

INSTITUTE OF GEOGRAPHY AND SPATIAL ORGANIZATION
POLISH ACADEMY OF SCIENCES

CONFERENCE PAPERS 5

JERZY KOSTROWICKI

**AGRICULTURAL CLASSIFICATIONS.
A REVIEW OF METHODOLOGY**



WARSZAWA

1990

ERRATA

Strona i wiersz	Jest	Powinno być
29 ⁶	dąsie	dąlsie
30 ⁸	Endro	Endre
72 ²¹	alibuid	aliquid
80 ²	Włochów	Wołochów
167 ⁷	Zbigniewa	do Zbigniewa
po 178 podpis na wkładce	„Servnika”	„Sennika”
193 ¹⁴⁻¹¹	tekst od miejsca: „s. 253 zamieszcza... w latach 1599 i 1600” powinien być w notce 11.	
218 ²⁵	nie strofujszę	nie strofujesz
219 ¹⁶	apostłami	apostołami
242 ⁵	lubuski	lubowski
245 ²¹	Protesz	Proteusz
245 ²⁰	reformacyjnego	reformacyjnej
246 ²⁴	w poprzednich	z poprzednich
247 ²	bentschen	Bentschen
248 ¹²	popularnych	reprezentantów popularnych

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Opracowanie redakcyjne

Teresa Lijewska

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PREFACE

This paper is a summary of a much more extensive study elaborated for UNESCO, but never published. In the present abridged form it served, however, as a basic document to the common UNESCO/International Geographical Union Seminar, held in Rabat, Morocco in March 1986.¹

As the project proposal was submitted to UNESCO too late, over one year after the Seminar, when UNESCO had been passing through the period of turmoils and organizational changes, the official answer has never arrived.²

INTRODUCTION

The first truly comparative studies of agriculture appeared sometime in the 18th and 19th centuries. In most cases they were meant to serve practical objectives by providing a better knowledge of experience regarding agricultural practices gained in other countries or regions in order to make use of them in the author's home country.

¹ Report and Proceedings of IGU/UNESCO Seminar on Methods of Comparative Studies in Agricultural Development, held at L'Institut Agronomique, Université Mohammad V, Rabat, Morocco, March 18th to 21st 1986, written and edited by M.J. Troughton, 166 p. More recent literature concerning the synthetic classifications of agriculture only, see: J. Kostrowicki, *Badania porównawcze rolnictwa światowego* (Comparative research in world agriculture. Methodological review), *Przegląd Geograficzny* 60(1988), 4, 511-571.

² It is the author's pleasant duty to thank Professor W.B. Morgan for his kind correction of the present manuscript.

Arthur Young from Britain (1770, 1780, 1792), A.D. Thaer (1798) and J.N. Scherz (1807, 1816 a, b, 1836) from Germany, should be mentioned as precursors of such a comparative approach to agricultural development. Similar studies have been continued throughout the 19th and 20th centuries until today. More recent examples of such an approach are numerous books by René Dumont who even in some of his titles (1951, 1954, 1961, 1977) turns back to those early writers. Also a large volume by Duckham and Masfield (1970 a) represents a similar approach.

Agricultural geography - a result of a common effort of economists and geographers - has by its very nature become a comparative discipline. However, as in some other disciplines, it has been found quite early that for comparative studies it is not enough just to describe the agriculture of two or more countries or areas in a comparative way. To make such comparisons more scholarly and more comprehensive the objects under research have to be ordered according to a certain system i.e. to be classified.

There is no room here to discuss the general theory and methods of classification that have been considerably developed during the last decades. It should be stressed, however, that classifications differ between themselves according to their objectives, concept and scope, as well as in methods, techniques and procedures applied.

As far as their objectives are concerned, an agricultural classification could be aimed either at enriching our knowledge or at solving some practical objectives, or both. A classification can cover agriculture as a whole, or some of its branches or even its elements. It can be descriptive or analytic, divisive or aggregative, qualitative or quantitative. Various terms have been used in agricultural classifications, such as systems, zones, forms, formations, regions, types, combinations and orientations.

Sometimes the same terms when used in different classifications denote different meaning while different terms may mean the same. It may also happen that different terms are used as alternatives in classification. Therefore, in spite of certain improvements introduced during the last decades, due to the development of the theory of classification, there is still a considerable terminological confusion.

From the very beginning agricultural classification has been dominated by two concepts that still are most common, i.e. agricultural systems and agricultural regions. Although both concepts are meant to classify a complicated reality to make it more comprehensive, they belong to two distinct ca-

tegories. A system is a systematic or taxonomic concept and its identification is based essentially on similarities between various individuals. Since individuals, characterized by similar agricultural attributes, may occur repeatedly both in time and space, the same system can be identified in various periods of time and in various territories. Since agricultures with similar attributes are often distributed in space in a mosaic-like pattern, the distribution of the resulting systems does not necessarily form a contiguous area, but agricultures of the same system are usually dispersed and intermingled with others. By contrast, the region is a spatial or territorial concept. It is delimited on the basis of differences between places, rather than similarities between individuals. Consequently the region should be considered as a fraction of the earth's surface extending contiguously over a given territory with definite limits, which is characterized by a peculiar association of attributes that render its character unique and differentiate it from all other regions.

Both systems and regions may be hierarchical. On the basis of their similarity, systems of a lower order may be grouped into systems of a higher order, irrespective of their distribution in space or time, while regions of a lower order always form a territorial part of regions of a higher order.

On the other hand the spatial pattern of agricultural systems can easily be used as a basis for agricultural regionalization by generalizing a more complicated spatial pattern of systems into a simpler, regional picture, based on a dominance or co-dominance of individual systems over a given territory with the contiguity constraint taken into account.

The term "system" has also been used in various partial classifications of agriculture, such as land tenure systems, land use systems, land and/or crop rotation systems, systems of cultivation and systems of livestock breeding. While regions may be single-featured units when delimited on the basis of only one element of agriculture, they may be multi-featured, or total when they encompass all important agricultural attributes.

As far as other terms are concerned, the term "zones" has mainly been used for single-featured regions, while agricultural forms or formations have been meant as more or less equivalent to agricultural systems. Combinations and orientations are based on the identification of leading elements in various structures such as land use, crops and livestock production, etc. The last are also sometimes called systems of types. In addition, the term "types" is used by some authors as synonymous with "systems".

In some theories of classification, however, the typology, is considered as a special kind of a classification, in which classes, i.e. types, are not established in advance but identified in an aggregative way by grouping individuals around certain cores or models recognized as the most typical. Such groupings are not separated from one another by any tight limits, but their limits may overlap, making up various transitional forms, or be separated by blank spaces. The typological approach is mainly used when the objects under study are too numerous and too differentiated to be at once classified in an aggregative way and in consequence the classification continues to develop.

In all its aspects the concept of agricultural types is closer to that of agricultural systems than to agricultural regions. Of course, no classification is absolute and changes as more knowledge is gained about the objects under study. A better understanding of the objects classified leads invariably to the revision of their classification.

Because of the multiplicity of classificatory concepts of agriculture it is not possible to discuss all of them thoroughly enough on the number of pages the author has at his disposal. Therefore, only the most important are examined below and some others only specified and referred to the literature. The discussion is arranged according to the content rather than to the terms used by different authors.

AGRICULTURAL SYSTEMS

The concept of agricultural systems was first developed in Russia (Pavlov 1821, Sovetov 1867, Lyudogovskiy 1872, Yermolov 1879, 1894 - for the review see Krokhalov 1960) and subsequently in Germany (von Thünen 1826, Göriz 1848, Aereboe 1896, Brinkmann 1913). In France de Gasparin (nd) and later on Heuzay (1862) and Hitier (1913) also conceived the same notion.

Quite early, however, the concept of agricultural systems was connected with the discussion on the stages of the development of human economy. This was due to the influence of Eduard Hahn (1892, 1926; for the discussion see Kramer 1967), who presented in a sequential way the following principal forms of the World economy (Wirtschaftsformen), identified upon their evolving technologies: (1) hunting and fishing, (2) hoe culture, (3) plantation agriculture, (4) European and West Asiatic agriculture, (5) animal husbandry, and (6) horticulture.

Vierkandt (1897) pursued the same approach, but Schlüter (1919) and Sapper (1925) narrowed the concept to bioproductive systems only, but at the same time they expanded the classification. This genetic approach has been followed until the present day by both geographers and agricultural economists with various modifications, including the use of different terms. For example, Krzymowski (1914, 1915) and Fries (1924) used the term of systems of economy (Wirtschaftssysteme); Aereboe (1896), Krzymowski (1914), Beschorner (1923), Rolfes (1954), Geuting (1956), Woermann (1959) - farm systems (Betriebssysteme); Büttner (1934), Otremba (1953), Hoffmann (1954), Andreae (1972, 1976, 1977 a, 1985), Hambloch (1974) - forms of farms (Landwirtschaftliche Betriebsformen); Laur (1926), Paravicini (1929), Gerner (1943), Rolfes (1948), Kranz (1953), Otremba (1953), Hoffmann (1954), Geuting (1956), Stern (1956), Ruthenberg and Andreae (1982) - land-use systems (Bodennutzungssysteme); Góritz (1848), Müller-Wille (1939, 1941), Kuls (1951) and Monheim (1954) - field systems (Feldsysteme); Laur (1930), Stern (1957), Fuss (1958) and Krauter (1970): types of farms (Landwirtschaftliche Betriebstypen); Borchardt (1979, see Andreae 1985): types of forms of farms (Typen von Betriebsformen) etc.

