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# Soil Conservation And Soil Survey In India

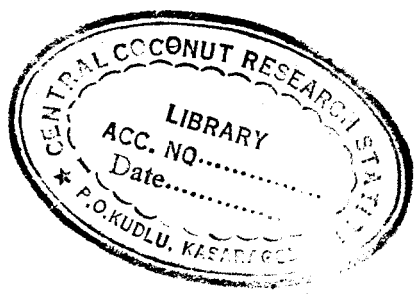
by

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# SOIL CONSERVATION AND SOIL SURVEY IN INDIA

by

CHARLES E. KELLOGG

The suggestions that follow were formulated after study of several documents about the current soil programmes under way, conversations with many people in India, and short visits to a few locations. The limited time for detailed field work, study, and reflection must be recognised.

Since soil conservation and soil surveys are intimately related together and with other soil and agricultural research and with plans for irrigation, drainage, and flood protection it is not possible to deal adequately with any one aspect separately from the others. For ease of presentation, I have grouped those items pertaining mainly to soil survey under one general heading, those relating to the soil conservation under another those relating to technical training under a third, and the status and recruitment of soil scientists and soil conservationists under a fourth. But this division is somewhat arbitrary since the whole purpose of the training and of the soil survey is to achieve soil conservation in the broad sense of using the kinds of soil available in India at the highest economically feasible level of sustained production with whatever combinations of practices and materials are available for use.

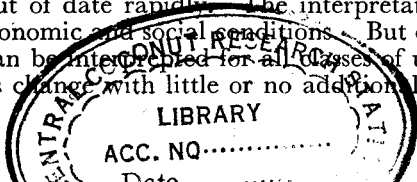
## SOIL SURVEY

### 1. *Single Standard Soil Survey*

For reasons of economy and effectiveness, and to make full use of the small number of soil scientists trained to carry out field work, it is strongly recommended that one standard soil survey (with varying scales of mapping and detail of classification as required) be developed cooperatively by the Centre and the States to serve *all* users. These include soil conservation, irrigation, agricultural extension, consolidation of holdings, catchment basement planning afforestation, grazing land development and guarding, and the like. It is entirely feasible to develop one standard soil survey that can be used and understood by all. Having separate soil surveys, as now by the Centre, by individual States for soil conservation planning, and for developing irrigation is bound to lead to unnecessary duplication, confusion in terminology and misunderstandings among both the field scientists and the users of the results.

Once a standard soil survey is available, either from copies of field sheets or from publications, all classes of users can have the specific interpretations from it for their immediate purposes.

Such standard soil surveys should take into account all soil characteristics that are significant to the various uses. The soil classification and mapping should be objective. If instead, interpretations are mapped rather than the soils themselves, the maps are likely to be useless for other interpretations and are very likely to go out of date rapidly. The interpretations change with changes in the agricultural arts and in economic and social conditions. But once an objective standard soil survey has been made, it can be interpreted for all classes of users and these interpretations can be revised as conditions change with little or no additional expense for costly field work.



## 2. Memorandum of Understanding

It is recommended that a memorandum of understanding be drawn up to cover the objectives and plans for cooperative soil surveys between the Centre and each State in full consultation with the representatives of all major using agencies of the Government of India and of the States. Where special organizations are operating, such as the D.V.C., three-way memoranda should be developed to include the three agencies making and using the survey.

The memorandum should provide for following additional documents to be prepared :

A. The development of a tentative long term (5 to 10 years) plan of areas to be taken up for soil survey in accord with priorities as required to give the greatest possible service to planned developments dealing with soil conservation, irrigation, consolidation of holdings, watershed protection, and the like. Surveys in advance of these developments should be emphasized since they play a very large role in the ultimate outcome of heavy public expenditures. These long term plans should be revised annually as developments proceed and conditions change.

B. A firm annual plan should be developed each year, preferably at a fixed date, for the soil survey work to be undertaken. This plan should include specific boundaries of the areas to be surveyed and the personnel, transport, supervision, laboratory-work, research on the soils, cartography and interpretation of the soils for use. The names of the scientific officers and the specific functions and the contributions of each cooperating agency should be written into this annual plan. With full cooperative work of high priority, personnel from two or more agencies may be working as a soil survey team under the guidance of one specific individual as party chief.

