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THE DIFFUSION OF AGRICULTURAL INNOVATIONS IN TÜRKİYE: THE İZMİR CASE

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ÖZET

Türkiye'de Yeni Tarım Yöntemlerinin Yaygınlaşmasına İzmir Örneği

İzmir çevresinde, özellikle kentin batısındaki kıyı düzlüklerinde geniş sera alanları vardır. Ancak kıyı gerisinde yükselen dik yamaçlar seraların içerilere doğru fazla yayılmasını engellemiştir. Türkiye'de seraların bir "sera denizi" gibi geniş alanlar kaplaması, batı Akdeniz ülkelerinden sonra olmuştur. (HÜTTEROTH 1982, STRUCK 1986). Fakat kent nüfusunun ve buna bağlı olarak sebze ve meyve gereksiniminin hızla artaması nedeniyle sera alanları burada daha hızlı bir genişleme göstermektedir. Isıtma ve sulama sistemlerine sahip, basitçe plastik kaplanmış veya çelik konstrüksiyonlu cam seralar üretim koşullarını ve olanaklarını önemli ölçüde değiştirmiştir. Bu yazıda seraların yalnız kapladıkları alanların görünüşünde yaptıkları değişiklikler değil, işleyiş düzenleri ve bunları etkileyen faktörler ekonomik bakımdan da incelenmiştir.

Sonuç olarak.—1) Akdeniz çevresinin bütününde olduğu gibi Türkiye'de de kent nüfusu oranı ve buna bağlı olarak sebze ve meyve gereksinimi artmaktadır. Bu gereksinimi karşılamak için son yirmi yılda, özellikle Türkiye'nin batı ve güney kıyı bölgelerinde tarımsal üretimi artırma girişimleri olmuştur. Çeşitli yeniliklerin benimsenmesiyle yüksek verimli arazi kullanımı, düşük verimli arazi kullanımını kent merkezlerinden uzaklaştırma, ayrıca oralarda da düşük verimli tarım alanlarında arazi kullanımı değişmiştir. 2) Üretimde büyük artışa neden olan, üretim yöntem ve özelliklerini temelden değiştiren yenilik, meyve ve sebzelerin üstü örtülerek yetiştirilmesi olmuştur. Bu yöntemin uygulandığı her yerde çiftçiler gelirlerini artırmışlar ve yeni ürünleri, teknikleri denemek için yeterli parasal imkân sağlamışlardır. Sonuçta; sonraki dönemlerde daha yeni yöntemlerin yayılması (seraların yapılması,

çeşitli ürünlerin yetiştirilmesi gibi) daha önce olduğu gibi artık kent merkezinden uzaklığa tabi olmamıştır. Bunun diğer bir nedeni, medyanın bugün tüm bölgelerde tarımdaki yeni olanaklar konusundaki bilgileri yaymasıdır. Öyle ki, bu yeniliklerin benimsenmesi ve yayılmasında çiftçiler arasındaki ilişkinin önemi gün geçtikçe azalmaktadır. 3) Anket sonuçları, somut yeniliklerin çiftçiler tarafından benimsenmesinde dört değişkenin etkili olduğunu göstermiştir. Bunlardan ikisi kentten uzaklığa bağlı değildir. Diğer ikisinin ise kentten uzaklaştıkça önemi artmaktadır. Buna göre gelecekteki yenilikler büyük bir olasılıkla çevreden kent merkezine doğru yayılma gösterecektir.

SUMMARY

1) As in the entire Mediterranean region, the proportion of the urban population in Türkiye, and thus the demand for vegetables and fruits, has increased. In order to supply this demand, it was attempted to increase crop yields in the past two decades, particularly in the coastal regions of western and southern Türkiye. The adoption of various innovations revealed that those land uses with higher crop yields dispelled land uses with lower crop yields further from the urban centers, where these, in turn, displaced land uses with even lower crop yields per area under cultivation.

2) The innovation which resulted in the greatest increase in productivity and fundamentally changed the production conditions and possibilities was the introduction of foil cultivation of fruits and vegetables. The farmers were able to achieve secure and higher incomes everywhere where this innovation was carried out. Thus, the farmers in the **entire area** in which this innovation was utilized had sufficient financial leeway to repeatedly try out new craps and techniques, which they did. Consequently, in the ensuing period the diffusion of younger innovations, such as the building of greenhouses and the variety of crops cultivated, no longer proved to be dependent upon the distance from an urban center as it had previously. Another reason for this situation can be seen in the fact that the various media distribute information on innovative possibilities in agriculture today over entire regions so that the significance of personal contact between farmers for the reception and dispersion of innovations is decreasing.

3) In the analysis of the interview results it was revealed that the **present** innovative potential, i.e. the existence of concrete innovative goals among farmers, is determined chiefly by four variables (cf. Fig. 11). Two of these are not distance dependent and two increase in significance with increased distance from the urban center. Therefore, the probability is great that in the future innovations will additionally exist which diffuse centripetally-that is, from the periphery towards an urban certer.

