostly by the component of acreage change (about 65%) and to a lesser extent by the component of yield rate change or intensification factor (about 35%) and not at all by the component of crop association change.

In fact the cropping combinations have practically remained invariant over the decade in most of the districts of Nepal Whatever marginal growth in agricultural production has followed in Tarai area is mainly due to the extension of cropped area while that in Kathmandu valley is contributed by both. Although the component of acreage change has been predominant contributor to over-all agricultural growth in the recent past, it has reached certain saturation level, particularly in Tarai area and Kathmandu valley and as such the prospect of agricultural growth lies with the improvement in the component of yield rate change or in the intensification of agricultural practices in future.

(4) In view of the deteriorating and unimpressive trends in agricultural production it has been difficult to make any trend predictions of agricultural commodities that could be considered desirable in relation to rising population over time. To overcome this difficulty, we have attempted normative predictions of the particular agricultural commodity of foodgrains (here cereals in absence of production data on pulses) on the basis of per capita norms of cereal food consumption which usually remains stable, at least over a short time horizon, for biological reasons. We have however made predictions on the basis of two sets of regional norms, one set referred to here as alternative 2, is obtained from the family budget survey of 1973-75 and the other set referred to as alternative 1, includes derived regional norms modified by the residual method on national totals relating to 1977-78, the initial year of our time horizon ending in 1989-90. It should be noted that because of the incidence of the considerably better performance of agricultural production around 1973-75 compared with 1977-78, the survey norms of Alternative 2 were only 4 per cent higher than the

1977-78 norms of Alternative 1. In fact the performance of agricultural production had been so deteriorating in this period that the national export of foodgrains became substantially lower (less than half) in 1977-78 than that in 1971-72. Districtwise requirements of foodgrains for human consumption predicted under the two alternatives have been aggregated for the corresponding national totals of requirements. Taking national estimates of requirements as those of availabilities for human consumption matching national production levels of cereals have been derived for the two alternatives, after allowing margins for the conversion losses (from raw cereals to edible form) and other uses like seeds, feeds, etc. The national production totals have then been disaggregated to districtwise production levels on the basis of two consistent assumptions namely (i) districts with deteriorating agricultural production should achieve 1971-72 production levels by 1989-90 under both alternatives, and (ii) districts with improving agricultural production should multiply their growth ratios equally so that the estimated national totals in production levels under the two alternatives can be arrived at. The districtwise availabilities of cereal food for human consumption have again been derived from the corresponding estimates of production levels of foodgrains under the two alternatives after deducting the necessary margins for the conversion losses and other uses. While districtwise production levels correspond to the respective production tasks, the comparisons of districtwise estimates of availabilities and corresponding requirements help us determine the food-surplus and deficit areas.

(5) Optimal transportation tasks for 1989-90 and their enhancements as compared with the similar task for 1977-78, in

relation to the distributions of foodgrains between surplus and defeceit areas, have been ascertained for three possible alternative cases, namely (i) both requirements and production levels under Alternative 1 without any exportable surplus of foodgrains, (ii) both requirements and production levels under Alternative 2 without any exportable surplus and (iii) the requirements under Alternative 1 but the productions under Alternative 2 so that national exportable surplus production of foodgrains could be generated. Because of the special nature of transportation orientation of Hill and Mountain districts to their nearest Tarai districts, the optimal food distributions have been determined between districts within each of seven distribution zones and also between zones, rather than between districts for all Nepal. Among the three alternative cases of 1989-90, the third alternative has shown the minimum enhancements in the transportation tasks over time. Thus it is suggested that the task of productive activities should be geared to the production levels under Alternative 2 while the consumption of foodgrains should be set at the levels of Alternative 1 which would give rise to a sizable amount of desirable national exportable surplus of foodgrains.

(6) Granting that the production tasks of cereal crops would be accomplished through the intensive mode of agricultural practices, the necessary input requirements for chemical fertilisers have been estimated statistically by crop regions determined earlier.

(7) Industrial activities of the country is still in their infancies. Defining the activities of registered factories as the manufacturing activities, we notice that most of the little manufacturing aotivities that the country has, started around early-sixties. Of the 2434, factories operating

in 1972-73, about 87 per cent were established only after 1962-63 and a spectacular growth of factories followed during the later half of this decade. These are mainly agro-based industries and most of these are again concentrated in the Tarai area and Kathmandu valley where main agricultural development has also taken place. The eastern Tarai is however more industrialised than the western Tarai. Among non-Tarai districts, only the district of Kaski can be considered as industrialised besides the three districts in Kathmandu valley. Most of non-Tarai districts (37 districts) show total absence of manufacturing or the factory type activities. Though the types of industries covered by these factories are twentytwo in number, the cereal and oil processing industry alone accounted for about 75 per cent of total manufacturing output in 1972-73. Other industries of importance are mainly cash crop (jute, tobacco, sugarcane, etc.) oriented industries, located in a few pockets in the respective cash-crop growing areas. Thus the industrialisation has grown in Nepal in a complementary way to agricultural activities and the non-agro-based manufacturing activities which are so necessary to take the country on a path of industrialisation, have remained still out of picture.

(8) Because of considerable data and information gaps, the modified production model, that we have used with the incorporation of a localisation factor in addition to the usual technological factors of labour and capital inputs, could be fitted only with two kinds variations namely (1) with the variations over the types of industries for the nation as a whole (called the national industrial activity function), and (2) with the district level variations for the aggregate of all types of industries (called regional aggregate production function). Even in these fits certain appro-

priate surrogate variables have been used in the absence of productive capital data. From the analysis of all parameters related to the national activity function, following important conclusions emerge: (i) the core industry (with 75% of total manufacturing output) of cereal and oil processing is highly capital intensive and most flourishing with high efficiency, (ii) the higher capital-intensity has generally been concomitant with the industries having higher output levels and (iii) however, as compared with the percentage capital services change, the percentage labour change has been a greater contributor to the percentage output change.

(9) From the analysis of all parameters related to the regional production function, following important conclusions can be drawn: (i) because of the predominance of the capital intensive cereal and oil processing industry in the aggregate of all industries, which is regionally distributed, the roles of capital and labour changes in relation to the output change, have interchanged in the regional production function compared with those of national activity function; the capital change becomes the more important contributor to output change regionally, (ii) regionally, diminishing return to scale is operating which indicate that most industrially advanced districts should now deserve less attention; this corroborates the regional planning policy of the dispersal of industrial activities, and (iii) as the location factor of fuel and energy use has been taken as an explanatory localisation performance factor in the production function and also as the localisation performance factor turns out to be the more important factor than the internal technology factor in the over-all measure of technical efficiency (in the ratio of 2:1 roughly), an efficient localisation policy of industrialisation should take care in

providing the infrastructural facility of sufficient energy supply to the feasible locations desired for further industrialisation. As a prerequisite to further industrialisation an exploration for the possibility of developing indigenous sources of fuel and energy, particularly hydro-electricity, is most desired. This would also take the country on the path of self-sufficiency on energy requirements by abandoning the present practice of energy imports from India.

(10) As certain household industrial activities are present in many districts with or without manufacturing activities, an over-all index of manufacturing activities has been constructed using multivariate methods combining two sub-indices, namely the manufacturing output index and the all-industrial labour input index. These indices and other relevant data and parameters have been used to evaluate the regional structures and patterns of industrialisation in Nepal. From the analysis of regional structures and patterns, it is clear that many feasible areas have remained yet neglected in the recent industrialisation and that the industrialisation must remain agro-based unless enhanced efforts are made to diversify the industrial activities and extend them to the less industrialised areas by tapping local resources like forestry, minerals and other physical resources.

(11) Of the four indices, namely tertiary activity index, urbanisation index, transportation intrastructure index and literacy index, constructed for regional analysis of subsidiary activities and facilities, the tertiary activity index is the best explained spatial variable. This means that the tertiary activitives did develop in different areas of Nepal with the influence of these four factors. The literacy index is however the least important factor among them and it is also a common conditioning factor for industrial and

urbanisation activities. As such a composite index of tertiary and allied activities has been statistically constructed by combining three indices, namely, the tertiary activity index, the urbanisation (or the central place functional) activity index and the transportation infrastructure index. On the basis of this composite index and the related indices, the regionalisation of tertiary and allied activities has been made. Here again it is noticed that all districts in Hill and Mountain areas are least advanced in these activities except for Kathmandu valley and Kaski district. Among the more advanced districts, those occurring in western Nepal is relatively less advanced than the ones in eastern Nepal.

(12) Although literacy index has been an important conditioning factor for the non-agricultural activities, it has practically no relationship with the agricultural development index. As the people are predominantly agricultural in Nepal, the absence of influence of education is hardly helpful towards enlightening the major section of people for a proper appreciation of planning measures needed for the betterment of their own fate. Thus it is urgently necessary to take proper actions towards the spread of education to all sections of people everywhere in Nepal.

(13) From the analysis of the limited data and information that we have on forest resources in Nepal, it appears that the forest resources of non-Tarai area have not been fully tapped yet towards improving the conditions of local people with limited arable cropping. Following an Indian example of good planning with the forest resources of Karnataka state, suggestions are made towards developing Hill forest resources by the establishment of Charcoal processing plants in hill areas. Again as the exploita-

tion of forest resources is quite substantial in Tarai areas it is necessary to have a properly integrated land use planning in these areas and certain feasible suggestions have been made in this regard.

(14) For a necessary application of intensive modes of agricultural practices, and also for finding a substitute for the forest-fuel resources, the vast water resource potentials of the country should be appropriately tapped. The irrigation potentials should be fully exploited towards supplying the water-requirements of Tarai-agriculture. It is also necessary to make investigations towards identifying the fruitful locations of hydel — power potentials and take necessary planning measures to tap this resource where it is economically quite feasible.

(15) The existing mineral based industries are negligible and they were mainly based on certain purely chance discoveries of minerals in the past. A few recent exploratory works are however going on for the further discovery of minerals. The recent discoveries of some of the commercially feasible mineral ores are very encouraging. However then exploratory works are being carried out only in limited areas mainly around the capital region and not over all feasible areas for the discovery of the entire mineral resource endowment of the country. On the basis of the present knowledge and data on geological formation and associated minerals, there are reasons to be more optimistic than what pessimistic conclusions were drawn earlier on the basis of incomplete or yet unexplored information on Nepal's true position of mineral wealth. The urgency for the explorary works towards the discovery of minerals in a more scientific way should be appreciated in view of the limited agricultural prospects in the vast non-Tarai areas

where there are possibilities of occurrence of minerals. As the prospects of sustaining development of the non-Tarai area rest on the development of industrial activities based on minerals, forests and other physical resources, it is all the more important to give proper planning attention in these aspects.

(16) For a synthetic ranking of districts in respect of all activities together an over-all development index of all activities has been constructed by combining the agricultural development index and also the non-agricultural development index constituted of the industrial activity index and the tertiary and allied activity index. This over-all development index formulated by the economic principles has a better spatial relation with the non-agricultural development index rather than with the agricultural development index, which implies that the prosperity of people has been associated more with the non-agricultural activities. This shows the importance of the creation of more of non-agricultural productive activities for a relatively rapid pace of development, especially in less developed areas. In fact, extremely high over-all development (in the relative sense) has occurred in only two areas, namely, Kathmandu valley and Morang district in eastern Tarai. This relatively spectacular development is contributed more by the growth of multifunctional non-agricultural activities rather than agricultural activities.

(17) The synthetic regional picture of the concentration of economic activities and development is as follows: (i) With the advantage of the less-ruggedness of terrain, and of the extraordinary governmental attention as usually available in a capital region, more of economic activities have flourished in the districts of Tarai and Kathmandu valley.

with the result of relatively higher levels of over-all development there. On the other hand, with the disadvantage of the more-ruggedness of terrain, the concentration of economic activities has remained low without diversification in most of the districts of non-Tarai areas, with the result of a low level of over-all development there, (ii) In the less-rugged area, so long the population pressure on land has remained low as in the western Tarai the high levels of agricultural or over-all development could even be achieved through mainly the agriculture and allied primary activities, even without intensification. However, with the increased population pressure on land, as we have in many districts of eastern Tarai or Kathmandu valley, the high or very high levels of over-all development could hardly be achieved without the diversification and the intensification of economic activities by the creation of more and more productive activities with increasing share in the non-agricultural sector, (iii) The complex phenomenon of population concentration has been influenced not only by the spatial concentration of three major cereal crops, but also by the concentration of tertiary and allied activities. Although the concentration of people is often higher in the less-rugged terrain, it is moderate or high in some patches of more rugged terrain where in the particular food crop, maize, could be grown despite ruggedness, and also the tertiary and allied activities have tended to grow side by side. Among the main cereals maize is the heaviest food crop providing maximum calory supply that is needed by the Hill and Mountain people living in the cold climate, (iv) Despite national planning efforts economic improvements are not in sight. But the population growth follows unabated over the recent past and there is no prospect of having a falling growth rate of population in the near future.

In fact, prior to 1981 census there has been a spurt of immigrants mainly Indian Nepalease coming back to Nepal because of the recent scare spread by the "foreign national issue" raised in the far eastern states of India. As a result the population growth rate increased from 23 per cent per annum to about 2.7 per cent in the decade ending in 1981. In the following decade this rate is not likely to go down 2.3 per cent per annum.

(18) Because of this rising population there would be substantial addition to labour force in future. We have the estimations for this addition to labour force for all districts of Nepal for our target year 1989-90. The national planning efforts must be made right now on how to utilise and employ these vast mass of labour potentials in different regions. It should be emphasized that in order to avoid large scale migration to the Tarai area local employment oppertunities with productive activities must be created in the non-Tarai areas. This is also needed for the reason that virtually the Tarai will remain the surplus food producing area and the non-Tarai area has to depend upon the food supply from Tarai. So the people of the non-Tarai area must have some other possible kinds of productive activities so that healthy economic relations in the form of trade exchanges could develop for the betterment of both Tarai and non-Tarai areas.