C. A specific work plan should be prepared for each soil survey project. It should be signed by the responsible officer of each cooperating agency so that no misunderstandings will arise about intentions. This work plan can be amended, formally, if conditions change during the course of the survey. The work plan is very important because some soil surveys may continue for three or four years during which there may be important changes in administrative personnel in the agencies. The work plan should provide at least the following :

- (1) Objectives and uses to be expected of the soil maps and reports,
- (2) The planned contributions of personnel and facilities of each cooperating agency,
- (3) The names of the scientific officers and of the immediate supervisors and co-operators,
- (4) The Scale of the soil map—
  - (i) For field work
  - (ii) For publication
- (5) The interpretations to be made of the soil survey.

These interpretations may take the form of tabular ratings or index numbers, or they may take the form of groupings of the kinds of soil (types and phases) shown on the map and described in the legend. In most agricultural areas a great many interpretations can and should be made for use by agriculturists, foresters, engineers, and others. Examples of such interpretations include the following :

- (i) The estimated average yields of the adapted crops under each specific system of management important to each mapping unit.

NOTE.—The harvest from any soil results from the nature of the soil and the combinations of practices in the management system. Commonly there are several alternatives and yield estimates are needed for each significant alternative in order to give the cultivator a choice.

- (ii) *Erosion hazard*.—Commonly soils can be grouped into about five classes in accord with degree of erosion hazard under clean cultivation.
- (iii) Soils can be grouped into capability units (or managements groups) that bring together those kinds of soils that have approximately the same potentialities and management requirements for high sustained use under soil conservation. These may be further grouped into capability classes in accordance with their general potentiality and the hazards and limitations of use for the common agricultural crops.
- (iv) Suitability of the Soils for various species of productive trees (forest site index).

(6) Plans and authors of (a) the tentative report or handbook containing the soil descriptions and interpretations for immediate use with copies of the field sheets and (b) the final report for publication. As soon as the soil survey is initiated, it is important to have a descriptive legend that gives the mapping symbol on the map and a description of each unit as mapped. As the work progresses and data are accumulated, the individual soil descriptions can be supplemented with interpretations that are needed by the map users. This expanded descriptive legend serves as a handbook of the soils. It can be tested in the field by those using the results, criticized, and perfected. At the close of the soil mapping work, this handbook forms a basis for the preparation of the published report. In this way there is *always* available a text that can be reproduced for using the soil maps from the time the survey is initiated until its final publication. Of course, such handbooks are revised during the course of the survey.

D. Following the development of the work plan for an area, the soil survey party leader under the technical guidance of the soil correlator and of his immediate superior, should prepare an initial review of the area that includes a suitable legend of the kinds of soil, such as types and phases, in order that the soil survey can be carried out in a way to accomplish the objectives of the work plan.

Normally, one does not find all the soils during this first review. As the work goes forward the soil correlator and other representatives of cooperating agencies should go over the survey together and make progress reviews to check the adequacy of the legend, the accuracy of the mapping, and the soundness of the interpretations. Finally, as the survey is finished the same officers make a final review with recommendations for the names to be used in the final map. These names should be subject to review at the Centre to avoid confusion or duplication.

### 3. Base Maps and Scale

A. It is recommended that the All-India Soil Survey give its main emphasis to detailed standard surveys on village maps (16"=1 mile or 8"=1 mile according to the detail required), supplemented where possible by aerial photographs (8"=1 mile), with overlap to permit advanced, study of the area under the stereoscope. In many countries, including the United States, essentially all soil mapping is done directly on aerial photographs. But most of these countries do not have these 16"=1 mile village maps. The individual holdings are so small in many of the villages in India, and it is so important that the soil boundaries be accurate in respect to these individual small holdings, that I believe it is better to use the village maps for plotting the boundaries than to use the air photographs unless there is found to be a cheap and practical way to transfer the boundaries of the holdings to aerial photographs of large scale.

For publications, these field maps can be reduced to a scale somewhere between 2"=1 mile and 4"=1 mile according to the detail on the field sheets and the uses to be made of the published soil map. In most agricultural parts of India a soil map on a scale of 1"=1 mile is far too small for ready use by extension officers, soil conservationists, or conservation engineers.