Introduction

In the area surrounding Izmir-in particular on the western border of the city there are large greenhouse tracts which are limited chiefly to the plains because further growth is made impossible by the steep ascent to the higher inland region. The expansion of such greenhouse tracts to genuine "hothouse landscapes" is a later development in Türkiye than in the western Mediterranean regions. But, since the percentage of the urban population and the demand for vegetables and fruit are also increasing at a considerable tempo in this Mediterranean country (cf. HÜTTEROTH 1982, p. 381; STRUCK 1986, p. 37 f.), the greenhouse areas are growing all the faster at the present. The establishment of covered crops - whether simple covering of vegetable fields with plastic sheets of costly iron and glass contructions with heating and irrigation systems - is radically changing the production conditions and possibilities.

In the following text, not only the changes in the outward appearance of the hothouse areas will be examined, but also the inner dynamics and their controlling factors as well as the economic perspectives.

Changes in Land Use on The Western Border of İzmir (1984-1993)

The penetration of urban building in the once exclusively agrarian land on the southwestern border of the area being charted* makes clear the stress situation for the remaining agricultural users. Since these rarely own enough land to easily be able to attain a sufficient, long-term income from its sale, they attempt to withstand the pressure of urban demand for land with constantly increasing intensification of agricultural production and/or by taking up non-agricultural supplementary work.

The construction of greenhouses makes it possible to react quickly to the changing market situations since, after a relatively short period of growth and ripening of one crop, it is possible to plant another crop. Hence, the survey taken in the spring of 1987 reflects the high spring demand for lettuce and, in addition, flowers and ornamental plants. Only a few greenhouses, in comparison, are blocked for a longer term by one type of land use or are left fallow. Although at the time of mapping many wooden and plastic constructions were replaced by iron and glass constructions, the less expensive constructions (wood and plastic) are still dominant (approx. 85 %).

An additional mapping in August of 1987 showed that in many cases the second harvest of the current year had been begun. Most of the

* The studies in Turkey were carried out with the financial assistance of the Deutsche Forschungsgemeinschaft, whom I would like to thank once again. I should like to express my thanks to all those interviewed for their patience and their willingness to give information. I should also gratefully acknowledge the support of Dr. E. Şen and the students of Geography of the Ege University of Izmir for carrying out the interviews.

greenhouses which had been occupied by ornamental plants in the spring now sheltered melons, cucumbers and paprika. All of the greenhouses accommodating flowers in August - with the exception of the ones with roses - were those in which lettuce had been grown in the spring. All in all, melons were the chief crop in August 1987 (36 %), followed by paprika (21 %), cucumbers (16 %), carnations (9 %), tomatoes (4 %), roses (2 %) and other flowers (6 %) and vegetables (6 %). The adaptation to the existing market possibilities are manifested by the spectrum.

Whereas the individual mappings express the seasonal changes in the use of the greenhouses, a generalized land use mapping based on diagonal aerial photographs (spring 1984, 1987, 1990, and 1993 - fig. 1-4) contain five different types of land use, which make the variation of use intensity more distinct. The changes between 1984 and 1993 were planimeterad for both partial areas of the region under investigation and for the entire region. In the first three years' period already marked alterations can be recognized: less intensive uses recede (barren land from 9.3 % to 8.7 %, field crops from 36.1 % to 31.8 % and tree crops from 26.2 % to 25.0 %) and greenhouses as well as urban built-up areas are expanding (the first from 15.8 % to 18.7 %, the latter from 12.6 % to 15.8 %). As one can see in table 1 this trend is going on up to 1993. But there are many differentiations within the area under investigation.

land use	1984 in %	1987 in %	1990 in %	1993 in %
field-crops	36.1	31.8	24.1	23.3
tree-crops	26.2	25.0	25.0	22.4
greenhouses	15.8	18.7	22.7	21.2
built-up area	12.6	15.8	19.0	22.4
fallow	9.3	8.7	9.2	10.7
su.	**100**	**100**	**100**	**100**

Table 1 Changing land use in the study area on the western border of Izmir 1984-1993

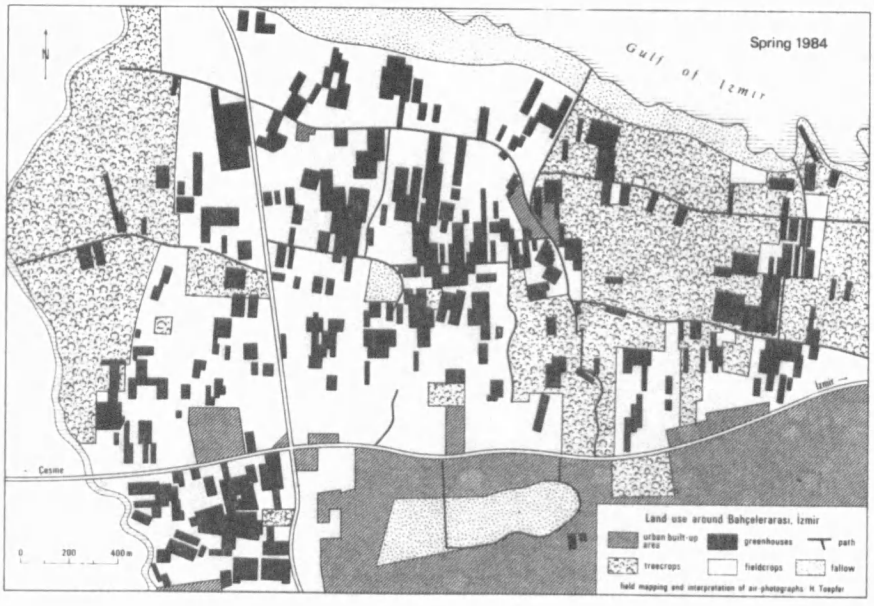


Fig.1 : Land use around Bahçelerarası, İzmir, spring 1984.

