



## Organic Matter and Soil Fertility



In accordance with the planned program, the Study Week on *Organic matter and soil fertility* covered all the aspects deemed worthy of interest and provided an opportunity for specialists in different fields to exchange views and contribute to the resolution of problems as complex as those which were the subject of the Study Week.

The working groups, created in order to unify the criteria related to the different aspects of the problem, allowed the Study Week to reach, in its last session, perfectly homogeneous final conclusions, which revealed a complete agreement among the Participants on the most important points of this complex problem. We can already conclude that this Study Week has generated some important results.

Moreover, the guidelines discussed during the Study Week and the agreements reached during its sessions will undoubtedly contribute, in our opinion, to solving the problem of world hunger, or at least to spurring governments and study groups and providing them with the most suitable guidelines for achieving the desired results in this field.

We are currently experiencing a new period of crisis in the endemic problem of insufficient food production on a global scale, which is so well expressed by the expression "world hunger".

This problem and crisis have moved the world's conscience following the urgent appeal made by His Holiness Pope Paul VI, who, like his predecessors, maintains two permanent observers of the Holy See at the FAO.

Since science can and must respond to the appeal of the Holy See and contribute to clarifying and exploring the various means that can lead to the expansion of food production, the Pontifical Academy of Sciences, following the Holy Father's directives, wishes to play an active role in solving this problem from the scientific point of view.

With this Study Week on *Organic Matter and Soil Fertility*, the Pontifical Academy of Sciences has shown that one of the most effective means is undoubtedly the increase of productivity through the improvement – or at least the conservation – of soil fertility, which, in turn, is intimately related to its content in organic matter.

As organic matter is the main subject of this Study Week, the latest knowledge on its origin, conservation and transformation in soils has been taken into account, especially the most modern techniques, both from the microbiological and chemical points of view.

In this perspective we addressed both the processes involved in the nitrogen cycle and those concerning organic matter in different types of soil, in relation to their fertility.

The subsequent sessions dealt with the more concrete aspects of organic matter related to soil fertility: the physical properties of soil, i.e. its physical structure and the effect of cultivation methods on this absolutely fundamental characteristic of soils, also considered from the biological point of view.

Chemical processes in organic matter were then considered, both in relation to the organic matter-clay complex and, more concretely, to the transformation of carboxyl groups.

One particularly interesting argument in this area is the effect of organic matter and phosphates on nitrogen fixation in the soil by photochemical processes. All of this, we hope, has allowed us to coordinate the various ideas generated by current research in this area.

The discussion continued on the action of microorganisms on organic matter. In this sense, we considered all aspects of organic matter related to fertility, as well as factors that can encourage it. Then we dealt with the action of fauna on the formation and decomposition of humus. In addition to the topics considered in the previous sessions, this allowed us to discuss the main factors that can improve soil fertility.

Finally, we discussed the effects of the application of organic matter and derived or similar products, as well as their action on plant growth, thus giving a more concrete nature to the results of the previous discussions.

Applications to fertility problems were also discussed, and the latest findings on plant development were specifically considered.

Natural and artificial humus, fertilizers prepared from it and their effect on agricultural production were discussed, as well as the causes of non-accumulative effects on yield and the intensification of the use of these products.

We hope that the discussions and exchange of views in the various sessions have provided a more complete picture of the problem as a whole; above all, it is expected that the aspects which are still unclear will serve as a basis for future research and will help determine which of them are of greater practical importance in terms of their influence on increasing fertility and, in short, on increasing soil production.

Pietro Salviucci

Chancellor of the Academy

## Introduction

The problem of organic matter in the soil is of such great complexity that it occupies the attention of eminent specialists in the most diverse fields of science. Thus, soil chemists and physicists, biochemists, microbiologists, zoologists, etc., work in their particular fields of activity and try to obtain clarification of the problems raised by the formation, transformation and conservation of soil organic matter, but with a limited and particular specialist perspective.

Precisely at the moment when science has reached an advanced degree of specialisation, it is essential to realise when the exchange of ideas and results between the various specialists who, from their respective fields, seek the solution of identical problems, becomes necessary. It seems to us that, in the complex question of organic matter in the soil, the moment has arrived and even passed when the co-ordination of the efforts made in the different fields of work becomes indispensable.

This Study Week, promoted by the Pontifical Academy of Sciences under the title of *Organic Matter and Soil Fertility*, has therefore been, we hope, of great use because it has been possible to make a real effort, at the highest level, in favour of the necessary coordination.

Soil fertility is very closely related to its organic matter content. Therefore, anything that can be done to increase the accumulation of organic matter in the soil will be reflected in an increase in the potential fertility of the soil, given that we are experiencing a new period of crisis in the endemic problem of insufficient food production on a global scale, which is so well summed up by the expression "world hunger".

Let us now consider the characteristics of the soil on which organic matter acts:

- 1) The type of structure, and consequently, the root development, water retention capacity of the soil and, consequently, the effectiveness of rainfall or irrigation;
- 2) Fixation of nitrogen from the atmosphere by microorganisms and photochemically, because in both cases the presence of organic matter is fundamental. These two processes for supplying nitrogen to plants are the most economical, whereas the compounds produced artificially by man, apart from being more expensive, are still, even with the current state of technology, produced in quantities too small to cover the needs of plants;
- 3) Protection of the soil against erosion, as erosion alters the structure of the soil, and consequently the organic matter content;
- 4) The life of the microorganisms that carry out the dynamic soil cycle;
- 5) The supply of humic acids and plant hormones to plants (respiratory and elemental absorption processes);
- 6) The direct or indirect supply of macro or micro elements for plants, facilitated by the organic matter itself in its decomposition or by the action of the products of this decomposition on the mineral fraction of the soil;
- 7) The compensatory action of anomalous balances between anions and cations in the soil solution.

This is an extraordinarily complex problem, which immediately derives from the very complexity of soil organic matter and the mineralogical, chemical, physical and biological mechanisms that condition its incessant transformations.

The following are some of the lines on which the final programme was based, which was naturally prearranged according to the opinions of the specialists participating in the Week.

- 1) Origin, transformation and conservation of organic matter in soils.
- 2) Use of natural organic substances and model substances.
- 3) Reciprocal action of soil microorganisms and fauna on organic matter.
- 4) Characteristics of organic matter in the main types of soil and their importance on fertility.
- 5) Joint study in relation to cultivation techniques, including the use of humic fertilisers.

Based on the results obtained from the discussion of the aspects already known by the various participating specialists, the Study Week was able to highlight the results obtained, as well as the gaps that still exist, and therefore indicate the lines along which current research should be conducted.

As a further result, it is hoped that many other researchers will recognise the importance of the problems to be solved and will feel encouraged to contribute to their solution.

In this way we will have helped to avoid the fate of ancient civilisations that disappeared precisely because they did not know the transcendental role that organic matter plays in soil productivity.

Today, it would be even more deplorable to fall back into the same errors when science has revealed the reasons that caused the decline of these civilisations.

Valentin Hernando Fernández

Deputy Director of the Institute of Edaphology and Plant Biology in Madrid, participant in the Study Week and Technical Secretary of the same.