Field sheets should be reproduced directly by the cheapest process for use by all those officers working directly with land development or with the cultivators on soil and water management and conservation.

In this way the soil maps will be accurate in relation to the boundaries of the cultivators' fields. Smaller scale field sheets are not likely to be usable in direct work with specific cultivators, which is by far the outstanding present need of soil maps in India.

B. It is recommended that field soil maps of small scale, say less than 4"=1 mile, be made under only two situations :

(1) Where there is urgent need immediately of a general or schematic soil survey in *advance of planning* a land development project, say for new irrigation or land reclamation by clearing in order to locate the most promising areas that should be mapped in greater detail, in order to develop new or revised fields, canals, and other works of improvement, and for soil conservation planning. In planning watershed protection such preliminary soil maps may be made in order to locate quickly the most critical areas producing the silt that goes into the reservoirs.

(2) In non-farm areas of rough grazing or woodland where the needs for conservation planning, afforestation, and controlled grassland developments can be met by a map of small scale.

#### 4. *Trained Personnel Essential*

It is recommended that the All-India cooperative soil survey programme be continued and gradually expanded on a relatively modest basis in areas of high priority. The programme should not be expanded beyond the availability of trained soil scientists who can direct the local field work in ways that produce reliable soil maps and interpretations. An over expansion beyond the availability of trained personnel would certainly lead to unreliable results and costly failures.

#### 5. *Diploma Holders as Field Workers*

It is recommended that further trials be made of using diploma holders as field workers under the direction of trained soil scientists in order to cover as much land as possible at low cost consistent with accurate results. As is already being done in a few places, the party leaders can lay out grids, or lines, on the village maps for such men to follow. On these lines he can indicate the spots for examination of the soil profile and the measurement of soil slope. Descriptions need to be in strictly objective terms, in writing, on an appropriate outline. From these orderly notes a tentative soil map can be drawn by the party leader which he *then corrects and completes in the field* by observing all the soil boundaries *throughout* their courses.

In some places now in India, such workers map only soil slope and soil depth as a basis for laying out bunds. They can be trained *also* to map the soil types and thus have a soil survey for all purposes.

#### 6. *Correlation*

Soil correlation should be directed during the next three or four years to obtaining uniformity of soil descriptions (according to the *Soil Survey Manual* or other appropriate handbook) so that soils can be compared and later correlated as soils types (and phases of soil types), with a uniform nomenclature throughout India. But before countrywide soil correlation can be

attempted soil descriptions need to be on a uniform basis and many soils described within the areas that are mapped in detail. In these local areas mapping units should be soil types with any necessary phases for soil slope; salinity; truncation by erosion or excavation; gullying; stoniness; depths to the water level; hardpan; or rock; and so on. It should be emphasised that each phase of the soil type must be included within the definition of that soil type, and that the definitions of phases within different soil types may not be uniform. For example, some soils are highly erosive at 1% slope. With those soils a line should be drawn to separate those soils above 1% slope from those below it. In other soils, erosion is not serious until one reaches 5 or perhaps 7 per cent slope. For those the line should be drawn at that appropriate percentage of slope.

During this initial period, the four soil correlators should take a few well-planned field trips together and with the appropriate State soil scientists to be sure that they are describing similar soil characteristics alike.

### 7. *Subdivision of Survey by Regions*

It is recommended that the four areas for soil correlation be revised from the present basis and be established as four groups of States so that each soil correlator works with *all* the soils in his assigned region. The suggestion of soil correlation by broad soil regions is absolutely certain to involve unnecessary overlapping travel and administrative confusion. To take one example, Alluvial soils are found throughout India.

### 8. *Map Preparation*

It is recommended that simple cartographic services be supplied at regional centres or at State centres, as convenient, and as agreed on in the memorandum of understanding, and that final map compilation be at the same places or at the Centre according to available facilities and cost.

Reproductions of field sheets and of compiled manuscript maps for immediate use in the field should probably be done at the Centre in order to conserve equipment.