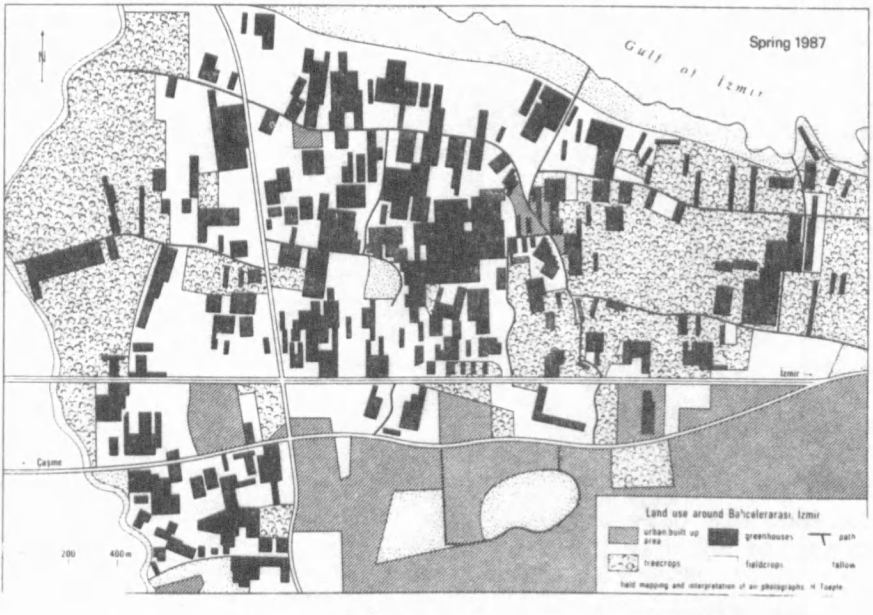


Fig 2 Land use around Bahçelerarası, İzmir, spring 1987

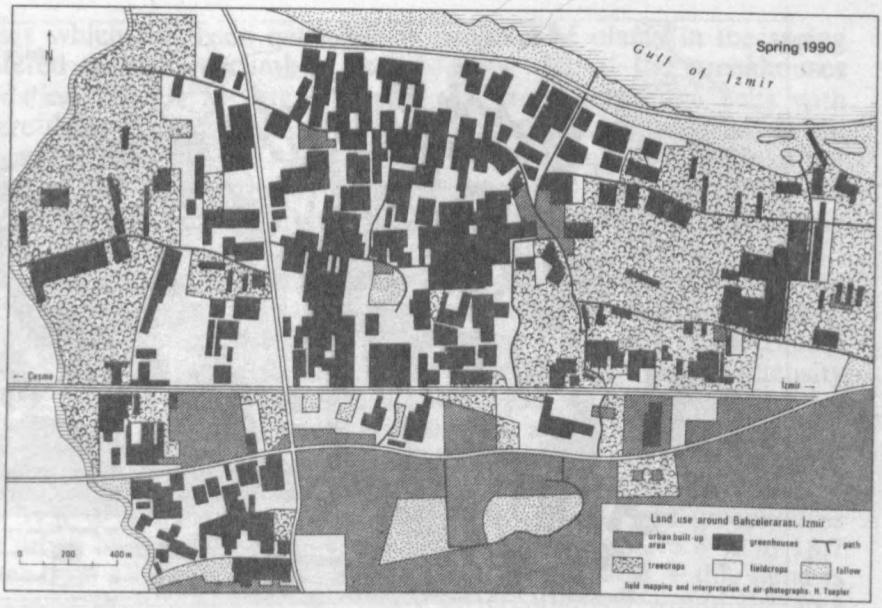


Fig.3 : Land use around Bahçelerarası, İzmir, spring 1990

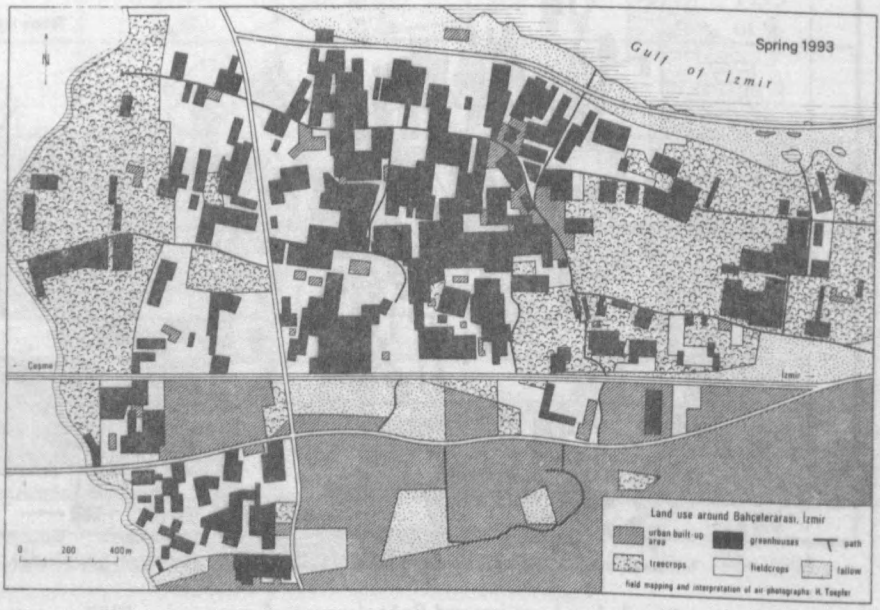


Fig.4 : Land use around Bahçelerarası, İzmir, spring 1993

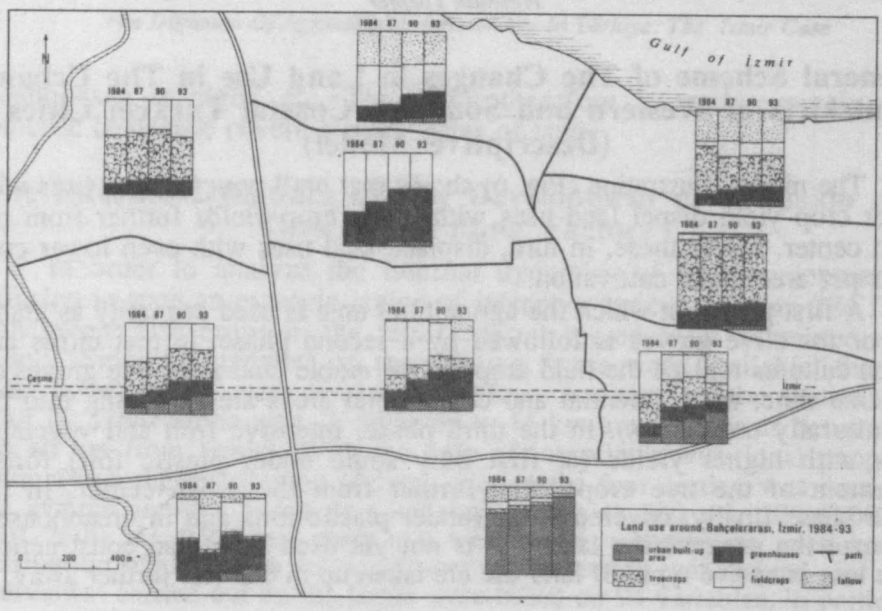


Fig.5 : Land use around Bahçelerarası, İzmir, spring 1984-1993

Here it should be noted that the very intersive use of tree crops, particularly citrus trees, increases further away from Izmir in some regions at the expense of field crops, but nearer the city decreases again, this in favor of the greenhouse areas, on which even greater crop yields can be achieved (fig. 5). The greenhouse area, however, also increases at a greater distance from Izmir. Changing land use very often is interrupted by periods in which land is left fallow. We can see this in the south-western part of the area especially between 1987 and 1990, and in the south-eastern part from 1984 on where the fallow area is quickly decreasing in favour of the built-up area.

The most dynamic part, however, can be found in the central araea, especially between the two main roads crossing from Izmir to Çeşme. Here urban land use is expanding very fast and, additionally, quite a large area is being prepared for urban functions (fallow area for the moment). Built-up complexes are also penetrating into the northern part of the central area where the greenhouses are still e .panding, too.

