CLIMATIC AND EDAPHIC DEMANDS OF GROUNDNUT GROWING IN HUNGARY

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Introduction

Groundnut is an important nutrient and oil plant of the tropical and subtropical zones. Its seed and oil — on account of the wide possibilities of their utilization — are products in demand in the areas of the temperate zone as well.

Brasil is its ancient home, though its South-American origin was not accepted by all research workers (e. g. R. Brown), it is undoubtable however that the Spanish Oviedo mentions it already in 1547 as plant very frequent in the gardens of Indian (REINHARDT, 1911).

The plant was described in 1579 by a Spanish physician Monardes, then in 1753 in details by Linné (SPRECHER VON BERNEGG, 1929).

Investigations of the French botanist, A. De Candolle confirmed likewise the Brazilian origin and this opinion referring to the origin of the plant is also accepted nowadays.

According to some opinions it reached Africa in the 16-th century already, while F. H. BAHTEEV (1960) estimates that it spread in the 18-th century to Africa. Its distribution in Africa and North America is in connection with the slave trade between the Continents.

In Europe knowledges of the plant were obtained already in the 16-th century, it arrives however to the European Continent only in the 19th century through Spain. Its growing was attempted in Europe mainly on the southern areas (in Spain, France, Italy, in Bulgaria and on the southern territories of the Soviet-Union and such efforts are continued even today with more or less success. In our days it is grown from the 43° of N-latitude to the 38° of S-latitude.

The plant has two types:

with a procumbent stem (Arachis hypogaea var. procumbens) and the second with an erect stem or bushy (Arachis hypogaea var. fastigiata.)

The vegetative period of the procumbent type lasts 160 to 180 days, the most frequents being Virginia Runner, Jumbo and Virginia Bunch (this latter is of the semi-erect type). The vegetative time of the erect type is shorter, 120 to 150 days; the most important varieties are the White Spanish, Red improved Spanish, Valencia and Red Tenessee.

India is the most considerable groundnut producer of the world, nevertheless it is in African countries the most wide-spread. According to B. BADINAND (1967) the world production was distributed in 1966/67 as stated below (Fig. 1.)

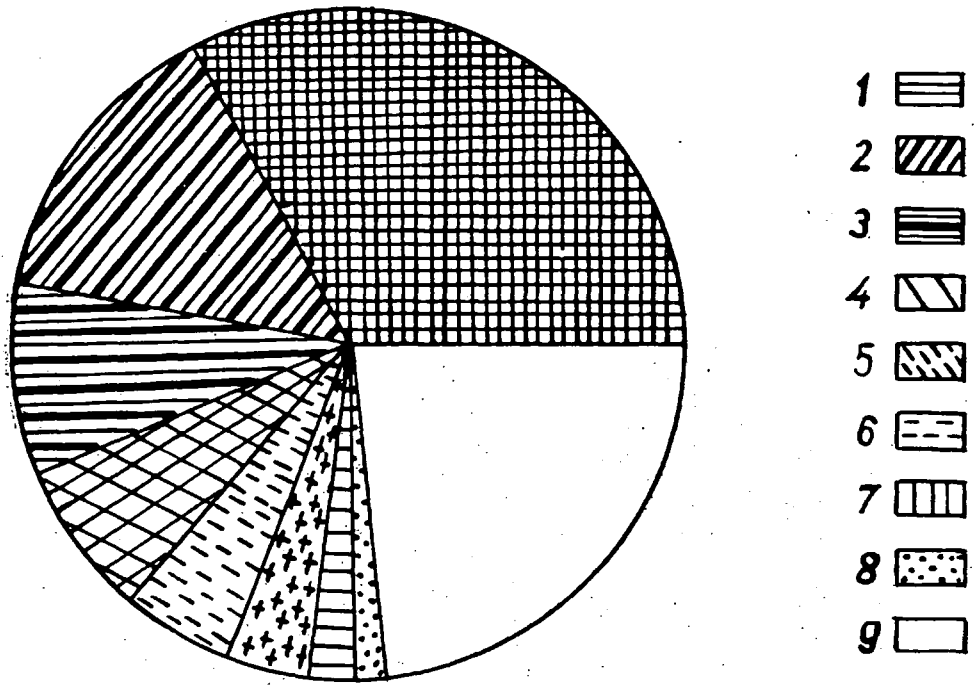

Fig. 1. Distribution of the world production of groundnut in 1966—67. 1 = India, 2 = China, 3 = Nigeria, 4 = United States of America, 5 = Senegal, 6 = Brasil, 7 = South Africa, 8 = Argentine, 9 = Others.

The product entered into the World Trade in the beginning of the 20-th Century. Senegal and Gambia were the first exporters. The groundnut with a raw seed-coat and the groundnut-oil participate also today with a significant share in the world exports of agricultural products (Fig. 2.) 1965.

The groundnut requirements of Hungary were imported in 30 per cent in 1962, but in 1967 already 87 per cent were covered from imports. The reduction of the domestic productive areas and of crop-averages is responsible for the increase of imports. In these latter years our import was in function of the inland production and of the favourable trend in the world market prices (Fig. 3.)

In the months of September and December the groundnut prices are high on a world scale. In 1967 the price of groundnuts was regulated and it amounted to 180 $/ton on the world market. This low price remained in vigour between the years 1967—1969 (B. BADINAND, 1967).

As the groundnut is a seasonally (chiefly in winter) demanded commodity also in Hungary (in roasted condition it is claimed by the retailed trade), thus the requirement in this direction could be satisfied with a small-size increase of the actual crop-land and with the quantitative and qualitative improvement of the production. A problem is caused however by the supply of the oil-industry with groundnut-oil.