### 9. *Cooperation with Survey of India on Color Separations*

It is recommended that every effort be made to work out arrangements for the survey of India to make the necessary color separation plates for colored soil maps and to print all soil maps to be published. Considering the relatively low volume of work for publication during the next few years and considering the high engineering skill required, it would be very costly indeed for the Centre to support the staff and equipment required for making color separation plates and for printing soil maps.

### 10. *Cartographer on Central Staff*

At the Centre headquarters of the soil survey, a skilled cartographer on the soil survey staff should serve as liaison with the Survey of India. He should supervise the reproduction of field sheets and such compilation of soil surveys as is undertaken at the Centre. He should be responsible for seeing that each survey project leader in India has copies of all available cartographic materials, including aerial photographs of appropriate scale, all available topographic maps, geological maps, cadastral maps, and all other maps of the soil or land, vegetation, land use, and climate. As soon as a work plan is being considered it should be called to his attention *immediately* so that these materials may be gathered because the availability of such materials has an important bearing on priorities and on the development of the most efficient work plan for the survey.

### 11. *Survey Interpretations*

It is recommended that a highly qualified, well-trained officer be assigned on the staff of the Director at the Centre to promulgate methods for interpreting the soil classification and the soil maps in terms of suitability for adapted crops, trees, and grasses under alternative systems of management for each kind of soil, and for the many groupings of soils needed in land development programmes. Such groupings include: arability under irrigation, erosion hazard, capability groupings, arability of soils with drainage or flood control, general fertilizer requirements, engineering properties in respect to water disposal, road construction, and the like, and the many uses of the soil survey in various types of land classification. This officer needs not only field experience in the soil survey, but also training in agronomy, horticulture, and economics. Under this officer should also be included the final technical editing of the soil survey publications being prepared in the field and reviewed by the regional correlators.

### 12. *Research in Soil Classification*

It is recommended that the Centre have a highly qualified staff officer to carry out and supervise the carrying out of the specific researches necessary for understanding soils that are to be classified and mapped. That is in some survey areas, preliminary research is often required in order to develop a practical legend. These researches include both field studies in soil morphology (and related ecology, geology, and geomorphology) and combined laboratory and field researches. The laboratory should be under this officer and should be a national one responsible for methods and for standardized determinations made in the field laboratories under the regional leaders. As a general estimate, somewhere between five and ten percent of the soil survey funds will be required for these field researches and for the laboratory work. For example, researches are often needed to find just where to separate soil types from one another according to permeability of the subsoil in order to recommend contour terraces or graded terraces and the kinds of rotation. Similarly, field research is necessary to establish slope phases at the proper place. Many other examples could be given where research must either precede or go along with the development of a soil survey legend that will give soil maps that can be interpreted in terms of specific practices. Further, unless the genesis of the soils is clear, the boundaries are not likely to be drawn accurately.

### 13. *Geomorphologist on Centre Staff*

It is recommended that a well-trained geomorphologist be added to the staff at the Centre, probably under the Director of Soil Survey Research, in order to give training in this important field to the soil correlators and especially to the soil survey party chiefs. In any old tropical landscape there have been many changes in climate and many erosion cycles. Rarely are soils in tropical areas actually developed *in situ* from the rocky materials deep below. Most of the surface materials have been moved about many times. An understanding of these geomorphological processes, and their evaluation, are important in order to assess the significance of the various layers seen in the soil section and to predict erosion hazard.

### 14. *Priorities*

Priority of surveys should be given great emphasis. The soil survey programme in India can be developed only gradually over a period of years. No whole country can be mapped at once. Thus, the All-India Soil Survey will have the critical problem of establishing priorities for taking up publishable units of survey. Normally, a convenient size is about 2 to 5 lakh acres. It is also convenient in the use of the surveys to have important local governmental units included within one survey.

It is recommended that these priorities be worked out in cooperation with the States at a high level in the Government of India so that the needs of all agencies using the results can present their views. Following are the chief items to take into account :

A. It is of first importance to emphasize soil surveys in those areas where the greatest possibility exists for substantial improvement in agricultural production and efficiency. In this way, the soil survey can begin at once to have a direct effect on incomes of both cultivators and the government. The excellent work done in parts of India along this line can be seen. One example has been the improved yields and efficiency of sugarcane growing in Bombay State. Such results can be had all over the country with all crops.