Along the coastal-line land reclamation is going on, so that the still fallow land will change into a more useful area in the near future. On the other hand a high demand for land is made by road constructions. Between 1984 and 1987 a new main road (4 lanes; Izmir-Çeşme) was constructed which has been expanded to 6 lanes, meanwhile. And due to new road constructions a large area near this road is lying fallow 1993.

These documentable detailed changes fit into a hypothetical, model illustration of the changes in land use in the urban outskirts of western and southern coastal Turkish cities.

General Scheme of The Changes in Land Use in The Urban Outskirts of Western and Southern Coastal Turkish Cities (Descriptive Model)

The model illustration (Fig. 6) shows that until now the land uses with higher crop yield dispel land uses with lower crop yields further from the urban center, where these, in turn, displace land uses with even lower crop yields per area under cultivation.

A first phase, in which the agricultural area is used primarily as arable land or for olive groves is followed by a second phase, in that citrus and garden cultures replace the field crops of the arable land and olive groves (at the same time, the residential and commercial areas are spreading into the agriculturally used areas). In the third phase, intensive fruit and vegetable crops with higher yields (at first only some under plastic foil) forces movement of the tree crops even further from the urban center. In the fourth phase finally, covered crops (under plastic foils and in greenhouses) dominate the surrounding land that is not yet used for urban construction, while less intensive types of land use are taken up in districts further away.