(19) In the recent past the economic growth has not been buoyant and it has become difficult to make any trend predictions of growth path on techno-economic parameters. Under these circumstances we have already made foodgrain requirement predictions. On the basis of regional consumer behaviours and demand analyses we have made further predictions on the growth rates for all food and non-food items of consumption that would be concomitant with the rising population. In

this exercise stabilities in regional cereal consumption norms and the shares of total consumption expenditures spent on cereal food have been reasonably assumed. Granting the predicted cereal food situation, the matching consumption expenditure could then be determined and subsequently by use of expenditure elasticities, predictions on all items of consumption have been possible. We have also been able to make the quantitative predictions for certain food items like pulses, milk products, meat and fishes, eggs, edible oils, vegetables, fruits, spices, sugar and also a non-food item tobacco product for which past quantitative data were available. All these predictions have been made for different food distribution zones. These predictions would certainly be helpful for production planning of the country if we are to avoid heavy imports from other countries in future. Matching with the growth rate of total consumption expenditure as estimated above, we have also examined what would be the income expansion and saving generation possibilities. According to our predictions for the time horizon 1977-78 to 1989-90, total national consumption expenditure is supposed to rise by 3.3 per cent per annum corresponding to the cereal food requirement growth rate (under Alternative 1) of 2.3 per cent per annum. On the basis of our exercises on the assessment of the saving generation possibilities the associated growth rate of national income would be somewhere between 3.8 and 4.2 per cent per annum.

(20) As the activity bases are very poor in non-Tarai area except Kathmandu valley, saving generation possibilities are practically limited there. On the other hand saving generation possibility is much better in Kathmandu valley and in the Tarai area. As these areas are productive, the investment for productive activities have also to be made there for

the sustainance of productive activities and also for the optimisation of national income. But this optimisation aspect is often not concomitant with the distributional aspect to be considered under welfare considerations. The best compromise suggested here is to (i) earmark planning investment funds into two categories: productive activity improvement fund and welfare promotion fund, (ii) allocate the productive activity improvement fund on the basis of dimensions of productive tasks assessed by sectors of activities, and (iii) distribute the welfare promotion fund, with the motive for a creation of productive bases towards sustainance of people's welfare, on the basis of some kind of inverse function of the over-all development level by regions. Here comes an important use of development indices constructed earlier for decision making under the well-known regional planning policy of reducing the disparities in economic activities and development.

It is clear from the above findings and observations that a number of difficulties were encountered in our attempt for regional analysis of an under developed country — Nepal and these difficulties were overcome largely through appropriate and judicious application of statistical and quantitative tools. Our present attempt is only a beginning for a scientific orientation towards regional planning in Nepal; more should however follow for the actual regional plan implementation.

APPENDIX

A. Abstracts of the Methods of Computation of Indices Used

A.1 Indices computed by the specific representations equalising principle [Pal 1963, 1971]. The formula for this index I_e constituted of suitably transformed inter-related spatial variables $x_1, x_2, \ldots, x_n$, varying over spatial units of observation $j = 1, 2, \ldots, N$ is given by

$$I_{ej} = \frac{a_1 x_{1j} + a_2 x_{2j} + \ \cdot + a_n x_{nj}}{a_1 \bar{x}_1 + a_2 \bar{x}_2 + \ldots + a_n \bar{x}_n} \quad . \qquad (A1.1)$$

where, $\bar{x}_i$ and σ_i are the mean and standard deviation of the ith variable x_i,

r_{ij} = the correlation coeff. between the variables x_i and x_j

$a_i = w_i/\sigma_i$

The estimates of w_i's and also the common specific representation ρ_e can be solved from the following system of (n+1) equations given in (A1.2).

$$\begin{array}{l} w_1 + w_2 + \ldots + w_n = 1 \\ w_1 + r_{12} w_2 + \ldots + r_{1n} w_n = \rho_e^2 \\ r_{12} w_2 + w_2 + \ldots + r_{2n} w_n = \rho_e^2 \qquad \ldots \qquad (A1.2) \\ \ldots\ldots\ldots\ldots\ldots\ldots \\ r_{1n} w_1 + r_{2n} w_2 + \ldots + w_n = \rho_e^2 \end{array}$$

The mean point $(\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_n)$ constituted of averages of variables correspond to the central value of unity in the index formula (A1.1). It should be noted that at times we have used location factors or their power transforms as the spatial variables for which the critical value of unity is a more meaningful national value than the average. When it is desired that the critical values of unity of the variables should correspond to the central (or critical) value of same unity for the constituted index, we have to take such an index I_e^* as proportional to I_e as follows:

$$I_{ej}^* = \frac{a_1 x_{1j} + a_2 x_{2j} + \dots + a_n x_{nj}}{a_1 + a_2 + \dots + a_n} \quad \dots \quad (A1.3)$$

$$= G_e I_{ej}$$

with the constant of proportionality

$$G_e = \frac{a_1 \bar{x}_1 + \dots + a_n \bar{x}_n}{a_1 + \dots + a_n} \quad \dots \quad (A1.4)$$

For the case of $n = 2$ the formulas (A1.1) and (A1.3) reduces to (here $w_1 = w_2 = 1/2$):

$$I_{ej} = \frac{\sigma_2 x_1 + \sigma_1 x_2}{\sigma_1 \bar{x}_1 + \sigma_2 \bar{x}_2} \quad \dots \quad (A1.1)$$

and $$I_{ej}^* = \frac{\sigma_2 x_1 + \sigma_1 x_2}{\sigma_1 + \sigma_2} \quad \dots \quad (A'1.3)$$

with $G_e = (\sigma_1 \bar{x}_1 + \sigma_2 \bar{x}_2)/(\sigma_1 + \sigma_2)$ ... (A'1.4)

A.2 Indices computed by the aggregate representations maximising principle [Kendall, 1939].

The formula for this index, I_m and I_m^* comparable to I_e and I_e^* are given by

$$I_{mj} = \frac{b_1 x_{1j} + b_2 x_{2j} + \dots + b_n x_{nj}}{b_1 \bar{x}_1 + b_2 \bar{x}_2 + \dots + b_n \bar{x}_n} \quad \dots \quad (A2.1)$$

and,

$$I_{mj}^* = \frac{b_1 x_{1j} + b_2 x_{2j} + \dots + b_n x_{nj}}{b_1 + b_2 + \dots + b_n} \quad \dots \quad (A2.2)$$

$$= G_m I_{mj}$$

with

$$G_m = \frac{b_1 \bar{x}_1 + b_2 \bar{x}_2 + \dots + b_n \bar{x}_n}{b_1 + b_2 + \dots + b_n} \quad (A2.3)$$

where

$b_i = r_i/\sigma_i$

r_i = specific representation of ith constituent variable x_i in the index I_m or, I_m^* and,

$$\rho_m = \sqrt{(r_1^2 + r_2^2 + \dots + r_n^2)/n}$$

= aggregate representation.

The solution column vector of specific representations denoted by r can be solved from the following equation [following Kendall, 1939]:

$$R \cdot r = n \rho_m^2 \quad r \quad (A2.4)$$

where R is the correlation matrix $((r_{ij}))$. We have followed Hotelling's [1939] iterative method of computation to solve the vector r and hence ρ_m of (A2.4).

In this iterative procedure we go for the (i+1)th stage of iteration through the computation shown in relation (A2.5) below when the weight vector (column vector) w_i of the ith stage of iteration is known.

$$R.\ W_i = \Sigma_{i+1}$$

and

$$W_{i+1} = \Sigma_{i+1}/M_{i+1} \qquad \ldots \qquad (A2.5)$$

where M_{i+1} is maximum element in the computed vector Σ_{i+1}.

The initial weight vector W_o could conveniently be chosen as the <u>sum vector</u> or the vector with each element as unity. The iterations stop at the sth stage when we have

$$W_{s-1} = W_s \qquad \ldots \qquad (A2.6)$$

Any further iteration will not change the W_s which is called the <u>stable</u> weight vector. Using (A2.5) and (A2.6), we can deduce

$$R.\ W_s = M_s \cdot W_s \qquad \ldots \qquad (A2.7)$$

which is comparable to the equation (A2.4). Taking W_s as proportional to R, we can write

$$W_s = G.r \qquad \ldots \qquad (A2.8)$$

where G is a scalar. Using (A2.8) in (A2.4), we can deduce

$$R.\ W_s = n\ \rho^2 .\ W_s \qquad \ldots \qquad (A2.9)$$

and hence we have

$$M_s = n \rho_m^2 = r' r \qquad \ldots \quad (A2.10)$$

From (A2.8) and (A2.10), we obtain

$$W_s' \cdot W_s = G^2 \cdot M_s \qquad \ldots \quad (A2.11)$$

and hence we have the solution vector as given in (A2.12):

$$r = W_s \cdot \sqrt{\frac{M_s}{W_s' \cdot W_s}} \qquad \ldots \quad (A2.12)$$

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Appendix

Table 1: Ruggedness index (τ), Inverse of ruggedness index (T), Constant price weighted labour productivity index for all crops (W) and Physical index of land productivity (Z).

FD zone/districts	(τ)	(T)	(W)	(Z)
Zone I				
1. Teplejung	2.60514	0.33276	0.53739	1.02020
2. Panchthar	1.06678	0.68177	0.48608	0.97304
3. Ilam	0.84236	0.80492	0.86176	1.39142
4. Sankhuwasabha	2.47541	0.34778	0.45830	0.99769
5. Terhathum	0.91310	0.76156	0.76736	1.06616
6. Bhojpur	0.99363	0.71755	0.63308	1.07127
7. Dhankuta	0.66312	0.94063	0.85351	1.02800
8. Jhapa	0.05061	2.21921	2.81624	0.98448
9. Morang	0.19592	1.67808	2.74071	0.94726
10. Sunsari	0.11063	1.95837	1.94179	0.90914
11. Saptari	0.06786	2.13739	1.55683	1.88642
Zone II				
1. Dolakha	2.21138	0.38294	0.29065	1.00801
2. Solokhumbu	2.60108	0.33321	0.40669	1.04811
3. Khotang	0.93575	0.74864	0.45288	1.04935
4. Okhaldhunga	1.01610	0.70616	0.56771	1.00879
5. Ramechhap	1.81712	0.45104	0.34282	0.84123
6. Sindhuli	0.57837	1.02211	0.71688	1.03066
7. Udayapur	0.59750	1.00251	1.22676	1.00122
8. Siraha	0.06444	2.15313	1.24708	0.90082
9. Dhanusha	0.08347	2.06838	1.65071	0.86753
10. Sarlahi	0.06334	2.15824	1.86088	0.89321
11. Mahottari	0.09111	2.03620	1.64463	0.91256
Zone III				
1. Rasuwa	2.00503	0.41580	0.74364	1.00873
2. Sindhupalchowk	1.87701	0.43917	0.46661	1.06979
3. Dhading	2.07949	0.40331	0.21935	0.83457
4. Nuwakot	1.50100	0.52604	0.53851	1.05413
5. Kavrepalanchowk	0.86309	0.79171	0.42430	1.10573
6. Kathmandu	0.39421	1.25911	1.63801	1.36241
7. Lalitpur	0.75945	0.86248	1.40179	1.25817
8. Bhaktapur	0.56500	1.03627	1.49178	1.39645
9. Makawanpur	0.81752	0.82134	1.03116	0.97404
10. Bara	0.10804	1.96835	2.15626	0.99449
11. Parsa	0.07840	1.78725	2.44996	1.08332
12. Rautahat	0.08053	2.08104	1.58688	0.86661
13. Chitawan	0.15952	1.78725	2.44996	1.08332

Contd.....

Contd. ... Table No.1

FD zones/districts	(Y)	(T)	(W)	(Z)
Zone IV				
1. Mustang	2 10327	0.39948	0.60083	0.93149
2. Manang	2 23514	0.37949	0.40000	1.02286
3. Myagdi	2.55330	0.33860	0.71137	1.03199
4. Baglung	1 50631	0.52457	0.28854	0.84508
5. Parbat	0.86707	0.78922	0.26735	0.90198
6. Kaski	2.57814	0.33578	1.09220	1.13092
7. Lamjung	2 35753	0.36264	0.49087	0.95535
8. Gorkha	1.93909	0.42152	0.41739	0.93456
9. Gulam	0.85202	0.79871	0.35879	1.17910
10. Palpa	0.52925	1.07614	0.34603	0.86557
11. Syanja	0.32648	1.37650	0.40758	1.00825
12. Tanahu	0.28026	1.47003	0.56563	1.11303
13. Nawal-parasi	0.20387	1.65599	2.060[illegible]	0.86083
14. Rupandehi	0.07934	2.08620	2.15698	0.90255
Zone V				
1. Rukum	1.82693	0.44905	0.39724	0.95333
2. Rolpa	1.05949	0.68517	0.21208	1.0200[illegible]
3. Sallyan	0.73535	0.88079	0.88755	1.15586
4. Pynthan	0.97588	0.72681	0.68501	1.06318
5. Argakhanchi	0.65117	0.95132	0.26671	0.88554
6. Dang-deukhun	0.24920	1 54036	1.84153	0.96070
7. Kapilvastu	0.11511	1.94133	1.97007	0.88930
Zone VI				
1. Jumla	1.72387	0.47084	0.22358	1.00122
2. Humla	1.96013	0.42371	0.48932	0.97282
3. Mugu	1.69087	0.47827	0.56117	0.96179
4. Dolpa	1.79029	0.45656	0.45000	0.94496
5. Tibrikot	1.39772	0.55645	0.60000	0.97057
6. Jajarkot	1.39448	0.55726	0.64391	1.04583
7. Dailekh	1.02283	0.70282	0.52983	1.03835
8. Surkhet	0.65640	0.94661	0.91705	1.01897
9. Bardiya	0.19281	1.68688	3.05196	0 93557
10. Banke	0.26205	1.51046	2.55509	0.85717
Zone VII				
1. Darchula	2.14451	0.39300	0 45636	0.97845
2. Bajhang	2.12049	0.39675	0.32435	0 98816
3. Bajura	1.80820	0.45028	0.51116	0.96972
4. Baitadi	0.90456	0.76654	0.35050	0 98816
5. Doti	0.91599	0.75988	0.48149	1.01809
6. Achham	0.77908	0.84812	0.31696	0.88521
7. Dadeldhura	0.74093	0.87648	0.63037	0.94520
8. Kanchapur	0.18846	1.69935	2.09774	0.85814
9. Kailali	0.19000	1.69492	2.50704	0.88128

Appendix

Table 2: Share of agricultural production to total primary output(g_1), location factor of primary output to agricultural output (ζ_1), location factor of other primary output to agricultural output (ζ_2), development index of agricultural and allied activities (D).