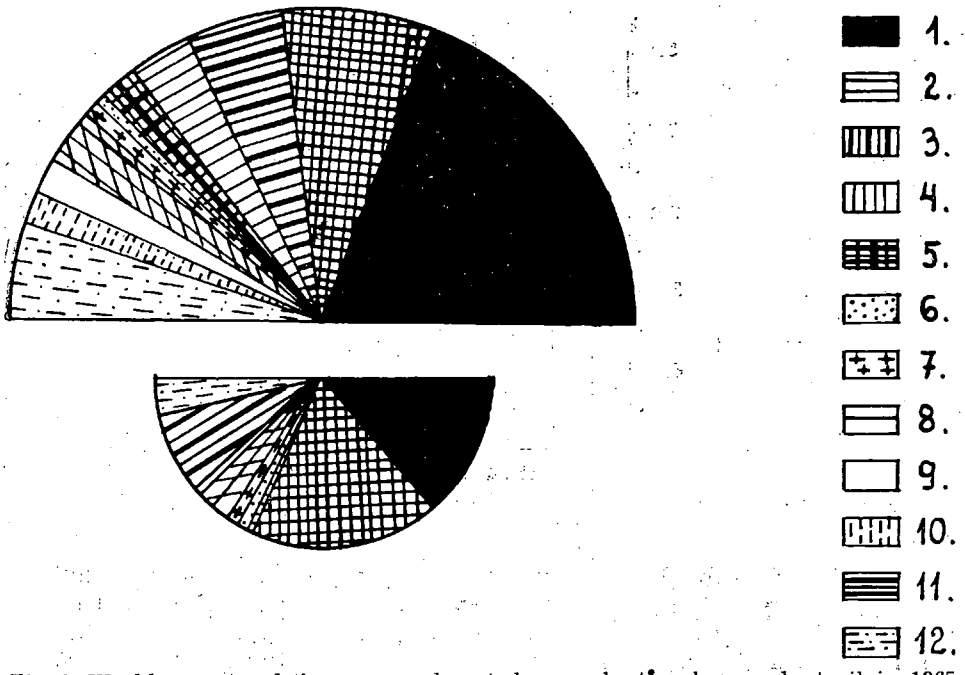

Fig. 2. World-exports of the raw seed-coated groundnut and groundnut oil in 1965. I. Raw seed-coated groundnut. II. Groundnut oil. 1 = Nigeria, 2 = Senegal, 3 = Sudan, 4 = Niger. 5 = Mali, 6 = Republic of South Africa, 7 = Portuguese Afrika, 8 = United States of America, 9 = China, 10 = Brasil, 11 = Others, 12 = Argentine.

The present study aims et the examination of the most important conditions of groundnut growing — of its climatic and soil demand — in the interest of the above outlined yield-increase.

Seeds of the plant contain 14 to 16 per cent carbohydrates, 23 to 37 percent proteins, 14 to 56 percent oil and 8 percent water. Their calory-value is high. After the first cold pressing of the seeds the plant yields a for eating outstandingly suitable oil, of a value similar to that of the olive-oil, which is consumed mostly in the form of table-oil but can be well utilized also in the canning-, sweets and pharmaceutical industries. Its seed is after roasting a very much liked dessert in our country as well. The residual product of pressing, the oil-cake, is utilized likewise in several ways by the sweets industry and baker industry; may come into consideration as an excellent feed also in the cattle-and pig-breeding. Hay of the groundnut is a green manure equivalent to clover and lucerne. The shelled pod is suitable for insulations.

In Hungary the retail trade and the sweets industry lay a claim for roasted groundnut. The groundnut oil is employed by the vegetable oil industry for margarine manufacturing. For the latter purpose a quantity of 1000 to 1500 tons raw material would be required to the economical utilization and this quantity cannot be warranted with the actual volume

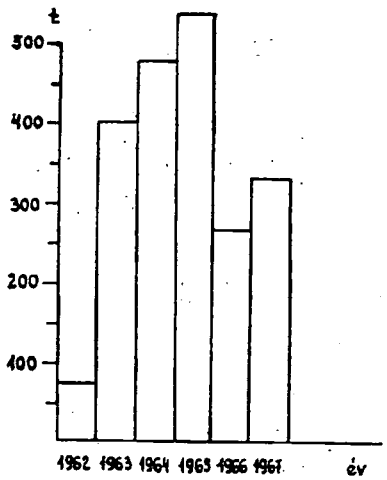

Fig. 3. Trend in the groundnut-imports of Hungary in the last years.

of production since in the last years the necessary quantity was produced in Hungary only in 1964. Taking however the demand of the retail trade and sweets industry into consideration, the oil-industry will be compelled also in the future to have to recourse to the importation of groundnut or groundnut-oil respectively.

The groundnut reached Hungary in the beginning of the 1900 years. It was about 1935, when on the Plant Production Experiment Station at Szeged a commencement was made with its acclimatization (RIGLER, 1937). Later on, experiments with its growing were conducted sporadically even in several counties. In 1936 already 87 producers were kept in evidence in the country. Acclimatization of the plant acquires a particular importance at the time of the import-prohibition in 1936. Early in the 50-ies a serious attention is devoted again to the growing of groundnuts. In 1951 it is included in the modified Five-Year-Plan among the plants to be acclimatized. During the research of productive regions 45 groundnut-sites have been examined (BRUDER, 1952). Mezőhegyes, Sövényháza and Tótkomlós were the habitats giving the best yields. The production was then extended also to other communities of the Mezőkovácsháza district. In 1954 several producers of the district have attained crop averages between 8 to 10 q/cad. hold (KARAKASEVICH, 1957). In 1960 groundnut was grown in Medgyesegyháza on areas of the Aranykalász and Béke cooperative farms on 550 cad. holds, in Ujkigyós om 320, in Medgyesbodzás on 100 and in two cooperative farms of Pusztaottlaka on 200 cad. holds (1 cad. hold = 0,57 ha.) Furthermore groundnut growing was pursued in the same year on the area of county Békés in further 25 communities, on areas under 100 cad. hold per community.

In Hungary the most important natural conditions of groundnut growing are:

a) climatic endowments,

b) soil endowments,

and its economic conditions:

a) soil cultivation,
b) return of the elements of soil fertility,
c) a high level of the mechanization of growing,
d) labour conditions,
e) import-possibilities.

These have acted in the direction that in our days the growing became confined to the boundary of Medgyesegyháza. The following table shows the reduction of the large-scale crop-land in the last eight years:

Size of the groundnut area in the cooperative farms of Medgyesegyháza (in cad. holds.)

1961	1962	1963	1964	1965	1966	1967	1968	1969
260	300	300	300	306	214	91	78	25

In 1968 in addition to the collective farms, growing continued also on 128 cad. hold household area.

In Medgyesegyháza the y/13 early ripening regional variety of Mezőhegyes, selected from the Valencia type of short vegetative period is wide-spread. (By crossing the Sovietic Stepnjak and the y/13 of Mezőhegyes a type with more advantageous varietal qualities sould be produced.).

In our opinion it would result useful to examine the given climatic and edaphic conditions among the conditions of groundnut growing, since this plant belongs to our plants to be acclimatized. Results of such an investigation may provide a direction indication for a reduction or perhaps extension of the production.

Climatic claims

The groundnut being a plant of the tropical zone — is susceptible chiefly to the temperature, length of the sunshine period, intensity of radiation as well as to the quantity of precipitations in the critical periods of its development. The trend in the crop-averages is thus considerably influenced by the trend in the mentioned climatic elements.

