Some Geographical Indicators Of Regional Well-Being Agricultural Development In Jordan

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Abstract

Regional disparity in levels of regional development is of major concern for regional planners. Since the levels of regional development cannot be measured directly, one must select suitable indicators. A development indicator should represent some aspects of development such as agriculture, urbanization, etc. It may be of direct measure of some non-measurable phenomena, viz, standard of living.

Research effort in agriculture activities in Jordan has so far paid little attention to the geographic analysis of physio- economic indicators such as crop- combination regions, agricultural productivity and its spatial variation in the light of its importance in the social well-being.

In order to probe into the dynamics of agriculture in regional development, a number of variables viz. Value of agricultural production, amount of rainfall, irrigated area and area under different uses are hypothesized to explain the areal differentiation in the levels of agricultural development.

The explanatory model built up in this paper has been tested with a stepwise minimum deviation methods introduced by "Weaver" 1945, and simple linear regression analysis. The research effort has been mainly directed to areas such as indices of regional development and the effeciency patterns in the agricultural productivity, however continues to be the exclusive field of the economist.

Introduction

Even though the primary concern of the regional planners are the identification of the regional inequality, regional study of the levels of regional well-being has remained grossly ignored (Miller, E. 1976, 16-32). The social planners could not realise that social inequality is crucial not only to the study of human geography of Jordan but also to the improvement of social conditions within the Jordanian society as a whole.

Among the non-physical factors, the size and quality of population comes out as the strongest stimulant to the well-being in Jordan. The hypothesis that socio-economic well-being exhibits close relation with Urbanization and industrialization is conclusively proved (Friedmann, J. 1959, 16-180).

The study of causal relationships, a dependent variable and one or more independent variables, becomes more useful when the relationship is defined in terms of mathematical form (Gregory, S. 1969, 13-25). These mathematical forms of the relationships are used in making prediction and also help us in assessing the relative influence of each of the independent variables on the dependent variable (Murray, R. 1961, 241-282). In this paper we will be discussing first how such a mathematical equation is worked out from a given set of bivariate data. Secondly, the type of functional form of linear relationship between different variables.

Methodology

There are two main approaches to study of the levels of regional development; the functional approach (Hance, W. 1954, 253-270) in which only a single component of the levels of regional development is examined to provide answers to some such specific questions as the planners may like to ask in respect of some specific socio- economic issues, and secondly the integrated approach (Friedmann, S. 1964, 36-84) in which a general view of the situation is measured with the help of a number of socio- economic variables to provide a more comprehensives view for the measurement of regional planning. (Hirschman, A. 1958, 8-17).

Since the purpose is to bring out a general state of levels of regional development, the employment of the second approach has been preferred. Since the principal objective is the identification of degree of departures from the equality or equity. With this objective in view, the levels of regional development has been evaluated in terms of the deviation from the average for the whole country.

Development Reflections

Demographic indicator in regional development is the main stream where regional planners have to take care and to be aware in all socio- economic analysis.

According to the latest census of 1979, (Department of Statistics, 1984, 23-25) the population living in Jordan numbered 2.7 million, which is more than thrice of that of 1961. Thus, the major events since independence have had Considerable effects on the demography of Jordan. In the meantime, rapid economic and social changes since then have had the effect of reducing death rates, while birth rates have maintained their high level. The rates of natural increase is estimated at present around 35 per thousand population which is considered to be one of the highest in the world.

In terms of education, Jordan has experienced a rapid expension and progress in educational attainment (Attending school 6-22 age group 72.3%). (Department of Statistics, 1984, pp 25). Consequently, the economically active population has increased from 211370 in 1961 to about 446316 in 1979. The observation is that there is an increase in female participation from 3.1% in 1961 to about 6.70% in 1979. (Department of Statistics, 1984, pp 47). As such, about 22.2% of males and 93% of females are economically inactive. (Department of Statistics, 1984, pp 48).

The housing conditions are far better in Urban than in rural areas in terms of water supply, electricity and sewage system. In general, housing conditions in Jordan are far better than those in most developing countries; about 70% of housing units have piped water, 72% have public electricity, 94% have either public sewage or private septic latrine, 66% own their own housing units, 94% have either central or kerosene heating. (Department of Statistics, 1984). All these can be considered as ceiling for determining the level of economics development or social well being. The justification for selection of particular indicators and a particular process of selection will depend, however, on the purpose for which they are to be selected. Thus the selection of indicators requires subjective judgement on the part of the planners. (United Nations, 1966).

Agro-Economic Well-Being In Regional Development

Though overdependence on agriculture and related persuits indicates backwardness of the economy, there is need to study the relative development of agriculture for measuring the economic condition of the people engaged in cultivation. The level of the development in this case can best be reflected in agricultural efficiency. Thus, it is reflected in the total production from a particular unit area and in per area yield. However, the gross value of agricultural output per agricultural workers would be the best indicator of agricultural development. It accounts for total production as well as their market value. Unless the farmers receive higher price for their produce cultivation will not bring prosperity to them. A slight deviation of this indicator is the gross value of agricultural output per hectare of net area sown. In their absence, the following indirect indicators can be studied:-

1. Cultivable area per agricultural worker;
2. Net area sown per agricultural worker;
3. Area sown more than once as percentage net sown arca;
4. Percentage of gross irrigated area to gross sown area; and
5. Wage rates of agricultural workers.

The first indicator will throw light on the availability of land to workers, which is the basic requirement in agriculture. However, availability of more land would not bring economic prosperity unless appropriate modern agricultural practices are followed. (United States Department of Agriculture, 1974, 26-43).

The second is also a good indicator of agricultural development, because all the cultivable area indicates the fertility of the soil. So net area sown per agricultural worker is a refinement of the first indicator, i.e. cultivable area per agricultural worker.

Intensity of cropping is yet another good indicator of agricultural prosperity. Other things being equal, the more number of crops raised in a year from a piece of land the higher is the level of agricultural development. The percentage of area sown more than once to net area sown is, therefore, an important economic indicator. It is a composite end expression of effort in three directions: area, yield and cropping pattern and an urge for cash crops.

Irrigation is an important input of agriculture. It is also an indirect measure of total inputs that go with irrigation, viz., better techniques, manures, fertilisers, high yielding varieties of seeds, pesticides and a higher level of farming activity and the urge for cash crops. Therefore, the percentage of gross irrigated area to gross area sown is a good economic indicator.