FD Zone/Dists.	(g_1)	(ζ_1)	(ζ_2)	(D)
Zone I				
1.	0.59917	0.74896	2.00415	0.71752
2.	0.69750	0.87187	1.51250	0.55751
3.	0.80017	1.00021	0.99915	0.86158
4.	0.50300	0.62875	2.48500	0.72891
5.	0.60211	0.75264	1.98945	1.01956
6.	0.65786	0.82234	1.71065	0.76985
7.	0.79005	0.98756	1.04975	0.86426
8.	0.93315	1.16644	0.33425	2.41439
9.	0.90675	1.13344	0.46625	2.41805
10.	0.90048	1.12560	0.49760	1.72512
11.	0.86163	1.07704	0.69185	1.44547
Zone II				
1.	0.60888	0.76111	1.95555	0.38188
2.	0.62684	0.78355	1.86580	0.51904
3.	0.66728	0.83410	1.66360	0.54296
4.	0.75662	0.94577	1.21690	0.60026
5.	0.66855	0.83569	1.65725	0.41022
6.	0.73569	0.91962	1.32150	0.77954
7.	0.80555	1.00694	0.97225	1.21831
8.	0.88943	1.11180	0.55280	1.12168
9.	0.92108	1.15135	0.39460	1.43372
10.	0.85717	1.07146	0.71415	1.73677
11.	0.88216	1.10270	0.58920	1.49146
Zone III				
1.	0.46995	0.68008	2.27970	1.09347
2.	0.71895	0.89869	1.40525	0.51921
3.	0.66728	0.63211	2.47155	0.34701
4.	0.72768	0.90961	1.36155	0.59202
5.	0.72912	0.91140	1.35440	0.46555
6.	0.83948	1.04936	0.80255	1.56096
7.	0.87759	1.09699	0.61205	1.27785
8.	0.91989	1.14985	0.40060	1.29737
9.	0.79888	0.99860	1.00560	1.03261
10.	0.93693	1.17116	0.31535	1.84113
11.	0.92063	1.15080	0.39680	1.55033
12.	0.91338	1.14174	0.43305	1.38988
13.	0.88703	1.10879	0.56485	2.20958

Contd. .....

Contd. ... Table No.2

FD Zone/Dists.	(g_1)	(ζ_1)	(ζ_2)	(D)
Zone IV				
1.	0.45277	0.56596	2.73615	1.06161
2.	0.64065	0.80081	1.79675	0.49949
3.	0.78270	0.97837	1.08650	0.72710
4.	0.50008	0.62510	2.49960	0.46159
5.	0.65634	0.82044	1.71825	0.32586
6.	0.75662	0.94577	1.21690	1.15483
7.	0.65045	0.81306	1.74775	0.60373
8.	0.63647	0.79559	1.81765	0.52463
9.	0.60891	0.76114	1.95545	0.47139
10.	0.58942	0.73677	2.05290	0.46966
11.	0.62002	0.77502	1.89990	0.52590
12.	0.70465	0.88081	1.47675	0.64217
13.	0.93322	1.16652	0.33390	1.76605
14.	0.87670	1.09587	0.61650	1.96828
Zone V				
1.	0.61412	0.76765	1.92940	0.51748
2.	0.60155	0.75194	1.99225	0.28204
3.	0.76703	0.95879	1.16485	0.92570
4.	0.75609	0.94511	1.21955	0.72479
5.	0.44165	0.55206	2.79175	0.48312
6.	0.79638	0.99547	1.01810	1.84991
7.	0.94945	1.18681	0.25275	1.65997
Zone VI				
1.	0.58097	0.72621	2.09515	0.30787
2.	0.45641	0.57051	2.71795	0.85769
3.	0.46848	0.58560	2.65760	0.95828
4.	0.52201	0.65251	2.38995	0.68964
5.	0.57801	0.72251	2.10995	0.83044
6.	0.62322	0.77902	1.88390	0.82656
7.	0.63768	0.80221	1.79115	0.66046
8.	0.63154	0.78944	1.84225	1.16165
9.	0.88442	1.10551	0.57795	2.76068
10.	0.86495	1.08120	0.67520	2.36320
Zone VII				
1.	0.58290	0.72864	2.08545	0.62632
2.	0.54302	0.67877	2.28490	0.47785
3.	0.52894	0.66118	2.35530	0.77310
4.	0.66429	0.83036	1.67855	0.42211
5.	0.66306	0.82882	1.68470	0.58093
6.	0.54326	0.67907	2.28370	0.46676
7.	0.64800	0.80999	1.76005	0.77824
8.	0.92726	1.15908	0.36370	1.80983
9.	0.87946	1.09933	0.60270	2.28052

Appendix

Table 3: Annual growth rates in agriculture over 1967-68 to 1977-78 and midterm annual population growth rate (1971-1976)

FD Zone/Dists.	acreage change rate(a_1)	yield rate change rate(a_2)	over all rate of change of agrl.prodn.(a_0)	midterm annual popn. growth rate 1971-76 (g_0)
Zone I				
1.	0.835	- 1.178	- 0.180	1.470
2.	2.992	0.398	3.014	1.8755
3.	1.284	0.023	1.054	1.2925
4.	0.424	- 0.888	- 0.181	1.1931
5.	2.670	- 1.166	1.381	1.6143
6.	1.706	- 0.579	1.556	1.7095
7.	3.641	- 1.657	1.833	1.6274
8.	2.299	0.881	3.003	2.2013
9.	1.730	0.636	2.259	2.2062
10.	1.209	1.944	2.486	2.1064
11.	1.919	0.172	2.020	2.1064
Zone II				
1.	2.165	- 2.146	0.161	1.2847
2.	0.409	- 0.815	- 0.181	1.0822
3.	0.475	- 2.179	- 0.251	1.6917
4.	0.696	- 2.113	- 1.534	1.6063
5.	3.347	- 2.036	1.912	2.2053
6.	2.652	0.206	3.346	2.1879
7.	1.947	- 0.389	1.583	1.6097
8.	2.579	- 0.018	2.405	2.2868
9.	1.288	- 0.106	0.677	2.6045
10.	0.887	- 0.086	0.968	2.0225
11.	2.378	- 1.186	0.452	2.1787
Zone III				
1.	1.651	- 1.172	- 0.238	1.5357
2.	- 0.097	- 0.250	0.006	1.4233
3.	2.571	- 1.087	1.604	2.1930
4.	0.949	0.883	0.371	2.1530
5.	1.014	- 0.315	1.003	2.2329
6.	0.427	1.293	1.219	2.2861
7.	- 0.998	0.958	- 0.659	2.3226
8.	1.088	0.753	1.446	2.1662
9.	1.326	0.935	2.423	2.1457
10.	1.058	0.279	1.139	2.2145
11.	3.549	1.989	5.075	2.4652
12.	0.346	- 0.594	- 0.405	2.4628
13.	0.885	0.898	1.777	3.1999

Contd.

Contd. ... Table No.3

FD Zone/Dists.	(a_1)	(a_2)	(a_0)	(g_0)
Zone IV				
1.	- 2 817	- 0.102	- 2.662	1.2573
2.	- 2.817	- 0.102	- 2.660	0 7211
3.	- 1.689	- 0.482	- 1.579	1 9786
4.	2.335	- 0.566	2.019	1 9546
5.	1.337	- 0.166	1.126	1.9835
6.	0.771	- 0.658	0.219	1.8985
7.	4.631	- 1.680	0.675	1.8374
8.	1.144	- 0.773	- 0.419	1.8924
9.	0.772	- 1.499	- 0.732	1.9332
10.	2.307	- 0.967	1.544	1.9157
11.	3.413	- 1.515	1.644	1.8220
12.	5.098	- 1.170	4.386	2.3122
13.	1.778	2.037	3.556	2.5756
14.	1.546	0.583	1.822	2.6195
Zone V				
1.	0.162	- 2.275	- 2.189	2.0996
2.	0.067	- 1.241	- 1.089	2.0377
3.	0.224	- 1.189	- 1.224	2.0660
4.	1.614	- 0.027	1.176	2.0461
5.	4.216	- 0.245	3.985	1.9553
6.	2.484	- 0.119	2.099	3.4927
7.	1.144	0.468	1.484	2.5440
Zone VI				
1.	- 0.093	- 1.124	- 1.107	1.3208
2.	- 1.636	- 2.398	- 2.926	1.3568
3.	- 3.413	- 1.190	- 3.878	1.3644
4.	- 0.805	- 1.749	- 2.561	1.2285
5.	- 4.173	- 0.196	- 5.040	1.3208
6.	1.180	- 2.147	- 1.924	2.0999
7.	- 0.705	- 0.855	- 1.190	2.1036
8.	4.997	0.134	5.336	2.1805
9.	- 0.284	1.858	1.463	4.0871
10.	5.660	0.300	0.623	3.4820
Zone VII				
1.	0.534	- 4.998	- 3.881	1.3776
2.	- 1.828	- 1.857	- 3.221	1.2492
3.	- 1.771	- 2.078	- 3.444	1.6065
4.	0.948	- 1.020	0.183	2.0855
5.	1.260	- 1.446	0.124	1.9018
6.	- 0.529	- 2.073	- 2.254	1.7529
7.	0.780	- 1.707	- 1.878	2.0014
8.	6.501	- 0.304	6.030	3.6306
9.	2.926	0.608	3.273	3.0383

Appendix

Table 4.0 : The optimal LP solutions for zonal movements of foodgrains with National surplus : 1977-78 Vs. 1989-90.

supplying zones	year of reference	movements of foodgrains (in tonnes) to receiving zones								Avaia-ability in tonnes
		I	II	III	IV	V	VI	VIII	dummy (net export or surplus)	
I	1977-78	356951	31165	10461	2664				64215	465456
	1989-90	450292	38102		18576	5057			127953	639980
II	1977-78		369572							369572
	1989-90		483952							483952
III	1977-78			527810						527810
	1989-90			723385	9847					733232
IV	1977-78				365865					365865
	1989-90				477323					477323
V	1977-78				19101	203050	7184			229335
	1989-90					272293	21625			293918
VI	1977-78						140957	21167		162124
	1989-90						185402	30581		215983
VII	1977-78							168346		168346
	1989-90							220696.		220696
Reqts.	1977-78	356951	400737	538271	387630	203050	148141	189513	64215	2288508
	9-90	450292	522054	723385	505746	277350	207027	251277	127953	3065084

Appendix

Table 4.1 : The optimal LP solutions for movements of foodgrains in Zone I with National surplus : 1977-78 Vs. 1989-90

supplying district	year of reference	movements of foodgrains (in tonnes) to receiving districts 1	2	3	4	5	6	7	8	9	10	11	dummy (surplus)	availability in tonnes
1	1977-78	12105												12105
	1989-90	13794												13794
2.	1977-78		20811											20811
	1989-90		27027			1598								28625
3.	1977-78		4031	22344										26375
	1989-90	5565		27427		1713								34705
4.	1977-78				20615									20615
	1989-90				22748									22748
5.	1977-78	1209				15327								16536
	1989-90					19914								19914
6.	1977-78						22834							22834
	1989-90				1041		26710							27751
7.	1977-78	3371						17269						20640
	1989-90				2561	1682		21358						25601
8.	1977-78			902					44347				51280	96529
	1989-90								58816				81772	140588
9.	1977-78									54994			44709	99703
	1989-90									73039			68082	141121
10.	1977-78				1962	4931					41289	1122	12516	61820
	1989-90										56435		38394	94829
11.	1977-78						10378					57110		67488
	1989-90						14626					74238	1440	90304
Reqts. in tonnes	1977-78	16685	24842	23246	22577	20258	33212	17269	44347	54994	41289	58232	108505	465456
	1989-90	19359	27027	27427	26350	[illegible]	41336	21358	58816	73039	56435	74238	189688	[illegible]

optimal 1977-78 transportation task in tonne-kms = 3,555,645

optimal 1989-90 transportation task in tonne-kms = [illegible]

Appendix

Table 4.2 : The optimal LP solutions for movements of foodgrains in Zone II with National surplus : 1977-78 Vs. 1989-90

supplying district	year of reference	movements of foodgrains (in tonnes) to : receiving districts 1	2	3	4	5	6	7	8	9	10	11	availability in tonnes
1.	1977-78	9215											9215
	1989-90	11450											11450
2.	1977-78		9123										9123
	1989-90		9937										9937
3.	1977-78			10745									10745
	1989-90			13553									13553
4.	1977-78				11460								11460
	1989-90			1274	13800								15074
5.	1977-78					18754							18754
	1989-90					24587							24587
6.	1977-78						26186						26186
	1989-90						29992						29992
7.	1977-78			12109				19117					31226
	1989-90			11616				23492					35118
8.	1977-78			10362	2443				57712				70517
	1989-90			14073					77577				92450
9.	1977-78	16604	11542		10963	5160				57747			102016
	1989-90	19040	13841		16801	798	10928			82486			143894
10.	1977-78					5638	4687				32996		43321
	1989-90					13910					42086		56796
11.	1977-78									6553		61621	68174
	1989-90									7503		81700	89203
Reqts.	1977-78	25819	20665	33216	24866	29552	30873	19117	57712	64300	32996	61621	400737
		30490	23770	41326	30601	39295	40920	23492	77577	89989	42886	81700	522054

: task in tonne-km. = [illegible]

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Appendix

Table 4.3 : The optimal LP solutions for movements of foodgrains in zone III with National surplus : 1977-78 Vs. 1989-90

supplying districts	year of reference	1	2	3	4	5	6	7	8	9	10	11	dummy (surplus)	Availability in tonnes
		movements of foodgrains (in tonnes) to receiving districts												
1.	1977-78	2744												2744
	1989-90	3286												3286
2.	1977-78		21062											21062
	1989-90		25519											25519
3.	1977-78			21754										21754
	1989-90			28520										28520
4.	1977-78	786			22279									23065
	1989-90	1020			24285									25305
5.	1977-78					33856								33856
	1989-90					34774								34774
6.	1977-78		20258		13821		72636							106715
	1989-90		24153		23350		112043							159546
7.	1977-78			4530		12302		30650						47482
	1989-90			4670		24530		40447						69647
8.	1977-78								63445					63445
	1989-90								86018					86018
9.	1977-78						4167		9297	52275	1832			67571
	1989-90								13589	69358	8665			91612
10.	1977-78			18060							44107			62167
	1989-90			25681							59716			79941
11.	1977-78						44842					43568		88410
	1989-90					2945	50787					65485	9847	129064
reqts. in tonnes	1977-78	3530	41320	44344	36100	46158	121645	30650	72742	52275	45939	43568		538271
	1989-90	4306	49672	58871	47635	62249	162830	40447	99607	69358	62925	65485	9847	733232

optimal 1977-78 transportation task in tonne-km. [illegible]443,748

optimal 1989-90 transportation task in tonne-km. [illegible]44,632

Appendix

Table 4.4: The optimal LP solutions for movements of foodgrains in Zone IV with National surplus: 1977-78 Vs. 1989-90

Supply- ing Dists.	year of refer- ence	movements of foodgrains (in tonnes): receiving districts 1	2	3	4	5	6	7
1.	1977-78	3071						
	1989-90	3266						
2.	1977-78		1302					2158
	1989-90		1432					2247
3.	1977-78			8234				
	1989-90			9851				
4.	1977-78			2693	17034			
	1989-90			4275	21588			
5.	1977-78	1797				10230		
	1989-90	2474				13294		
6.	1977-78						21249	
	1989-90						15629	
7.	1977-78							21622
	1989-90							23085
8.	1977-78							
	1989-90							
9.	1977-78							
	1989-90							
10.	1977-78							
	1989-90							
11.	1977-78							
	1989-90							
12.	1977-78							2442
	1989-90							7963
13.	1977-78					12156	7230	
	1989-90					15665	20815	
14.	1977-78				13445			
	1989-90				17586			
Reqts.	1977-78	4868	1302	10927	30479	22386	28479	26222
(tonnes)	1989-90	5740	1432	14126	39174	28959	36444	33295

Contd. .....