Due to a certain acclimatization the plant has spread on several areas of the temperate zone and thus also in our country. Its seed germinates above 12 °C, the development stops below 12 °C. Is sown mostly at 14 to 15 °C. A cold rain, a few days after the sowing, may be very harmful. Its sprouting supports already even — 1,5 °C, the more considerable fluctuation of the temperature acts however unfavourably on its development, at 0,5 °C the vegetative part of the plant is frozen off, while at —3 C the vital functions of the unripe pods cease (MINKEVICS—BORKOVSKIJ, 1951).

Seeds sown in the first decade of May (1—10th May) germinate after 10 to 15 days. The seed sown earlier than this does not lead to an earlier ripening in the majority of cases, since the time of sprouting may be considerably delayed. The extreme values of sowing date are 15th

April and 25-th May. The flowering starts earlier on plants sown at the proper time.

During the germination period — jointly with a temperature above 12 °C — the moisture content of soil is likewise important.

The warm soil is similarly a condition of the good germination ratio. The sown seed germinates in general between 15th and 20th May (Extreme values of sprouting: 10th May and lst June respectively).

Tillering begins at 18 °C daily mean temperature, the optimum temperature claim at this time is however 25 to 28 C. The tillering is enhanced by a favourable relative humidity of the air.

Flowering commences intensely in 30 to 35 days from sowing (from 10-th and 20-th June to 10-th and 20-th July). In case of a warmer weather flowering bushes may be found also earlier and at the same time in the autumn even about the 10th September. The periods of flowering and fruit-setting are critical (in the latter case precipitations are important from the point of view of soil moisture). During the vegatative period 250 to 300 mm precipitations are required, but from the point of view of yields in the phase prior to ripening (from May to August) 500 mm is the optimum quantity of precipitations. The most precipitations are required in June or in the first decade of July respectively at the time of flowering; due to the keeping the soil in moist condition however precipitations are important in July and early in August as well. When the necessary quantity of precipitations is not obtained during this period, irrigation is required. According to experimental data (KOVÁCS, 1960) the irrigation performed in due time contributes to the shortening of the vegetative period and to the increase of the crop-averages also in our country.

Groundnut ripens in the fifth month after sowing. At the time of ripening, in the second half of September and early in October — but already commencing from 10th or 20th August respectively a sunshine-period is demanded, excessive precipitations lead to the deterioration of seeds. The harvesting time lasts from 20th September 20 20-th October.

According to Sprecher the groundnut thrives well, where the heat-sum of the vegetative period is 3600 °C. As demonstrated by Hungarian experiments it prospers also when the heat-sum is 2500 to 2800 °C (BRUDER, 1952). To ensure this heat-sum 65 or more summer days are required.

Nevertheless from the point of view of oil-accumulation — as already mentioned previously — the length of sunshineperiod is important and in the vegetative period 1200 to 1300 sunshine hours are needed.

In Hungary the above outlined climatic conditions are warranted mainly on the South-Lowland area. In the following let us examine the given climatic conditions of Medgyesegyháza and of its environs on the basis of a 50 years average. (The temperature data are values interpolated from the data of the climate stations at Békéscsaba, Orosháza and Mezőhegyes of the National Meteorological Institute. The precipitation data originate from observations of the Farm at Bánkut.)

The vegetative period of groundnuts in Hungary lasts from May to October. On the ground of 50 years average, during the vegetetive period the mean value of temperature does not fall below 10 °C in none of the months (the lowest October temperature was 11,1 °C), while in May 16,7 °C is the mean temperature. The annual sum of the sunshine period amounts to 1991 hours of which 1419 hours fall to the vegetative period. On the area the heat-sum of the vegetative period is 3293 °C, and quantity of precipitations 327 mm, both on the ground of 50 years average. With the highest probability (14—14 percent) the 251—275 mm and 326—350 mm precipitation quantities occurred during the vegetative period. The annual average number of summer days is 86,3, that of heat days was 26,8. In June (at tillering time) the mean monthly value of the relative air-humidity on the climate stations of Békéscsaba and Mezőhegyes are 65 and 66 per cent respectively (National Meteorological Institute: Atlas of the Hungarian Climate, Volume II. Data-Collection 1967).

Mean value of soil-temperature (50 years average) in 10 cm depth at Mezőhegyes is 12,4 °C, already in May 17,4 °C and 12,6 °C in October, in 5 cm depth 12,6 °C, in May 18,1 °C, in October 12,7 °C. The temperature demands of groundnuts are therefore satisfied in this respect as well.

In the following we are performing — on the ground of the last 7—8 years — the comparative examination of the climatic data (temperature, heat-sum, length of the sunshine period, precipitations) important from the point of view of plant developeent and of the crop-averages (Fig. 4.)

Comparison of the climate-data of the period between 1960—67 with crop-averages

The plant being in the course of acclimatization also at present is the most sensitive to the air-temperature and soil-temperature at the time of sprouting (first decade of May), to the precipitations at the time of flowering and fruit-setting (June, July) and to the heat-sums and length of the sunshine period from flowering to ripening (August—September).

In conformity with the minimum law the plant is particularly susceptible in its critical periods to those or that factor which are present in minimum. In the following we are examining the correlation of crop-averages and critical factors for the above-mentioned years. We do not digress to the detailed analysis of the given climatic conditions existing in optimum.

In 1960 the crop-average (it was 5,5 q/cad. hold) exceeded that of 8 years (4,8 q) cad. hold and cannot be ranged among the well-yielding years. The soil temperature in the germination period is, related to 8 years, of a very low value. The precipitations fallen during the vegetative period would have been quantitatively sufficient but the ripening ratio was spoiled by the precipitations having fallen in September—October for the greater part. The length of the sunshine-period and the heat-sum during the vegetative period have also lagged far behind the best year (1963).

