A Survey of the Agro-Ecological Potential of Hungarian Agriculture

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The background

Hungarian agriculture made considerable progress during the past twenty-five years. Between 1955 and 1980 production practically doubled. This coincided with the intensive application of the results of scientific and technical research. Mechanization, the use of fertilizers and pesticides, the introduction of combined technological procedures, the quickness with which the large-scale growing of new varieties of plants was launched, the development of animal husbandry and animal hygiene, the significant improvement of the agricultural infrastructure (system of roads, buildings, storehouses, services, etc.) jointly underlay this advance. Social factors, too, had a beneficial effect. In the early 60s the socialist reorganization of agriculture took place, with the strict observation of the voluntary principle. The large-scale agricultural co-operatives and state farms were formed. In the late 60s the modernization of the management of Hungarian economy commenced. Within the framework set by central planning, characteristic of the socialist system of society, the producing enterprises were given considerable independence in respect of structuring production, increasing efficiency and profitability. This was accompanied by the extension of a system of financial incentives for both the enterprises and their employees. The state made great efforts for the vocational training of people working in the field of agriculture. Development was furthered by the comparatively favourable natural circumstances of the country, too. The quality of soils, the supply of water, thermal conditions and the relief of the terrain are all good enough to make intensive agricultural production possible.

Natural, social and technical factors jointly resulted in a situation where, by the late 70s, Hungary turned out 1.15 tons of grain and 140 kilograms of meat per capita. With these two indices the country found itself among the ones leading the field in Europe. 75 % of the goods produced by agriculture and food industry is consumed within the country, 25 % is sold abroad. One third of Hungarian exports delivered against payment in convertible currency is turned out by agriculture and food industry. All this means that agricultural production has a determinative role in the economic development of the country.

Success, however, is not tantamount to lack of problems. The comparatively high level of meat production has entailed substantial imports of protein; that is, the country is not self-supporting in respect of proteinaceous

fodders. Neither can forestry cover the country's needs of wood; home production is to be supplemented by imports. Phosporus and potassium as raw materials as well as 80% of the petroleum used up in Hungary are to be imported. The world market prices of these articles showed a more marked increase during the last decade than those of the products of food industry. This has had an unfavourable effect on the prime cost of agricultural produce.

The earlier large-scale development of agricultural production and the demands for its continued progress necessitated a survey to size up whether, by the utilization of the ecological endowments of the country, production could be significantly stepped up, and to what extent, by the turn of the millennium, or there was some natural drawback that might prevent Hungarian agriculture from meeting the requirements of ensuring a high-level home consumption simultaneously with a considerable increase of exports.

At the 1978 General Meeting of the Hungarian Academy of Sciences in the course of the debate on the development of agriculture and the objectives of scientific research, a resolution was adopted for the forming of an *interministerial committee* to make a survey of the agro-ecological potential of the country and to elaborate proposals for the better utilization of natural resources.

Subsequently the Hungarian Academy of Sciences, the Ministry of Agriculture and Food, the National Hydrological Authority, the National Technical Development Board and the National Authority for the Protection of the Environment and Nature established a joint committee to reveal the connections between natural endowments and the required increase of yields.

The committee coordinated the work of about 50 research institutes, university computer centres, etc. and 400 experts. The two basic aims of the survey were to determine

- the highest level of plant production made possible by the agro-ecological conditions of the country by about the turn of the millennium, and the conclusions that can be drawn from such possibilities in respect of a long-term economic policy;
- the ways of how the present endowments of the production areas can be better utilized for the increase of yields and the decrease of costs in the meantime.

The survey

When calculating the expectable agro-ecological potential of the country in 2000, the experts started from the assumption that the primary materials for foodstuffs will be produced by procedures basically the same as today up to the end of the century. It was supposed that plants will mostly be grown in open fields, and no such profoundly and perfectly new inventions in the field of plant-breeding, chemicalization or the utilization of water were taken into account which would place plant production on entirely new bases. Fully known, but not yet fully exploited conditions underlay the calculations which were to depict a situation which had a large probability of ensuing and which was about the minimum to attain. Any important scientific discovery or practical advance might only brighten the prospects.