Gross Irrigated Area

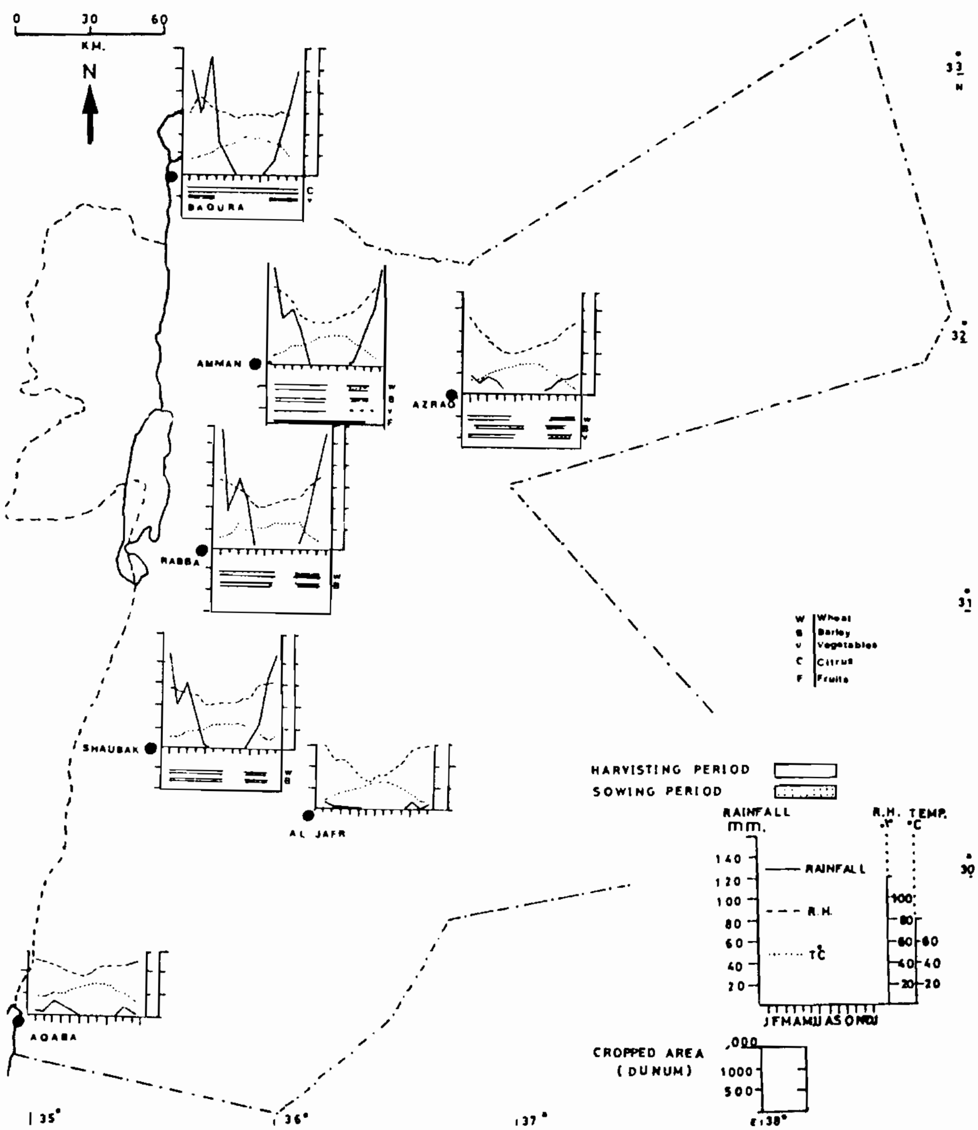
Water is one of the most important inputs essential for the production of crops. Both its shortage and excess affect the growth and development of a plant directly and, consequently its yield and quality.

Cropping pattern throughout Jordan is determined by two factors, the incidence of rainfall and the extent of irrigation. Irrigation is one of the most important factors for assured crop production. It permits better utilization of all other production factors and thus leads not only to increased yields per unit of land and time, but also to stability in the economic condition of the agricultural land. Since there is a great deal of variation in rainfall, there appears a mosaic of cropping pattern. Based upon the maturity period for the main crops, two types of crops are recognised; long duration crops with maturity period of 6-8 months, include all cereal crops and tobacco, and short-duration crops with a maturity period of 4 months includes all pulses. Long-duration crops need relatively cool climate during the growth period and warm climate during maturity (Fig. 1).

Most of the irrigated lands are situated in areas with a mean annual rainfall varying from 150-350 mm, monthly effective rainfall is balanced against the monthly evapotranspiration of a particular crop (Thornthwaite, C.W. 1953, 112-135).

FIGURE : 1

AGRO — CLIMATIC POTENTIAL



(Based On Ergograph Method)

In a dry year, there is hardly any rainfall in the desert regions as well as in the southern Ghors and southern parts of the valley. In a normal year, rainfall varies between 50-100 mm of which most was considered effective. However, this effective rainfall is almost negligible compared with the large consumptive water requirement in these regions. (Lioyd, J. 1969).

The northern highlands with significant irrigated agriculture is affected by strong local variation of annual rainfall. The annual mean values range from 250-300 mm at Amman/ Zarqa to 600 mm at Ajlun. In this region the storage of the effective rainfall as soil moisture was supposed to be important. (Water Resources Division, 1972).

The southern highlands, southern mountains and northern Jordan valley have rainfall characteristics similar to the northern highland. In various areas such as Zarqa, Ajlun and the southern Ghors, it appeared that 25- 30% of the area used for the irrigated vegetable was kept fallow, either because of water shortage or to facilitate a second crop in winter or summer. (Barber, W. 1975).

Rainfall is one of the most important inputs in an assured crop production in all such areas of the country where crop production suffers due to scarcity and/ or irrigularity distribution of rainfall. Any drop in the rainfall amount leads to reduction in crop yields and production. In other words, the availability of water in the right quantity and at the right time is essential for good plant growth and yield (Carter, D.B. 1966, 305-395). Both the amount of water as well as the time may differ in different crop plant. Thus what may be true for one crop may not necessarily be so for other crop. When we talk of the amount of water, our concern is both the shortage as well as the excess. However more often we come across situations when water supply is short of the need in Jordan. (Thornthwaite, C.W. 1954, 1-10) it is only during the rainy season that there may be excess water. A general picture is that reduction in rainfall amount leads to reduction and finally stopping of the synthetic process. On the other hand, the degradative processes become relatively more active.