In fact that terminological differentiation has only partly been associated with differences in the very meaning of those terms. In most cases field systems have been identified mainly upon differences in crop rotation systems; land use systems upon the organization of land and cropland use; farm systems upon the relative importance of the various branches of crop growing and animal breeding; farm forms - the production of the same product in the same way, etc.

Most of the classifications, particularly those which cover larger areas, following the example of Hahn, have been based on cultural and/or technological attributes of agriculture, such as crop rotation systems and the use of agricultural implements (Beschorner 1923, Otremba 1953, 1962, Andreae 1972, 1977 a, 1981, Hambloch 1972 etc.).

The criteria of identification of agricultural systems have only recently expanded to include such other criteria as size of holdings, commercialization or even social attributes of agriculture, i.e. Agrarsysteme (Borchardt 1979, see Andreae 1985). On the other hand, Waibel (1927, 1933 see also 1973) combined the concept of forms of economy with that of cultural landscape into what he called economic formations (Wirtschaftsformationen), viewed as a product of the "entire range of human forces as they are reflected in number and

distribution over the earth surface, and in social, cultural and above all - intellectual differentiation".

His former student, Pfeifer, narrowed that concept to agricultural formations (Landwirtschaftsformationen; 1936). He was followed by other scholars (Tichy 1958, Quasten 1975, Nitz 1970, 1971, 1975, Windhorst 1974, Bruster 1977).

In most of the French studies the systems of crop cultivation (systèmes de culture) have been treated separately from the systems of livestock breeding (systèmes d'élevage). Put together they are supposed to form agricultural production systems (systèmes de production agricole), a concept which is very seldom in use in France. The first classification of the cultivation systems of the world was presented by Chevalier (1925), followed by Faucher (1949) and his types of cultivation (types de culture).

In the USSR already in 1962 an interesting concept of forms of agriculture (formy zemledeliya) was elaborated by Rakitnikov (1970), followed with his enterprise combinations and types of agricultural regions (1970, 1972 a, b, 1973, 1975).

Sometime in the fifties the concept of agricultural systems was transmitted from Germany to the United States, mainly through the Californian school of agricultural geography led by C.O. Sauer. Sauer, more interested in "agricultural origins and dispersals" was never concerned with any classification, however his ideas greatly influenced his students and followers. Some of them introduced these ideas into their textbooks on human or cultural geography. For example, Gregor (1963) distinguished and described the following "principal forms of economy: (1) plow culture, (2) garden culture, (3) plantation farming, (4) livestock ranching, (5) nomadic herding, (6) hunting, fishing and gathering" and the additional five mixed forms.

Zobler (1965), Dicken and Pitts (1970), and Anderson (1971) developed the classifications by introducing some criteria representing commercialization and land tenure. The first two called their classifications a "typology". The most comprehensive approach, however, was provided by Spencer (also a former student of Sauer) and Stewart (1973). According to them "The term system is here taken to refer to a recognizable assemblage of agricultural procedures and activities that can be distinguished as a functionally integrated pattern characterized by genetic and generic cohesion of elements, traits, technologies, procedures and activities. Individual systems differ in the "innovative development and employment of dissimilar socio-cultural, technological and

operational methods, brought to bear on the production and disposition of assemblages of plant and animal commodities". According to the authors the proposed 13 agricultural systems represent a "loosely evolutionary sequence that have been practised since the onset of the Neolithic, including developing contemporary systems". The effects of the classification are described on several pages.

In spite of some reservations, the present writer believes that the classification by Spencer and Stewart is the best of those published to date. Unfortunately it has never been applied and tested in any concrete situation neither by the authors nor by anybody else. On the other hand, both in reasoning and the selection of criteria not only in this classification, but also in those by Dicken and Pitts or Anderson, certain reflections of the typological concept may be traced. This is not surprising, given the existing contacts and the fact that both Anderson and Spencer were taking part in the development of that concept. Spencer himself greatly contributed to that development in its initial stage, particularly by his very well-founded criticisms that always required some rethinking.

Several attempts have also been made to devise some classification of agricultural systems for the tropical or developing countries (Morgan 1978, Ruthenberg 1976, Andreae 1972, Wood 1972, 1973, Schultz 1975, 1976, Ruthenberg and Andreae 1982). From the methodological point of view those by Wood and Schultz seem to be the most advanced. Both of them laid down the criteria of their classification, but only Wood tried to express them in quantitative terms, while Schultz ends his study with a map of agricultural systems based on air-photo interpretation.

Here also the classification of cultural-productive types (proizvodstvenno-kulturniye tipy) by Soviet ethnographers (Andrianov 1968, 1975, 1979, Andrianov and Cheboksarov 1972, 1975, Svanidze 1978) should be mentioned.

Most of the classifications mentioned above and especially those that cover large areas are based on the personal knowledge of their authors, who do not offer any criteria for their classifications. One may only guess that in most of them solely cultural and technological characteristics of agriculture, such as land and/or crop rotation systems and agricultural implements, are used as basic criteria, representing however only one side of agriculture. The divisive approach dominates and no quantitative bases are offered in the classifications, except in those covering some more restricted areas.

STRUCTURAL CLASSIFICATIONS

As mentioned in the preceding chapter some of the classifications, particularly those produced in Germany, are mainly based on the structures of land or cropland use, and consequently the identified systems have been named after the dominant or prevailing crops and/or categories of land use.

It was only in 1930 that Brinkmann drew attention to the fact that the proportion of individual crops in the total area under crops did not represent the relative importance of particular crops and proposed the introduction of special coefficients or multipliers (Anbaugewichte), based on the potential labour inputs into particular crops or land uses. The method was developed by Busch (1936) who proposed such multipliers for Middle Europe. He also put all crops into three categories: fodder, grain and root crops, naming individual systems after the dominant and associated groups of crops (e.g. grain-root crop system). The method became very popular in Germany. Various authors applied it to various areas and countries (Busch 1939, Hesse 1949, Stern 1956, 1957, Woermann 1943, 1953 as well as Tsuzuki 1962). Only after World War II did Blohm (1950) supplement these multipliers with another, representing farm animals; thus, it was possible to cover by one and the same method all branches of agriculture and to distinguish combined agricultural or farming systems. A simplified version of that method was used by Andrae (1964) to identify the agricultural systems of Europe and for comparative purposes of some other areas as well. Both in crop and livestock systems, basic, associated and side branches were distinguished. The absolute majority of scores decided whether a given system was to be called a crop or an animal one.

However all these methods have been under criticism for several years; it has been indicated that with the technological development labour inputs on even the same crop may be different, depending on capital inputs, and that therefore the use of unified multipliers could no longer be effective in more industrialized agriculture. Taking into account those criticisms Busch (1938) and Hoffmann (1954 a) proposed to substitute the multipliers based on inputs by coefficients based on outputs of particular crops adjusted to the common measure by means of conventional (grain) units.

The German methods listed above have also been widely used by Polish agricultural economists to identify the orientations of agriculture based on the structure of either cropland use, the structure of intensity or of the structure of agricultural production (Surzycki 1925, An-

toniewski 1934, 1958, Ponikowski 1935, Okuniewski 1958, Urban 1960, Około-Kużak 1962, Wojtaszek 1965 - see also Wojtaszek 1966). These methods were developed and most widely used by Kopeć (1958, 1960, see also Kostrowicki 1964, pp. 124-125) to identify the economic system (systemy gospodarcze) based on the structure of intensity of both crop growing and animal breeding, computed by use of coefficients for four principal groups of crops and animals raised.

On the other hand Manteuffel (1961) proposed a three-level classification: (1) production types defined by size of farm, quality of soil and land use structure; (2) economic systems identified based on the structure of total output, and (3) orientations - based on the structure of gross output.

In Russia Studentskiy proposed much earlier (1925, 1927) gross income as a common measure of the intensity of farming systems (which in fact could represent intensity only indirectly. J.K.). This he applied to agricultural census data on European Russia, averaged over the 1911-1915 period. The gross income of the major provinces was computed and then related to a *dyesatina* (1.09 ha) of agricultural land. This way Studentskiy was able to produce a pattern of agricultural regions based on agricultural systems. In the same study, he also applied the gross income index to the 1920 Agricultural Census statistics for the United States.

It is an interesting fact that the structure of agricultural output (mainly commercialized) expressed in monetary units became a favoured basis of types-of-farming identification by American agricultural economists. The first types-of-farming scheme was proposed by Spillmann (1908). The most detailed, however, was that by Elliott (1933) in which 514 types of farming were grouped into 100 type-of-farming regions and the 12 following major type-of-farming regions named after dominant enterprises: (1) general, (2) cash grain, (3) cotton, (4) crop speciality, (5) fruit, (6) truck, (7) dairy, (8) animal speciality, (9) stock ranch, (10) poultry, (11) self sufficient, and (12) abnormal types.

In the latter publication (entitled *Generalized Types of Farming in the United States, 1950*), 165 generalized type-of-farming areas were identified, grouped then into regions (see p. 28). Alongside those studies, covering the whole country, a great number of type-of-farming studies of individual states have appeared. While in most cases the structure of commercial output was the basis for the classification, the criteria and methods of grouping farms into types of farming varied and their results are not fully comparable,

at least in interstate comparisons (see Pretzer and Finley 1974). For the criteria of farm classification see Ackerman and Riecker (1964) as well as Grove (1965), Hurley (1965), Nikolitch and McKee (1965).