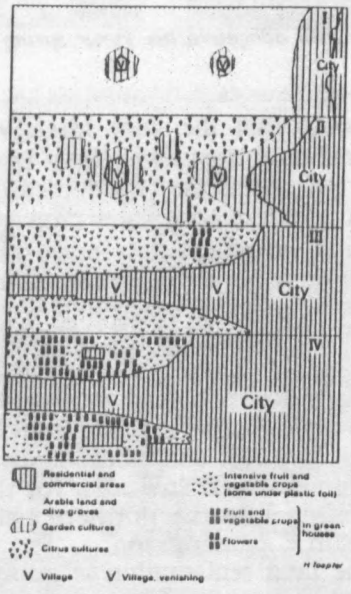


Fig.6 : General scheme of the changes in land use in the urban outskirts of western and southern coastal Turkish cities.

At the same time, attempts are made in the greenhouses to increase yields by (1) replacing fruit and vegetable crops with ornamental plants, (2) converting to seed and young plant breeding and (3) with artificial yield-increasing methods such as the use of fertilizers. artificial lighting of the

greenhouses at night, etc. The result therefore is an intensively used hothouse landscape covering many acres of land.

The Internal Dynamics of The Development of Diffusion and Their Controlling Factors

In order to analyze the internal dynamics of the development of diffusion in such an example region of intensive agricultural use, 284 farms with greenhouse crops in the Izmir coastal region were examined more closely. Since no statistics on the existing farms were available, the area under investigation was divided into four sections to the southwest of Izmir (1. Izmir urban area, 2. areas up to 15 km away, 3. areas between 15 and 40 km from Izmir). With the help of interviews with local people, a summary on the distribution of farm sizes in the four section was drawn up and sample surveys based on four size classes (1-500 m^2, 501-1500 m^2, 1501-2500 m^2, 2501 and more m^2) were made, whereby an even spacial distribution of the farms surveyed over each section was strived for. The interviews carried out on the farms were based on 94 variables, in particular the ownership situation, farm size, farm equipment, number of workers, income, supplemental income, land uses, sales areas and pathways, plans for the future and the necessity for improvements. Four primary controlling factors were delineated by the analysis of these variables:

1. Distance from the center of Izmir,
2. Immigration from other provinces of Türkiye,
3. Age of the first greenhouse,
4. Number of greenhouses.

Controlling factor "distance"

The farms have different operational possibilities depending on their distance from the main center of Izmir (cf. Fig. 7):

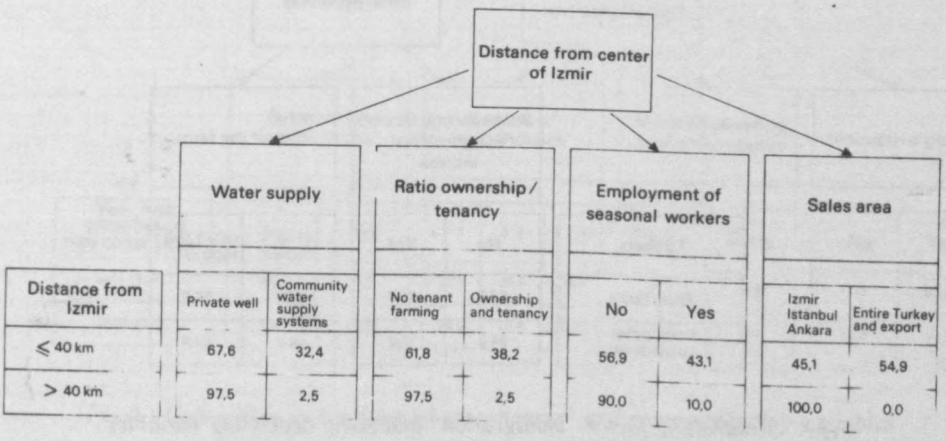


Fig.7 Controlling factor "distance" and some depending variables

1) In remote regions, the existence or construction of a private well is a fundamental prerequisite, whereas farms near cities are partially dependent upon community water supply systems (community wells, reservoirs, Balçova Lake reservoir, public pipe systems).

2) Due to the high demand for land in the city and the near surroundings of Izmir, extensive stretches of agricultural land have come into the hands of city-dwellers, so that in the town and nearby-in contrast to remoter areas-there is a considerable amount of tenant farming.

3) Due to the large supply of workers in Izmir, many farms near the city can employ seasonal workers whenever they wish, in contrast to the remoter villages where the farms depend more on family and (local) non-related long-term workers.

4) Because of the higher informational and organizational intensity in the city and near the city, the sales area for the products grown by the farms located there covers far more than the traditional centers of consumption in Izmir, Istanbul and Ankara on which the other farms continue to depend.

Controlling factor "immigration"

There are two significant differences in the farming strategies of the farmers depending upon their origins (cf. Fig. 8):

1) Farmers and their families who have moved to the province of Izmir from other provinces limit themselves chiefly to farming activities, whereas nearly one of every three native farmers and their families pursue supplemental occupations to increase their economic basis.

2) The immigrants' greater concentration on their farms also has the effect that they seek to secure their income to a greater extent through the size of their farms than native farmers.