Accordingly, the area under cereal crops have been controlled by the amount of rainfall since these crops mostly rainfed crops (Table 1) (Department of Statistics, 1985, 87-92). In Wheat and Barley, deficiency of water is known to reduce tillering and the fertility of spikes. When these crops were grown under normal water-stressed conditions, there was reduction of yield to varying degrees. In the north, we had the maximum stability in yield and production. Barley also showed greater stability in yield and production where the water stressed conditions increased. It is apparent that the productivity of these crops is higher in the areas of more than 250 mm of rainfall.

The relationship of growth of olives and grapes with time is normally sigmoid in nature. The initial growth rate is slow but once a few leaves have emerged they start photosynthesizing and contributing to the development of more leaves and branches. Accordingly, the evapotranspiration demand increases. The root goes deeper and draws moisture from the lower regions. Depending upon the time when

Table (I) Cropping Pattern In Jordan

Crops	Net Sown Area Dunum	%	As % of Net Sown Area	Irrigated Area Dunum	Irrigated Net Sown Area	Area as % of: Total Irrigated Area
Cereals	1710720	100	65.3	58117	2.2	12.7
Wheat	1060710	62				
Barley	448165.4	26.2				
Others	201845.5	11.8				
Vegetables	426339	100	16.3	323814.7	12.4	70.6
Tomato	139462	33				
Eggplant	38629	9				
Others	248248	58				
Fruit trees	414676.5	100	15.8	76702.5	2.9	16.7
Cetrus	31716	7.6				
Olives	242177	58.4				
Grapes	102225	24.6				
Others	38558.5	9.4				
Tobacco	67032.5	2.6				
Net Sown Area	**2618768**		**100**	**458634.2**	**17.5**	**100**

rainfall is in short supply, the crop may enter the state in which cell division and cell growth would be either suspended or inhabited. Consequently, the productivity and yield of these crops will be affected. As a result, Olives and Grapes plantation areas mainly concentrated in mountanous regions which receive at least 250 mm of annual rainfall.

The development of water resources for irrigated agriculture, as a basic component of Jordan's economy, is given a high rating. Present irrigation schemes-both public and private-are scattered throughout the country and cover total areas of about 336.00 dunums (Natur, E. 1969). The average annual water used in the order of 405 MCM. Most of this volume (230 MCM) is taken from river flows, 100 MCM are spring flow diversions.

In Jordan, the major problem was the determination of the cropping intensities in the irrigation areas (Abu Khalid, A. 1974). Generally the crop rotation includes a fallow period of one or more growing seasons; thus, only a certain percentage of the area is cultivated. In vegetable areas each year about 25-30% is kept fallow. It depends on the availability of irrigable land and may last for two or even three seasons. In the vegetable wheat rotation, the wheat crop is sometimes left out for one year.

Information about cropping intensities was scarce, mostly they are based on information for a limited area. The determination of the cropping intensity was difficult mainly in the areas under vegetables. Tree crops are perennial (100% intensity), while areas under field crops were assumed to be fallow in summer and have a 100% cropping intensity during winter. Considering that in vegetable- areas about 25-30% of the land is kept fallow, the maximum vegetable cropping intensity either in summer or winter could be in the order of 75%.

Occasionally, double cropped areas have occurred when trees were still young and non-baring frequently vegetables are planted in between. Whenever this was known, 50% of the area have been allocated to vegetables and 50% to trees and the total area may have been counted once for vegetables and once for trees. Land under vegetables wheat rotation actually appears twice in the computations, once under the area of field crops, and again as under vegetables, but here with a cropping intensity of 75% in summer only.

Gross Sown Area

Any process of development has an inherited property of pushing the economic system from simpler to more complex. This complexity as manifested by diversification of places in terms of their economic activities can be measured by the different combination based on subjective judgements like wheat zone, fruit zone, ... etc. have not statistical basis. All the places, in fact, have multiple functions, but all of them may not be equally important. Some of them may be very significant while others might be quite inconsequential. A statistical basis is therefore necessary for identifying the group of significant functions, which represent the functional personality of an area.

However, in agricultural studies where in some cases only the nature of cropping pattern of an area is studied, one need not to relate it with cropping pattern of other areas (Ministry of Agriculture, 1974).

A simple and convenient method of finding out the combination of crops having significant share in the total cropped area has been suggested by Weaver (Weaver, J. 1954, 174-200). He compared the actual percentage area under each crop with hypothetical percentage. This theoretical percentage share of a crop is different in different hypothetical situations, for example in a hypothetical mono culture area. The theoretical percentage share of a crop is 100 percent. For a two crop combination region it is 50 percent for each crop. For a three-crop combination it is 33 1/3 percent for each and so on. The actual percentage of the area under different crops in a region is compared with these different theoretical percentages. It starts from the assumptions of one- crop combination, then two-crop combination, three crop combination and so on. Each time we work out an index 6_2 as given below. The minimum of 6_2 gives the bestfit (Morgan W.B., 1971, 104-125).

$$6^2 = \frac{(xi - \bar{x})\,2}{N}$$

where: $\bar{X}$ is the theoretical percentage.

Xi is actual percentage N.

N is the number of crops we include in the test.