In Britain most of the earlier farm-type classifications were based on the proportions of main categories of land use (see Morgan and Munton 1971). More recent ones either combined acreage proportion and livestock numbers per 100 acres (Bennett-Jones 1954) or were based on the structure of labour inputs in standard man-days for individual farming enterprises (Ashton and Cracknell 1960-61, Napolitan and Brown 1962, Church et al. 1968).

Barnes and Jeffrey (1964) employed a combination of input and output, data, together with data for natural resources and social characteristics, and Adeemy (1968) used gross output data as a basis to produce a threefold agricultural classification of North Wales by parishes.

Finally, by testing various units of measure and various quantitative techniques Aitchison reached a high standard of expertise as far as methods and techniques of agricultural classification are concerned (1972, 1975, 1979-1980, 1983).

The British approach to the types-of-farming classification was followed in some other countries, like Canada (Hudson et al. 1959, Reeds 1964), Ireland (Gillmor 1967), Australia (Scott 1961a,b) etc. By random sampling based on the structure of gross income of farms Scott grouped them into 27 types-of-farming subregions and 9 regions. In another study Scott (1972), used the combination of specialization, scale of operation and profitability; still another classification was carried out for Tasmania and Victoria, in which 11 types of farming were singled out. Laut (1974), using 43 variables and quantitative techniques (cluster analysis) arrived at an identification and description of 10 classes representing some kind of types of farming, then grouped into 8 regions.

In France it was J. Klatzmann (1952, 1955, 1973) whose contributions to the development of methods of classifications of agricultural enterprises were particularly valuable. Some other attempts have also been made to work out farm classifications based on "more objective" methods (Greiner et al. 1970, 1971; Lenco 1974) or to apply such methods in regional studies (Mathieu 1972, Maury 1981, Guermont 1983). J. Bonnamour (1972, 1973b, 1975) and her co-workers (1971a,b, 1974) developed the concept of regional systems of agricultural holdings (*systèmes d'exploitation agricole*) identified by a number of quantifiable criteria, which may be treated as a transition to the typological approach.

Several attempts have also been made in the farm classification of the European community (Baillet 1972, Analyse ... 1975, La classification ... 1979).

The first preliminary attempt to classify the agriculture of the USSR into productive types of agricultural enterprises (proizvoditelniye tipi selskokhozyaystvennikh predpriyatii) was made in 1963 by L.M. Zaltsman and N.P. Makarov (see Zaltsman and Polovenko 1972). The classification is based on the definition of leading and auxiliary branches of commercial agricultural production estimated on the basis of an efficiency measure of labour and capital inputs as well as of land and labour productivity. The second classification made by Isayenko (1973, 1979), groups farms into types based on the structure of commercial production and the share of the most important branches. Each type is presented by a code with 6 digits, and each element of that classification has its code number. On the basis of all the six digits, 670 types of agricultural enterprises have been identified. The whole classification is aimed to provide a scientific basis for both farm management and agricultural planning.

Production types and their distribution in different parts of the USSR are described in several books and papers (Proizvodstvenniye tipy ... 1968, 1973).

Besides agricultural attributes, the location of agricultural enterprises including natural conditions, has also been used as a criterion for the identification of types and this makes the concept close to some forms of agricultural regionalization.

Another approach is represented by the Moscow school of agricultural geography led by Rakitnikov (Rakitnikov 1970, 1972, 1973, 1975a,b, 1979, Kryuchkov 1978, 1979, Solovtsova 1979). As the "types of agricultural regions" of the USSR delineated by him and presented on the map are not a result of the subdivision of the country into smaller contiguous areas but represent the distribution of 58 units which can be treated as some kinds of types of farming, singled out mainly on the basis of differences in the structure of agricultural production, which are dispersed in the various parts of the USSR and therefore can hardly be called regions. Numerous regional studies of the USSR follow the same line (Mukomel 1972, 1979, Kryuchkov 1979, Parfenova 1979 and others).

Many of the studies presented above defined their systems, types of farms or production types by selecting the leading elements of given structures,

however no formal objective method of singling out such leading elements was outlined in any of them.

It was Weaver (1954a,b), who in his study on the dynamics of cropland use in the American Midwest, was the first to propose such a method. To do so he first computed for all the 1081 counties of the six Midwestern states the percentage of total harvested cropland, occupied by each crop, which held at least 1 per cent of the total cultivated land. Then he arranged these percentages in decreasing order and compared them with a standard theoretical distribution. Since the actual percentages of various crops in any area differed of course from any theoretical combination, the deviations of the real percentages of crops in the unit area, compared with a theoretical standard, were calculated by the author and allotted to that one in which the actual percentages showed minimum deviations from the theoretical values.

The minimum deviation was based on the standard deviation method expressed by the following formula:

$$b^2 = \frac{\sum d^2}{n}$$

where "d" is a deviation of the actual crop percentages in a given areal unit and the appropriate percentage in the theoretical curve, and "n" is the number of crops in a given combination.

Two years later Weaver together with some junior colleagues published a study on livestock combinations and regions of the same area (1956), in which the same method was used.

In time Weaver's concept has gained considerable popularity. Many studies have appeared without modifications (for example: Birukawa and Yamamoto 1964, Bhatia 1965, Islam 1965, H. Singh 1965, Keel Yong Hyun 1966, L.R. Singh 1966, Ahmad and M.F. Siddiqi 1967, Dayal 1967, Roy 1967, Mandal 1969, Powell 1969, Mohammad and Amani 1970, K.N. Singh and B. Singh 1970, S.C. Sharma 1971, Uzozie 1971, Husain 1972, P.L. Sharma 1972, A.H. Siddiqi 1972, Amaiya 1973, Mohammad 1975, T. Singh 1977, Bhattacharya 1981, Chakraborty 1981, Husain 1982) or with certain modifications, particularly in India.

Siddiqi (1967) evaluated and tested some of those modifications on material from India. Bielecka (1971) summarized those modifications and also appraised them. Already Siddiqi pointed out that "Weaver's method ... appears to be simple, but in practice it requires much calculation work ... it also tends to produce highly generalized results in areas of a large number of variants". By testing Weaver's methods and various modifications by Thomas (1963)

Rafiullah (1965) and Doi Kikukazu (1957), Siddiqi came to the conclusion that the results obtained by Thomas did not make a marked difference to the method, while the calculations were unnecessarily tedious. The results of Rafiullah's modifications are either identical or include a lesser number of crops than in the combination, while Doi's method gives the most realistic results. It can well be applied to both highly specialized areas and those where numerous crops are grown. Bielecka who has obtained and published some additional comments sent by Doi himself confirms that this diagnosis is correct. According to Doi his method could be more successful where the links between individual elements of a combination are real, than where such links are weak or non-existent. Elasticity is another value of that method, which does not make the use of a stiff scheme of theoretically conceived classes. In 1975 Siddiqi applied the Doi method in his study covering India.

In the following years further modifications of Weaver's method have appeared (Athawale 1966, Ayyar 1969); together with the previous ones they have been reviewed by Madjeed (1981).

The only study on the world scale that applies the crop combination concept in a very generalized way is that by Chang (1977), who points out that the use of Weaver's method without modification is impossible since it "would give tropical Africa and South Asia as many crops in the combinations as can be counted in these two regions. If the sum of the squares of the deviations is not divided by the number of crops, then the numbers of crops in the combinations ... are limited. This modified procedure was adopted by the author".

Most combination analyses attempt a reference to crop combinations with only two exceptions that determine both crop and livestock combinations. The first is Weaver's own study, mentioned above (1956), another is by Scott (1957) who has adopted Weaver's method with some modifications that according to him make the procedure more "objective and precisely repeatable".

The first and perhaps to date the only attempt to combine both crop and livestock combinations is that by Coppock (1964), who used the Weaver method with modifications by Thomas (1962). To group crops and livestock into farm enterprises, which occur in the less specialized British farms it was necessary to compare units described by dissimilar data, livestock with crops, and indeed different crops, the relative importance of which was not fully reflected by acreage. Therefore in order to combine crops and livestock other conversion units had to be used enabling both crops and livestock to be equated. Coppock decided to use standard labour requirements in which the theoretical

annual man days necessary for each crop or class of livestock provide a common measure.

It has already been noticed by some authors that Weaver's method has several shortcomings. Devised for the American Mid-West, where farms are large and highly specialized and where therefore only a few crops are cultivated, Weaver's method can produce very complicated results elsewhere - as can easily be seen in most of the Indian studies - where it has been applied to areas where farms are small and a greater number of crops is grown, some of similar or complementary character. Moreover, the inclusion into crop combinations of crops without any regard to their relative importance together with the treatment of all crops, even those covering over 1 per cent of the area, as if they were equal, falsify results. The modifications introduced later by other authors more or less improved that method but some shortcomings have still remained.

Another variant of the combinational analysis has been developed in Poland and given the name of "orientations". The term already used in Polish agricultural classification (see p. 13) is an equivalent of the German term "Richtung" or French "orientation" (e.g. orientation céréalière). The term has already been adopted in the Polish Land Utilization Survey (see p. 20).