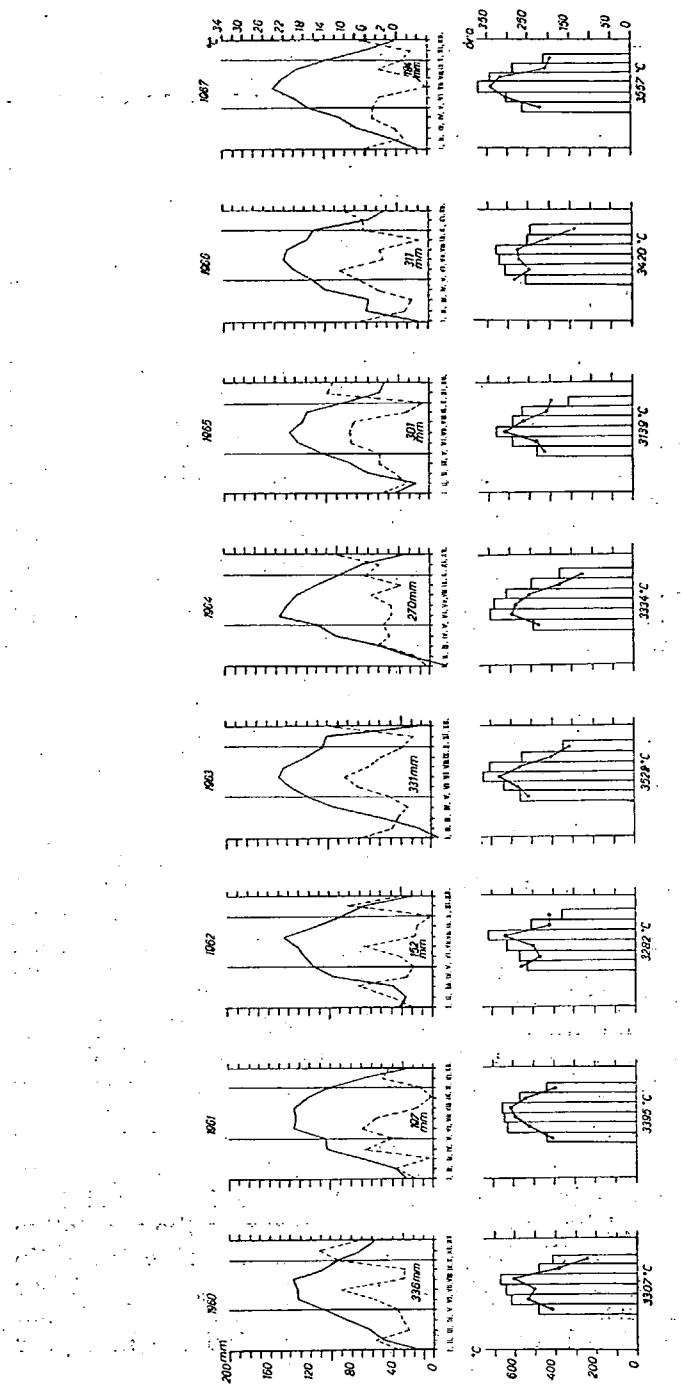

Fig. 4. Climatic data of Medgyesegyháza in the examined period: 1 = monthly mean temperature, 2 = precipitations, 3 = length of sunshine period, 4 = heatsum.

In 1961 the precipitations at the time of germination and fruit-setting amounted to 50—70 mm and also the total quantity of precipitations during the vegative period was low.

In 1962 again the precipitations were few and even at the time of flowering and fruit-setting did not reach 70 mm July precipitations caused a considerable reduction in the soil temperature.

The best year of our examined period was 1963 with 7 q/cad. hold crop-average. Therefore a detailed analysis of the total vegetative period seems opportune. With the exception of August the air temperatur was in all months of the vegetative period superior to the monthly means of former years, which is shown also by the 3522 °C heat-sum of the vegetative period. The trend in time of the temperature was similarly adequate. At germination time the air temperature exceeded 17 °C, while in July was above 23 °C. Abundant precipitations fell at the time of flowering and fruit-setting (June—July). Prior to the ripening period two-thirds of the precipitations of the vegetative time reached the soil. A strong warming-up of the soil and surface could be observed. Already at sowing date the mean temperature was between 18—20 °C, while in July it went above 24 °C in all the three soil-horizons (OMI, 1963).

In 1964 the crop-average decreased to 5,2 q/cad. hold The reason for this may be sought in the strong fall of air- and soil temperatures commencing from July, against which the quantity of precipitations rose in August (at the time of ripening). This latter fact led to a substantial cooling down of the soil and hereby to the lengthening of the ripening process.

In August 1965 a considerable heat-decrese occurred similarly to that of July in the preceding year and though the plant obtained the precipitations also in the critical period, the August-precipitations have reduced the ripening percentage. The heat-sum of the vegetative period was similarly the lowest (3139 °C) in this year.

In 1966 the distribution of precipitations in time was not appropriate: little precipitations fell in the period of fruit-setting and the not too high (20—22 °C) temperature in July and August contributed unfavourably to it. The regression in the sunshine-period of June or the low hour-values in July—August respectively play a substantial role in the formation of the poor crop-average.

In 1967 the crop-average is again above the 8 years' average. In this year precipitation is a factor existing in minimum (184 mm). Precisely in the critical period of fruit-setting the plant did not receive the desired quantity of precipitations. The other weather factors were given in optimum, thus in this year the irrigation would have resulted in a higher crop-average.

It can be established that in the examined 8 years period the shortage of precipitations and the intensive change of soil temperature were responsible for the low crop average.

We can consider that with the concrete analysis of weather factors made in the above-said, the connection between the weather and crop-averages is fully proved.

Our findings are confirmed also by the correlation coefficients computed on the basis of the simple bivariate correlational connection. The variables were formed by the individual weather factors and the crop averages (relatively to the years 1960—67.)

The correlational coefficient is expressed by the connection:

$$v = \frac{\sum x_i y_i}{\sqrt{\sum x_i^2 y_i^2}}$$

As a matter of fact we have used here the first step of the „critical factors" method (DR. LÁSZLÓ HALABUK—KATALIN HULYÁK, 1961) of the mathematical statistics for the demonstration, as this part serves for the justification of the traditional factors.

On our area (Medgyesegyháza, Haladás cooperative farm) the sum of the sunshine period during the vegetative time and the heat-sums of August show a positive correlation with the crop averages (correlational coefficients: 0,6719, and 0,7152 respectively), the quantity of precipitations however resulted in a negative correlation precisely in the critical period (June). The precipitation-quantity increasing in September led likewise to the decrease of the crop averages. On the ground of the regression hyperplane equation ($x_1 = a_1 b_{12}x_2 + \ldots + b \quad x$) the multiple correlation of the crop average as of a dependent variable and of the critical factors as of independent variables can be examined further on (the latter is however not a task of this study).

The mathematical method — jointly with working-up the empirical material — supplied data for the examination of critical factors of the groundnut in the above, according to which in the examined 8 years the crop-averages of groundnut were influenced by the following weather factors on the area of Medgyesegyháza:

a) the mean-temperature of air in positive,
b) the heat-sums and the sunshine period in positive, and
c) the measured quantity of precipitations in negative direction.

Since on the basis of an 8 years average the measured quantity of precipitations proved small among the weather factors, it is desirable to analyze the trend in this latter factor on the basis of a longer period. (Precipitation data are also further on data of Bánkút—Rózsamajor climate station).