Concld. ... Table No.4.4

supply-ing dists.	year of refer-ence	movements of foodgrains (in tonnes) receiving districts 8	9	10	11	12	13	14	Availa-bilities in tonnes
1.	1977-78								3071
	1989-90								3266
2.	1977-78								3460
	1989-90								3679
3.	1977-78								8234
	1989-90								9857
4.	1977-78								19727
	1989-90								25863
5.	1977-78								12027
	1989-90								15768
6.	1977-78	13267							34516
	1989-90	25479							41108
7.	1977-78								21622
	1989-90								23085
8.	1977-78	16637							16637
	1989-90	17284							17284
9.	1977-78		22117						22117
	1989-90		25950						25950
10.	1977-78			21131					21131
	1989-90			27703					27703
11.	1977-78				27738				27738
	1989-90				32437				32437
12.	1977-78	3539				28497			34478
	1989-90					35792			43755
13.	1977-78			13411			30417		63214
	1989-90			16808		2540	42290		98118
14.	1977-78		18019	2893	19292			46009	99658
	1989-90		25496	3365	26993			64439	137879
Reqts. (tonnes)	1977-78	33443	40136	37435	47030	28497	30417	46009	387630
	1989-90	42763	51446	47876	59430	38332	42290	64439	505746

optimal 1977-78 transportation task in tonne-km = 22,505,621

optimal 1989-90 transportation task in tonne-km = 35,768,942

Appendix

Table 4.5 : The optimal solutions for movements of foodgrains in Zone V with National surplus : 1977-78 Vs. 1989-90

supplying district	year of reference	1	2	3	4	5	6	7	dummy (surplus)	availability in tonnes
1.	1977-78	7284								7284
	1989-90	8284								8284
2.	1977-78		7626							7626
	1989-90		8258							8258
3.	1977-78			21944						21944
	1989-90			23309						23309
4.	1977-78		685		18941					19626
	1989-90				21368					21368
5.	1977-78					18524				18524
	1989-90					24285				24285
6.	1977-78	10994	22523	3948			36743			74208
	1989-90	15712	13738	10488			57352			97290
7.	1977-78				6167	5155		42516	26285	80123
	1989-90		18167		11323	6191		58875	16568	111124
reqts. in tonnes	1977-78	18278	30834	25892	25108	23679	36743	42516	26285	229335
	1989-90	23996	40163	33797	32691	30476	57352	58875	16568	293918

optimal 1977-78 transportation task in tonne-km. = 5,531,519
optimal 1989-90 transportation task in tonne-km. = 11,251,805

Appendix

Table 4.6 : The optimal LP solutions for movements of foodgrains in Zone VI with National surplus : 1977-78 Vs. 1989-90

supplying district	year of reference	movements of foodgrains (in tonnes) to receiving district 1	2	3	4	5	6	7	8	9	10	dummy (surplus)	availability in tonnes
1.	1977-78	5901											5901
	1989-90	6329											6329
2.	1977-78		2509										2509
	1989-90		2964										2964
3.	1977-78			2342									2342
	1989-90			2446									2446
4.	1977-78				3433								3433
	1989-90				3781								3781
5.	1977-78		2858	334		1064							5056
	1989-90		2987			2382							5369
6.	1977-78	13440											13440
	1989-90	6910					8554						15464
7.	1977-78							15482					15482
	1989-90							17432					17432
8.	1977-78	2876		2001					18642				23519
	1989-90	13041	457	3144					14678				31320
9.	1977-78							13148	694	23066		12642	49550
	1989-90							20119	10932	35300		8956	75307
10.	1977-78				14		15876				23661	1341	40892
	1989-90				436		12259				42076		55571
reqts. in tonnes	1977-78	22217	5367	4677	3447	1864	15876	28630	19336	23066	23661	13983	162124
	1989-90	26200	6408	5590	4217	2382	20813	375[illegible]	[illegible]5610	35300	42076	8956	215903

[illegible] task in tonne-km : 10,994,563
[illegible] task in tonne-km : 15,373,[illegible]

Appendix

Table 4.7 : The optimal LP solutions for movements of foodgrains in Zone VII with National surplus : 1977-78 Vs. 1989-90

supplying district	year of reference	movements of foodgrains (in tonnes) to receiving districts									availability in tonnes
		1	2	3	4	5	6	7	8	9	
1.	1977-78	6293									6293
	1989-90	8311									8311
2.	1977-78		7048								7048
	1989-90		8571								8571
3.	1977-78			6436							6436
	1989-90			7790							7790
4.	1977-78				10924						10924
	1989-90				12302						12302
5.	1977-78			4880		13660					18540
	1989-90			6160		12939					19099
6.	1977-78						9064				9064
	1989-90						10611				10611
7.	1977-78		4076					6552			10628
	1989-90		1610					11234			12844
8.	1977-78	6240	8495						17976		32711
	1989-90	6693	12922						28612		48227
9.	1977-78				12659	16444	14737	10723		32506	87069
	1989-90				18558	25543	20290	11131		48000	123522
reqts. in tonnes	1977-78	12533	19619	11316	23583	30104	24601	17275	17976	32506	189513
	1989-90	15004	23103	13950	30860	38482	30901	22365	28612	48000	251277

Appendix

Table 5.0: The optimal LP solutions for zonal movements of foodgrains without national surplus in 1989-90 under alternatives 1 and 2

supplying zones	alternative	movements of foodgrains (in tonnes) to: receiving zone I	II	III	IV	V	VI	VII	availabilities in tonnes
I	1 : (b1)	450292	59093	25554	42195	34462			611596
	2 : (b2)	470045	60346	22368	50415	36806			639980
II	1 : (b1)		462961						462961
	2 : (b2)		483952						483952
III	1 : (b1)			697831					697831
	2 : (b2)			733232					733232
IV	1 : (b1)				463551				463551
	2 : (b2)				477323				477323
V	1 : (b1)					242888	37683		280571
	2 : (b2)					252632	41286		293918
VI	1 : (b1)						169344	38944	208288
	2 : (b2)						174692	41291	215983
VII	1 : (b1)							212333	212333
	2 : (b2)							220696	220696
Reqts. in tonnes	1 : (b1)	450292	522054	723385	505746	277350	207027	251277	2937131
	2 : (b2)	470045	544298	755600	527738	289438	215978	261987	3065084

optimal transportation task in tonne-km : (b1) = 73,353,919

optimal transportation task in tonne-km : (b2) = 78,936,137

Appendix

Table 5.1: The optimal LP solutions for movements of foodgrains in Zone I without national surplus in 1989-90 under alternatives 1 and 2

supplying dist.	alternative	movements of foodgrains (in tonnes) to receiving district 1	2	3	4	5	6	7	8	9	10	11	dummy (surplus)	availabilities in tonnes
1.	1:(b1)	13794												13794
	2:(b2)	13794												13794
2.	1:(b1)		26982											26982
	2:(b2)	369	28256											28625
3.	1:(b1)	5243	45	27427										32715
	2:(b2)	6031		28674										34708
4.	1:(b1)				22748									22748
	2:(b2)				22748									22748
5.	1:(b1)	322				19592								19914
	2:(b2)					19914								19914
6.	1:(b1)						27751							27751
	2:(b2)						27751							27751
7.	1:(b1)				3602	5315		16684						25601
	2:(b2)	7			3358			22236						25601
8.	1:(b1)								58816				73708	132524
	2:(b2)								61438				79150	140588
9.	1:(b1)									73039			59986	133025
	2:(b2)									76235			64886	141121
10.	1:(b1)							4674			56435	2700	27610	91419
	2:(b2)				1390	6126					58904	2510	25899	94829
11.	1:(b1)						13585					71538		85123
	2:(b2)						15464					74840		90304
Reqts. in tonnes	1:(b1)	19359	27027	27427	26350	24907	41336	21358	58816	73039	56435	74238	161304	611596
	2:(b2)	20201	28256	28674	27496	26040	43215	22236	61438	76235	58904	77350	169935	639980

Appendix

Table 5.2: The optimal LP solutions for movements of foodgrains in Zone II without national surplus in 1989-90 under alternatives 1 and 2

supplying dist.	alternative	movements of foodgrains (in tonnes) to : receiving district 1	2	3	4	5	6	7	8	9	10	11	availabilities in tonnes
1.	1:(b1)	11450											11450
	2:(b2)	11450											11450
2.	1:(b1)		9937										9937
	2:(b2)		9937										9937
3.	1:(b1)			13553									13553
	2:(b2)			13553									13553
4.	1:(b1)			6577	8497								15074
	2:(b2)			7390	7684								15074
5.	1:(b1)					23177							23177
	2:(b2)					24587							24587
6.	1:(b1)						29992						29992
	2:(b2)						29992						29992
7.	1:(b1)			11626				23492					35118
	2:(b2)			10559				24559					35118
8.	1:(b1)			9570					77577				87147
	2:(b2)			11621					80829				92450
9.	1:(b1)	19040	13841		22104	5466	10928			87438			158817
	2:(b2)	20366	14874		24247	4263	12707			89681			166138
10.	1:(b1)					10652					42886		53538
	2:(b2)					12112					44684		56796
11.	1:(b1)									2551		81700	84251
	2:(b2)									4079		85124	89203
Reqts. in tonnes	1:(b1)	30490	23778	41326	30601	39295	40920	23492	77577	89989	42886	81700	522054
	2:(b2)	31816	24811	43123	31931	40962	42699	24559	80829	93760	44684	85124	544298

optimal transportation task in tonne-km : (b1) = 18,794,662

optimal transportation task in tonne-km : (b2) = 20,[illegible].637

Appendix

Table 5.3: The optimal LP solutions for movements of foodgrains in Zone III without national surplus in 1989-90 under alternatives 1 and 2

supplying dist.	alternative	movements of foodgrains (in tonnes) to: receiving district											availabilities in tonnes
		1	2	3	4	5	6	7	8	9	10	11	
1.	1:(b1)	3286											3286
	2:(b2)	3286											3286
2.	1:(b1)		25519										25519
	2:(b2)		25519										25519
3.	1:(b1)			26884									26884
	2:(b2)			28520									28520
4.	1:(b1)	1020			24285								25305
	2:(b2)	1207			24098								25305
5.	1:(b1)					34774							34774
	2:(b2)					34774							34774
6.	1:(b1)		24153		23350		102889						150392
	2:(b2)		26312		25608		107626						159546
7.	1:(b1)					25208		40447					65655
	2:(b2)					27484		42163					69647
8.	1:(b1)								81085				81085
	2:(b2)								86018				86018
9.	1:(b1)								18522	67838			86360
	2:(b2)								18163	72543	906		91612
10.	1:(b1)			31987		2267	3764			1520	62925		102463
	2:(b2)			32849		2632	1919				64909		102309
11.	1:(b1)						56177					65485	121662
	2:(b2)						60572					68492	129064
Reqts. in tonnes	1:(b1)	4306	49672	58871	47635	62249	162830	40447	99607	69358	62925	65485	723385
	2:(b2)	4493	51831	61369	49706	64890	170117	42163	104181	72543	65815	68492	755600

optimal transportation task in tonne-km : (b1) = 34,084,621
[illegible]

Appendix

Table 5.4: The optimal LP solutions for movements of foodgrains in Zone IV without national surplus in 1989-90 under alternatives 1 and 2

supplying dist.	alternative	movements of foodgrains (in tonnes) to receiving district						
		1	2	3	4	5	6	7
1.	1:(b1)	3266						
	2:(b2)	3266						
2.	1:(b1)		1432					2247
	2:(b2)		1492					2187
3.	1:(b1)			9851				
	2:(b2)			9851				
4.	1:(b1)			4275	20104			
	2:(b2)			4863	21000			
5.	1:(b1)	2474				12389		
	2:(b2)	2713				13055		
6.	1:(b1)						15629	
	2:(b2)						13847	
7.	1:(b1)							23085
	2:(b2)							23085
8.	1:(b1)							
	2:(b2)							
9.	1:(b1)							
	2:(b2)							
10.	1:(b1)							
	2:(b2)							
11.	1:(b1)							
	2:(b2)							
12.	1:(b1)							7963
	2:(b2)							9410
13.	1:(b1)					16570	20815	
	2:(b2)					17111	24115	
14.	1:(b1)				19070			
	2:(b2)				19920			
Reqts. in tonnes	1:(b1)	5740	1432	14126	39174	28959	36444	33295
	2:(b2)	5979	1492	14714	40920	30166	37962	34682

Contd. .....