As the primary concern of land-use studies is a rational use of land, this grouping was based on agronomic criteria, such as the requirements of crops with regard to natural conditions, position in crop rotation, labour inputs, etc. Thus the following grouping was introduced: (1) intensive (or intensifying) crops, (2) soil structure-forming crops, and (3) extractive (or exacting) crops. The rank of each group of crops is based on the dominance or co-dominance of the individual crop in each group. Since such a procedure has also several shortcomings, a new technique of successive quotients has been introduced (Kostrowicki 1970b, 1976b, Kulikowski 1981); which is largely modelled on d'Hondt's procedure used in some countries in counting the results of parliamentary elections. The hectarage under particular groups of crops is first divided successively by 1, 2, 3, 4, etc., until the desired number of classified places (quotients) is obtained. The result is presented by a formula showing the relative importance of both particular groups or crops.

The successive quotients technique has later been applied to establish land use classifications, based on the proportion between arable, perennial crops and permanent grassland as well as the orientations of livestock breeding (Szczęsny 1969). Finally, the method has been extended to define the orien-

tations of both total and commercial agricultural production, in which however various elements have been grouped according to their economic rather than agronomic criteria. Crops were grouped into food, fodder and industrial and animal production into meat, milk, wool, etc. (Szczęsny 1964, Kostrowicki 1970, 1976b, Biegajło and Kulikowski 1972, Kulikowski and Szyrmer 1978, Stola 1981). As the studies on agricultural orientations have been extended to include other countries, a double classification of world crops has been attempted (Kostrowicki 1964a).

Dramowicz (1979) formalized the procedure and introduced the following formula to express agricultural orientations:

$$\sum_{w=1}^6 w = \max$$

where w (the area under study) = $\frac{d}{i}$, $i = 1, 2, \dots, 6$ quotients;
 $d = 1, 2, \dots, n$ individual elements in a structure.

The method was also used in other countries (Ceron and Diniz 1969, Diniz and Ceron 1972, Diniz 1981, 1984, V.R. Singh and M. Lal 1974). Panda and Saxena (1973) and Panda (1979), who had tested both crop combination and crop orientation concepts in their studies carried out in India, expressed the opinion that the latter was more effective as it revealed some important crop combinations, such as with pod crops or various millets, ignored in Weaver's method because they were not grouped. In fact, the method could successfully be applied in any study, in which leading elements in structure are to be singled out.

LAND-USE SURVEYS CLASSIFICATIONS

Comparable to the concept of agricultural systems are some classifications proposed by various land-use surveys. In the Land Utilization Survey of Britain, carried out in 1930-1947 under L.D. Stamp (1948), which was the earliest of those covering large areas, only a few principal categories of land use were introduced. His example was followed in numerous studies carried out in various countries. In order to assist and to coordinate these, the Commission on World Land Use Survey of the International Geographical Union (IGU) was established in 1949. It was decided in order to ensure comparability of results that "the first objective of the survey will be to record the present use of land in all parts of the world on a uniform system of classifica-

tion and notation". To achieve that a master key was adopted "that should be enlarged, according to the needs indicated by local conditions and the scale, on which the survey is being carried out. The enlarged specification should always be one, which can be correlated with the master key" (Report ... 1952).

Many countries followed that line, developing the recommended classification according to their conditions, without losing comparability. The best examples of such an adaptation are the classifications used in the surveys carried out in Canada, South Africa, Sudan, Pakistan (see Jankowski 1975) and Malaysia. Also the 2nd Land Utilization Survey, carried out in 1961-1967 under Alice Coleman (Coleman and Shaw 1980), in spite of some deviations, particularly as far as non-agricultural categories are concerned, may also be included into that group. Some other land-use surveys, however, either considerably altered the classification proposed, or completely ignored the recommendations of the IGU Commission. Here the Japanese and Italian land-use maps should be mentioned, very successful but completely incomparable with those made in accordance with the Commission classification.

In contrast the Polish land utilization survey carried out in 1953-1970 went further (Kostrowicki 1960a, 1962). As far as the classification is concerned, as L.D. Stamp put it once (1964), the Polish maps consisted of two layers. The first one, seen at a distance, presented a familiar picture of land-use categories, as recommended by the IGU Commission, while the second layer, seen only at a close proximity, differentiated multiple subcategories within these categories, including several seldom seen on other maps, such as the social forms of agricultural holdings, their degree of fragmentation, crop rotation systems, land improvement, and also the orientation of arable land utilization (see p. 18)

Since 1960, following a growing cooperation with the other countries of East-Central Europe, the Polish methods have become popular there, but the classification had to be enlarged and adapted to their specific conditions (Kostrowicki ed. 1962, Sarfalvi ed. 1967, Vojvoda ed. 1975). Consequently, the full key of the map has reached about 300 items (Kostrowicki 1964c).

The classification applied in the World Atlas of Agriculture (1969) may also be mentioned in this Chapter, since - as no other agricultural attributes are presented on the maps - this is more a land-use atlas of the world than a genuine agricultural atlas. Although the Atlas is undoubtedly a great achievement, since it presents the agricultural land utilization of the whole world in a more or less comparable way, the classification adopted may raise many

reservations. First of all, such a very broad and varied category as "arable land", covering large areas of the world without any information as to what is cultivated, is treated as equal with such narrow categories as "spice plantations" or "agave plantations" etc., which cover very restricted areas. Also the combinations of land use (except the last two representing shifting cultivation) do not represent in fact any real combination, but only the statistical proportions between various land-use categories. It is astonishing that the Atlas ignores completely not only the classification applied in land-use surveys, but also all methodological achievements in agricultural classification, developed either by agricultural economists or geographers which are analysed in the present study.

In spite of that the original idea of Sir Dudley Stamp, who was a geologist by training, that because of a common classification and notation, land-use maps similarly to geological maps could be read everywhere and by everybody without much attention paid to the key has never come true, and the survey has not covered the whole of the world. The example of the Commission and its classification has exerted its influence upon many, even the most recent surveys, which are based almost entirely on the interpretation of satellite imagery as well as on computer processing of the data collected. The classification used by the US Geological Service in the maps of "land use and land cover for use with remote sensory data" (Anderson and others 1976, Anderson ed. 1977) may serve as the best evidence of that statement.

On the other hand, the classifications, reduced to what could be deciphered from satellite imagery have become poor, not so much in objects but in classes of a more synthetic character. In spite of a few successful attempts to interpret satellite imagery in order to arrive at the identification of some agricultural systems (Kedar 1982), no effort has been made to use these techniques in broader comparative studies. For what could be the need and desirable qualities of such a classification see Hill (1984). In any case it should be adapted both for the requirements of comparative studies and for the techniques which present-day research may have at its disposal. An attempt to produce such a classification though undoubtedly imperfect, based on experience from both the IGU Commissions of The World Land Use Survey and Agricultural Typology has been outlined and more fully explained by the present author (1983a,b).

Land use systems differ between themselves qualitatively, according to various forms of human activity, and quantitatively, first of all by their

intensity. All land-use systems of the World may be grouped into three principal categories: (1) bioproductive, (2) technoproductive, and (3) non-productive i.e. service systems. Within each of these categories numerous systems of a lower order have been identified. No quantitative basis of that classification was offered but the possibilities of the introduction of such a basis were discussed.

All agricultural classifications proposed by land use surveys should be treated as partial, as they do not refer to more than one section of agriculture i.e. land utilization. On the other hand, they frequently cover many more aspects than merely agricultural land use. Yet, land use maps may serve as an excellent basis for mapping in a comparative way the spatial distribution of the results of any classification.

AGROECOSYSTEMS

From the very beginning geography in general and agricultural geography in particular have dealt with certain complexes or systems. Therefore, when in the last decades the systems approach has become more and more popular, these new possibilities raised great hope and induced vivid discussion. The introduction of the systems approach into agricultural classification was discussed by the IGU Commission on Agricultural Typology from the very beginnings of its activity (Birch 1972, Olmstead 1970, Duckham and Masefield 1970a,b, etc.).

In his paper, sent to the 1968 Commission meeting in New Delhi Duckham presented the four "farming systems": (1) Perennial tree and shrub crops, (2) Tillage (annual crops with or without livestock), (3) Alternating between tillage and either grassland, fallows or bush, and (4) Grazing or Grassland (pasture and dominant livestock) subdivided into temperate and tropical, distributed according to their intensity and typical food chains. Then in the "spectrum" he characterized seven farming systems in terms of: (1) ecological influents (12 properties), (2) operational influents (3 properties), (3) local socio-economic influents and resultants (4 properties), (4) output, food chains, etc. (4 properties). Some of those are quantified, whereas some others are expressed in classes (high, medium, low, very low) or only described.

Since then the agroecosystems approach (although that name has not been used) has been developed mainly in the University of Reading whose publica-

tions include a special magazine "Agricultural Systems" and in several books on this subject (Dalton ed., 1975, Spedding 1975, 1979). In most of them, however, interest is concentrated on the internal and external interrelationships of various forms of agriculture or of agricultural systems. No new classification has been proposed but some agricultural systems already identified have been explained and described in terms of the systems approach with graphs showing characteristic interrelationships.