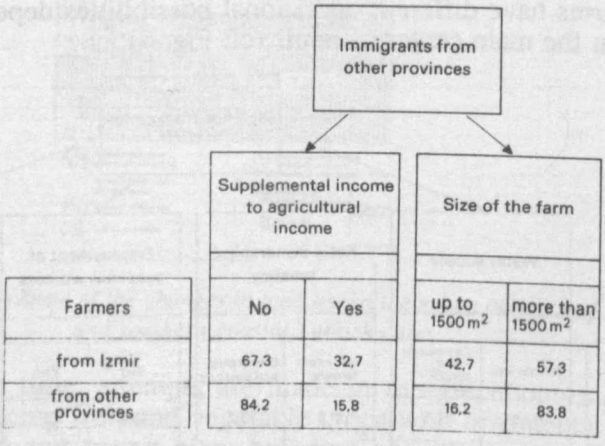


Fig. 8 Controlling factor "immigration" and some depending variables

Controlling factor "age of the greenhouses"

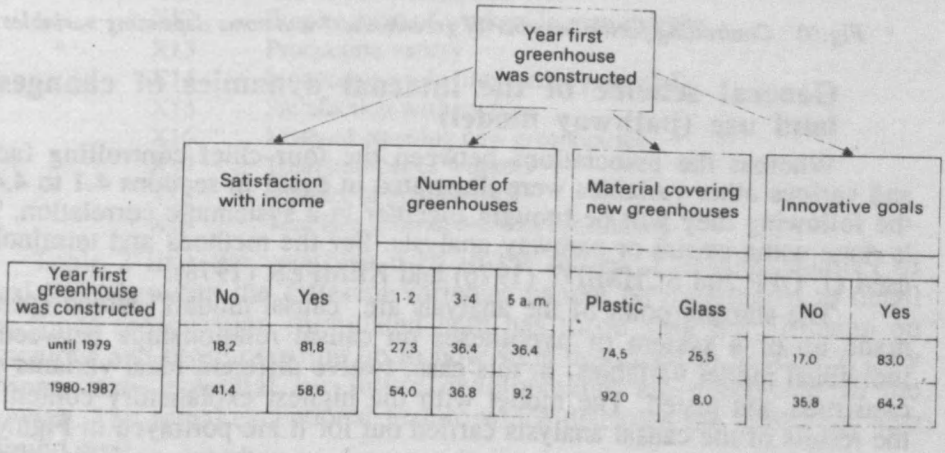
A farm's investment in the construction of a greenhouse and the intensification related to it change the farm completely. The effects, however, have a different magnitude depending on how long the greenhouse exists (cf. Fig. 9):

1) Farmers who began converting to greenhouse cultivation earlier are satisfied with their current income to a much higher degree than those who only recently began conversion. This is due on the one hand to the longer experience and the resulting successful optimization of growing crops in greenhouses and on the other hand to the fact that through greenhouse cultivation the income has become more reliable (e.g. preventing frost damage in colder months) and greater (sales possibilities at times with better morket situations for the producer). Investment in the construction of greenhouses has also often paid for itself over the course of the years.

2) Due to positive experiences with cultivation in greenhouses, farms which began conversion earlier are more able and willing to make further investments and increase the number of their greenhouses.

3) Farms who converted at an earlier date are also more likely to set up iron and glass rather than wood and plastic constructions-the iron and glass greenhouses are less expensive to maintain but more expensive to build and thus pay for themselves over a longer term.

4) The earlier a farmer has adopted the "greenhouse" innovation, the more concrete innovative goals they are apt to have today. This is surely due to both the generally higher willingness to try out new innovations and to positive experiences and increased incomes.



Year first greenhouse was constructed	Satisfaction with income		Number of greenhouses			Material covering new greenhouses		Innovative goals	
	No	Yes	1-2	3-4	5 a.m.	Plastic	Glass	No	Yes
until 1979	18,2	81,8	27,3	36,4	36,4	74,5	25,5	17,0	83,0
1980-1987	41,4	58,6	54,0	36,8	9,2	92,0	8,0	35,8	64,2

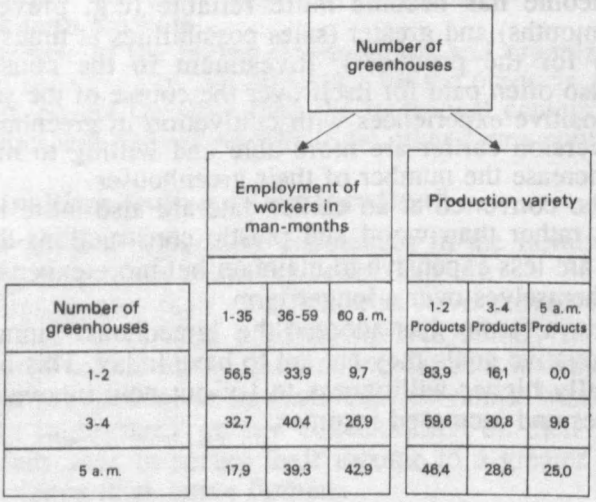
Fig.9 : Controlling factor "age of greenhouses" and some depending variables

Controlling factor "number of greenhouses

Although the variable "number of greenhouses" is-as shown in the last section -a dependent variable, so many resultant effects are caused by it that it can also be seen as a fourth primary controlling factor (cf. Fig. 10):

1) For example, the number of workers employed is controlled primarily by the number of greenhouses managed by a farm.