The fundamental *objective* of the survey was to determine the *maximum yields* permitted by the environment provided by nature (precipitation, tem-

perature, soil cover, relief, water supply, etc.) and the genetic properties of the plants in 2000.

The survey covered all branches of cultivation, that is:

— field crop production
— the management of grasslands and pastures
— vegetable growing
— fruit production
— grape-growing
— forestry, and
— the growing of medical plants.

Figure 1 presents the flow-sheet of the survey of the agro-ecological potential.

The survey was conducted in four steps:

a) *The qualification of Hungary's territory on the basis of agro-ecological factors*

The character of a production area is determined by several factors: climatic conditions, soil properties, hydrological conditions, irrigation, etc. The country was divided into regions, then the regions into "mosaics" within which plant production was going on under more or less "homogeneous" circumstances.

It happened as follows:

— All the ecological factors were evaluated together and then, on their basis, the country was divided into 35 *agro-ecological regions*. Meteorological conditions were considered homogeneous within each region.
— The agro-ecological regions were then further divided according to the breakdown of the 31 types of soil occurring in Hungary. At the end we had 205 distinguishable soil mosaics.

These mosaics served as *calculation units* for the purposes of the survey. The territories of these mosaics add up to the territory of Hungary.

The type of amelioration needed was stated for each mosaic and it was also determined where it would be expedient to introduce irrigation. The data arrived at underlay uniformly the prediction of yields.

The change in time of meteorological conditions was characterized plant by plant. Weather characteristics with a critical influence on the development of certain field crops served as a basis for the elaboration of *climatic types of years*. Each type was described region by region and the relative frequency of its occurrence was stated.

Once the agro-ecological mosaics were established, an estimate was prepared concerning the percentages of the country's territory belonging to each branch of cultivation. The so called "excepted areas" were determined on the basis of long-term development plans.

b) *Yield predictions*

The forecasts were made independently of each other but on the basis of the same principles.

The aim was to predict the yields permitted by the natural-environmental conditions by the turn of the millennium in case the techniques considered most