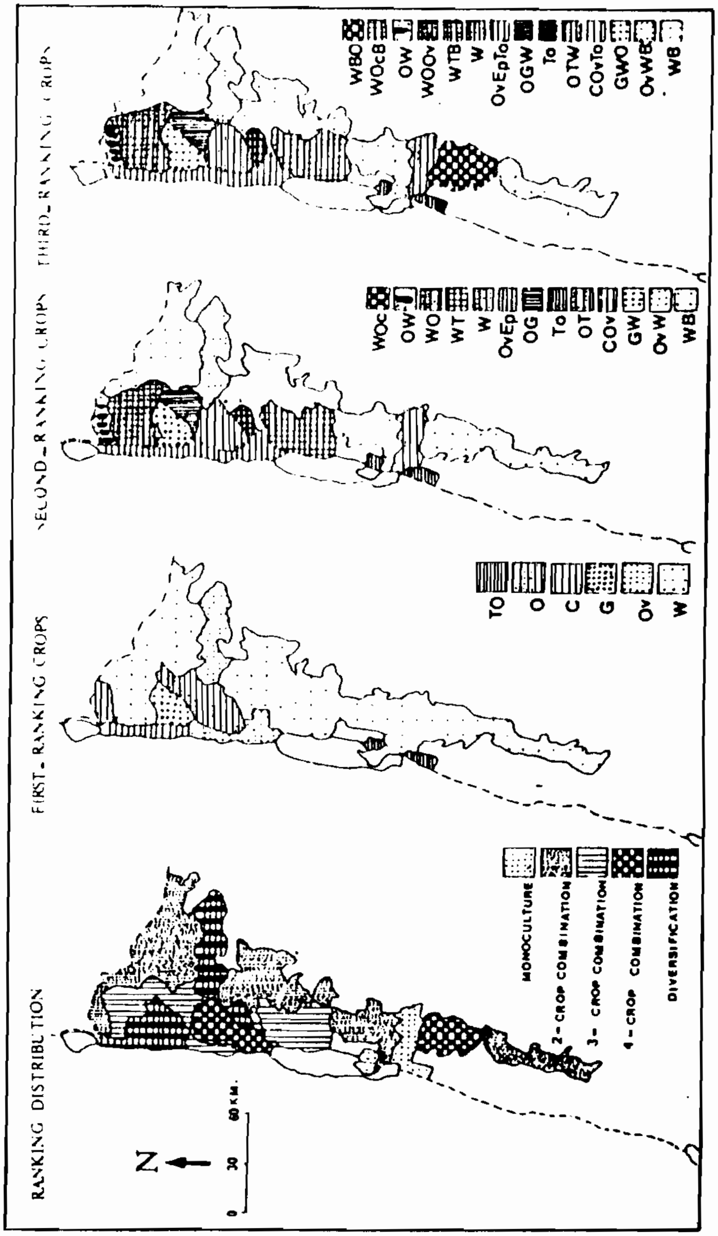
The cropping zones must take into consideration the combinational analysis and the relative position of the crops which can explain the impact of water resources availability on the crops hierarchy and the economy of the region.

The statistical approach applied in the delineation of crops regions brings to light the important crops which inter the crops association. It has been ascertained that according to minimum deviation methods, five crop combination regions may be recognized, (Fig. 2).

Wheat area estimated at 1060710 Dunums or 62% of the total cereal area. Olive is the second in rank in the crop combination regions of Jordan, occupied about 242177 Dunums or 58.4% of the total fruit area. The area occupied by citrus trees estimated about 31716 Dunums or 7.6% of the total fruit area. Among vegetables, Eggplant and Tomato are the main two crops intered the crop association. All these crops count 58% of the total cropped area.

FIGURE : 2

INDEX OF COMBINATION



(Based On Minimum Diviation Method)

Wheat:W, Barley:B, OtherCereals:Oc, Tomato:To, Eggplant:Ep,

Olive:O, Grape:G, Tobacco:T, OtherVeg.: Ov, Citrus:C .

When the delineation of crop regions is based on the first two crops, 13 crop combination regions can be distinguished. It will be seen from the figures that the crop combination regions of Jordan become higher in number if the first three crops are taken into consideration and consequently will be still higher by taking the first four or five crops into account.

Weavers method, however, in case of one or two functions are predominantly significant, gives undue importance to the functions of very low significance. In many empirical problems, therefore, Weaver's method does not give intuitively correct results. The basic reason of this fallacy in Weaver's method is that:

— it ignores the signs of the deviations.

— for a higher number of crops or functions, the theoretical percentages go down and so the deviations caused by last values are under-estimated.

Regional Disparity In Agricultural Productivity

Water function in agricultural productivity may be defined as the quantity of water, regardless of its sources, required by a crop or diversified pattern of crops in a given period of time for its normal growth (Mas'ad, A.M. 1982, pp 189). Water is needed mainly to meet the demands of evapotranspiration and the metabolic activities of the crops, both together known as consumptive use.

Water requirement is, therefore, a demand and the supply would consist of contributions from any of the source of water, the major sources being the irrigation water, effective rainfall and soil profile contribution including that from shallow water table.

In order to explain the agricultural productivity of Jordan by the rainfall, the variables chosen are:

1. Value of agricultural production in kg/ dunum (Y).

2. Annual average rainfall of the districts in mm (X).

This conclusion may further be given as:

$$Y = a \quad bx$$

$$\text{where} \quad b = \frac{\sum x \quad Y - \dfrac{\sum x \sum Y}{n}}{\sum x^2 \quad - \dfrac{(\sum x)^2}{2}}$$

$$a = Y'' - bx''$$

The slope of this regression line (b) which is also known as regression coefficient, (Aslam, M. 1977, 89-103) shows the estimated average change in (Y) with respect to (X).

Thus from the regression equation we can say that the relationship between agriculture productivity and rainfall is such that a milimeter change in rainfall by and large cause an increase of X kg. in the agricultural productivity.

The result indicates towards the fact that a great deal of agricultural productivity in Jordan depends on rainfall.

When in a regression equation different values of X are put, we get the corresponding estimated values of Y These estimated values are the mean of a given values of X. For example, suppose in few districts the rainfall (X) is equal, it does not mean that their productivity (Y) will also be equal. Each such district will have different values of Y. The mean of all these different values of Y would be equal to the estimated values Y. Even if no two values of X are the same, Y maintains average position.