Subsequently energy (Leach in Duckham et al. 1976) and nutrients (Frissel 1978) flows have been included in descriptions of the systems. Bayliss-Smith (1982) has identified "seven types of agrarian society" and then to exemplify them he calculated energy inputs and outputs per ha as well as their efficiency in terms of energy yield, gross energy productivity, surplus energy income and energy ration. Putting the nutrients and energy together Simmons (1980) has arrived at six "farming types": (1) Extensive livestock farming, (2) Shifting cultivation, (3) Extensive arable farming, (4) Mixed farming, (5) Intensive agriculture, and (6) Large-scale recycling systems. As the author points out "the titles of the categories are quite familiar but the characteristics are less so. Each type has its own qualitative and quantitative types of nutrients flow, its energy source and intensity characteristics and an energy input-output ratio. With such a combination of features, it is scarcely practicable at present to give boundary levels for each measurement, nor, perhaps, are sufficient data yet available from all parts of the world".

While it may be true, as the author claims, that such a classification would make it possible to place agriculture within a general ecosystem classification, a possibility that is lacking in numerous other agricultural or land use classifications (for the discussion see Kostrowicki 1983b), it is also true that the criteria proposed elucidate only one side of the agricultural characteristics, important though it may be. Perhaps in the future, new measurements such as energy flows, nutrient flows of food chains could be substituted for some of the agricultural attributes applied in other classifications, including agricultural typology. At present, however, as the author has himself admitted, this is impossible, as sufficient quantitative data are not available.

AGRICULTURAL REGIONALIZATION

Along with agricultural systems, agricultural regionalization is one of the oldest concepts in agricultural classification. From the very beginning, however, very divergent views have been - and still are - held as far as both the very meaning of an agricultural region and the methods of regional delimitation are concerned. Some agricultural regionalizations have been based exclusively, or mainly, on a spatial differentiation of natural conditions. In others, natural conditions have been taken into account, along with agricultural activities or in some cases spatial differentiation of agricultural activities provides the sole basis of agricultural regionalization.

Quite early, however, it was realized that the spatial differentiation of natural conditions is not well reflected in differences in agriculture and therefore natural units and agricultural regions seldom coincide. As Birch (1954) puts it, "the use of purely physical criteria is both dangerous and unfruitful, since it presupposes rather than proves their influence on farming practices". This conclusion can better be proved by a study of agricultural activities independently of the conditions, in which they develop, and then by a subsequent analysis of their interrelationships by means of the correlation calculus, or otherwise. Rakitnikov (1970) added that "the confusion of one region - natural or agricultural - with another destroys the principal value of both by making their comparison impossible". One can also distinguish single-feature, multiple-feature and total regions (see p. 7). As one may see in the previous chapters quite often, spatial patterns of such classifications of agricultural systems, types of farming, crop combinations, etc. are also called regions.

Although it was Marshall (1787, see also Darby 1954) whose understanding of the concept of an agricultural region was quite modern, agricultural regionalization first developed in Russia. In 1793 Pleshcheyev subdivided Russia into three zones and characterized the agriculture of each of them. Arsenev (1818) divided Russia into 10 areas, based on climatic and soil conditions; these were supplemented subsequently (1848) with such criteria as: (1) the way and method of utilizing the land, (2) a surplus or deficit of agricultural production, and (3) fodder resources and animal husbandry (see Volskaya 1943, Jackson 1961 and Jensen 1967). These have been followed by other studies (Yermolov 1878, 1879, Fortunatov 1896, Chelintsev 1911, Skvortsov 1914 and others). Studenskiy (1925, 1927) presented an agricultural regionalization of

European Russia based on the spatial pattern of farming systems. In the same study he also subdivided the United States into 9 state groups or regions (see p. 13).

Agricultural regionalization continued to arouse interest in Russia also after the Revolution, since it was considered a useful tool in planning agricultural development (Knipovich 1925). In 1930 Yakovlev introduced a map of agricultural zones based largely on natural regions. The map was regarded as a preliminary step toward the anticipated reorganization of agriculture (Jackson 1961). After considering both the natural conditions and economic data, the map of 44 agricultural regions was drawn by the Academy of Sciences (see Jackson 1961). In the following years several maps of planned zones of the specialized agricultural production of the USSR were devised (see Rakitnikov 1959, 1973, Nikishov 1960, Krylov et al. 1964, Rakitnikov and Mukomel 1964, Rakitnikov and Kryuchkov 1966, Mukomel 1968, Nikishin 1969). Finally Rakitnikov's agricultural regionalization of the USSR (1970, 1972b, 1975a, 1979) should be reminded here (see p. 15). A number of regionalizations of selected areas have also been carried out.

It is an interesting fact that in more recent times some Soviet scholars have continued to share the interest of their "forefathers" in the agricultural regionalization of North America (Zhukovskaya 1964, Zhukovskaya, Karpov 1968, Zhukovskaya, Kuzina 1971, 1973, Zhukovskaya, Kriuchkov, Kuzina 1975) using modern taxonomic quantitative methods.

In some other countries most of the agricultural regionalizations have also been started by combining natural conditions and agricultural attributes. In Germany, the concept of agricultural zones (Landbauzonen) developed by Engelbrecht has gained considerable prominence. The concept was first applied to North America (1883), then to nontropical countries (1899). The delimitation of those zones was based upon importance of the leading crop in relation to the next higher category, such as wheat to grain or grain area to cropland. Subsequently Eckhard and Hennig (1911) described agricultural zones of the tropics, basing primarily on the climatic conditions, and then the impact of vegetation, animal world and man's economic activities. In 1930 Engelbrecht summarized the whole experience in a monumental work on the world agricultural zones. Though each zone was named after major crops, they coincided roughly with climatic zones. All of them were grouped into three larger "tropical", "subtropical" and "extra tropical" zones.

In the meantime the concept of Landbauzonen spread over various areas, such as Europe (Troll 1925), Finland (Cajander 1927), France (Bernhard 1927), Austria (Bernhard 1931) and Germany (Busch 1938).

Some attempts at agricultural regionalization in Poland were made in the interwar period (Ernst 1932, 1934, Sowiński 1935, Dziedzic 1937, 1939, Ponikowski 1937, Piekałkiewicz and Rutkowski 1937). Since World War II even more studies on this subject appeared considering theoretical and/or methodological problems as well as the practical utility of agricultural regionalization (Te-picht 1953, Gałęski and Szemberg 1953, Urban 1960, Około-Kużak 1965, see also Niewiadomski 1979). Some attempts have also been made to use various taxonomic methods, either diagraphic ones (Fierich 1957, Steczkowski 1966) or factor analysis (Zeljaś 1968, 1970). Several schemes of agricultural regionalization of Poland have also been devised based on the typological concept in its various stages (Kostrowicki 1970c, 1978a, Kostrowicki and Szczesny 1972b, see also the National Atlas of Poland 1976).

In Hungary (Enyedi 1961) another method of agricultural regionalization was proposed; it is based on a number of scores representing values of crop and animal production per unit area multiplied by correlation coefficients expressing the ratio of a given crop, or of animal production, to the total value of crop or animal production in a given unit area.

In France, it was Klatzmann, whose contribution to the methodology of agricultural regionalization was the greatest. Already in his monographic study (1952) he presents a regional division of French agriculture. Later on in his important methodological study (1973) he groups by means of a computer programme several hundred small agricultural regions to arrive at 21 homogeneous large agricultural regions (see also 1972).

Several attempts at the delimitation of agricultural regions for the EEC countries have also been made (Agricultural Regions ... 1960, Bertrand 1978).

Two agricultural regionalizations of Norway (Sømme 1949 and Nordgard 1977) and of Denmark (Kampp 1970) have to be mentioned. From the methodological point of view, however, two Norwegian papers by Byfuglien and Nordgard (1973, 1974) should be considered as particularly important. In order to produce regions by the aggregation of basic areal units according to their similarity, they applied and tested six different quantitative taxonomic methods. They concluded that: "typification should give the best basis for possible discovery of causal facts which explain the geographical distribution we study

Typification and regionalization are not competing but complementary procedures serving different purposes".

In Britain, as elsewhere, most of the earlier agricultural regionalizations were based exclusively, or mainly, on natural conditions (see Grigg 1969). Later on the grouping of types-of-farming into farming-type regions became the most popular procedure. The same can be said about some regionalizations carried out in some other countries of the British Commonwealth (Freeman 1945, Cumberland 1948, Gillmor 1967, Scott 1957, 1961a,b).

Much more attention has been paid to agricultural regionalizations in India (for the review see Roy 1972, L.R. Singh 1975 and Mukhopadhyay 1981). Similarly a number of such regionalizations have been based on both natural conditions and agricultural activities, or on grouping crop combinations; some original Indian solutions have also been proposed (Sen Gupta 1968, P.S. Sharma 1971, J. Singh and S.S. Dhillan 1984). Here the Kulkarni study on Maharashtra (1968) deserves special attention; the regionalization based on 9 "indicators" representing various agricultural attributes was carried out by means of principal component analysis.

In Japan, the agricultural regionalization sprang up from a general economic regionalization (see Birukawa 1962, 1966, Ishii 1969 and Shirahama 1970). Different criteria have been used by various authors, ranging from crop combinations (Birukawa and Yamamoto 1964), and farming management intensity (K. Watanabe and Nobei 1953) to land productivity (Yokeno 1956), agricultural income, etc.

A very comprehensive and detailed agricultural regionalization of South Korea (Chung-Myun Lee 1970, 1973) should also be mentioned here. Four groups of criteria (land use and farm management, size of management, intensity of management, and pattern of land ownership) expressed in 44 indicators applied to over one thousand units served as a basis for the delimitation of 17 truly total agricultural regions.