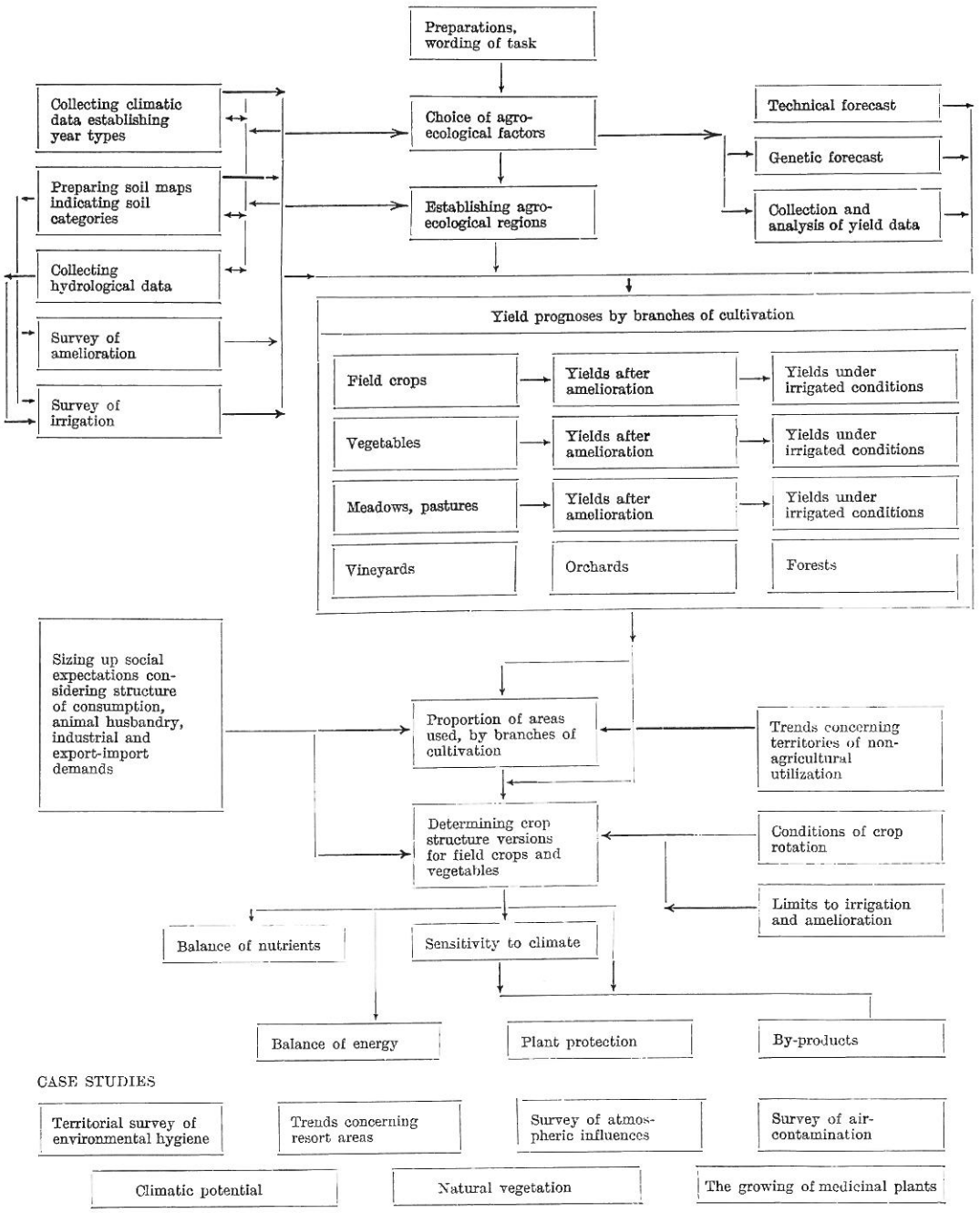

Fig. 1

Flow-sheet of the survey of the agro-ecological potential

advanced at present will *generally* be used until then. At this stage, however, it was not possible to investigate all the social and economic factors which may slow down or prevent the *general* introductions of the most advanced technologies in two decades under our circumstances and may, accordingly, reduce the actual yields.

Such slowing and/or hindering factors may be among others:

— the lack of the necessary financial means and of suitably qualified people to do the job;
— the slow realization of investment projects, importation problems concerning machinery and/or chemicals, etc.;
— conservatism, traditionalism and incompetence within the producing apparatus, the multitude of local and group interests, the force of habit and the resistance against innovations, which will all stand in the way of the general introduction of up-to-date techniques and their application all over the country.

The prognoses for vegetables, fruit, officinal herbs and forestry were elaborated by the research institutes in charge and that of grape-growing by a group of experts formed for this purpose. Similar teams were organized to prepare the forecasts for field crops and grasslands. When surveying the various branches of field crop production, not only the yields — subject to ecological influences — of different species were determined, but the expectable demand, too, was taken into account to make a realistic prognosis.

The working parties formed to examine the possibilities inherent in our pastures and grasslands sought answers to the questions of what yields can be achieved by rational management — in the light of the present conditions — after amelioration or with irrigation.

Meadows fit for both hay and crop production were identified. The future use of these fields depends on economic considerations.

The most detailed forecast was devoted to the expectable average yield of *field crops*. The experts proceeded as follows:

I. First the genetic potentials of the main field crops were sized up by plant breeders.

II. Then an expert prognosis of feedback, based on written and verbal questioning, was prepared on the main field crop yields for each ecological mosaic, drawing on

— the genetic prognosis,
— the results of the comparative testing of varieties by a network of research stations,
— statistical analyses of past harvest results,
— international analyses, etc.

Expectable average yields were determined by taking into account the frequency of the various types of years described in the prognoses for the different *climatic types of years*.