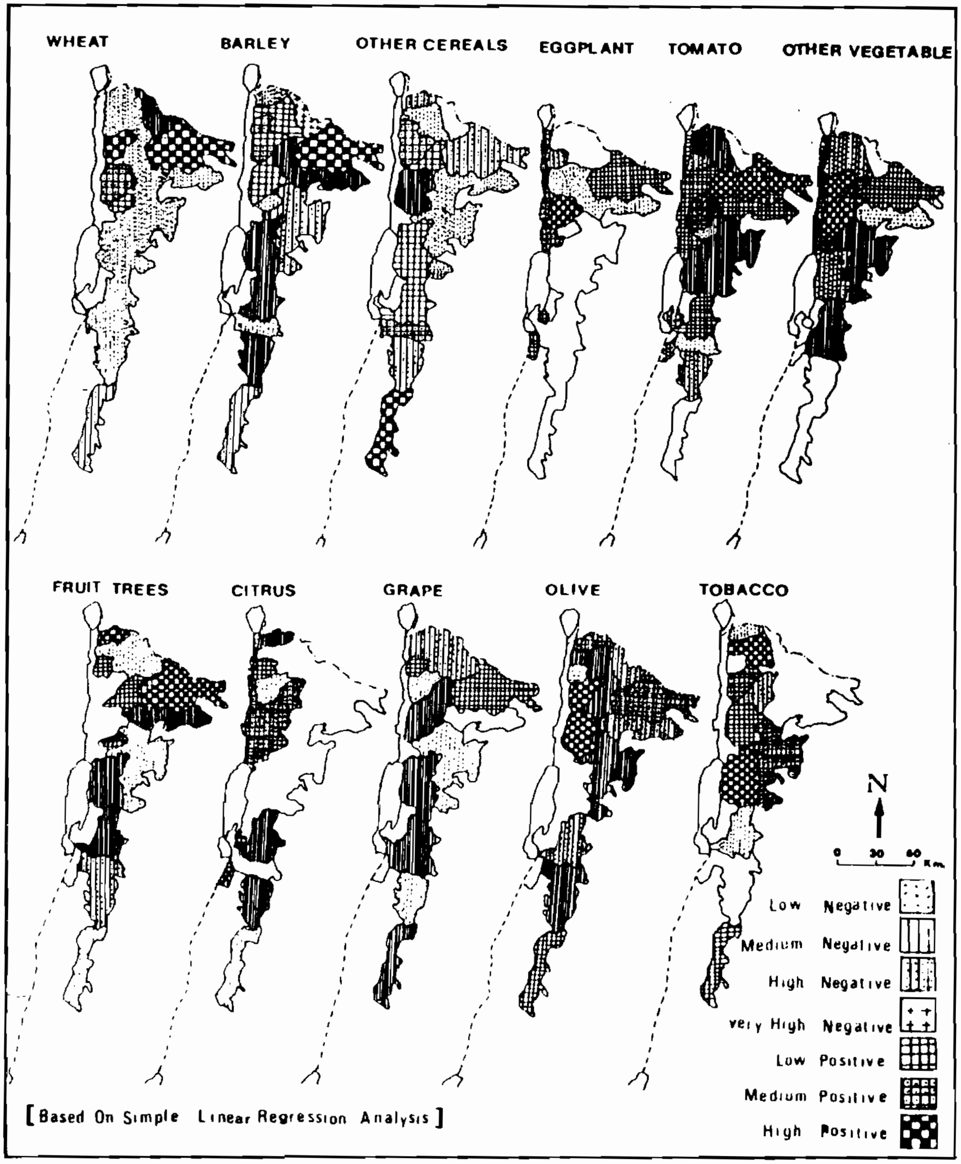
Hence, residual mapping has been used as a tool to identify and regionalise the areas having negative and positive impact over agricultural productivity (Y), when the effect of rainfall (X) is removed. With the help of these maps we can easily find out the more effective spatial variables for further explanations of the variations in the dependent variable Y.

Because the number of observations are small, we may not get sufficient observation in each category. As the number of observations increase the plus and minus residuals are expected to distributed equally, such that a large number of observations will fall between O-medium negative and O-medium positive. Relatively smaller number of observations will fall in between medium negative to high negative and medium positive to high positive and there will be few outlines in below very high negative and very high positive. (Fig. 3).

In certain cases, why for a given values of rainfall (X), the different districts do not show the same agricultural productivity. The most plausible answer is that rainfall is not the only determinant of agricultural productivity. There are several other variables also operating positively as well as negatively. The agricultural productivity will be more than the average in districts where the positive factors dominate, and also than the average where the negative factors dominate. Thus the residual (Y_Y'') becomes a very meaningful indicator which shows the nature and intensity of operation of factors in determining (Y) other than the independent variable already taken in the model.

FIGURE : 3

INDEX OF PRODUCTIVITY 1982/1983

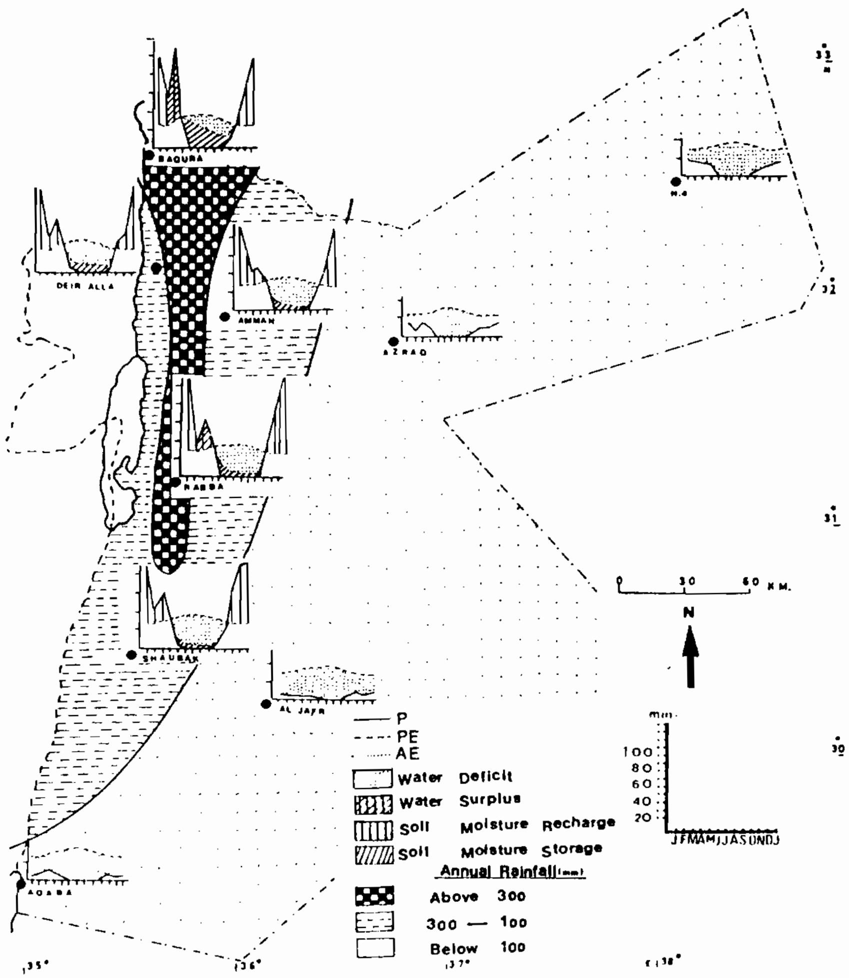


Regional Disparity In Agricultural Water Use Planning

An appropriate cropping pattern in Jordan should be evolved for different agro-climatic zones (fig. 4) taking into consideration the availability of rainfall, water deficit, water surplus, soil moisture recharge, soil moisture storage and potential evapotranspiration (Thornthwiate, C.W. 1952). Crop requiring less water should be preffered over those having stringent water requirements, which are likely to fall in the event of a drought (Mas'ad, A.M. 1987, 45-52).