B. The plans for land development and conservation schemes should all include detailed surveys in advance to ensure economy and effectiveness. This is specially urgent (a) for public works of considerable cost and (b) where cultivators are expected to make substantial changes in their farming systems.

C. Plans should give emphasis to extension work in the various parts of the States, especially plans for the consolidation of holdings and for village improvement.

D. As early as practicable, detailed soil surveys should be made in each significantly different kind of soil region so that the general scheme on soil classification for all of India can be developed as soon as practicable.

E. The availability of existing cartographic materials, including aerial photographs and geological maps should be considered. Other things being equal, preference should be given to those areas already having such maps.

#### 15. *Cooperation with Existing Agencies*

It is recommended that the soil survey establish cooperative relationships with existing agencies for special assistance in agronomy, economics, forestry, engineering, and geology (except for geomorphology) and not add experts in these fields to the soil survey staff.

#### 16. *Soil Augers*

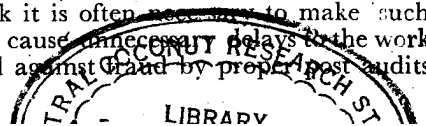
It is recommended that field soil scientists in India be furnished more appropriate soil augers with special reference to the cylindrical types, some of which are adapted to dry soils and other types to wet soils.

#### 17. *Travel Allowances*

It is strongly recommended that the travel allowances for field scientists be increased as necessary to insure that the scientists are fully compensated for their field expenses. At the present time, the travel allowances for some field scientists are below their actual costs in the field and they must make up the difference out of their salaries. It will be impossible to attract highly competent men for such work unless they are fully compensated for their field expenses. The work is more difficult than inside work and it takes men away from their families. The soil survey of India can never develop unless there are reasonable incentives for highly competent men to take up the work as a scientific career.

#### 18. *Small purchases*

It is recommended that the administrative regulations be amended where necessary to permit reimbursement for small items of equipment obtained by scientists in the field without prior administrative approval. In carrying out field work it is often necessary to make such small expenditures and requirements for prior approval cause unnecessary delays to the work to no purpose. The Government can be fully protected against fraud by proper post-audits as needed.



## SOIL CONSERVATION

19. *Basic Concepts*

It is recommended that the working concept of soil conservation be broadened to include all the combinations of soil and water management practices that are needed to achieve sustained production of crops, grasses, and trees from the specific kinds of soil at the highest practical level. In every place where soil conservation is fully effective, a proper combination of four elements has been achieved: soil, water, plants, and people.

The control of soil erosion is only one aspect of soil conservation, but a very important one on certain kinds of soils. Basically, practical erosion control requires control of water which, along with proper fertilization and other practices, gives a stabilizing *productive* and protective cover as much of the year as possible.

Water control includes run-off control to allow as much water as possible to enter the soil and the remainder to flow harmlessly into prepared outlets; irrigation, drainage, or, more commonly, the two together; the conservation of the moisture in cropped soil through proper tillage and weed control; and the maintenance of productive grass cover or forests on soils too unstable or too unresponsive for cultivation. Water control is closely related to the prevention of either permanent or temporary waterlogging of soils and to the prevention or amelioration of accumulations of excess salts in the soil.

The stabilization of gulleys is a part of soil erosion control closely related to water control to land farming to reclaim previously eroded soils, and to the establishment and guarding of useful protective trees and grasses.

Good evidence of this concept was seen in parts of India. For example, yields are increased three-fold at Sholapur by bunding and improved dry-farming methods. This has been proved in cultivators' fields. Research has shown that this yield may be doubled again by proper fertilizers being added to the combination.

The preparation of new lands or the improvement of formerly cultivated land through land clearing, irrigation, drainage, flood protection, and land forming are important parts of any national soil conservation programme.

Since a soil conservation programme requires research (including soil survey), education technical assistance, cost-sharing between the government and the cultivators, credit, and stable agricultural prices, many national, state, and local agencies must cooperate together. The development of such cooperative relations should be a major function of the Soil Conservation Board and its staff.

The Soil Conservation Board should be prepared to make grants for any of these conservation measures in accordance with priorities of other public works that must be protected the prospects of increasing agricultural production, and the prevention of loss of highly valuable agricultural soil and water.