III. As a control of the estimates made by experts, prognoses were also prepared by *statistical methods*. They were based on the changes in the national average as against the detailed predictions given by the experts.

IV. Having surveyed the possibilities of amelioration and irrigation, the experts also predicted to what extent these measures — if adopted — will increase average yields.

The calculations of the mathematical model were based on figures provided by the forecasts described in item II. The boosting effects of amelioration and irrigation on the yields were shown additionally.

c) *The determination of crop structures adjusted to social expectations and objectives*

The analysis of the structure of plant production, and the determination of the variants of crop structure were only performed in respect of field crops and vegetables. For the purposes of the mathematical model, the following conditions were taken into account:

- The limits up to which land was available in each agro-ecological mosaic for the growing of field crops and vegetables;
- The area of irrigable lands in each agro-ecological region and in the country as a whole;
- The limits of allocations in the national budget for investments in amelioration. Supposing different limits of such investments, an ideal order of sequence for the various areas was established.
- The ratio of the growing area of certain field crops, which is subject to biological restrictions and territorial characteristics, for every region and sometimes for groups of soil within a region. Separate estimates were made for ameliorated and non-ameliorated lands.
- The distribution of irrigated land among the various species, determined separately, and in proportion to each other.

The aim was to establish a *range of crop structures*, realizable under the above conditions, which meet the expectable requirements of the country in respect of both quantity and quality, and in a given composition. For the exact formulation of these requirements, a *model of social expectations* was elaborated, forecasting the needs of the country in more than one version, considering changes in the population, consumer habits, food processing, and commodity reserves for export.

For the purposes of the model of consumption, animal proteins were converted into vegetal products. Conditions ensuring reproduction were taken into account in respect of both animal husbandry and plant production. The factors controlling the product pattern of plant production were determined on basis of the social/consumption model.

For a few variants the quantity of products ensured by the given crop structure was also figured out for each climatic type of year, to form an idea of the "weather sensitivity" of the structure.

d) *Supplementary studies, maps, etc.*

The main line of the course of the survey of the agro-ecological potential was supplemented by several case studies. Some of them discussed the conditions of realization, like a survey of required nutrients, others presented an analysis of the factors that may hinder production (atmospheric influences, air pollution etc.), yet others dealt with other aspects of the potential (e. g. climatic potential). Altogether 43 such studies were prepared.

Conclusions of importance

1. The *favourable natural endowments* of Hungary (the duration and intensity of sunshine, the quantity of heat during the growing season, precipitation and water supply, and arable land) permit the annual production of large amounts of produce of varied composition.

It must be, however, taken into account that certain climatic factors affecting farming — first and foremost precipitation due to its fluctuations and uneven distribution — may jeopardize future crops.

Modern techniques and amelioration can curb these variable, unfavourable influences. It would, therefore, be expedient to vigorously develop the technical possibilites of local protection. As regards improvement, the abilities of plants to resist the adversities of the weather and to regenerate, respectively, are to be increased. By developing the material-technical basis of plant production, crop losses resulting from unfavourable weather conditions can be reduced. Inevitable, partial losses can be offset by storing reasonable reserves.

2. Careful management of the country's water supply *(precipitation, surface and underground waters)*, and its full utilization are also of basic importance. In more than half of Hungary's territory, water is a factor limiting plant production and, in case of increasing the crop capacity of the fields, its role as such may become more and more restrictive. Therefore it is fully warranted to increase the area supplied with up-to-date irrigation. Irrigation should be provided, first of all, for those areas, whose soils as well as the crops to be grown on them make it likely that the yields will significantly and steadily exceed the average.

80 to 85 percent of cultivated land will only get natural precipitation in the future, too. A plan — also encompassing complex amelioration — should be formulated and systematically carried out to provide for the storage of excess precipitation, to prevent runoff and to utilize underground water supplies because that way it would be possible to fulfill — by and large — the water requirements of agriculture and to protect water quality.