ntd. ... Table No.5.4

pply- g sts.	alter- native	movements of foodgrains (in tonnes) to receiving district							availa- bilities in tonnes
		8	9	10	11	12	13	14	
1.	1:(b1)								3266
	2:(b2)								3266
2.	1:(b1)								3679
	2:(b2)								3679
3.	1:(b1)								9851
	2:(b2)								9851
4.	1:(b1)								24379
	2:(b2)								25863
5.	1:(b1)								14863
	2:(b2)								15768
6.	1:(b1)	25479							41108
	2:(b2)	27261							41108
7.	1:(b1)								23085
	2:(b2)								23085
8.	1:(b1)	17284							17284
	2:(b2)	17284							17284
9.	1:(b1)		25950						25950
	2:(b2)		25950						25950
10.	1:(b1)			26114					26114
	2:(b2)			27703					27703
11.	1:(b1)				32437				32437
	2:(b2)				32437				32437
12.	1:(b1)					35792			43755
	2:(b2)					34345			43755
13.	1:(b1)			12381		2540	42290		94596
	2:(b2)			7005		5696	44191		98118
14.	1:(b1)		25496	9381	26993			64439	145379
	2:(b2)		27789	15302	29643			67217	159871
Reqts. in tonnes	1:(b1)	42763	51446	47876	59430	38332	42290	64439	505746
		44545	53739	50010	62080	40041	44191	67217	527738

optimal transportation task in tonne-km (b1) = 36,449,587

optimal transportation task in tonne-km : (b2) = 40,538,132

Appendix

Table 5.5: The optimal LP solutions for movements of foodgrains in Zone V without national surplus in 1989-90 under alternatives 1 and 2

supplying dist.	alternative	movements of foodgrains (in tonnes) to receiving district 1	2	3	4	5	6	7	dummy (surplus)	availabilities in tonnes
1.	1:(b1)	8284								8284
	2:(b2)	8284								8284
2.	1:(b1)		8258							8258
	2:(b2)		8258							8258
3.	1:(b1)			23309						23309
	2:(b2)			23309						23309
4.	1:(b1)				21368					21368
	2:(b2)				21368					21368
5.	1:(b1)					22892				22892
	2:(b2)					24285				24285
6.	1:(b1)	15712	8157	10488			57352			91709
	2:(b2)	16712	8700	11949			59929			97290
7.	1:(b1)		23748		11323	7584		58875	3221	104751
	2:(b2)		24879		12736	7508		61521	4480	111124
Reqts. in tonnes	1:(b1)	23996	40163	33797	32691	30476	57352	58875	3221	280571
	2:(b2)	24996	41837	35258	34104	31793	59929	61521	4480	293918

optimal transportation task in tonne-km : (b1) = 12,247,838

optimal transportation task in tonne-km : (b2) = 13,043,192

Appendix

Table 5.6: The optimal LP solutions for movements of foodgrains in Zone VI without national surplus in 1989-90 under alternatives 1 and 2

supplying dist.	alternative	movements of foodgrains (in tonnes) to receiving district: 1	2	3	4	5	6	7	8	9	10	dummy (surplus)	availiti tonn
1.	1:(b1)	6329											6
	2:(b2)	6329											
2.	1:(b1)		2964										2
	2:(b2)		2964										
3.	1:(b1)			2446									2
	2:(b2)			2446									
4.	1:(b1)				3781								3
	2:(b2)				3781								
5.	1:(b1)		2987			2382							5
	2:(b2)		2888			2481							
6.	1:(b1)	3724					11740						15
	2:(b2)	3907					11557						
7.	1:(b1)							17432					17
	2:(b2)							17432					
8.	1:(b1)	16227	457	3144					9694				29
	2:(b2)	17139	823	3376					9982				
9.	1:(b1)							20119	15916	35300		1261	72
	2:(b2)							21742	16735	36825		5	
10.	1:(b1)				436		9073				42876		52
	2:(b2)				612		10156				44803		
Reqts. in tonnes	1:(b1)	26280	6408	5590	4217	2382	20813	37551	25610	35300	42876	1261	208
	2:(b2)	27375	6675	5822	4393	2481	21713	39174	26717	36825	44803	5	215

optimal transportation task in tonne-km: (b1) = 15,629,108

optimal transportation task in tonne-km: (b2) = 16,875,832

Appendix

Table 5.7: The optimal LP solutions for movements of foodgrains in Zone VII without national surplus in 1989-90 under alternatives 1 and 2

supplying dist.	alternative	movements of foodgrains (in tonnes) to receiving district 1	2	3	4	5	6	7	8	9	availabilities in tonnes
1.	1:(b1)	8311									8311
	2:(b2)	8311									8311
2.	1:(b1)		8571								8571
	2:(b2)		8571								8571
3.	1:(b1)			7790							7790
	2:(b2)			7790							7790
4.	1:(b1)				12302						12302
	2:(b2)				12302						12302
5.	1:(b1)			6160		12939					19099
	2:(b2)			6741		12358					19099
6.	1:(b1)						10611				10611
	2:(b2)						10611				10611
7.	1:(b1)		4690					8154			12844
	2:(b2)		4419					8425			12844
8.	1:(b1)	6693	9842						28612		45147
	2:(b2)	7319	11076						29832		48227
9.	1:(b1)				18558	25543	20290	14211		48000	126602
	2:(b2)				19891	27787	21577	14907		50070	134232
Reqts. in tonnes	1:(b1)	15004	23103	13950	30860	38482	30901	22365	28612	48000	251277
	2:(b2)	15630	24066	14531	32193	40145	32188	23332	29832	50070	261987

optimal transportation task in tonne-km : (b1) = 18,483,825
optimal transportation task in tonne-km : (b2) = 19;911,129

Appendix

Table 6: Various comparisons of foodgrain requirements, foodgrain availabilities and the corresponding cereal outputs : 1977-78 and 1989-90

FD Zones/ Districts	1977-78 figures in tons			ratio of availability to requirement 1989-90			
	cereal output	foodgrains for human consumption		1977-78	without national surplus		with national surplus
		availability	requirements		Alt. I	Alt. II	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Zone I	783920	465456	356951	1.3040	1.3582	1.3615	1.4213
1.	15820	12105	16685	0.7255	0.7125	0.6828	0.7125
2.	27130	20811	24842	0.8377	0.9983	1.0131	1.0591
3.	38420	26375	23246	1.1346	1.1928	1.2103	1.2654
4.	31910	20615	22577	0.9131	0.8633	0.8273	0.8633
5.	22320	16536	20258	0.8163	0.7995	0.7647	0.7995
6.	31360	22834	33212	0.6875	0.6714	0.6422	0.6714
7.	28430	20640	17269	1.1952	1.1987	1.1513	1.1987
8.	176110	96529	[illegible]	2.1767	2.2532	2.2883	2.3903
9.	179030	99703	54994	1.8130	1.8213	1.8511	1.9321
10.	108830	61820	41289	1.4973	1.6376	1.6099	1.6803
11.	124560	67488	58232	1.1590	1.1466	1.1675	1.2164
Zone II	595460	369572	400737	0.9222	0.8868	0.8891	0.9270
1.	12500	9215	25819	0.3569	0.3755	0.3599	0.3755
2.	10840	9123	20665	0.4415	0.4179	0.4005	0.4179
3.	13500	10745	33216	0.3235	0.3280	0.3143	0.3280
4.	15050	11460	24866	0.4609	0.4926	0.4721	0.4926
5.	25380	18754	29552	0.6346	0.5898	0.6002	0.6257
6.	36260	26186	30873	0.8482	0.7329	0.7024	0.7329
7.	47410	31226	19117	1.6334	1.4949	1.4299	1.4949
8.	123210	70517	57712	1.2219	1.1234	1.1438	1.1917
9.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.1203	1.1756
10.	72800	43321	32996	1.3129	1.2484	1.2711	1.3213
11.	118550	68174	61621	1.1063	1.0312	1.0479	1.9018

Contd. ... Table No.6

FD Zones/ Districts	ratio of 1989-90 figure to 1977-78 figure					
	requirement of foodgrains		availability of foodgrains		cereal output	
	Alt.I	Alt.II	Alt.I	Alt.II	Alt.I	Alt.II
(1)	(9)	(10)	(11)	(12)	(13)	(14)
Zone I	1.2615	1.3168	1.3140	1.3750	1.3018	1.3596
1.	1.1603	1.2107	1.1395	1.1395	1.1241	1.1241
2.	1.0880	1.1374	1.2965	1.3755	1.2783	1.3504
3.	1.1799	1.2335	1.2404	1.3158	1.2229	1.2919
4.	1.1671	1.2179	1.1035	1.1035	1.0885	1.0885
5.	1.2295	1.2854	1.2043	1.2043	1.1879	1.1879
6.	1.2446	1.3012	1.2153	1.2153	1.1989	1.1989
7.	1.2368	1.2876	1.2404	1.2404	1.2235	1.2235
8.	1.3263	1.3854	1.3729	1.4564	1.3536	1.4299
9.	1.3281	1.3862	1.3342	1.4154	1.3154	1.3896
10.	1.3668	1.4266	1.4788	1.5340	1.4580	1.5060
11.	1.2749	1.3283	1.2613	1.3381	1.2435	1.3137
Zone II	1.3027	1.3582	1.2527	1.3095	1.2386	1.2931
1.	1.1809	1.2323	1.2425	1.2425	1.2257	1.2257
2.	1.1506	1.2006	1.0892	1.0892	1.0744	1.0744
3.	1.2442	1.2983	1.2613	1.2613	1.2442	1.2442
4.	1.2306	1.2841	1.3154	1.3154	1.2975	1.2975
5.	1.3297	1.3861	1.2358	1.3110	1.2184	1.2872
6.	1.3254	1.3831	1.1453	1.1453	1.1298	1.1298
7.	1.2289	1.2847	1.1246	1.1246	1.1094	1.1094
8.	1.3442	1.4006	1.2358	1.3110	1.2184	1.2872
9.	1.3995	1.4582	1.4075	1.4932	1.3877	1.4660
10.	1.2997	1.3542	1.2358	1.3111	1.2184	1.2872
11.	1.3258	1.3814	1.2358	1.3085	1.2184	1.2846

Contd. .....

Contd. ... Table No.6

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Zone III	806590	527810	538271	0.9806	0.9647	0.9704	1.0136
1.	3420	2744	3530	0.7773	0.7631	0.7314	0.7631
2.	27340	21062	41320	0.5097	0.5138	0.4924	0.5138
3.	30580	21754	44344	0.4906	0.4567	0.4647	0.4844
4.	34150	23065	36100	0.6389	0.5312	0.5091	0.5312
5.	47240	33856	46158	0.7335	0.5586	0.5359	0.5586
6.	160390	106715	121645	0.8773	0.9236	0.9379	0.9798
7.	64830	47482	30650	1.5492	1.6232	1.6519	1.7219
8.	111310	63445	72742	0.8722	0.8140	0.8257	0.8636
9.	115600	67571	52275	1.2926	1.2451	1.2629	1.3209
10.	89540	51706	45939	1.1255	1.2222	1.2146	1.2704
11.	122190	88410	43568	2.0292	1.8579	1.8844	1.9709
Zone IV	542170	365865	387630	0.9439	0.9166	0.9045	0.9438
1.	3810	3071	4868	0.6309	0.5690	0.5462	0.5690
2.	4070	3460	1302	2.6575	2.5691	2.4658	2.5691
3.	10850	8234	10927	0.7535	0.6974	0.6695	0.6974
4.	24890	19727	30479	0.6472	0.6223	0.6320	0.6602
5.	15760	12027	22386	0.5373	0.5132	0.5227	0.5445
6.	49020	34516	28479	1.2120	1.1280	1.0829	1.1280
7.	29730	21622	26222	0.8246	0.6933	0.6656	0.6933
8.	23570	16637	33443	0.4975	0.4042	0.3880	0.4042
9.	28590	22117	40136	0.5511	0.5044	0.4829	0.5044
10.	29910	21131	37435	0.5645	0.5455	0.5539	0.5786
11.	39840	27738	47030	0.5898	0.5458	0.5225	0.5458
12.	47230	34478	28497	1.2099	1.1415	1.0928	1.1415
13.	100470	63214	30417	2.0782	2.2368	2.2203	2.3201
14.	134430	77893	46009	1.6930	1.6013	1.6284	1.6986

Contd. .... Table No.6

(1)	(9)	(10)	(11)	(12)	(13)	(14)
Zone III	1.3439	1.4038	1.3221	1.3892	1.3056	1.3673
1.	1.2198	1.2728	1.1975	1.1975	1.1813	1.1813
2.	1.2021	1.2544	1.2116	1.2116	1.1952	1.1952
3.	1.3276	1.3839	1.2358	1.3110	1.2184	1.2872
4.	1.3195	1.3769	1.0971	1.0971	1.0823	1.0823
5.	1.3486	1.4058	1.0271	1.0271	1.0132	1.0132
6.	1.3386	1.3985	1.4093	1.4951	1.3899	1.4684
7.	1.3196	1.3756	1.3827	1.4668	1.3633	1.4401
8.	1.3693	1.4322	1.2780	1.3558	1.2601	1.3311
9.	1.3268	1.3877	1.2781	1.3558	1.2601	1.3311
10.	1.3698	1.4327	1.4874	1.5461	1.4665	1.5179
11.	1.5031	1.5721	1.3761	1.4598	1.3567	1.4333
Zone IV	1.3047	1.3614	1.2670	1.3046	1.2580	1.2942
1.	1.1791	1.2282	1.0635	1.0635	1.0491	1.0491
2.	1.0998	1.1459	1.0633	1.0633	1.0489	1.0489
3.	1.2928	1.3466	1.1964	1.1964	1.1801	1.1801
4.	1.2853	1.3426	1.2358	1.3110	1.2184	1.2872
5.	1.2936	1.3475	1.2358	1.3111	1.2184	1.2872
6.	1.2797	1.3330	1.1910	1.1910	1.1748	1.1748
7.	1.2697	1.3226	1.0677	1.0677	1.0532	1.0532
8.	1.2787	1.3320	1.0389	1.0389	1.0248	1.0248
9.	1.2818	1.3389	1.1733	1.1733	1.1574	1.1574
10.	1.2789	1.3359	1.2358	1.3110	1.2184	1.2872
11.	1.2637	1.3200	1.1694	1.1694	1.1535	1.1535
12.	1.3451	1.4051	1.2691	1.2691	1.2519	1.2519
13.	1.3903	1.4528	1.4964	1.5522	1.4754	1.5239
14.	1.4006	1.4610	1.3247	1.4052	1.3060	1.3796

Contd. .....