As already earlier set forth by me, 250 to 300 mm precipitations in the vegetative period are sufficient for groundnut growing under our native conditions. Apparently this condition is similarly given on the area, since on the ground of 38 years data (between 1931—1968) the average of the precipitation amount in the vegetative period was 320,9 mm. During this time with 47 per cent probability could be counted upon this precipitation quantity, which means that a year in which 300 to 400 mm precipitation was measured, occurred every two years. Being aware of the developmental phases of the plant we know also that the plant demands a considerable percentage (at least 70 per cent) of precipitations during the vegetative period at the time of flowering and fruit-

setting, thus the former examination of the precipitations of the vegetative period cannot serve as a departing point for our expositions. It is more advisable to examine the precipitation conditions of the flowering and in part of the fruit-setting period (10th June to 20th July). The analysis seems to be justified as according to Florov (KOVÁCS, 1960) the precipitation conditions are of the optimum when prior to ripening 500 mm precipitation arrives on the soil.

Between 1934 and 1968 the precipitation average of 35 years was 84,5 mm in the mentioned period. This gives barely more than 30 percent of the total precipitation quantity of the vegetative period. Frequency of 100 to 150 mm precipitations is 3,5 years, while in 11,6 years once can be counted upon precipitations above 150 mm. These latter figures provide an evidence that the growing becomes uncertain without irrigation.

The quantity of early autumn precipitations (month of September and early October) has — according to the examination — a minor influence on the crop results, since on 33 years' average a quantity of precipitations — from lst September to 20th October — was 61,5 mm. In some years (1960, 1968) however the autumn precipitation conditions have likewise contributed to the reduction of the ripening ratio.

The detailed analysis of precipitation amounts on the average of many years shows that this condition is not warranted in the critical periods of the plant and the growing may perhaps become reliable and safe with irrigation.

Edaphic claims of groundnut growing

The well aerated, light coloured soil, rich in nutrients is the most convenient for the growing of groundnut. On tropical and subtropical areas it is grown in laterite and terra rossa, in the temperate zone on sand- or sandy soil. The nitrogen-fixing bacteria do not survive on sticky, loamy soils and the danger of seed-rotting subsists in the period of seeding and ripening. The optimum soil for the plant is a pH value between 6,0—6,2. On more acidic soil liming is to be applied to neutralise the soil acidity.

In Hungary groundnut is grown in the Mezőkovácsháza district on sandy soils.

The crop-land extends on the southern loess-ridge beyond the River Tisza. In the Pleistocene during the sedimentation in the Maros River gravel, sand, silt and on the top, loam became deposited on the surface. Sedimentation was modified by tectonic movements as well as by changes of the climate, thus on some places the sediment layer is repeated. Later on from the flood plain a drift sand surface became established from the sand blown out by the wind, on which by the end of the Pleistocene a subtle alluvial material became deposited in the form of a dropping dust. The loess is the mixture of the typical and infusion-loess. A large part of the area is covered by the former and of a Lowland-loess developed in the Holocene in a similar way. (STEFANOVITS, 1963). Depending upon the mechanical composition of the loess, various soil-types came into

being. On silty loess tchernozjom and meadow tchernozjom, on sandy loess soils of chernozem character, on loamy Lowland-loess meadow and alkaline (szik) soils developed. The light, loose, sandy variant of the Lowland loess was formed on the higher terrains, while the loamier variant on the lower situated parts.

On the central part of the region, in NE—SW direction Lowland chernozem-soil with lime incrustation can be found. A considerable part of the area is dominated however by meadow-and in depth salty meadow chernozems. On lower situated parts meadow-soils and meadow soils turning into steppe are frequent.

The Pedological Department at Szeged of the National Agricultural Quality Testing Institute, under the direction of József IMRE conducted a soil survey in 1965 in the boundary of a community important also from the point of view of groundnut growing, on the area of the Aranykalász and Béke cooperative farms at Medgyesegyháza. Results of the examinations were summarized on the basis of local minutes on genetical soil-maps, humus-cartograms, nurient-cartograms and soil utilisation cartograms. On the ground of the four cartograms we have drawn up the additive soil-cartogram, of the cooperative farms which since then were amalgamated under the name Haladás (Progress). (Fig. 5.). The areas utilized in 1965 with groundnut growing were also indicated on the map (on basis of the Minutes).

On the area of the Cooperative Farm meadow chernozem, chernozem meadow, leached chernozem and calcareous — and chernozem with lime incrustation — soils respectively occur. For groundnut growing one subtype of the meadow chernozem, the carbonate meadow chernozem and also the calcareous and chernozem soils with lime-incrustation are suitable. We shall now proceed to the examination of these soil-types with an exhaustive analysis of a soil profile of each.

On medium-high terrains *meadow chernozem soils* can be found in the largest extension. They have a blackish or darkbrown colour, an angularly crumbly structure and on the more southern parts are stickier more strongly. Thickness of the humus-layer is 80 to 110 cm on the average, the total humus content is on the N—NE parts 1,5 to 2,5 but in some sites 3 to 4 per cent. In the humus layer Ca is the prevalent replaceable cation. The groundwater has an alcaline quality, its medium depth being 2,3 to 3,6 m and its level seasonally changing.

Among its sub-types the carbonate and in depth solonetz chernozem soils are very frequent.

In S—W. direction from the boundary of Pusztaottlaka community the clayey sand-soils, of blackish-brown colour, and of tiny crumbly structure, becoming dusty on pressure are dominant on the surface, in medium depth *carbonate meadow chernozem soils* having on the protuberant parts a deep and on medium-high terrains very deep humus layers. Groundnut is grown on this soil type on the largest area. The dominating fraction is an — in its mechanical composition — coarse and fine sand. Thickness of the humus-layer is 81 cm, the total humus content in the upper 20 cm layer 1,85 per cent. In the same depth the soil pH is

Fig. 5. Additive soil cartogram of the Haladás Cooperative Farm of Medgyesegyháza. A. Mechanical composition. 1 = sandy clay, 2 = clay, 3 = loamy clay, B = Humus-layer: 4 = very deep, 5 = deep, 6 = moderate, C. State of phossphorus and potassium supply: 7 = good or moderate respectively, 8 = moderate, or good respectively, 9 = weak. D. Genetic type of soil: 10 = Lowland calcareous, or chernozom with calcium-incrustation, 11 = carbonate meadow chernozem, 12 = in depth solonetz meadow chernozom, 13 = chernozom meadow. E Soil-variants: weakly humous, 15 = humous, 16 = from the surface carbonate, 17 = carbonate in medium-depth, 18 = carbonate in depth. Soil utilisation: Sz = arable land, Z = vegetables, Gy = fruits, Fm = groundnut.

7.3, its value increasing with the depth. Poorly supplied with phosphorus and potassium, but well and moderately in patches.

The adequate nitrogen supply of the soil is ensured by the groundnut (as it is a papilionaceous plant). On the lower parts of the 30 to 35 cm horizon calcium-incrustation and calcium-concretions can be demonstrated, the upper horizons are, however, poor in calcium. For this reason liming with 20 q/cad. hold dosage, mixed with organic manure, is suggested by József IMRE (on the ground of his investigations). Following the manuring, however, a copius rain or an excess irrigation respectively is detrimental as an elution of the nutrients and a deterioration of the soil structure may occur.