The reduction of the harmful effects of water (water-logging, secondary salinization, the fluctuations of the water table) is of basic importance when production is to be maintained on a high level. Water control facilities are to be developed according to the existing hazard. The harmful surplus of natural precipitation appearing in some places from time to time is to be drained off, keeping damages at a minimum, and protecting the quality of the water as far as possible. The bigger proportion of such surpluses can be reserved, the better.

The construction of flood control systems has to be continued for the protection of both arable lands and their natural environment.

3. The possibilities of increasing crop production are determined, besides the weather and hydrological conditions, by the fertility of the soil, and the extent of arable lands. As the area of arable lands cannot be increased, every effort is to be made

— to preserve cultivated lands,
— to protect and increase their fertility, and
— to ensure reasonable use of the land.

When carrying out soil-amelioration projects, the order of sequence, for which detailed proposals were elaborated in the course of the survey of the agro-ecological potential, based on economic considerations, is especially important.

Amelioration and water control can make possible the development of an agriculture much more efficient than the present one. Production can be kept on a high level with the best choice of cultivation branches and crop structures based on agro-ecological considerations, with the requirements of environmental hygiene also met at the same time.

4. The genetic value of all cultivated plants and plant communities should be increased continuously in order to further the better utilization of natural resources. If we wish to make better use of the potentialities of the interrelations of species, environment and technology, we shall need more special varieties.

One of the objectives of plant breeding should be to satisfy higher quality requirements concerning the so-called "*useful material contents*" of crops.

It would be expedient to speed up plant improvement through international co-operation and the proper adaptation of foreign varieties.

Preservation of the biological assets of our nature conservation areas, the organization and maintenance of gene banks can also contribute to the better utilization of Hungary's renewable natural resources in the long run. Rise in production, if we wish to maintain it for a long time, must not entail a deterioration of the natural environment. Therefore agrotechnical procedures protecting, or at least not harming the environment are to be employed.

5. A collective forecast has been prepared concerning *field crop* yields at the turn of the millennium. The experts examined 13 of the most important plants. The expectable yield of each plant was predicted in each of the 35 ecological regions, taking into consideration the 3 to 5 soil categories and all 4 climatic types of year. Other teams sized up the effects of complex amelioration operations, including irrigation, on the increase of crop yields.

These data have given valuable indications of the proportions of potential differences between the individual regions and between the "ecological mosaics" within each. They constitute a sound basis for decisions on where each crop should be grown to have optimum yields.

Calculations using the data of the collective forecast of experts have shown that by the turn of the millennium, with crop structures utilizing natural endowments at optimum level, corn production can be increased by 80 percent — as compared to the present gross yield — and also significantly higher yields of alfalfa, sunflower, fodder peas, soya, potatoes and sugar beet may be obtained, provided land improvement is carried out continuously, the proper supply of plant nutrients in soils is ensured and mechanization is on a high level.

Calculations aimed at the determination of *crop structures fitting* the given *agro-ecological endowments at optimum level* have demonstrated that the proper selection of crops to be grown on a given area can result, even in the short run, in a 15—20 percent rise in the total national yield.

6. Roughly half of Hungary's *grasslands* of about 1,290,000 ha. can be put to intensive production so that, in the wake of water control, fertilization, and irrigation, hay harvests can be doubled even before the turn of the millennium. The rest should be rated as meadows where no remarkable increase of yields can be expected as a result of intensive cultivation though the amount of produce, here, too, could be doubled by better methods. Survey results, however, have made it obvious that the surpluses achieved this way could only be utilized by a larger cattle population than the country has at present. By in-

creasing hay yields, that is, the territory of intensive grasslands, the production of field fodder crops can be reduced.

A considerable proportion of low-yield meadows has an environmental function, so some of them are to be maintained by all means; others may be used for afforestation, then for game-preserving purposes.

7. The climatic conditions of Hungary are by and large satisfactory for *growing vegetables*. In the suitable areas, with well-chosen varieties harvest results can futher increase. The extremities of weather (drought, spring and early-autumm frosts) may greatly influence production, so a fluctuation of 25 to 30 percent should always be reckoned with.