Contd. ... Table No.6

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Zone V	346690	229335	203050	1.1295	1.0116	1.0155	1.0597
1.	9200	7284	18278	0.3985	0.3452	0.3314	0.3452
2.	9640	7626	30834	0.2473	0.2056	0.1974	0.2056
3.	29970	21944	25892	0.8475	0.6897	0.6611	0.6897
4.	26110	19626	25108	0.7817	0.6536	0.6266	0.6536
5.	23270	18524	23679	0.7823	0.7511	0.7638	0.7969
6.	111260	74208	26743	2.0197	1.5991	1.6234	1.6964
7.	137240	80123	42516	1.8845	1.7792	1.8063	1.8875
Zone VI	249040	162124	148141	1.0944	1.0061	1.0000	1.0433
1.	8070	5901	22217	0.2656	0.2408	0.2312	0.2408
2.	3160	2509	5367	0.4675	0.4625	0.4440	0.4625
3.	3000	2342	4677	0.5007	0.4376	0.4201	0.4376
4.	4240	3433	3447	0.9959	0.8966	0.8607	0.8966
5.	6200	5056	1864	2.7124	2.2540	2.1640	2.2540
6.	18130	13440	15876	0.8466	0.7430	0.7122	0.7430
7.	21180	15482	28630	0.5408	0.4642	0.4450	0.4642
8.	34420	23519	19336	1.2163	1.1528	1.1723	1.2230
9.	82380	49550	23066	2.1482	2.0565	2.0450	2.1333
10.	68260	40892	23661	1.7282	1.2218	1.2403	1.2961
Zone VII	262260	168346	189513	0.8883	0.8450	0.8424	0.8783
1.	8740	6293	12533	0.5021	0.5539	0.5317	0.5539
2.	10510	7048	19619	0.3592	0.3710	0.3561	0.3710
3.	9890	6436	11316	0.5688	0.5584	0.5361	0.5584
4.	15620	10924	23583	0.4632	0.3986	0.3821	0.3986
5.	26790	18540	30104	0.6159	0.4963	0.4758	0.4963
6.	13150	9864	24601	0.4010	0.3434	0.3297	0.3434
7.	13910	10628	17275	0.6152	0.5743	0.5505	0.5743
8.	54080	32711	17976	1.8197	1.5779	1.6166	1.6856
9.	109570	65902	32506	2.0274	1.8262	1.8562	1.9363
Nepal	3586130	2286508	2224293	1.0289	1.0000	1.0000	1.0436

Contd. ... Table No.6

(1)	(9)	(10)	(11)	(12)	(13)	(14)
Zone V	1.3659	1.4255	1.2234	1.2816	1.2140	1.2694
1.	1.3128	1.3675	1.1373	1.1373	1.1220	1.1220
2.	1.3026	1.3568	1.0828	1.0828	1.0682	1.0682
3.	1.3053	1.3617	1.0622	1.0622	1.0478	1.0478
4.	1.3020	1.3583	1.0888	1.0888	1.0740	1.0740
5.	1.2870	1.3427	1.2358	1.3110	1.2184	1.2872
6.	1.5609	1.6310	1.2358	1.3110	1.2184	1.2872
7.	1.3848	1.4470	1.3074	1.3869	1.2890	1.3617
Zone VI	1.3975	1.4579	1.2847	1.3322	1.2782	1.3231
1.	1.1829	1.2322	1.0725	1.0725	1.0580	1.0580
2.	1.1940	1.2437	1.1813	1.1813	1.1655	1.1655
3.	1.1952	1.2448	1.0444	1.0444	1.0303	1.0303
4.	1.2234	1.2744	1.1014	1.1014	1.0866	1.0866
5.	1.2779	1.3310	1.0619	1.0619	1.0474	1.0474
6.	1.3110	1.3677	1.1506	1.1506	1.1350	1.1350
7.	1.3116	1.3683	1.1260	1.1260	1.1107	1.1107
8.	1.3245	1.3817	1.2552	1.3317	1.2376	1.3074
9.	1.5304	1.5965	1.4651	1.5198	1.4445	1.4921
10.	1.8121	1.8935	1.2811	1.3590	1.2630	1.3342
Zone VII	1.3259	1.3824	1.2613	1.3110	1.2514	1.2999
1.	1.1972	1.2471	1.3207	1.3207	1.3027	1.3027
2.	1.1776	1.2267	1.2161	1.2161	1.1996	1.1996
3.	1.2328	1.2841	1.2104	1.2104	1.1939	1.1939
4.	1.3086	1.3651	1.1261	1.1261	1.1109	1.1109
5.	1.2783	1.3335	1.0302	1.0302	1.0162	1.0162
6.	1.2561	1.3084	1.0757	1.0757	1.0611	1.0611
7.	1.2946	1.3506	1.2085	1.2085	1.1922	1.1922
8.	1.5917	1.6595	1.3802	1.4743	1.3608	1.4475
9.	1.4767	1.5403	1.3301	1.4103	1.3114	1.3846
Nepal	1.3205	1.3780	1.2834	1.3393	1.2717	1.3248

Appendix

Table 7: Final 1989-90 targets of cereal output, foodgrain availability and foodgrain supply for human consumption

Districts by distribution Zones	Final 1989-90 targets (in tonnes)			% annual rate of growth during the period 1977-78 to 1989-90		
	cereal output	availability of foodgrains	supply of foodgrains for human consumptions	cereal output	availability of foodgrains	supply of foodgrains
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Zone I	1065836	639980	450292	2.593	2.689	1.955
1.	17783	13794	19359	0.979	1.094	1.246
2.	36637	28625	27027	2.535	2.692	0.705
3.	49634	34705	27427	2.157	2.314	1.388
4.	34734	22748	26350	0.709	0.824	1.296
5.	26515	19914	24907	1.446	1.561	1.737
6.	37597	27751	41336	1.523	1.638	1.840
7.	34785	25601	21358	1.695	1.811	1.787
8.	251823	140588	58816	3.025	3.183	2.381
9.	248788	141121	73039	2.780	2.937	2.393
10.	163901	94829	56435	3.471	3.630	2.638
11.	163639	90304	74238	2.300	2.457	2.044
Zone II	769974	483952	522054	2.165	2.272	2.228
1.	15321	11450	30490	1.710	1.826	1.395
2.	11647	9937	23778	0.600	0.715	1.176
3.	16797	13553	41326	1.838	1.954	1.837
4.	19528	15074	30601	2.194	2.311	1.744
5.	32668	24587	39295	2.126	2.282	2.403
6.	40967	29992	40920	1.022	1.137	2.376
7.	52596	35118	23492	0.869	0.984	1.732
8.	158592	92450	77577	2.126	2.282	2.496

Contd. ....

Contd. ... Table No.7

(1)	(2)	(3)	(4)	(5)	(6)	(7)
9.	175858	105792	89989	3.239	3.397	2.841
10.	53706	56796	42886	2.126	2.283	2.209
11.	152294	89203	81700	2.109	2.266	2.378
<u>Zone III</u>	1102856	733232	723385	2.641	2.777	2.494
1.	4040	3286	4306	1.398	1.513	1.670
2.	32676	25519	49672	1.497	1.612	1.546
3.	39362	28520	58871	2.126	2.282	2.390
4.	36959	25305	47635	0.661	0.775	2.338
5.	47862	34774	62249	0.109	0.223	2.524
6. KV	235511	159546	162830	3.253	3.408	2.460
7.	93362	69647	40447	3.086	3.244	2.338
8.	148165	86018	99607	2.412	2.569	2.654
9.	153875	91612	69358	2.412	2.569	2.384
10.	135915	79941	62925	3.539	3.698	2.657
11.	175129	129064	65485	3.045	3.203	3.454
<u>Zone IV</u>	701690	477323	505746	2.173	2.240	2.241
1.	3997	3266	5740	0.400	0.514	1.383
2.	4269	3679	1432	0.399	0.513	0.796
3.	12804	9851	14126	1.389	1.505	2.163
4.	32038	25863	39174	2.126	2.283	2.113
5.	20286	15768	28959	2.126	2.283	2.169
6.	57589	41108	36444	1.352	1.467	2.076
7.	31311	23085	33295	0.433	0.547	2.010
8.	24155	17284	42763	0.205	0.318	2.070
9.	33090	25950	51446	1.226	1.341	2.090
10.	38499	27703	47876	2.126	2.282	2.071
11.	45957	32437	59430	1.197	1.313	1.969
12.	59126	43755	38332	1.890	2.006	2.501
13.	153107	98118	42290	3.573	3.732	2.784
14.	185462	109456	64439	2.718	2.875	2.847

Contd. .....

Concld.... Table No.7

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Zone V	440102	293918	277350	2.008	2.089	2.633
1.	10322	8284	23996	0.964	1.078	2.294
2.	10297	8258	40163	0.551	0.666	2.227
3.	31402	23309	33797	0.390	0.504	2.245
4.	28042	21368	32691	0.597	0.711	2.224
5.	29952	24285	30476	2.126	2.282	2.125
6.	143211	97290	57352	2.126	2.283	3.780
7.	186876	111124	58875	2.606	2.763	2.750
Zone VI	329514	215983	207027	2.361	2.419	2.828
1.	8538	6329	26280	0.471	0.585	1.409
2.	3683	2964	6408	1.284	1.398	1.488
3.	3091	2446	5590	0.249	0.363	1.497
4.	4607	3781	4217	0.694	0.808	1.694
5.	6494	5369	2382	0.387	0.502	2.064
6.	20577	15464	20813	1.061	1.176	2.282
7.	23525	17432	37551	0.879	0.993	2.286
8.	45002	31320	25610	2.259	2.416	2.369
9.	122923	75307	35300	3.391	3.550	3.610
10.	91074	55571	42876	2.432	2.589	5.079
Zone VII	340908	220696	251277	2.210	2.282	2.379
1.	11386	8311	15004	2.228	2.345	1.511
2.	12608	8571	23103	1.528	1.644	1.372
3.	11808	7790	13950	1.488	1.604	1.759
4.	17352	12302	30860	0.880	0.995	2.266
5.	27223	19099	38482	0.134	0.248	2.067
6.	13954	10611	30901	0.496	0.610	1.918
7.	16583	12844	22365	1.476	1.591	2.175
8.	78281	48227	28612	3.130	3.288	3.949
9.	151713	92941	48000	2.749	2.906	3.301
Nepal	4750880	3065084	2937131	2.371	2.465	2.344

Appendix

Table 8.0 : Route distances between zonal centres.

(figures are in km.)

Distribution zone	Zonal centre (District)	Distribution zone I	II	III	IV	V	VI	VII
I	Biratnagar (Morang)	0						
II	Janakpur (Dhanusha)	220	0					
III	Birganj (Parsa)	320	160	0				
IV	Bhairahawa (Rupandehi)	507	347	247	0			
V	Tulsipur (Dang Deokhuri)	637	477	377	175	0		
VI	Nepalganj (Banke)	737	577	497	275	100	0	
VII	Dhangadhi (Kailali)	867	707	627	405	230	130	0

Appendix

Table 8.1 : Ruggedness accounted distances between districts (below diagonal entries) and the ruggedness intensity factors within and between districts of zone I.

(Entries below the principal diagonal are in km.)

Districts of zone I	1	2	3	4	5	6	7	8	9	10	11
1.	3.60514	2.5556	2.2875	3.5357	[illegible]	3.0000	2.4750	1.9031	1.9032	1.9379	1.6946
2.	115	2.06678	1.9429	2.6765	2.0000	2.5185	1.8800	1.7400	1.4129	1.5391	1.3873
3.	183	68	1.84236	2.4369	1.9651	2.3846	1.9500	1.6308	1.2583	1.2454	1.1905
4.	196	182	251	3.47541	3.0455	2.2500	2.5962	1.5829	1.8268	1.8632	1.5920
5.	134	48	116	134	1.91310	2.5455	1.7778	1.3158	1.4505	1.4554	1.3208
6.	288	272	341	90	224	1.99363	1.8704	1.3862	1.5349	1.5462	1.2824
7.	198	94	117	135	64	101	1.66312	1.1926	1.2933	1.2769	1.1870
8.	289	174	106	296	225	262	161	1.05061	1.1333	1.1091	1.1012
9.	295	219	151	232	161	198	97	136	1.19592	1.1538	1.1071
10.	281	177	137	218	147	184	83	122	30	1.11063	1.0862
11.	344	240	200	199	210	109	146	185	93	63	1.06786

Appendix

Table 8.2 : Ruggedness accounted distances between districts (below diagonal entries) and the ruggedness intensity factors within and between districts of zone II

(Entries below the principal diagonal are in km.)

Districts of zone II	1	2	3	4	5	6	7	8	9	10	11
1.	3.21138	3.3000	2.3500	2.5375	3.0000	2.5889	2.1419	1.9086	2.0333	1.8820	1.9636
2.	231	3.60108	2.3538	2.9600	2.4933	2.3182	2.0300	1.8120	1.7787	1.8030	1.8703
3.	282	153	1.93575	1.9750	2.1333	2.0800	1.3231	1.3655	1.2865	1.6995	1.7550
4.	203	74	79	2.01610	2.2600	2.1294	1.7200	1.5000	1.4742	1.6358	1.7000
5.	165	187	192	113	2.81712	1.9429	1.4353	1.4083	1.4737	1.3021	1.4455
6.	233	255	260	181	68	1.57837	1.3037	1.1882	1.1613	1.1591	1.2133
7.	332	203	86	129	244	176	1.59750	1.4000	1.2667	1.2345	1.2409
8.	334	212	198	138	160	101	112	1.06444	1.0667	1.0606	1.0646
9.	305	217	238	143	140	72	152	48	1.08334	1.0824	1.0588
10.	335	357	362	283	170	102	179	123	92	1.06334	1.0737
11.	324	346	351	272	159	91	170	66	18	102	1.09111

Appendix

Table 8.3 : Ruggedness accounted distances between districts (below diagonal entries) and the ruggedness intensity factors within and between districts of zone III

(Entries below the principal diagonal are in km.)