Some attempts have also been made at an agricultural regionalization of China (Hoyanagi 1971, Deng 1982). A few studies could also be mentioned from Latin America (Berry and Pyle 1970, Mesquita and Silva 1970, Winsberg 1970, see also Diniz 1984).

In the United States after a series of relatively simple studies on cropping and livestock raising regions, explained mainly in terms of environmental factors (Smith, Baker, Hainsworth 1915, Finch, Baker, Hainsworth 1917), it was Baker (1922, 1926) who provided a sound agricultural regionalization

of the USA, using names, some of which such as "Cotton Belt" and "Corn Belt" had already been in common everyday usage. Baker defined an agricultural region as "a large (sub-continental) area of land characterized by homogeneity of agricultural conditions, especially crops grown, and sufficient dissimilarity from conditions in the adjacent territory as to be clearly recognizable".

Inspired by Baker (1926) an impressive more detailed and refined regionalization of American agriculture based on the type-of-farming concept was completed by Elliott (1933) and his co-workers. Twelve major "type-of-farming regions" and one hundred subregions were outlined. In 1950 a revised, less detailed version of agricultural regionalization, which comprised 9 major agricultural regions and 61 sub-regions was produced. For the map and the description of major regions see Marschner (1950, 1959). See also Haystead and Fite (1955).

Baker's work also inspired an imposing series of empirical studies on the agricultural regions of the continents, in which he also took part. Throughout 18 years (1925-1943) studies of the following continents were published in "Economic Geography": Europe (Jonasson 1925-1926), North America (Baker 1926-1933), Latin America (C.F. Jones 1928-1930), Australia (Taylor 1930), Asia (Van Valkenburg 1931-1936 together with Cressey 1934 and Hall 1934) and Africa (Shantz 1940-1943). The material contained in these studies is very rich. However, since they represent not only different periods of time, but also a different scholarly level and degree of detail, as their authors were of different backgrounds, introduced different criteria and methods of regionalization, the results are hardly comparable.

In 1935 an attempt was made (Hartshorne and Dicken) to delineate the agricultural regions of North America and Europe on the uniform statistical basis. It was probably the first attempt of a comparative study of agriculture of two continents, based on statistical measurements, referring mainly to the relative importance of different crop and livestock products.

The most important step towards agricultural classification on a world scale was made by Derwent Whittlesey (1936). His classification is based on a broad range of agricultural activities such as "(1) crop and livestock combinations, (2) methods employed to grow crops and husband livestock, (3) the intensity of application to the land of labour, capital and organization, (4) the method of disposal of the farm products, (5) the farm buildings and structures commonly found necessary to carry on the agricultural activities". Basing on these criteria he distinguished 13 major agricultural regions of

the world. He also indicated in a possibly most accurate way how the criteria should be applied to include a given agriculture in one or another region; however, he suggested no quantitative measurement for those criteria, in spite of the fact that some of them were easily quantifiable.

Whittlesey expected that geographers would attempt in the future to give some form of quantitative expression to the system he had devised. He was also under no illusion about the temporary value of his classification and the modifications which it must undergo. Because of the sound, logically selected and clearly defined criteria covering a broad range of agricultural activities Whittlesey's classification was certainly superior to any other applied previously. From the present-day point of view it is not void of some deficiencies (for the discussion see Laut 1968). The most important of them is certainly negligence of both social attributes of agriculture and of the scale of operation. As far as the present definition of agricultural regions is concerned, his classification could hardly be called regionalization as, with a few exceptions, his regions are not contiguous but scattered over several continents. Also because of the sequential arrangement of his "regions", from the most primitive to the most advanced, the Whittlesey concept is not very far from that of agricultural systems. In fact Whittlesey himself, who did not pay much attention to terminology, often used "systems" alternatively with "regions".

In spite of those deficiencies Whittlesey's classification has gained a very great popularity and has been widely used until now, without or with some modifications, in numerous studies, books, and atlases, at least in English-speaking countries. Most modifications consist in changing in some way or other the proposed criteria. Only Helburn (1957), Whittlesey's former student convinced that the criteria should not be too numerous but according to the theory of classification should contain the maximum of accompanying criteria, proposed the following three groups of criteria: 1) relation between crop and animal production, 2) inputs of labour per unit area, and 3) commercialization, and in addition: the degree of specialization and settled or migratory habits.

Since Grigg (1969) published a very comprehensive analysis of these modifications, the present author will only summarize briefly the content of his study and draw a few conclusions. After the necessary introduction Grigg first discusses the terminology applied, the purposes and methods of agricultural classifications and then in several tables he compares the criteria put

forward by some authors (Whittlesey 1936, Helburn 1957, Kawachi 1957, Rakitnikov 1962a, Thoman 1962, Kostrowicki 1964b), agricultural regionalizations proposed by several authors (Whittlesey 1936, Timmons 1944, Van Royen 1954, Kawachi 1957, Thoman 1962, Fryer 1965 and Oxford World Economic Atlas 1959), types of agriculture by others (Lynn Smith 1953 and Farmer 1970) and "agricultural forms" as devised by Hahn (1892), Sapper (1925) and Gregor (1963).

Finally, world maps of agricultural regions, forms, zones or systems are reproduced (Hahn 1892, Sapper 1925, Engelbrecht 1930, Whittlesey 1936, Timmons 1944, Van Royen 1954, Kawachi 1957, Oxford Atlas 1959, Thoman 1962 and Gregor 1963). Grigg concludes as follows: "The typologies arrived at in these different schemes show considerable similarity, which is not surprising as they mostly appear to be derived from Whittlesey's work". But there are also "some significant differences" particularly with those of a quite different tradition based on the system introduced by Eduard Hahn in 1892". It should be added that quite different criteria and a different regionalization were also proposed by Kawachi (1957).

In the last part of the paper Grigg examines the possibilities and ways of revising the existing classification. There is no room in the present study to discuss his concepts and views, many of which are fully acceptable. In any case Grigg is right that a new more comprehensive and accurate classification could hardly be devised by one individual. It could be done only in an organized way, basing on the cooperation of many individuals, which is by no means easy. Here the IGU Commission of World Land Use Survey has provided a good example. In fact this example as well as many other experiences drawn from various agricultural classifications have been used to devise a new approach to an agricultural classification - agricultural typology.

AGRICULTURAL TYPOLOGY

As one can see from the above, the terms "types" or "typology of agriculture" have already been used not only in the types-of-farming concept but also by Faucher (1949) and some American geographers (Zobler 1965, Dicken and Pitts 1970) in their classifications of world agriculture. The typology concept elaborated in 1964-1976 by the IGU Commission on Agricultural Typology, while based on all earlier experiences, is the only one which introduces a completely new approach to agricultural classification.

The idea of organizing international co-operation in the field of agricultural classification emerged from a lively discussion held on a paper read by Kostrowicki (1960b) at the 19th International Geographical Congress in Stockholm. One of the participants in the discussion was Nicholas Helburn. In the subsequent years with his co-operation the idea was developed and the proposal to the IGU Executive Committee to create the Commission on Agricultural Typology was prepared, submitted and then approved by the General Assembly of the Union in 1964.

During the twelve years of its activity (Kostrowicki 1979) the concept, criteria, methods and techniques of agricultural typology were elaborated and tested in numerous studies on all continents followed by consecutive schemes of world types of agriculture (Kostrowicki 1964b, 1966a, Kostrowicki, Helburn 1967, Kostrowicki 1972, 1973, 1975b, 1976c, 1977, 1978b, 1980). About 140 people representing 45 countries and 5 continents took part in the Commission's activity. Numerous methodological and regional studies were published in the proceedings of the Commission meetings (Kostrowicki, Tyszkiewicz - eds 1970, 1979, 1983, Vanzetti - ed 1972, 1975, Reeds - ed 1973, Rakitnikov et al. - eds 1976) or elsewhere (Enyedi 1964, 1965, Stola 1968, 1974, Diniz 1969, 1980, Molnar 1969, 1973, Ceron and Diniz 1970, Keller 1970, Kruglova and Hoffmann 1971, Rikkinen 1971, Anderson 1972, 1973b, Pecora 1972, Rakitnikov 1972, Dongmo 1973, Kamp 1973, Matusik 1973, Gregor 1974, Jaćimović 1976, Bonnamour and Gillette 1980, Tyszkiewicz 1980, 1982, Szczesny 1982, Hill 1983, B.L. Sharma 1983a,b, Gałczyńska 1984, Szyrmer 1984), marking the development of the concept and methods concerned. Because of financial difficulties, however, the intended mapping of types of agriculture on the world scale did not pass beyond the initial stage.

Though the Commission was discontinued in 1976, the idea has not been abandoned. In the subsequent years several improvements have been introduced to the method and techniques of agricultural typology and many new types of agriculture described. Already in the early stage of the Commission's activity it had been agreed that the typology should be of total character and cover all important aspects of agriculture, be based on firm criteria expressed in a measurable way, and be of an aggregative character. It has also been assumed that agriculture should be considered as a complex or system, in which all of its components were interconnected and interrelated. Consequently individual agricultures, understood as such complexes or systems, might be compared with one another and then grouped into types according to their similarity.