FIGURE : 4

CLIMATIC —WATER POTENTIAL



(Based On Thornthwaite Method)

The rainfall distribution and the soil types are the main factors governing the irrigation water requirement in different parts of Jordan. On the base of the above factors, Jordan can be divided into the following zones:

1. Low Need Irrigation Zone

The main features of this region are the water surplus from November- February and low water dificit period. In this region the water surplus is higher than the soil misture recharge. This region is relatively rich in surface water sources, where Yarmouk river had been diverted for major irrigation schemes in Wadi al-Arab in the north. This region can be divided into two sub- regions depending on the irrigational variation, rainfall and soil. Cereals are the first crops grown in this region.

a. Heavy Rainfall Region Over 400 mm Rainfall Zone

This is the northern most part of Jordan includes the slopes of Ajlun, Shoubak and Tafila mountains. Because of high rainfall and the predominance of rainfed cultivation, the requirement of irrigation is minimal.

b. 300 - 400 Rainfall Zone Of Deep Black Soil

Moisture retentive soils are the dominent types in this region (Moorman, F. 1959). It occurs in the central region of the eastern hills. The moisture retentive property of the deep blacksoils and moderately rainfall makes it possible for crops to grow without their being adequate irrigation.

c. 300 - 400 mm Rainfall Zone Of Medium Black Soil

This region has a low water surplus, with a water deficit during the year. The water surplus is lower than the soil moisture recharge. The region is rich in the surface water resources, and there are many major and minor irrigation schemes. The main sources of irrigation is the ground - water. This is the transition zone between red mediteranean soils zone and yellow soils regosols.

2. Moderate Need Irrigation Zone

This zone is dominated by the soil moisture recharge in December - April with the absence of water surplus, and the water deficit is high. The main source of irrigations is the ground water in the east and south, and surface water in the Ghore area.

According to rainfall and soil types, this region can be divided into the following-sub -regions:

a. 300 - 100 mm Rainfall Zone In The East And South

The presence of lime in the soil, allow percentage of clay and the absence of moisture retention properly make irrigation necessary for major parts of the year. A yellow soils regosols is the dominant soil. The main source of irrigation is the ground water (Natural Resources Authority, 1977, 6-38).

b. 300 - 100 mm Rainfall Zone In The Rift Valley

This area includes Ghore area along the Jordan valley. The water deficit is high throughout the year and the irrigation is possible mainly from the irrigation schemes which spread over along side the eastern Ghore Channel.

3. High Need Irrigation Zone

In this zone, the water deficit is high throughout the year, and the irrigation is possible mainly from the ground-water resources, which are well utilized in this region. Vegetation crops are fit very well within the new scientific plantation regime applied all over the low rainfall areas in east and south Jordan. The region receives rainfall below 100 mm, the rainfall is lower than the potential evapotranspiration throughout the year, which means that the water deficit is very high. The region is dry during the non - rainy season, while during the winter it is not effectively drained and water logging results. There are very few streams which find their way during winter season after every heavy rainfall.

Development Indices

Planners have recently become interested in describing a complex spatial structure of a large number of socio - economic and other variables through some small number of underlying dimention (Hammond, R. 1974, 102-103). In regional studies, the differentials in large number of variables are described in terms of some directly unobservable dimentions like urbanization and agricultural development (King, L. 1967, 506-516). These underlying dimentions are extracted from the given set of structural variables on the basis of inter - correlations among them.

In order to identify the dimensions along which the spatial differentials in the economy of Jordan can be studied, the variables chosen are:

1. Net sown area per agricultural workers (X_1).
2. Percentage of irrigated area to net sown area (X_2).
3. Percentage of net sown area to total geographical area (X_3).
4. Percentage of area under commercial crops to net sown area (X_4).
5. Number of workers in manufacturing per 10000 workers (X_5).
6. Number of workers in trade and commerce per 1000 workers (X_6).
7. Urban population per 10000 population(X_7).
8. Number of registered vehicles per 1000 population (X_8).
9. Length of roads per 1000 sq. km. (X_9).
10. number of beds in the hospitals per 1000 population (X_{10}).
11. Per capita consumption of electricity (X_{11}).
12. Percentage of literate to total population (X_{12}).

The factor loading of first principal component (Hotteling, H. 1933, 407-441), show that it has a significant positive correlation with workers in manufacturing, urban population, persons in trade and commerce, number of vehicles, number of beds in hospitals, consumption electricity per capita and literacy. As these variables can be considered as the consequences of the industrialization, and so this factor may be called as "index of industrial development".

The second principal component has positive significant correlation with irrigation, commercial cropping and the length of roads. It also has the negative significant correlation with per worker net sown area. All these correlations indicate towards intensive cropping with good marketing facilities and so this factor may be called as "Index of Agricultural Development".

The third principal component has only two significant negative correlations, with percentage of net sown area to total geographical area and the length of roads per 1000 sq. km. Any factor based on its correlations with only a few variables cannot be named precisely. However, in the context of Jordan where topography is major speatail variate, this factor may be named as "Index of Physiographic Inefficiency". In order to maintain the parity with the first two components we can call it as "Index of Physiographic. Efficiency" also (Aslam, M. 1977, 145-167). If further precision required some new variables should be added such as:

1. Dependency rate.
2. Unemployment rate.
3. Rural electrification.
4. Connectivity.
5. Houselessness.
6. Persons per occupied house.
7. Population doctor ratio.
8. School spacing.
9. School expenditure.
10. Children - teacher ratio.
11. Population police.
12. Population per commercial bank.
13. Democratic participation.

Among these variables, we can illustrate the index of living environment, index of social well-bing, index of social security, index of social belonging and index of Democratic participation etc.

Whenever, a multiple regression analysis is attempted, it is useful to know as to how the parameters get changed when new variables are added (Murray, R. 1961, 269-272), one by one, in the model. This procedure helps us in many ways. Firstly, it tells us the contribution of an added variable in explaining the dependent variable. Secondly, it helps to see whether the new variable is worth including in the model or not. It also helps us in keeping a watch over the changes in the values of the regression coefficient and their standard errors.