Calcareous and lime-incrustated chernozem soils are like-wise encountered (though on a smaller area on the N and E foreground of the community in patches.) In contrast to the leached chernozem here the calcium carbonate may be found already from 52 cm. The soil-pH is about neutral in the upper 20 cm, while in deeper layers the reaction is slightly alcaline. $CaCO_3$ is present in the form of calcium-veins and calcium-incrustation. The upper 50 cm are poor in calcium, therefore in plant growing the above mentioned liming is necessary also here. Its subtype occurring on the area is a calcareous Lowland-chernozem developed on loessy sand. It is a dark brown, in some places blackish brown coloured soil, with 1,6 to 2.7 per cent humus content and an average 80 to 100 cm thickness of the humus layer.

Replacement of the elements of soil fertility

Groundnut is pretentious toward the soil, so that a replacement of the nutritive elements is necessary by all means. The research workers are in agreement concerning the need of organic fertilization in view of maintaining the soil fertility. On soils of lower quality the application of 150 to 200 q barnyard-manure is recommended which is to be brought into the soil under the previous plant or by ploughing it down in the autumn. Among chemical fertilizers 100 to 150 kg potassium-salt are necessary per cad. hold. The potassiumsalt has to be dispersed one year but at least one month prior to seeding as it is taken up by the deeper benetrating roots. The potassium salt present in the upper soil layer hinders the absorption of calcium. In Medgyesegyháza 100 kg/cad. hold potassium salt were used in the last years (1965—1968). Phosphorus fertilization has to be employed on soils poor in phosphorus. The Hungarian crop-land is for the greater part moderately supplied, therefore the phosphorus quantity used per cad. hold in the last three years is increasing.

In addition to the state of humus- and nutrient supply of the area also soil-utilisation can be read off from the Chart. On this the sites of groundnut growing have been marked within the branches of cultivation.

In the knowledge of soil-characteristics the productive area could be extended to the carbonate meadow- and to the in patches occurring calcareous or calium-incrustation Lowland-chernozem soils which can be found in the eastern foreground of the community. On soils moderately

supplied with phosphorus the cultivation shall be combined with phosphorus fertilization.

Sandy soils of similar properties can be encountered on other areas of the Mezőkovácsháza district as well (Fig. 6.), thus in the N-foreground of Pusztaottlaka, Almáskamarás and Kevermes, in the Westen foreground of Nagykamarás and of the Eastern of Kemeres, and also in the N-boundary of Medgyesegyháza. From the soil point of view this area is similarly suitable for groundnut growing. In its main features the area tallies with the terrains suggested for groundnut growing by Karakasevich (1960).

The above examined natural factors, given on the area, correspond to the claims of the plant only in part. Particularly the inappropriate distribution of precipitations may cause damages in the crops. The shortage of precipitations in the critical period and the abundance of precipitations in the autumn lead — on the ground of experiences gained in the production — to a deterioration of the quality. A certain soil-weariness appears likewise together with the given soil conditions which are already otherwise not al all in the optimum.

Quality of the seeding material has — in the opinion of local specialists — depreciated in the last years, in view of which fact they are engaged in the ara in producing good seeding material by way of selection.

In addition to the examined natural conditions — as we have already pointed out in the introduction — the development of groundnut growing in Hungary is influenced also by other factors, such as e. g. by the level at which the production is mechanized, labour situation, rentability conditions, import possibilities. To support the latter we are now examining the rentability of groundnut growing.

Rentability of the production

In Hungary groundnut is utilized in roasted condition as dessert and in raw state as basic material of the sweets industry and of margarine manufacturing. On the ground of experiences made so far in the large-scale production a quantity economical for the oil-industry cannot be safely produced.

Referring to groundnut growing a calculation was made by János Bruder in the beginning of 50-ies by which he wished to demonstrate the rentability of inland production. He has shown that with a 5 q per cad. hold crop-average the production cost of 1 q groundnut is 274 Ft. Among the inputs he did not take in consideration however the seeding material requirement, fertilization or the numerically even today not demonstrable accessory costs respectively. Besides these he could not be aware of many years experiences of a largescale production of which nowadays data are already available for us. The trend in crop-averages and production-inputs is the following in the Haladás Cooperative Farm of Medgyesegyháza:

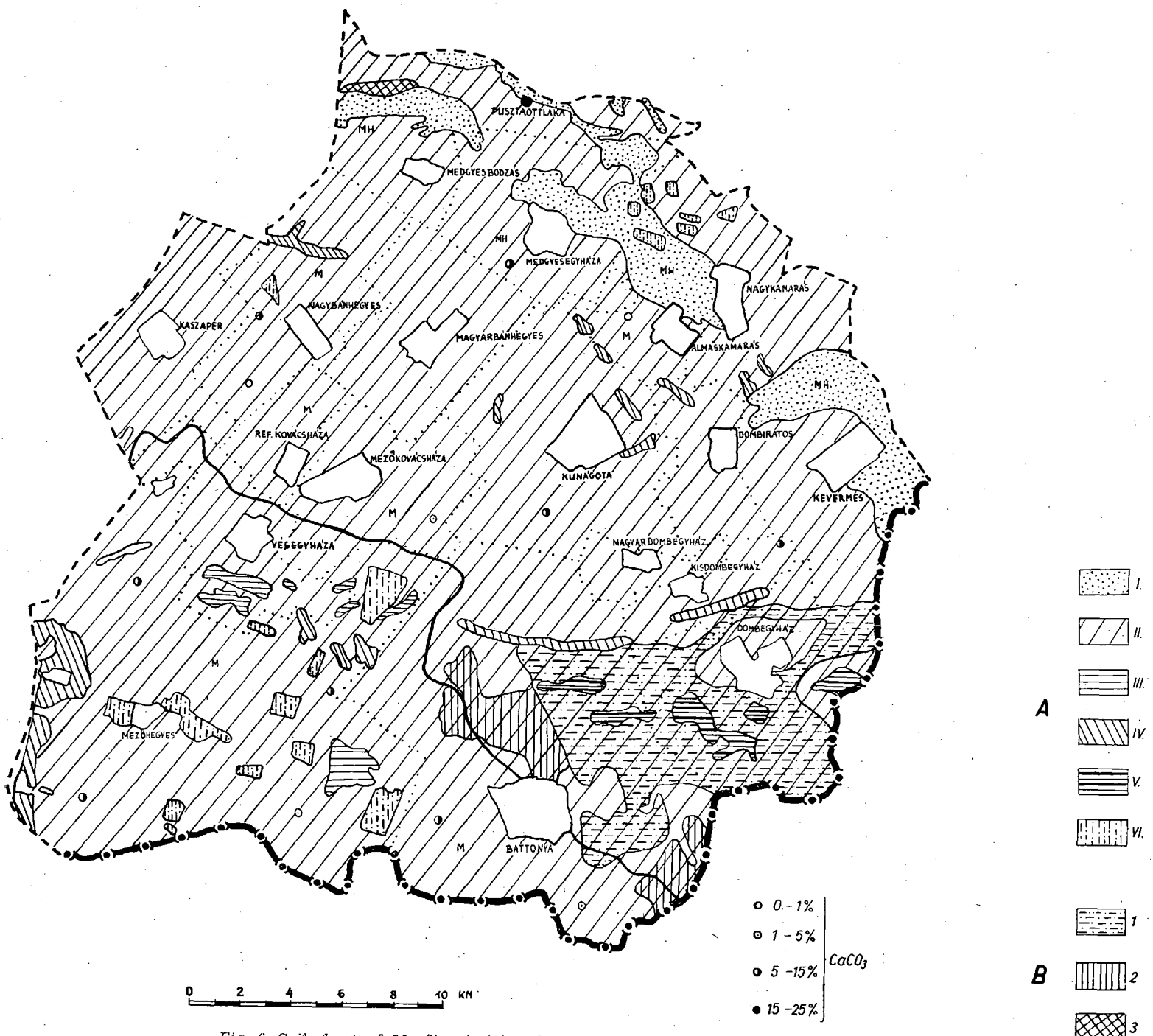

Fig. 6. Soil-chart of Mezőkovácsháza district (after Andó). A. I = sand, II = clay, III = loam, IV = conditionally productive meadow, V = infertile alkaline (szik), VI = forest, B. 1 = sodic, saline layer, 2 = sodic ameliorable with calcium carbonate, 3 = sodic (szik), ameliorable with gypsum or other material with acidifying effect.

	1960	1961	1962	1963	1964	1965	1966	1967	1968
Crop average q/cad. hold	5,5	5,0	4,8	7,0	5,2	3,0	2,6	5,3	2,5
Input q/Ft	758	834	868	595	802	1390	1604	786	1668

On the ground of several years' average we have calculated that 4171 Ft is the input for 1 cad. hold groundnut-growing (this includes the seeding material requirement, the cultivation inputs and chemical fertilization).

On this basis the production cost of 1 q groundnut with raw seed coat amounts to 1034 Ft on 9 years average in which the accessory costs are not comprised, e. g. control-operations in the case of pests, organic manuring and other inputs depending upon the extremities of weather.

While the Ft 274 input could be considered economical, with the latter amount the growing becomes uncertain particularly in years where crop-averages are weak (in 1966 the crop average was 2,6 q/cad. hold, in 1968 also 2,5 q/cad. hold).

Comparing the production cost of groundnut with the preduction cost of on the area grown other plants, we arrive similarly to the mentioned conclusion. In 1965 on the average of all the cooperative farms of the Country the production cost of winter wheat was 176 Ft/q, of barley 159 Ft/q (E. CSIZMADIA—L. DANKOVITS—L. UDVARI, 1968) while at the same time the production cost, on ground of a 9 years average, attained 1043 Ft/q. [This latter production cost was computed by means of the work unit Ft average of 7 years, the value of which is 37 Ft in Medgyesegyháza. From 1966 the income per capita of one working day reached on the average 90 Ft in the cooperative farms of the Mezőkovácsháza district and this contributed considerably to the increase of the groundnut production cost. Taking into consideration that groundnut requires an intensive cultivation (soil cultivation, hoeing, hilling up twice, pulling-up, hulling of the crop) — cultivation of 1 cad hold demands 18—20 work-days, this means a heavy engagement of manpower.] It is to be noted that the production cost demonstrated in the agriculture has not a quite veritable content and either the materialized labour figures at the effective price, the ratios may be however — even with a certain error percentage — direction-indicators.

The above mentioned plants, with their lower production cost, demand an extensive cultivation, the labour engagement is less heavy and beyond these — on the basis of the given natural-geographical conditions and of the production experience, produce safer and more reliable crops.

This tendency is confirmed by the change in the crop-structure of plant growing on the fields of Medgyesegyháza in the last seven years as well (Fig. 7.). The area sown to groundnut (within the other category) decreased and the areas sown to maize and roughages have also diminished. The area of sugarbeet is about unchanged while the areas sown to cereals and feed-grains increased.

On the basis of rentability (which we approached with the comparison of the raw production costs and buying-up prices, having considered also the 9 per cent rise of the buying-up prices in 1966) between