Following such assumptions it has been accepted that the type of agriculture is to be understood as: (1) a more or less established form of crop growing and/or livestock breeding characterized by an association of its attributes, (2) a total or overall concept in an agricultural classification combining all partial classifications such as land tenure systems, land use systems, crop or/and livestock combinations, farming systems, types of farming, etc., (3) a hierarchical concept comprising types of various orders from types of farms, identified on the basis of the classification of individual holdings, through several intermediate orders to the types of world agriculture as the highest order, identified on the basis of various aggregates, (4) a dynamic concept, which involves changes in an evolutionary or revolutionary way along with a change of agricultural attributes.

Irrespective of the order and area concerned, to retain comparability of results, both in space and time, the identification of agricultural types should always be based on the same criteria, that represent internal attributes of agriculture expressed in a quantitative way.

There are two important methodological problems with which every scholar is faced when starting work on agricultural typology, namely: (1) the choice and adequate expression of variables to represent agricultural attributes, and (2) the choice of a technique for comparing and grouping into types - according to their similarity - the individual basic units of study, each characterized by a set of such variables.

Agricultural attributes may be expressed as a countless number of variables. To retain comparability and equilibrium between various attributes it was decided to select purposefully a limited number of variables of a synthetic or composite character, as much as possible significant, representative and universal, covering all aspects of agriculture (for the discussion see J. Kostrowicki 1977, 1980).

After a long discussion it has been decided that agricultural typology should be based on the four principal groups of agricultural attributes: (1) social and size of operation, (2) operational, (3) production, and (4) structural ones, and that each of those groups will be described by 7 variables (Table 1). These variables are to be presented as a code with 28 digits each representing a class (0 to 5) of the World range of a given attribute (Table 2).

The second methodological problem was to select the best possible method of comparing and grouping into types the individual units of studies described by such codes. To arrive at a proper selection, a number of taxonomic methods

and techniques, applied in various disciplines or newly offered, were tested by a combined group of geographers and mathematicians (Bielecka, Paprzycki and Piasecki 1975, 1979, 1980, 1981, Bielecka and Paprzycki 1979, see also Kostrowicki 1980).

One of the conclusions drawn from these investigations is that all mathematical methods tested are more or less effective for a single set of units only, while any addition or subtraction of one or more units may alter the effects of the whole classification. Consequently none of those methods can meet the principal requirement of agricultural typology as of many other classifications, that their results should be comparable both in space and time. Therefore the deviation method which is one of the methods implying terms of reference, has been adopted and recommended, at least until a better method ensuring comparability of results is devised. With that method codes representing sets of variables, compiled for any unit of a study are compared with the codes established in the same way for the model types of agriculture based on the study of several thousand cases covering the whole world. When the taxonomic distance between the code representing a unit under study and a model code does not exceed the arbitrarily adopted maximum, the agriculture of that unit is considered as being of the type represented by that model-code.

By use of the methods and techniques, characterized very briefly above, 6 types of the 1st order, 24 types of the 2nd order, and over 100 types of the 3rd order have been identified to date and described by model codes. While it is doubtful that more types of the 1st order can be identified, it is certain that a number of types of the 2nd order and particularly these of the 3rd order can be singled out especially in the countries that have not yet been more thoroughly investigated.

Since it is impossible to use all 28 variables that characterize individual types of agriculture to build their names, the names of the types as quoted here (Table 2) have been formed on the basis of a few of their most distinctive characteristics. To make them even more handy, a symbol is ascribed to each type in the form of one capital letter for the types of the 1st order, one capital and one small letter for the types of the 2nd order, and one capital and two small letters for the types of the third order. For the codes for the types of the 1st and 2nd orders see Table 3.

As any other method the typological method is also not without some deficiencies, which could probably be eliminated in the future. Its two weakest points are: the way in which the model types are established and arbitrary

decisions concerning maximum taxonomic distances. But even the most sophisticated quantitative methods are not without some arbitrary decisions.

Though the Commission was discontinued, the idea of mapping types of world agriculture has not been abandoned. Since it is a well known fact that the most convincing is to set a good example, some former members of the Commission started to work on a map of Europe on the scale 1:2.5 million, without support from any international organization. The draft of the map has been presented at several international meetings (1982) and then the map in a printed form in 1984 to the 21st International Geographical Congress in Paris. The map (Kostrowicki 1984) is based on statistical data collected by over 20 scholars from various countries for over 870 administrative or agricultural units. All the 6 types of the first order have been identified in Europe, at least in a residual or transitional form, 15 types of the 2nd order, out of the total of 24, described to date, and about 60 types of the 3rd order.

Though the Types of Agriculture Map of Europe is static, since it represents one period only (1975-1980), the dynamic character of the classification has made it possible to draw certain conclusions as to the current changes in European agriculture (Kostrowicki 1982, 1984), confirmed by the dynamic studies or data collected for some countries, e.g.: France, Austria, Belgium, Norway and Poland (Kostrowicki 1974, Stola 1975, Szczesny 1978a,b, 1981a,b, 1983, Bonnamour *et al.* 1984).

More interesting conclusions as to the tendencies and rates of development could certainly be drawn, if typology is carried out repeatedly every decade or so for a longer period. Until now, however, the studies mentioned above covered at most a period of only a few decades. Only recently has the first successful study been made that covers some 150 years of evolution of the Caribbean sugar plantations (1827-1975), from the slave plantation to the modern market-oriented or socialized ones, through various intermediate stages and types (Dembicz 1984). The study is an evidence that the typological method is also valid in historical investigations.

Such dynamic comparative studies, based on a firm methodology, may provide some conclusions as to the way in which agriculture passes from one stage of development to another. Besides their cognitional values such studies may also be of some practical significance. By comparing trends, tendencies and the rate of development of agriculture in some areas or countries evolved in comparable external conditions, conclusions may be made as to why agriculture in certain areas lags behind, while it is rapidly developing in others, and

then what may be done to eliminate such underdevelopment by changing either some agricultural attributes or some external conditions. In fact, some comparative studies of that kind have already been made (Stola 1983). The typological methods may also be useful in forecasting, programming or planning agricultural developments (for examples see Kostrowicki 1966b, 1968, 1974, 1975a, 1976a, Gervaise et al 1975, Szczesny and Szyrmer 1978).

CONCLUSION

A great number and variety of agricultural classifications presented above - and still many more omitted - point out to a considerable interest in this kind of synthetic studies. Now, the question can be posed which of them may be considered the most valuable. There is not - and could not be - a direct answer to that question, since the value of any classification depends largely on the objectives for which it is designed. Generally speaking, as it has already been pointed out, these might be either scientific or practical objectives, or both.

The first and the most important is probably the scientific purpose that aims at increasing our knowledge of agriculture and its differentiation in space and time. The second is the application of some classifications in solving various practical problems such as farm management, and agricultural and spatial planning at various levels. The third might be the combination of both.

The classifications realizing the first purpose are usually interested not only in the present-day agriculture, but also in its origin and past evolution, the classifications for the second are chiefly oriented towards the future. To increase our knowledge is to expand it and to make it more profound. With this purpose in mind classifications covering the whole field of agriculture and larger areas seem to be the most effective.

In the past, several concepts of agricultural systems, arranged in an evolutionary way and able to explain the origins, further development, expansion or retreat and sometimes disappearance of certain agricultures, seemed best to serve that purpose, particularly if firm and uniform criteria of such classifications were offered. Also some kindred classifications, like that by Whittlesey have greatly contributed to a better knowledge of world agriculture in his time. However, if precise instructions how to classify individual cases (Spencer) were provided, sound quantitative bases to make comparisons possible

were lacking. Although it is true that a good specialist, with a deep knowledge of the problems and of the area concerned, can produce an excellent classification, without using any quantitative base, it is also true that nobody else, not even the same scholar, is likely to obtain the same results after some lapse of time, because the way of thinking and interpreting facts cannot be repeated. It would be even more difficult to obtain in this way comparable results for another area or another period of time. This is why the excellent, as it were, classification of Whittlesey has been repeated for such a long time, almost without changes, and a comparable classification for another period has never been decided, although world agriculture has since undergone considerable transformation. Only the use of quantitative data and techniques can guarantee that the same method, when applied to the same data, will always yield the same results, and will give comparable results when applied to another area or another period of time. Therefore, only those classifications that are based on firm criteria as well as on quantitative bases and methods, which make full comparability of results in space and time possible, meet completely the requirements of scientific objectives.

Much less effective from the point of view of scientific rigour is regionalization in which the homogeneity of the delineated units must be sacrificed to contiguity constraint. On the other hand some partial classifications may be of value for scientific purposes as they can penetrate more deeply into the differentiation of such partial problems as land tenure, land use, systems of crop growing and livestock breeding, structures of land and/or cropland use, input and output and in the commercialization of agriculture etc.

On the other hand, classifications devised to serve practical purposes have to be closely related to them. In most cases these are partial classifications that cover restricted areas required to draw practical conclusions. The most valuable are classifications of agricultural holdings, since they are, in fact, the only real units of operation. Here quantitative bases and methods are even more important to produce meaningful practical conclusions. Here also agricultural regionalization could be useful, particularly in the countries where the differentiation of agriculture on a regional or national scale is sharper than that between the adjacent agricultural units or small areas. This is particularly true of countries where large-scale specialized agriculture prevails, such as North America or the USSR. On the other hand, in small-scale agriculture, particularly but not only of traditional, semi-subsistence or semi-commercial character, differences in land tenure, sizes

of farms, labour and capital inputs as well as in land and/or cropland use, are often greater within, say, a village or a small area than between the averages for villages or areas. In such cases modelling agricultural enterprises is usually more effective as a tool in agricultural planning than agricultural regionalization. For obvious reasons such classifications are valid for restricted area at most on a national scale and therefore they require comparability in time but not necessarily with other countries or regions.