Precipitation in the growing period does not usually meet the requirements of several greens, so they can only be grown in safety where irrigation water is available. At present only 30 percent of the land under vegetables is irrigated. To ensure dependably high production it would be advisable to double this acreage by the turn of the millennium.

Besides the better utilization of the endowments of the growing areas and the improvement of technology, average yields could considerably be increased by the introduction of high-yield varieties resistant to diseases and having a good adaptability.

Under these conditions the average yield of vegetables can be one and a half times higher than that achieved in recent years.

8. The territory of Hungary is fit for the *production of* every *fruit* of the temperate zone although certain kinds having special requirements can be successfully grown only in specific areas of the country. The type of soil, the quantity of precipitation, the level of humidity, the number of sunny hours and the comparative altitude and relief, respectively, have a significant influence on the quantities yielded by the various species and varieties of fruit trees, as well as on the frequency and extent of damages caused by late spring and sometimes winter frosts. Natural resources can only be utilized with high efficiency, if, at the same time, production is brought to an up-to-date level.

By the turn of the millennium, the average yield of apple can be increased on the large-scale farms by 50 to 80 percent, and that of other fruits by 100 to 150 percent.

9. The ecological conditions of Hungary are favourable for *growing grapes* yielding "extra quality wines", "quality wines" and wines of good quality, though most vintages are threatened by the extremities of weather, e. g. frosts in the winter, spring or early-autumn, drought or too much rain, etc.

The present national average of 4.5 metric tons per hectare, which is low by international standards, *can be doubled* by the turn of the millennium if the new vineyards are located on protected slopes of favourable micro-climate in the mountainous and hilly regions and in those parts of the Great Hungarian Plain which are less exposed to the dangers of frost, if the growing of heavy-bearing and resistant grape varieties becomes general practice all over the country and if vine-stocks are planted, spaced and trained so as to permit cultivation by machines.

10. The climatic and soil conditions of the country are, in general, favourable for *sylviculture* and *forestry* on a large scale. The annual yield of fell is 4.3 cubic metres for 1 hectare of forest.

This is due, first of all:

— to the replacement of slow-growing deciduous trees with fast-growing acacia trees and poplars which account now for more than one third of Hungarian forests; and
— to the systematic development of forestry to end the acute shortage of wood; more than half a million hectares of land have been put under forest since the Second World War.

It has come to light during the survey of the agro-ecological potential that, simultaneously with the significant increase in tree-felling in the last two decades, considerable reserves have accumulated in the woods of Hungary. These reserves and the added yearly growth of the trees could increase lumbering by 20 to 30 percent by the turn of the millennium if the necessary technical conditions and industrial capacity for wood-working are ensured in the meantime.

It should also be kept in mind that, besides providing raw material for the wood-working industry, our forests have important environmental and recreational functions and play a role in nature preservation (preservation of genes). This is why it is very important *to maintain the natural forests* and to improve them, if possible, in a natural way.

Summary

The survey was a fruit of collective efforts, a synthesis of scientific accomplishments, data and practical experience which had previously accumulated. The committee also made an effort to demonstrate, by optimalizing the country's ecological resources, the possibilities of development for Hungarian agriculture. In case of a favourable shaping of social and economic conditions, plant production as a whole can be stepped up by about 80 percent in Hungary by the end of the century. The potentialities of natural endowments do not realize themselves automatically; several social and economic factors (professional training, a financial system incentive to work for higher yields, the development of the infrastructure of the villages, the promotion of industry, etc.) are needed to make their exploitation possible at optimum level.

Hopefully, the most important conclusions of the survey and its method of approach to the subject will make themselves felt in the course of preparing the central state plans for the development of the economy in the long run. The possibility of turning out a bigger volume of vegetal products necessitates further research into the various ways of utilizing the biomass (food, fodder, raw material, energy, manure), in harmony with the alternatives of developing the economy of the country.