2) The more greenhouses run by a farm, the larger the variety in production in most cases.



Number of greenhouses	Employment of workers in man-months			Production variety		
	1-35	36-59	60 a. m.	1-2 Products	3-4 Products	5 a.m. Products
1-2	56,5	33,9	9,7	83,9	16,1	0,0
3-4	32,7	40,4	26,9	59,6	30,8	9,6
5 a. m.	17,9	39,3	42,9	46,4	28,6	25,0

Fig.10 : Controlling factor "number of greenhouses" and some depending variables

General scheme of the internal dynamics of changes in land use (pathway model)

Whereas the associations between the four chief controlling factors and various other variables were illustrated in detail in sections 4.1 to 4.4, in the following they will be brought together in a systematic correlation. This is done using causal or pathway analysis. For the methods and terminology used cf. OPP and SCHMIDT (1976) and KEMPER (1978).

The starting point of the analysis are "causal models" which each are made up of a system of hypotheses on causal relationships between the individual model variables. In this case, twelve different ideal variants were construed and tested. The model with the highest explanatory content and the results of the causal analysis carried out for it are portrayed in Figure 11.

For explanatory purposes: the causal or pathway analysis offers a splitting-up into correlations (r) observed between dependent and

independent variables in "causal" and "non-causal" effects. Causal effects are made up solely of pathway coefficients (p). These pathway coefficients (p) which are estimated through the standardized partial regression coefficients of corresponding regression equations describe the effects between two variables which are symbolized in Fig. 11 by arrows. A direct causal effect exists when two variables are directly linked by a pathway. In the case of indirect causal effects, the effect takes place via one or more intervening variables. These indirect effects can be expressed by the products of each of the participating pathway coefficients. Opposite the causal effects are on the one hand, indirectly correlating effects, that is influences which occur when two correlating variables which are not connected by a pathway together influence a third variable, on the other hand, effects of third variables which occur because characteristics simultaneously causally influence both the dependent and an independent variable. In order to achieve an explicit model it is important to isolate causal effects which are as high as possible (cf. LAUX and THIME 1981, p. 78f.).

Table 2: Causal analysis: list of variables

X1	Distance from center Izmir
X2	Immigrants from other provinces
X3	Employment of seasonal workers
X4	Ratio ownership/tenancy
X5	Supplemental income to agricultural income
X6	Size of sales area
X7	Water supply
X8	Greenhouse heating
X9	Loans borrowed
X10	Size of the farm
X11	Use of non-related workers
X12	Employment of workers in man-months
X13	Production variety
X14	Innovative goals (innovative potential)
X15	Satisfaction with income
X16	Material covering new greenhouses
X17	Total number of workers
X18	Number of greenhouses
X19	Year first greenhouse was constructed

Table 2 lists the variables used in the model. The large number of causal links between the different variables cannot be illuminated in detail here. Since the question formulated here has to do with the diffusion on innovations and those occuring up to now were described in Section 2, only the innovative potential for future developments are elucidated in the following. The actual exceptional feature which discloses the model can also be found here.

The innovative potential is defined by the existence of farmers' concrete innovative goals: to enlarge the farm, introduce new products in he

crop program or to carry out any other measures which would change the course of production. This innovative potential (X14) is determined chiefly by four variables, as seen in Fig. 11: 1. by the ratio ownership/tenancy (X4), 2. by the amount of supplemental income (X5), 3. by the age of the greenhouses (X19) and 4. by the variety of crops (X13). With

$$\mathbf{X14 = 0.46X5 + 0.35X4 + 0.30X13 + 0.21X19}$$

a multiple correlation coefficient of R = 0.81 is reached.

The causal analysis shows that the innovative potential is particularly great on farms with a high proportion of their own land. On the one hand, a high proportion of property directly influences the desire to introduce innovations. On the other hand these farms are the ones which do not attempt to make up for the generally small size of the farms in the area under investigation (average 2224 m^2) by leasing more land, but rather by earning supplemental incomes in other occupations. And the amount of supplemental income has the greatest direct causal effect on the innovative potential. Thus, the causal effects of the proportion of property increase the innovative potential once more to a great extent inderectly via the supplemental income which is influenced by the proportion of property.

An extensive assortment of products from a farm usually means that experiments were already being made with new crops at the time of the interview. This, in turn, shows that the innovative potential is particularly high on such farms. In the same way, early use of greenhouse cultivation also points to great innovative potential.

The conclusions? According to the above, we must classify three chronological sections of different innovative diffusion:

1) It was recognizable that early innovations (fruit trees intensive vegetable crops and particularly growing spring crops under foil as the direct precursor to greenhouses) spread out from the center of Izmir to the surrounding areas (cf. Fig. 6). In the case of foil cultication, this has already been illustrated by BARTELS (1970). Wave-like expansion of innovations according to the HÄGERSTRAND model thus characterized the first phase.

2) This distance dependency-starting at an urban center-does not, however, apply to greenhouses; the correlation coefficient between X1 (distance from center Izmir) and X19 (year first greenhouse was constructed) is only r = -0.16 (therefore not listed in Fig. 11). This means that greenhouses can also be found at an early date at various locations further away from Izmir. The distance dependency also does not apply for crop variety (correlation coefficient between X1 and X13 only r = -0.15 and therefore not listed in Fig. 11).