Districts of zone III	1	2	3	4	5	6	7	8	9	10	11
1.	3.00503	2.9125	2.8143	2.8000	2.3611	2.6000	2.2000	1.8489	1.9194	1.9846	1.9591
2.	233	2.87701	2.3175	2.2119	2.3111	2.0685	1.9091	1.6468	1.7059	1.7553	1.7550
3.	107	292	3.07949	2.8286	2.3210	2.6604	2.4444	1.8529	1.9536	2.0519	2.0062
4.	98	261	99	2.50100	2.1507	2.4445	2.0174	1.6737	1.7443	1.8063	1.8000
5.	255	104	188	157	1.86309	1.6667	1.7245	1.4740	1.5346	1.5004	1.6071
6.	208	151	141	110	50	1.57209	1.7429	1.4345	1.5038	1.5565	1.5920
7.	330	273	220	232	169	122	1.81752	1.3100	1.3704	1.4308	1.5059
8.	416	359	315	318	255	208	131	1.00053	1.0889	1.0904	1.3161
9.	405	348	295	307	244	197	111	49	1.10004	1.1250	1.3529
10.	387	330	277	289	226	179	93	67	18	1.07040	1.3033
11.	431	374	321	333	270	223	128	204	184	166	1.15952

Appendix

Table 8.4: Ruggedness accounted distances between districts (below diagonal entries) and the ruggedness intensity factor within and between districts of Zone IV

(below diagonal entries in km)

Dist	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	3.1033	3.2000	3.3333	3.2667	2.9200	3.4200	3.2160	3.2059	2.8462	2.4000	2.6500	3.2286	2.2391	2.2864
2.	240	3.2351	3.2593	3.2333	3.0600	3.3913	3.2400	3.2106	2.9756	2.6400	3.2643	2.6800	2.4754	2.5186
3.	200	440	3.5533	3.0000	2.4333	2.3067	2.8621	2.2000	2.4286	1.9130	1.9667	2.3782	1.8529	1.8937
4.	245	485	45	2.5063	1.8667	2.1333	2.8462	2.1226	2.2727	1.7500	1.6222	2.3800	1.7419	1.7793
5.	219	459	73	28	1.8671	2.2222	2.9739	2.1500	2.1857	1.7294	1.5000	2.4706	1.7286	1.7692
6.	342	390	173	128	100	3.5781	3.4571	2.1158	2.9040	2.1125	2.6800	2.7500	1.9556	2.0160
7.	402	162	415	370	342	242	3.3575	3.1778	3.1026	2.7400	3.2526	2.1200	2.4683	2.5333
8.	545	305	374	329	301	201	143	2.9391	2.5636	2.1143	2.2333	2.0222	2.0217	2.0591
9.	370	610	170	125	153	363	605	564	1.8520	4.3111	2.9600	2.8667	2.8900	3.0778
10.	420	660	220	175	147	169	411	370	194	2.7903	1.8545	2.3250	1.7273	1.8444
11.	318	457	118	73	45	67	309	268	296	102	1.3265	2.7231	1.7909	1.8500
12.	452	268	283	238	210	110	106	91	473	279	177	1.2803	2.1371	2.1929
13.	515	755	315	270	242	264	506	465	289	95	197	374	1.2039	1.1600
14.	503	743	303	258	230	252	494	453	277	83	185	362	29	1.0793

Appendix

Table 8.5: Ruggedness accounted distances between districts (below diagonal entries) and the ruggedness intensity factors within and between districts of Zone V

(below diagonal entries in km)

Districts of Zone V	1	2	3	4	5	6	7
1.	2.82693	2.1400	1.9273	2.0800	1.9929	1.7684	1.4250
2.	107	2.05949	1.9762	2.0200	1.9111	1.8200	1.6667
3.	106	83	1.73535	1.5333	1.6414	1.5500	1.2757
4.	208	101	161	1.97588	1.7750	1.5231	1.4900
5.	279	172	238	71	1.65117	1.5700	1.3000
6.	168	91	62	99	157	1.24920	1.2000
7.	342	250	236	149	78	174	1.11511

Appendix

Table 6.6: Ruggedness accounted distances between districts (below diagonal entries) and the ruggedness intensity factors within and between districts of Zone VI

(below diagonal entries in km)

Districts of Zone VI	1	2	3	4	5	6	7	8	9	10
1.	2.72387	2.8316	2.7143	2.7625	2.5231	2.5200	2.5524	2.3732	2.0329	2.0321
2.	269	2.96013	2.9000	2.8000	2.7130	2.6941	2.5636	2.0082	1.8608	1.8629
3.	95	174	2.69087	2.7478	2.5222	2.5818	2.4143	2.2994	2.0282	2.0277
.	221	490	316	2.79029	2.6552	2.5165	2.7076	2.2456	2.0392	2.1594
5.	164	312	227	385	2.39712	3.0574	2.2200	2.0690	1.7468	1.7546
6.	189	458	284	229	373	2.39448	2.2500	1.9375	1.7744	1.8793
7.	268	423	338	463	111	162	2.02283	1.8649	1.5278	1.5487
8.	337	492	407	384	180	155	69	1.65640	1.3521	1.3947
9.	433	588	503	520	276	291	165	96	1.19281	1.2069
10.	443	598	513	447	286	218	175	106	35	1.26205

Appendix

Table 8.7: Ruggedness accounted distances between districts (below diagonal entries) and the ruggedness intensity factors within and between districts of Zone VII

(below diagonal entries in km)

Districts of Zone VII	1	2	3	4	5	6	7	8	9
1.	3.14451	3.1343	3.0690	2.4219	2.6613	2.4244	2.1981	1.9687	1.8683
2.	210	3.12049	3.0364	2.3371	2.6422	2.4598	2.4800	2.0360	2.0088
3.	356	167	2.80820	2.5041	2.1967	2.2745	2.0339	1.6635	1.7797
4.	155	208	308	1.90456	1.8846	1.8571	1.8571	1.6509	1.5243
5.	330	288	134	147	1.91599	1.8125	1.8596	1.4467	1.5514
6.	417	214	116	234	87	1.77908	1.8381	1.4727	1.5794
7.	233	186	240	78	106	193	1.74093	1.5156	1.2951
8.	252	283	351	175	217	243	97	1.18846	1.1964
9.	312	454	315	157	166	199	79	67	1.19000

Appendix

Table 9 Fertiliser consumption, the output of cereals and the 1989-90 production tasks for cereals.

district/ crop regions	1977-78				1989-90	
	F in tonnes	F_c/F	A_c in hactares	Y_c in tonnes	Y_c^*(Alt.I) in tonnes	Y_c^{**}(Alt.II) in tonnes
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Jhapa (1.1)	811	.8713	97500	176110	238378	251823
Morang (1.1)	1415	.8071	103690	179030	235502	248788
Sunsari (1.1)	540	.8328	59360	108830	158672	163901
Saptari (1.1)	551	.9070	83290	124560	154896	163639
Siraha (1.2)	650	.9166	83520	123210	150123	158592
Dhamsa (1.2)	956	.8589	77230	119960	166468	175858
Mohattari (1.2)	1667	.8750	88910	118550	144445	152294
Sarlahi (1.2)	879	.9380	51420	72800	88702	93706
Rautahat (1.3)	792	.9315	87730	111310	140257	148165
Bara (1.3)	2850	.7940	70580	115600	145663	153875
Parsa (1.3)	2229	.6529	55190	89540	131309	135915
Chitwan (1.4)	2323	.8074	67180	122190	165781	175129
Navalparasi (1.5)	1290	.5577	57150	100470	148230	153107
Rupandehi (1.5)	2044	.5985	96430	134430	175572	185462
Kapilvastu (1.5)	1410	.6211	91860	137240	176900	186876
Dang Deokhuki (1.6)	371	.8526	66150	111260	135563	143211
Banke (1.6)	388	.9065	46180	68260	86214	91074
Bardia (1.6)	374	.8856	39430	82380	118996	122923
Kailali (1.7)	434	.8851	69610	109570	143690	151713
Kanchanpur (1.7)	93	.9379	38810	54080	73590	78281
Kathmandu (1.8)	9076	.4000	35940	90740	128937	136211
Lalitpur (1.8)	2583	.4000	16700	34820	47580	50262
Bhaktapur (1.8)	4089	.4000	14130	34830	46417	49038

Contd.....

Contd..... Appendix Table 9

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Region 1.1 (4 dists.)	3317	.8436	343840	588530	787448	828151
Region 1.2 (4 dists.)	4152	.8911	301080	434520	549738	580450
Region 1.3 (3 dists.)	5871	.7590	213500	316450	417229	437955
Region 1.4 (1 dist.)	2323	.8074	67180	122190	165781	175129
Region 1.5 (3 dists.)	4744	.5941	245440	372140	500702	525445
Region 1.6 (3 dists.)	1133	.8820	151760	261900	340773	357208
Region 1.7 (2 dists.)	527	.8944	108420	163650	217280	229994
Region 1.8 (3 dists.)	15748	.4000	66770	160390	222934	235511
Region 2.1 (6 dists.)	664	.7233	122170	195070	233157	237764
Region 2.2 (4 dists.)	1182	.8423	91740	168030	204427	213254
Region 2.3 (5 dists.)	1161	.8226	108430	170460	204943	208710
Region 3.1 (3 dists.)	1143	.7202	43160	64810	77292	77292
Region 3.2 (2 dists.)	958	.8625	36300	61490	69635	69635
Region 3.3 (3 dists.)	1243	.8916	62630	102320	113055	113055
Region 3.4 (2 dists.)	94	.9398	29510	49380	56395	57994
Region 3.5 (4 dists.)	202	.8324	61740	103700	118101	120506
Region 3.6 (3 dists.)	203	.9202	38880	56320	61158	61158
Region 4.1 (5 dists.)	323	.6937	44030	74490	83525	83525
Region 4.2 (15 dists.)	302	.8409	85310	120290	137060	138144
Tarai (20 districts)	22067	.7758	1431220	2259380	2978956	3134332
Hills and Mountains (55 dists.)	23223	.5343	790670	1326750	1581682	1616548
Nepal (75 districts)	45290	.6520	2221890	3586130	4560633	4750880

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Appendix

Table 10 Fertiliser use and the fertiliser input requirement norms for cereals in 1977-78 and 1989-90 (Alts. I and II)

district/ crop region	1977-78	1989-90		1977-78	1989-90	
	F_c in tonnes	F_c^* (Alt.I) in tonnes	F_c^{**} (Alt.II) in tonnes	f_c	f_c^* (Alt.I)	f_c^{**} (Alt.II)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Jhapa (1.)	706	6550	7812	7.2	67.2	80.1
Morang (1.1)	1142	6442	7689	11.0	62.1	74.2
Sunsari (1.1)	450	5127	5618	7.6	86.4	94.6
Saptari (1.1)	500	3347	4167	6.0	40.2	50.0
Siraha (1.2)	596	3121	3916	7.1	37.4	46.9
Dhanusha (1.2)	821	5186	6067	10.6	67.2	77.6
Mohattari (1.2)	1459	3889	4625	16.4	43.7	52.0
Sarlahi (1.2)	824	2317	2786	16.0	45.1	54.2
Rautahat (1.3)	738	3454	4196	8.4	39.4	47.8
Bara (1.3)	2263	5084	5855	32.1	72.0	83.0
Parsa (1.3)	1455	5375	5807	26.4	97.4	105.2
Chitwan (1.4)	1876	5966	6844	27.9	88.8	101.9
Navalparasi (1.5)	720	5202	5659	12.6	91.0	99.0
Rupandehi (1.5)	1223	5084	6013	12.7	52.7	62.4
Kapilvastu (1.5)	876	4598	5534	9.5	50.1	60.2
Dang-Deokhuki (1.6)	316	2597	3315	4.8	39.3	50.1
Banke (1.6)	352	2037	2493	7.6	44.1	54.0
Bardia (1.6)	331	3768	4136	8.4	95.6	104.9
Kailali (1.7)	384	3586	4339	5.5	51.5	62.3
Kanchanpur (1.7)	87	1918	2358	2.2	49.4	60.8
Kathmandu (1.8)	3631	8277	8960	101.0	230.3	249.3
Lalitpur (1.8)	1033	2533	2785	61.9	151.7	166.8
Bhaktapur (1.8)	1636	3201	3447	115.8	226.6	243.9
Region 1.1(4 dists.)	2798	21466	25286	8.1	62.4	73.5
Region 1.2(4 dists)	3700	14513	17394	12.3	48.2	57.8

Contd.....

Contd..... Appendix Table 10

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Region 1.3 (3 dists.)	4456	13913	15858	20.9	65.2	74.3
Region 1.4 (1 dist.)	1876	5966	6844	27.9	88.8	101.9
Region 1.5 (3 dists.)	2819	14884	17206	11.5	60.6	70.1
Region 1.6 (3 dists.)	999	8402	9944	6.6	55.4	65.5
Region 1.7 (2 dists.)	471	5504	6697	4.3	50.8	61.8
Region 1.8 (3 dists.)	6300	14011	15192	94.3	209.8	227.5
Region 2.1 (6 dists.)	480	4055	4487	3.9	33.2	36.7
Region 2.2 (4 dists.)	996	4411	5240	10.9	48.1	57.1
Region 2.3 (5 dists.)	955	4191	4546	8.8	38.7	41.9
Region 3.1 (3 dists.)	823	1995	1995	19.1	46.2	46.2
Region 3.2 (2 dists.)	826	1591	1591	22.8	43.8	43.8
Region 3.3 (3 dists.)	1108	2116	2116	17.7	33.8	33.8
Region 3.4 (2 dists.)	88	747	897	3.0	25.3	30.4
Region 3.5 (4 dists.)	168	1520	1745	2.7	24.6	28.3
Region 3.6 (3 dists.)	187	641	641	4.8	16.5	16.5
Region 4.1 (5 dists.)	224	1072	1072	5.1	24.3	24.3
Region 4.2 (15 dists.)	254	1828	1929	3.0	21.4	22.6
Tarai (20 districts)	17119	84648	99229	11.6	59.1	69.3
Hills and Mountains (55 dists.)	12409	38178	41381	16.3	48.3	52.3
Nepal (75 districts)	29528	122826	140680	13.3	55.3	63.3