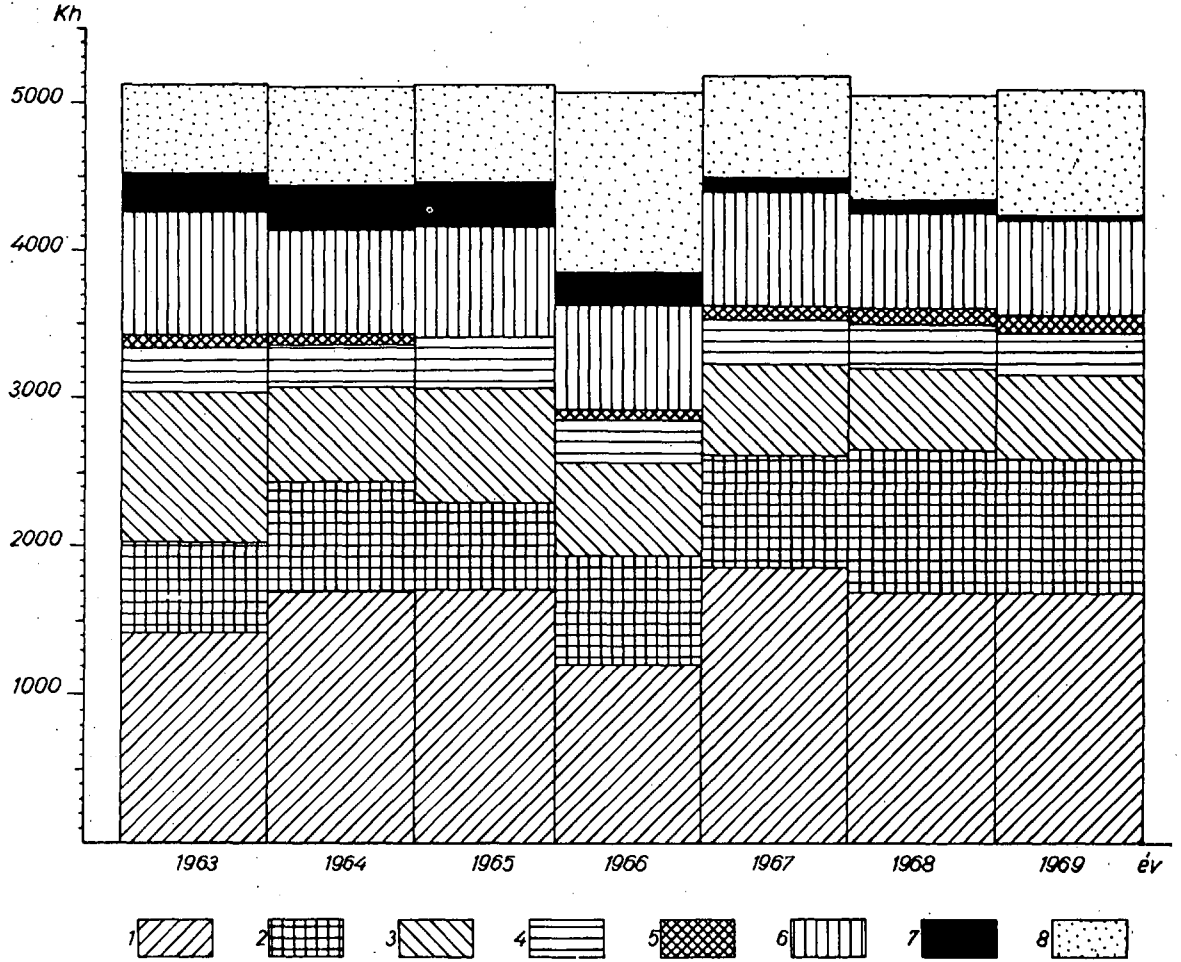

Fig. 7. Variation of the cultivation structure of cropping at Medgyesegyháza between 1963—1968. 1 = cereals, 2 = feed grain, 3 = maize, 4 = sugarbeet, 5 = potato, 6 = roughages 7 = groundnut, 8 = others.

1963 and 1967 an uniformly growing tendency is shown by the cereals (Fig. 8.). The income deriving from feed grain species is similarly increasing, though this increase cannot be called quite uniform. In the case of groundnut we may count upon a substantially larger income, in the individual years however the magnitude of the income is variable. Taking into account that the growing represents a substantial labour engagement and inputs and also the very considerable fluctuation of the crop averages, the growing of plants corresponding to the optimum of the given natural conditions is more appropriate.

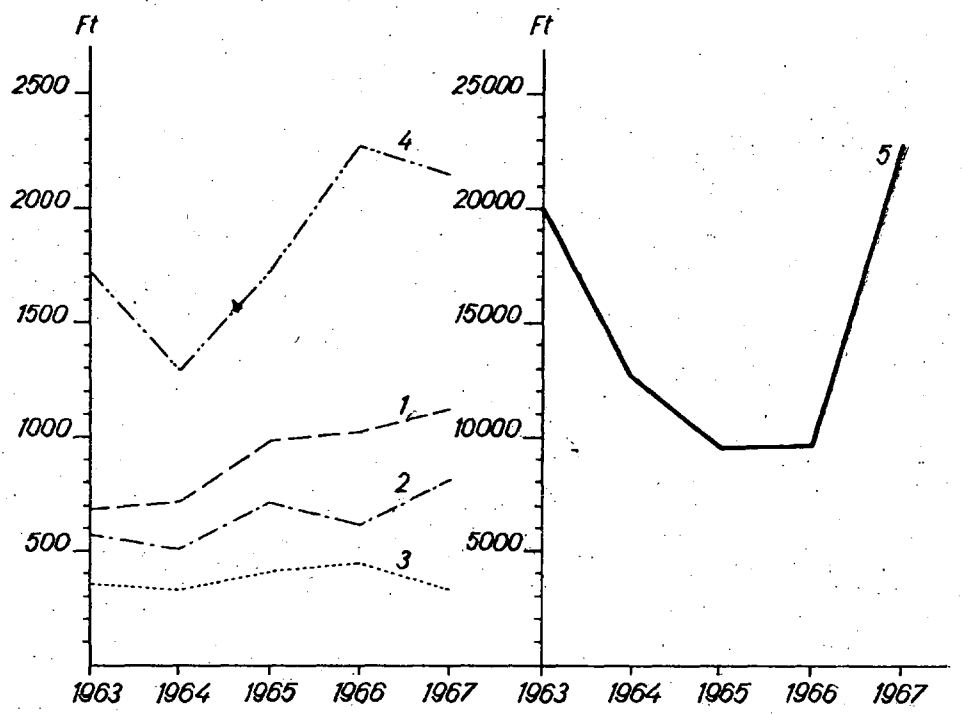

Fig. 8. Trend in the income per 1 cad. hold in Medgyesegyháza. 1 = wheat, 2 = barley, 3 = maize, 4 = sugarbeet, 5 = groundnut.

(Here also must be noted that the financial system, which on the 1st January 1968 entered into vigour, = has raised the agricultural price-level and with the system of assisting the income regulating system of cooperative farms influences the resulting incomes considerably, in the income formations however the demonstrated tendency comes into effect.

Examining the rentability of production, as an additional material may serve also, if the groundnut is compared with sunflower, an oil-containing plant grown in Hungary under optimum climatic endowments. The growing of sunflower is similarly more extensive and its production cost in 1965 was 404 Ft/q on the average of all cooperative farms (E. CSIZMADIA—L. DANKOVITS—L. UDVARI, 1968). The fact that either

the oil content of the shelled sunflower seed (45 to 55 per cent) remains behind the groundnut argues likewise in favour of sunflower growing.

The annual 1000 t requirement of the Hungarian oil industry could not be satisfied economically by our groundnut growing. It is more advantageous to import groundnut oil from abroad for this purpose or replace it by growing other plants respectively.

The examination of import possibilities belongs to the rentability calculations. The price of imported raw-seed-coated groundnut between 1962—1967 was 2700 Ft/q, while between 1967—69 Ft 2062 per q. (At the lower price also 100 tons groundnut of Vietnam provenience were imported in the past years but also its quality was inferior). (In the last two years the import price was formed with 60,06 Ft foreign exchange multiplier, taking 10 per cent customs duty, the inland freight charges and 11 to 12 per cent roasting loss in consideration. Seeds of imported groundnut have 8 per cent water and 47 to 48 per cent oil content. The extracted grits contain about 47 per cent crude protein.

Comparing the 2700 and 2062 Ft import price respectively with the buying up price of about 3500—3300 Ft in the last years at national economy level the growing of groundnut in Hungary is uneconomical. The risk in smaller on household areas, it is comprehensible therefore that the population which has experiences in the production is dealing with groundnut growing on smaller areas even today.

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