Therefore, the preceding innovations led to such structural changes that the diffusion processes of newer innovations no longer necessarily followed the old paths and familiar diffusion models.

Another cause for these circumstances cna be seen in the fact that Türkiye, in its efforts to join the EC, already finds itself compelled to conform its goods to EC standards and therefore attempts to distribute

information on Mediterranean products and other possibilities in the agricultural sector as broadly as possible through the available institutions and the media. This minimizes the importance of the farmers' private information field (HÄGERSTRAND 1967, p. 165) for the reception and distribution of information. We find experiments with new products and processes in practically the entire region under evaluation. These interrelations characterize the second phase.

3) Presently a transitional stage exists, caused by the high, secure income of many farms and characterized by great experimental intensity and sensitive dependency on environmental inluences, from which a third phase will emerge with new structures, some new structural elements and new process sequences.

However, an economic system is a system characterized by feedback. Since such feedback results in each condition of such a system initiating a new development the initial conditions for further development constantly change under the influence of the feedback.

The synergy has revealed that even the smallest variations in the initial conditions have a serious effect on the end conditions of such feedback systems, i.e. a sensitive dependency on the initial conditions exists. When such a system is constantly fed with new energy (in our case capital through high, secure incomes) this leads to a condition in which the existing structure is eliminated. A condition of "chaos" is created in which a maximum number of new structural variations are formed, those becoming stronger which prove to be useful, and in the end that variation prevails which generates new stability in the system. In the continual rotation of such systems between "order-chaos-reorganization", the prevailing condition in the region under evaluation can be described as deterministic chaos in terms of synergy (HAKEN 1988).

We know little about new processes in the future but there are, for example, already three signs that point to the great probability that such innovations will additionally exist in the future of which the diffusion at first runs centripetal-that is from the periphery towards an urban center:

a) The current potential for innovation is determined by two variables which are virtually not distance-dependent (variety of crops and age of greenhouse cultivation).

b) This potential for innovation is determined by another two variables which gain importance with increasing distance from the center (ratio owned/tenant land and extent of parttime farming).

c) An example of a completely new innovation: The origin of seed and seedling culture was a farm 34 km from Izmir. This innovation, which is increasingly finding approval in farms near Izmir has, however, not yet been introduced in areas further distant.

The term "centripetal diffusion" could be used in the future to describe such additional kind of diffusion.

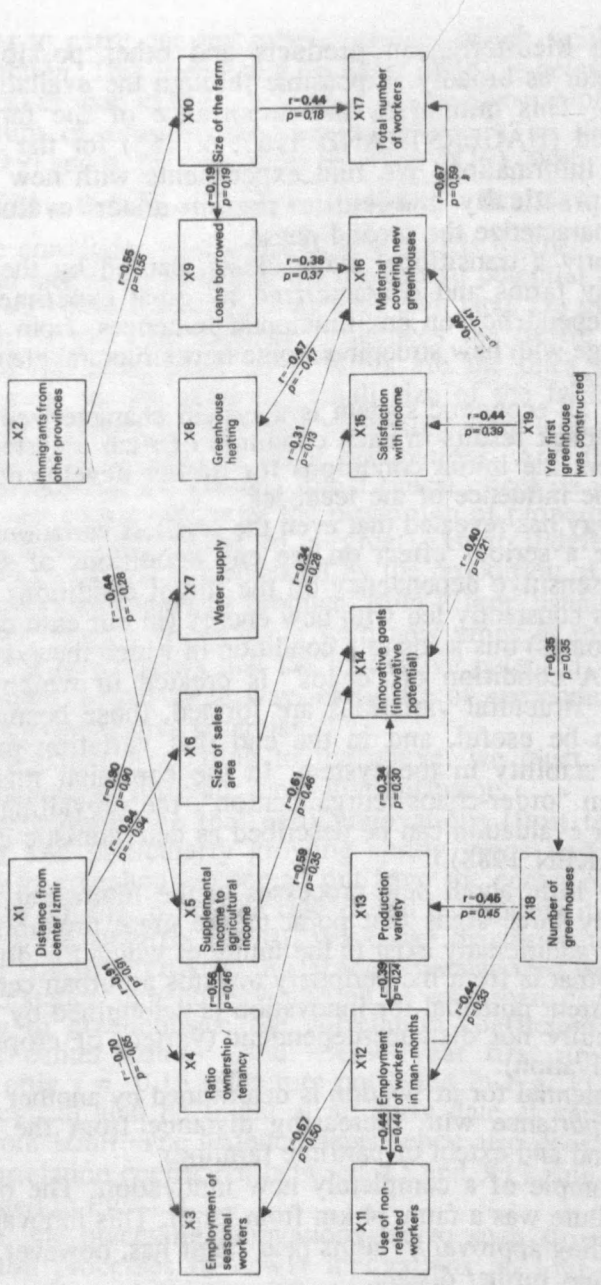


Fig.11: General scheme of the internal dynamics of changes in land use (pathway model).

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