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Appendix

Table 11: Regional indices for districts having manufacturing activities

Districts	I	class symbol	M	class symbol	T	class symbol	S	class symbol
1. Kathmandu	3.0269	vh	2.6679	vh	2.2025	vh	2.3914	vh
2. Morang	2.7071	vh	2.9039	vh	3.5764	vh	2.2004	vh
3. Lalitpur	2.4808	vh	2.0207	vh	2.2563	vh	0.9965	m
4. Bhaktapur	2.1360	vh	1.6113	vh	1.2392	h	1.0568	m
5. Parsa	1.9035	vh	2.6774	vh	2.9745	vh	1.8110	vh
6. Dhanusha	1.8391	vh	2.4287	vh	1.5158	h	2.4768	vh
7. Jhapa	1.7003	vh	2.1184	vh	1.3158	h	2.3901	vh
8. Rupandehi	1.5637	h	1.9442	vh	1.4916	h	1.9107	vh
9. Mahottari	1.5624	h	1.2389	h	1.0500	m	1.4949	h
10. Banke	1.5153	h	1.6692	vh	1.0774	m	1.6038	vh
11. Saptari	1.3233	h	1.5994	h	1.1882	m	2.2526	vh
12. Sunsari	1.3129	h	1.3467	h	1.4463	h	1.1176	m
13. Sarlahi	1.2785	h	1.8699	vh	1.1041	m	2.5907	vh
14. Rautahat	1.1578	m	1.5341	h	1.3156	h	2.2348	vh
15. Dangdeukhuri	1.1498	m	0.7304	l	0.6199	l	0.8034	m
16. Siraha	1.1415	m	1.2515	h	1.2475	h	1.2934	h
17. Kaski	1.0625	m	0.9955	m	0.7211	l	0.9644	m
18. Chitawan	1.0381	m	1.3088	h	1.0373	m	1.4410	h
19. Makawanpur	1.0033	m	1.1652	m	1.0608	m	0.7700	l
20. Bara	0.9694	m	1.2361	h	1.0927	m	1.3001	h
21. Kanchanpur	0.8934	m	1.4332	h	0.8972	m	1.1917	m
22. Kapilvastu	0.8606	m	0.8986	m	0.8089	m	0.8232	m
23. Bardia	0.8431	m	0.9021	m	0.6259	l	0.7596	l
24. Kailali	0.8164	m	1.0632	m	0.8972	m	1.1917	m
25. Nawal Parasi	0.7910	l	0.7911	l	0.7840	l	0.6949	l
26. Kavrepalamchowk	0.7428	l	0.6326	l	0.5448	l	0.7911	l
27. Gulmi	0.7345	l	0.3718	vl	0.3565	vl	0.8632	m
28. Sindhupalchowk	0.6896	l	0.3994	vl	0.2876	vl	0.8307	m
29. Tanehu	0.6520	l	0.7398	l	0.6935	l	0.7695	l
30. Syamja	0.6454	l	0.1179	vl	0.2509	vl	0.0906	vl
31. Palpa	0.6144	l	0.3381	vl	0.3904	vl	0.2934	vl
32. Nuwakot	0.6062	l	0.2401	vl	0.2477	vl	0.2703	vl
33. Dhenkuta	0.5938	l	0.3874	vl	0.4514	l	0.3470	vl
34. Ilam	0.5299	l	0.3219	vl	0.6069	l	0.1052	vl
35. Solakhumbu	0.4466	l	0.1786	vl	0.1510	vl	0.1012	vl
36. Udayapur	0.4441	l	0.3094	vl	0.2547	vl	0.3858	vl
37. Sindhuli	0.3183	vl	0.1258	vl	0.2032	vl	0.0882	vl
38. Dolakha	0.3020	vl	0.1318	vl	0.0944	vl	0.1070	vl

Table 12: Index of over all industrialization, tertiary and allied activities, urbanisation, tertiary, transportation infrastructure and literacy rates

Zone/Dists.	I	U	I_t	I_u	I_r	I_l
Zone I						
1.	0.2653	0.54777	0.32776	0.73688	0.51664	0.90728
2.	0.3272	0.55215	0.40184	0.68868	0.51295	1.02566
3.	0.5299	0.89498	0.76630	0.98879	0.91791	1.19412
4.	0.4444	0.54332	0.37104	0.77887	0.30487	0.86360
5.	0.2892	0.57123	0.41072	0.72199	0.51721	1.31753
6.	0.5008	0.49549	0.50552	0.51041	0.43929	0.93796
7.	0.5938	0.96074	0.80672	1.25451	0.54393	1.23070
8.	1.7003	2.26069	1.91235	1.80241	4.06608	1.56536
9.	2.7071	2.43707	2.48723	2.08906	3.19046	1.49672
10.	1.3129	2.35989	2.19148	1.79930	4.06257	1.53138
11.	1.3233	1.56093	1.71835	0.92947	2.79765	1.32332
Zone II						
1.	0.3020	0.50260	0.31016	0.68246	0.44002	0.75564
2.	0.4466	0.39894	0.29117	0.53141	0.28622	0.78171
3.	0.2636	0.55439	0.47036	0.68147	0.40824	0.98905
4.	0.3193	0.67693	0.61652	0.83262	0.41439	0.89054
5.	0.2457	0.52423	0.45230	0.68823	0.26395	0.83133
6.	0.3183	0.48906	0.37385	0.61585	0.40481	0.73151
7.	0.4441	0.57625	0.42783	0.69205	0.58407	0.73151
8.	1.1415	1.62635	1.35305	0.89393	3.95550	1.17188
9.	1.8391	1.89127	1.97794	1.18986	3.43803	1.16327
10.	1.2785	1.33219	1.30835	1.00008	2.19190	0.80479
11.	1.5624	1.25519	1.28062	0.94915	1.95439	1.10410
Zone III						
1.	0.4522	0.48356	0.55629	0.46179	0.39413	0.40946
2.	0.6896	0.71722	0.59740	0.61226	1.20929	0.64868
3.	0.336	0.49540	0.30262	0.64463	0.50847	0.45746
4.	0.6062	0.94638	0.77849	0.97129	1.21488	0.72931
5.	0.2457	0.52423	0.45230	0.68823	0.26395	0.83133
6.	3.0269	8.38613	8.40533	6.37573	13.26940	3.51822
7.	2.4808	4.59576	4.49569	4.34038	5.41723	2.23160
8.	1.1360	7.09891	5.46888	5.10336	15.18251	2.62833
9.	1.0033	1.00978	0.81661	1.04427	1.30447	0.85049
10.	0.9694	1.29313	1.30471	0.82959	2.40503	1.02115
11.	1.9035	1.86282	2.10225	1.55958	1.52287	1.36988
12.	1.1578	1.01828	1.20074	0.75269	1.31029	0.90848
13.	1.0381	1.22875	1.12139	1.19466	1.52287	1.36988

Contd. ... able No.12

FD Zone/Dists.	I	U	I_t	I_u	I_r	I_1
Zone IV						
1.	0.5850	0.58167	0.67960	0.54627	0.47611	0.67780
2.	0.3349	0.46473	0.50694	0.41353	0.50720	0.27882
3.	0.2849	0.53672	0.26367	0.71590	0.63400	0.82297
4.	0.5904	0.44200	0.53190	0.43699	0.27785	1.01271
5.	0.4529	0.41520	0.44393	0.45559	0.25997	1.25408
6.	1.0625	1.77102	1.48396	2.00227	1.76836	1.74878
7.	0.3781	0.33671	0.34328	0.40705	0.15165	1.22925
8.	0.3376	0.47141	0.49756	0.42244	0.46651	0.84978
9.	0.7345	0.52620	0.58545	0.56655	0.31115	1.36718
10.	0.6144	0.77953	0.71939	0.81918	0.80052	1.46815
11.	0.6454	0.84391	0.81432	0.69769	1.25987	1.51434
12.	0.6520	0.79797	0.50982	0.87535	1.17406	1.29806
13.	0.7910	1.20265	0.91073	0.67545	3.06603	1.18059
14.	1.5637	2.05075	1.71677	1.91827	3.03046	1.39075
Zone V						
1.	0.6512	0.44096	0.59960	0.25088	0.42571	0.51989
2.	0.5788	0.36442	0.30056	0.44734	0.28678	0.56664
3.	0.7940	0.48324	0.41610	0.59264	0.34724	0.71647
4.	0.6237	0.58387	0.55073	0.65779	0.46795	0.98990
5.	0.4295	0.43688	0.36148	0.50168	0.42623	1.09120
6.	1.1498	1.02924	0.81673	1.02024	1.46835	0.73083
7.	0.8606	1.19435	1.14609	0.80113	2.25158	0.97546
Zone VI						
1	0.3647	0.38129	0.32014	0.43059	0.38062	0.46194
2.	0.1511	0.28219	0.12707	0.37941	0.34863	0.51450
3.	0.2462	0.29073	0.13354	0.32356	0.51885	0.31472
4.	0.3590	0.37478	0.31309	0.43165	0.35663	0.28523
5.	0.3830	0.44614	0.42457	0.46405	0.44466	0.42018
6.	0.3280	0.41979	0.21286	0.60303	0.37740	0.38502
7.	0.3152	0.32805	0.23951	0.31364	0.53710	0.69325
8.	0.4160	0.57866	0.34981	0.79533	0.49744	0.67271
9.	0.8431	0.80214	0.53562	0.85664	1.19179	0.43761
10.	1.5153	2.02747	2.28108	1.71778	2.28777	0.88483
Zone VII						
1.	0.6108	0.46368	0.47342	0.49984	0.35605	0.95441
2.	0.4720	0.26486	0.15454	0.26816	0.47328	0.63425
3.	0.2461	0.31251	0.11865	0.47171	0.30330	0.32426
4.	0.5320	0.49512	0.53289	0.45819	0.51144	1.01044
5.	0.2289	0.34445	0.37645	0.32203	0.33654	0.55307
6.	0.2833	0.45370	0.20334	0.59770	0.59258	0.55076
7.	0.7655	0.47283	0.43978	0.35865	0.81717	0.97528
8.	0.8934	1.49399	0.64561	1.87289	2.23155	0.76528
9.	0.8184	0.96603	0.50475	0.83012	2.20398	0.50840

Appendix

Table 13: Composite index of non-agricultural activities, over all development activities, economically active population in 1977-78 and estimated labour increment over 1977-78 to 1989-90

FD Zone/Dists.	N		L_{78}	L	m^{*12}	e^{12}
Zone I						
1.	0.54099	0.62839	45766	3211	1.07016	0.92271
2.	0.56867	0.46843	78393	5936	1.07572	0.98724
3.	0.77152	0.78081	64529	20753	1.32161	1.11839
4.	0.61435	0.62915	55004	2699	1.04907	0.89916
5.	0.56012	0.82377	45026	5517	1.12253	0.91155
6.	0.61873	0.64700	81834	14464	1.17675	0.94402
7.	0.81814	0.83506	53650	11912	1.22203	0.99070
8.	1.58607	2.18918	97042	95363	1.98270	1.49391
9.	2.04170	3.02623	116138	103636	1.89235	1.42495
10.	1.44255	1.92145	89567	53423	1.59646	1.16814
11.	1.28037	1.36534	114610	34476	1.30081	1.02223
Zone II						
1.	0.53829	0.34000	74733	10575	1.14150	0.96696
2.	0.55403	0.46466	53420	5307	1.09934	0.95579
3.	0.54287	0.47018	59332	11826	1.19932	0.96432
4.	0.61162	0.51868	67487	12679	1.18787	0.96561
5.	0.52344	0.36021	92267	15955	1.17292	0.88331
6.	0.53954	0.64928	73701	25793	1.34997	1.01889
7.	0.62701	0.98888	55302	14197	1.25672	1.02113
8.	1.21918	1.01960	144802	99291	1.68570	1.25639
9.	1.56976	1.54357	123057	50844	1.41317	1.01164
10.	1.20633	1.51850	71831	42537	1.59218	1.22728
11.	1.30573	1.31229	117985	38383	1.32532	1.00147
Zone III						
1.	0.59340	0.91370	12044	2640	1.21920	1.00000
2.	0.78093	0.49807	115905	20499	1.17686	0.97935
3.	0.54858	0.30642	145400	24310	1.16720	0.88038
4.	0.81907	0.55061	93709	23775	1.25371	0.95046
5.	0.83321	0.45403	144530	53464	1.36992	1.01720
6.	2.95083	5.89444	130373	36325	1.27862	0.95308
7.	2.28511	3.58170	67093	17985	1.26806	0.94082
8.	2.44279	3.76257	47691	26537	1.55644	1.17732
9.	1.00422	1.05487	85234	43776	1.51359	1.14855
10.	1.06681	1.53770	91043	41429	1.45505	1.09449
11.	1.59074	1.87330	77690	39666	1.51057	1.10064
12.	1.07146	1.18610	131064	58399	1.44558	1.05361
13.	1.07897	1.87330	78026	42144	1.54013	1.02264

Contd. .....

Contd. ..... Table No.13

FD Zone/Dists.	N		L_{78}	L	m^{*12}	e^{12}
Zone IV						
1.	0.68816	0.94664	14321	2525	1.17631	1.00000
2.	0.53627	0.52532	3597	352	1.09786	1.00000
3.	0.54486	0.63612	35614	9988	1.28045	0.99254
4.	0.63362	0.43180	97288	27198	1.27956	0.99488
5.	0.56407	0.30824	73939	20751	1.28065	0.99207
6.	1.21828	1.46820	73351	30415	1.41465	1.10781
7.	0.49549	0.50670	69857	20873	1.29880	1.02503
8.	0.54024	0.45903	88442	26923	1.30441	1.02229
9.	0.72921	0.42040	131522	28558	1.21713	0.94892
10.	0.77031	0.48735	115894	32161	1.27750	0.99822
11.	0.80406	0.48628	145588	37538	1.25784	0.99468
12.	0.79210	0.58330	89137	24610	1.27609	0.94803
13.	0.96847	1.45082	65139	55041	1.84498	1.32563
14.	1.48726	1.98883	103109	70446	1.68322	1.20269
Zone V						
1.	0.65866	0.49854	45781	11853	1.25891	0.96091
2.	0.59324	0.27689	91747	23544	1.25662	0.96676
3.	0.73661	0.81271	70812	21592	1.30466	1.00009
4.	0.70523	0.66063	59726	13139	1.21999	0.93755
5.	0.56390	0.42685	79141	19570	1.24727	0.96969
6.	1.07125	1.61339	84679	49277	1.58193	1.01242
7.	0.99546	1.39913	105491	44430	1.42117	1.02521
Zone VI						
1.	0.51148	0.30449	69071+	14324+	1.20737+	1.01724
2.	0.37181	0.68674	17116	2867	1.16750	0.97990
3.	0.41632	0.77500	17372	2917	1.16791	0.97919
4.	0.50601	0.60575	8163	1918	1.23496	1.01172
5.	0.54844	0.69466	-	-	-	-
6.	0.51375	0.69153	43970	9074	1.20638	0.92077
7.	0.46475	0.53389	60147	11494	1.19110	0.90867
8.	0.61231	0.97732	36647	25079	1.68434	1.27245
9.	0.87360	2.16586	46506	55662	2.19688	1.30512
10.	1.46223	2.42463	56259	43613	1.77522	1.13767
Zone VII						
1.	0.65153	0.58095	35640	9100	1.25533	1.05079
2.	0.49676	0.40481	65723	10976	1.16700	0.99308
3.	0.42780	0.62777	36741	9791	1.26649	1.02948
4.	0.63166	0.40499	71496	21366	1.29884	0.99317
5.	0.43677	0.47858	77000	18381	1.23871	0.96963
6.	0.50991	0.40925	66879	15602	1.23329	0.98392
7.	0.72028	0.60220	44906	13276	1.29564	1.00139
8.	1.08436	1.74383	31871	53637	2.68294	1.68755
9.	0.91390	1.84187	60710	65385	2.07701	1.40752

\+ Jumla and Tibrikot together

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