However, there are some cases when an agricultural classification, covering more than one country, can be of practical importance. Such is the case of international organizations as the EEC, for which several farm classifications have already been made.

But this could also be of practical utility in the long term planning of individual countries, in which it is very practical to get acquainted with the experiences of other countries, particularly those that have already achieved a higher level of development in comparable environmental conditions. In such a case an agricultural classification ought to be compared with those of other countries devised by the same method. From such comparisons one can learn which agricultural attributes have been responsible for the better development of these countries, and which have hampered development in a home country. From such comparisons one may draw conclusions concerning the barriers which should be overcome, the weak points to be eliminated or reduced. This approach is particularly important for countries in which agriculture is not developed, as it could be, i.e. in various countries in which more or less traditional, subsistence, semi-subsistence or semi-commercial forms of agriculture still dominate or at least play an important role.

The typological concept and method, devised by making use of all the experiences of previous classifications seem to meet best both scientific and practical purposes of such comparative studies, at least as far as the total classification is concerned.

Table 1. Variables used in agricultural typology

A. Social attributes

1. Percentage rate of land held in common in the total agricultural land
2. Percentage rate of land in labour and share tenancy in the total agricultural land
3. Percentage rate of land owned by private persons (irrespective of the land tenure system) in the total agricultural land
4. Percentage rate of land operated by the consciously planned collective or state enterprises in the total agricultural land
5. Number of people actively employed in agriculture per 1 agricultural holding
6. Amount of agricultural land in hectares per 1 agricultural holding
7. Amount of agricultural gross production in conventional units per 1 agricultural holding

B. Operational attributes

8. Number of people actively employed in agriculture per 100 hectares of agricultural land
9. Number of draught animals (horses, mules, asses, oxen, buffaloes - if used in agricultural work) in conventional draught units per 100 hectares of cultivated land
10. Number of tractors and other self-propelling machinery in HP per 100 hectares of cultivated land
11. Amount of chemical fertilizers in pure content (NPK) per 1 hectare of cultivated land
12. Percentage rate of irrigated land in the total cultivated land
13. Percentage rate of harvested land in the total arable land (including fallow)
14. Number of farm animals in conventional (large) animal units per 100 hectares of agricultural land

C. Production attributes

15. Total agricultural production in conventional units per 1 hectare of agricultural land
16. Total agricultural production in conventional units per 1 hectare of cultivated land
17. Total agricultural production in conventional units per 1 person actively employed in agriculture
18. Commercial (delivered off farm) agricultural production in conventional units per 1 person actively employed in agriculture
19. Percentage rate of commercial agricultural production in total agricultural production
20. Commercial agricultural production in conventional units per 1 hectare of agricultural land
21. Degree of specialization in commercial agricultural production

D. Structural attributes

22. Percentage rate of perennial and semi-perennial crops in the total agricultural land
23. Percentage rate of permanent grassland in the total agricultural land
24. Percentage of land under food crops in the total agricultural land
25. Percentage rate of animal products in total agricultural production
26. Percentage rate of animal products in commercial agricultural production
27. Percentage rate of industrial crops in total agricultural production
28. Percentage rate of herd (herbivorous) animals in the total number of farm animals in conventional, animal units

Table 2. Types of Agriculture

I order / II order

- E. Traditional Extensive (Primeval) Agriculture
 - En Nomadic herding
 - Ef Shifting cultivation
 - Et Current fallow agriculture
- L. Traditional Large-Scale (Latifundia) Agriculture
 - Ll Traditional latifundia
 - Lp Traditional plantations
- T. Traditional Small-Scale (Peasant) Agriculture
 - Ti Labour intensive agriculture with crop growing prevalent
 - Tm Mixed agriculture
 - Ts Semi-commercial mixed agriculture
 - Tf Semi-commercial fruit crop agriculture
- M. Market Oriented Agriculture
 - Ms Small-scale perennial industrial crop agriculture
 - Mi Intensive specialized crop agriculture
 - Mm Mixed agriculture
 - Ma Specialized in livestock breeding
 - Ml Large-scale capital intensive agriculture
 - Me Large-scale extensive agriculture
- S. Socialized Agriculture
 - Se Incipient socialized agriculture
 - Sm Mixed agriculture
 - Sg Dual-purpose agriculture
 - Sa Specialized in livestock breeding
 - Si Labour intensive agriculture
 - Sh Socialized horticulture
 - Ss Specialized perennial crop agriculture
 - Sc Extensive specialized crop agriculture
- A. Highly Specialized Livestock Breeding
 - Ar Extensive livestock grazing
 - Ad Highly industrialized livestock breeding

Table 3. Model codes for the types of the Ist and IInd order

I.	E	5321311 - 1111121 - 1221111 - 1333314
	L	1551354 - 2211132 - 2334422 - 1323424
	T	1241222 - 4412242 - 4422221 - 1142213
	M	1151233 - 2154343 - 4455544 - 1223313
	S	1115555 - 3243242 - 3333433 - 1242214
	A	1133445 - 3000003 - 3045535 - 1515513
II.	En	4211201 - 1100121 - 1221112 - 1414515
	Ef	5321221 - 1111111 - 1221111 - 1151114
	Et	2441211 - 2211132 - 2311211 - 1322214
	Ll	1551354 - 2211132 - 2333323 - 1243314
	Lp	1351444 - 4411142 - 3333434 - 3332133
	Ti	1241212 - 5311452 - 5511221 - 1141113
	Ts	2241222 - 3212231 - 2222325 - 3131132
	Tm	1151222 - 4423143 - 3321321 - 1242314
	Tf	1151112 - 4254142 - 3422432 - 5131134
	Ms	1151333 - 3113341 - 4433444 - 5111142
	Mi	1151212 - 5145451 - 5545555 - 2151112
	Mn	1151222 - 3154143 - 4444443 - 1223313
	Ma	1151143 - 2153144 - 3455535 - 1515514
	MI	1151355 - 2154341 - 4455544 - 2132234
	Me	1151254 - 1152132 - 1255525 - 1342214
	Se	1115343 - 3232131 - 2222321 - 1242214
	Sm	1115555 - 2143143 - 3333432 - 1333313
	Sa	1115455 - 3255144 - 4444445 - 1515514
	Sg	1115554 - 4434342 - 2312423 - 1412335
	Si	1115555 - 5422343 - 4522232 - 1141112
	Sh	1115545 - 4155441 - 4434554 - 2151112
	Ss	1115555 - 2133442 - 3344535 - 4112144
	Sc	1115555 - 1142131 - 1234515 - 1151114
	Ar	1133455 - 1000001 - 1033515 - 1515515
	Ad	1133415 - 5000005 - 5055555 - 1015513

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POSTSCRIPT

As since the time, when the review presented above was elaborated (1985) and the proceedings of the Rabat symposium published (Troughton, 1986), no answer from UNESCO to the project proposal submitted in 1987 was received, much more modest project was initiated and carried at the Institute of Geography and Spatial Organization, Polish Academy of Sciences, namely to work out the types of agriculture map of the world to the scale of 1:15 million. Such a map would serve however not so much the developmental, but rather educational purposes.

The programme was approved and the respective funds were granted by the Polish Academy of Sciences. The studies started in 1986. The cooperation with the number of scholars from various geographical and/or agricultural institutions, Polish and foreign has been developed.

To make the materials collected by various people fully comparable special guidelines were elaborated (Kostrowicki and Szyrmer, 1988) and distributed to the participants. The French version of the guidelines has also been prepared to be edited by professor J. Bonnamour, at the Ecole Normale Supérieure, Fontenay-aux-Roses. The second improved edition of the English version is under elaboration.

As far as the techniques of the materials elaboration are concerned it has been decided, that for the countries having available and reliable agricultural statistics, the example of the Types of Agricultural Maps of Europe will be followed. However for the countries for which sufficiently detailed and/or reliable statistics are lacking the procedure has to be different. There, following the example set by R.D. Hill (1982, 1983, 1986) various other sources as maps and atlases could be used, as well as case studies published either as books or articles in various geographical, agricultural and other periodicals. While most of them would not provide much of desirable material a considerable part could certainly provide some useful material. In fact quite a number of typological studies have already been made for various countries and regions of the world. References to the most recent ones are listed at the end of this script.

As far as the statistics are concerned, while complete and fully reliable data are available for North America, Australia and New Zealand, the greatest problem is Asia. There, for some countries such data not only exist but like in India were already used for a number of typological studies. Good, reliable statistical data are also available for Japan and some other countries. As far as China is concerned the agreement has been made with Chinese geographers to elaborate by themselves the typology according to the adopted method. On the other hand there are countries for which, for various reasons, necessary data

are either non-existent or not available. The same could be said about most of African countries. There for some countries the typology could be made only based on either estimates or case studies already made of various detail and reliability.

At first the investigations have been concentrated on North Africa and the Near East, followed by the remaining part of Africa and Latin America. At the same time contacts have been made with several other countries. Also the materials collected by various international or national scientific and other institutions could be explored. Particularly rich materials have been accumulated and are available in FAO.

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