Such a useful procedure is known as stepwise regression analysis and is becoming increasingly popular among the social scientists.

To explain as to how all these concepts of regression analysis may be used in a real problem (Cole, J. 1968, 11-32), the following were used while explaining the agricultural productivity of Jordan.

1. Value of agricultural produce in J.D. per dunum (Y).
2. Percentage of rural population to total population (X_1).
3. Percentage of agricultural labour force (X_2).
4. Percentage of irrigation area to geographical area (X_3).
5. Agricultural mechanisation per dunum (X_4).
6. Annual average rainfall in cm (X_5).
7. Consumption of fertilizers per 100 dunum (X_6).

The regression of (Y) on (X) is given in the first step for the independent variable that gives the maximum R_2. In the second step the variable which gives next highest values of R2 is added in the previous regression equation. Likewise the variables are added one by one and the entire analysis is carried out for each step (Monkhouse, F. 1980, 475-517). These results are given below.

Correlation Matrix

Y	X_1	X_2	X_3	X_4	X_5	X_5
1	.18048	.44021	.37104	.1481	.72488	-.03006
	1	.82633	.19334	-.03104	.43557	.31805
		1	.28924	-.04711	.73348	.49649
			1	.69438	.07365	.52376
				1	-.3696	.54976
					1	-.04393

The above results show that rainfall (X_5) explains the maximum proportion of variations in agricultural productivity followed by irrigation (X_3), labour farce (X_2), mechanisation (X_4), fertilizers (X_6) and rural population (X_1). The contribution of fertilizers and rural population is however very low in increasing the values of R2 (Yeates, M. 1974, 55-73), as is clear from the column showing the difference in R2, caused by each of them.

The formula for working out R2 is (Aslam, M. 1977, 153-166):

$$R^2 \frac{\hat{B}X\acute{Y} - \frac{(\Sigma Y)^2}{n}}{\acute{Y} - Y - \frac{(\Sigma Y)^2}{n}}$$

where $\hat{B}X\acute{Y} - \frac{(\Sigma Y)^2}{n}$ Explained sum of squares.

$Y\acute{Y} - \frac{(\Sigma Y)^2}{n}$ Explained total sum of squares.

The null hypothesis that $\hat{B}_1 = \hat{B}_2 = \hat{B}_3 ... = \hat{B}_k = O$
can also be tested by the F_ ratio test given in this form of analysis of variance (Aslam, M. 1977, 148-149).

This analysis of variance is equalent to the test of significance of R2, as the F value given can be worked out as:

$$F = \frac{R^2 / (K - 1)}{(1 - R^2) / (n-k)} \text{ for } (K - 1, n - k) \text{ d.f.}$$

The values of R2 in two problems of multiple regressions, having unequal numbers of observations and unequal numbers of variables cannot be compared because of the obvious reasons. To make it comparable in such situations, the R2 is adjusted for degrees of freedom and is denoted by $\overline{R}2$ as given below (Aslam, M. 1977, pp 149)

$$\overline{R^2} = 1 - \frac{n-1}{n-K}(1 - R^2)$$

It is important to note that the above formula, if (K) increases, (1-R2) decreases, as R will increase with K. At the same time an increase in (K) causes a decrease in (n_1) (n _ k). Thus on R2, the increase in the value of (K) has inverse effect because of (n_1/n_k) and has positive effect because of (1_R2). If the positive effect of an additional variables is more than its negative effect, the value of (R2) will increase. The value of (R2), however, will decrease in the reverse case (Aslam, M. 1977, pp 150).

A study of R2 however, shows that though the contribution of mechanisation is very poor in R2 but it can be retained in the analysis, as it has caused marginal increase in R2. The value of R2 decreases as fertilizers (X_6) and rural population (X_1) are added into the model. This shows that their contribution in increasing the value of R2 is not strong enough to counter balance the reverse effect on the explanatory power of the model due to increase in the degree of freedom (n_k) (Morrison, D. 1967, 221-225).

The regression coefficient from step one to step four show a consistently significant values for irrigation and rainfall at 1% level of significance. The regression coefficient of irrigation is, however, significant at 5% level of significance as found in step three and four. After step four, the significance of regression co—efficients do not remain consistent (Berry, B. 1964, 147-163).

The value of F_ratio also becomes less significant after step four. Thus the relationship as given in step four may be identified as optimal fit (Spate, O. 1960, 337-394). The results given in this step show that irrigation and rainfall are the significant variables. The average change in agricultural production per dunum (Y) caused by unit change in the amount of rainfall is given in figure 3. Another significant regression (at 5% level) is that of irrigation which is consistently negative in third and fourth step. Further explanations to be found for this, because usually irrigation is expected to have a positive effect on agricultural production. The last variable given in the fourth step is number of tractors per dunum of cropped area which is insignificant, and remains so in the subsequent steps (Pal, M. 1971, 1-33).

Result of stepwise Regression Analysis

Variables	Regression Coefficient	S.E	t	R^2	Increase in R^2	$\bar{R}^2$	F
step 1							
x5	7.363	2.122	2.328	0.525	—	0.525	11.072
step 2							
x5	6.689	1.475	4.535				
x3	36.306	10.559	.3438	0.794	0.269	0.773	17.438
step 3							
x5	9.570	1.723	5.554				
x3	43.484	9.159	4.747	0.676	0.084	0.850	19.229
x2	—2.480	1.060	—2.340				
step 4							
x5	8.511	1.980	4.299				
x3	54.479	13.789	3.951	0.895	0.017	0.855	14.927
x2	—2.363	1.058	—2.234				
x4	—9.780	9.223	—1.050				
step 5							
x5	7.804	2.387	3.269				
x3	55.201	14.514	3.803				
x2	—1.684	1.583	—1.064	0.901	0.006	0.843	10.925
x4	—7.744	10.250	— .756				
x6	—1.913	3.181	— .601				
step 6							
x5	6.339	3.176	1.996				
x3	55.355	15.096	3.667				
x2	0.404	3.268	0.124	0.910	0.009	0.835	8.508
x4	—6.822	—10.733	0.636				
x6	—3.658	—4.063	0.900				
x1	—0.906	—1.225	0.740				

Conclusion

Levels of regional development cannot be measured directly. One must select suitable indicators for measuring it. The indicators should represent some aspects of development. The proper choice of indicators constitutes crux of the methodology in studying of regional development which depends on theoretical assumptions. It may be concluded that regional development and well-being exhibits strong relation to agriculture and environment.

Since regional development has to take place within a given framework of resources such as climate, water and land it is necessary that one should identify the role of each of these. The regional development has to consider the environmental aspects which will pose the problem of whether one wants affluence or effluence; economy or environment. A choice has to be made between two important components of the levels of development; namely consumption and environment. It is necessary to have the well-being and preserve the quality of environment.

Combinational analysis have been used to show the diversification of different regions of Jordan in terms of their functional specialization.

The statistica approach applied in the delineation of crop regions brings to light the important crops which inter the crops association. It has been ascertained that according to minimum deviation methods, five crop combination regions may be recognized.

Though overdependence on agriculture and related persuits indicates backwardness of the economy, their is need to study the relative development of agriculture for measuring the economic condition of the people engaged in cultivation. The level of the development in this case can best be reflected in agricultural efficiency. Residual mapping has been used as a tool to identify and regionalise the areas having negative and positive impact over agricultural productivity.

The factor loadings of principal components have significant correlation with second and third principal components.

The second principal components has positive significant correlation with irrigation, commercial cropping and the length of roads. It also has the negative significant correlation with per worker net sown area. All these correlations indicate towards intensive cropping with good marketing facilities and so this factor may be called as «Index of Agricultural Development».

The third principal components has only two significant negative correlations, with percentage of net sown area to total geographical area and the length of roads per 1000 km^2. Any factor based on its correlations with only a few variables cannot be named precisely.

Bibliography

Abu Khalid, A., & M. Hanbali,	**Evaluation of Data on Crop Water Use and Irrigation Methods,** Beirut, 1974.
Aslam, M.,	**Statistical Methods in Geographical Studies,** Rajeesh Publication, New Delhi, 1977.
Barber, W.,	**An Outline for Planning in East Jordan,** N.R.A., W.R.D., Amman, 1972.
Berry, B.J.L.,	"Cities as System Within System of Cities," **Regional Science Association,** 1964: 13.
Carter, D.B., and J.R. Mather,	**Climatic Classification for Environmental Biology,** Publication in Climatology, Vol. 19, No. 4, New Jersey, 1966.
Cole, J.P., and C.A. King,	Quantitive Geography, 1968.
Department of Statistics,	**Proceedings of the Symposium on Population. Fertility and Family Health in Jordan,** 28-30 August 1984.
Department of Statistics,	**Statistical Year Book,** The Hashemite Kingdom of Jordan, No. 36, 1985.
Friedmann, J.,	**Regional Planning** "A Problem in Spatial Integration, The Regional Science Association, Papers and Proceedings, 1959.
Friedman, s., and W., Alonso,	**Regional Development and Planning,** Cambridge, 1964.
Gregory, S.,	**Statistical Methods and the Geographer,** Longmans, 1969.
Hammond, R. and P.S., Mc Cullagh	**Quantitative Techniques in Geography, An Introduction,** Oxford, 1974
Hance, W.A.,	**«The Gezira: An Example in Development Geog. Rev. 1954.**
Hirchman, A.O.,	**Strategy of Economic Development,** Yale University Press, 1958.
Hotteling, H.,	"Analysis of a Complex Statistical Variable into Principal Component," **Journal of Educational Psychology,** Vol. 24, 1933.
King, L.J.,	"Discriminatory Analysis of Urban Growth Patterns in Ontario and Quebec," 1951-1961, **Ann. Ass. Am. Geog.,** Vol. 57, 1967.
Lioyd, J.W.,	**The Hydrogeology of the Southern Desert of Jordan,** Rome/Amman, 1969.
Mas'ad, A.M.,	**Agricultural Hydrology of Gujarat States,** Unpublished Ph.D. Thesis, Poona University, 1982.
Mas'ad, A.M.,	Environmental Hydrology of Jordan, **Annals of the Faculty of Arts,** Kuwait University, Vol. V111. No. 41, 1987
Miller, E.J., et al,	Poverty, "Inequality and Conflict," **Ann. Am. Ac. Pol. Soc. Sci. 2** 1967.
Ministry of Agriculture,	**Report on Agricultural Zoning,** Amman, 1974.
Monkhouse, F.J., and H.R. Wilkinson,	**Maps and Diagrams,** Methuen and Co. Ltd., 1980.
Moorman, F.,	**The Soils of Jordan, FAO, report 1132,** Rome, 1959.
Morgan W.B., & R.J. Munton,	**Agricultural Geography,** Methuen and Co. Ltd., London, 1971.
Morrison, D.F.,	**Multivariate Statistical Methods,** Mc Graw-Hill Inc. New York, 1967.
Murrey, A.R.S.,	**Schaum'sOutline of Theory and Problem of Statistic,** 1961.
Natur, E.,	**Natural Resources Authority, Land and Water Use in Jordan, Part IV, Irrigation in Jordan,** Amman, 1969.
Natural Resources Authority and Federal Republic of Germany,	**National Water Master Plan of Jordan,** Irrigation, Vol. V. Frankfurt, 1977.
Pal, M.,	"Quantitative Techniques for Regional Planning, **Indian Journal of Regional Science,** Vol.111, No.1. 1971.
Spate, O.H.K.,	Quantity and Quality in Geography, **Ann. Ass. Am. Geog.** 1960.
Thomthawaite, C.W.,	**Climate in Relations to** Planning and Irrigation of Vegetable Crops, **Publication in Climatology,** Vol. 5, No.5, New Jersey, 1952.

Thornthwaite, C.W.,	The **Water Balance in Arid** and Semi-Arid Climates, Desert Research Proc., **UNISCO, Jerusalem,** 1953.
Thornthwaite, C.W., and J.R. Mather,	**Climate in Relation to Crops,** Vol. 2, No. 8, New Jersey, 1954.
United Nations Research Institute for Social Development	Social and Economic Factors in Development. **The Level of Living Index,** Report 4, Geneva, 1966.
United States Department of Agriculture	**Manual on Conservation of Soil and Water, Handbook of Professional Agricultural Workers,** Oxford, New Delhi, 1974.
Water Resources Division,	**Water Resources for Irrigation in Jordan,** N.R.A. Amman, 1972.
Weaver, J.C.,	"Crop Combination Regions in the Middle West," **Geographical Review,** Vol. 1 LIV, 1954.
Yeates, M. H.,	**Introduction to Quantitive Analysis in Human Geography,** 1974.