20. *Survey, the Basis of Conservation Planning*

It is recommended that no grants for soil conservation be approved by the Soil Conservation Board until a standard soil survey of appropriate scale and detail has been made or is included in the plan for completion prior to the actual conservation planning. In the Poona area for example, depth of soil and soil slope are the major local factors important to bunding; but other very important soil differences are highly important to kinds of crops, expected yield and other practices necessary for a conservation plan to be fully effective to the cultivator.

## 21. *Planning by Cultivators*

Individual village and farm planning by the cultivators is the most important aspect of soil conservation. The cultivator must take all aspects of production into account and so should all the technicians who assist him in developing a plan for his operations.

## 22. *Local Leadership needed in Conservation Programs*

It is strongly recommended that every effort be taken to develop local leadership and responsibility for soil and water conservation within the villages and larger units of local government. Excellent work along this line was seen near Poona, specifically in the village of PARNER. The agricultural extension officers should be asked to carry the educational program about soil conservation to the cultivators. Booklets, cinema, and posters should be prepared to show clearly the problems and what can be done. The more local leadership can be developed in soil conservation, the more will cultivators take up the work and the more enduring will be the works of improvement. The work in any catchment basin, district, or village should be developed *with* the local people, *not* simply done *for* them. Plans made for individual cultivators or groups of cultivators that they do not understand are not likely to be carried out effectively. But if they do understand, they will carry them out, adopt others, and continue to improve their practices. It is as important to improve the understanding of the cultivators and for them to gain confidence that they can use technical information to improve their soil, their incomes, and their ways of life as it is to get the initial works of improvement on the hand. This may not be a dramatic way, but it is the most enduring way in a democratic society. For this purpose village or area associations comparable to soil conservation districts in the United States can be very helpful.

## 23. *Consolidation of Holdings*

It is recommended that special effort and priority be given to the consolidation, or partial consolidation, of holdings in the villages, especially where run-off and erosion control are significant problems. Satisfactory schemes have already been put into effect in some villages in the D.V.C., for example. In a great many villages such adjustments are the *first* necessity to the design and application of those water-control measures necessary for increased and sustained production. Such measures include contour terraces on permeable soils, graded terraces on slowly permeable soil, grassed waterways, diversion terraces and gully stabilization, masonry chutes for water outlets, and so on. Unless these practices are installed and maintained full benefits cannot be expected from the use of better seeds, fertilizers, and other practices. Some cultivators do not like curving bunds; but the need must be explained to them. If straight lines are followed for bunds on curving land the bunds will cause water-logging or will break and cause increased erosion.

## 24. *Inspection by Center*

It is recommended that the Center arrange to inspect all soil conservation work done by the Center or under grants of funds to the States in order (1) to see that the work done conforms to reasonable standards, (2) that the most improved methods, based on adequate soil surveys, are followed, (3) that the soil conservation work is carried on cooperatively with other village programs, (4) that villagers are given full understanding of the work and of their responsibility in it, and (5) that new and improved methods developed in the various States are rapidly spread to all other areas in India where they apply. Perhaps qualified soil conservationists of the Center may be at regional locations for such inspections; but no administrative "layer" should be developed between the States and the Center.

### 25. *Soil Study should Precede Land Clearing*

It is recommended that no further land clearing for settlement be approved without examination of the soil to be sure that any potential hazard of soil erosion, soil blowing, or low yields can be controlled by the cultivators with such technical and financial assistance as can be given.

### 26. *Follow-Through in Planning*

It is recommended that arrangements be made, cooperatively with the States, for continuous follow-through of soil conservation planning in order to be sure that works of improvement are maintained and that cultivators are given all possible assistance for further improvement. This is especially important where large expenditures have been made for works of improvement. For example, the new, elevated irrigation canal near milestone 106 west of Calcutta on the main road to Delhi is made of highly erosive material unprotected by vegetation. Unless steps are soon taken to protect the embankments, this huge investment will be lost.

### 27. *Integration with Soil Testing—Interactions with other Improved Practices*

It is recommended that all soil conservation work be carefully integrated with soil testing, extension work, and other services to cultivators so that the cultivators have the great benefit of the interactions among improved water control, fertilizers, improved seed, and the other phases of this farming operations. Only rarely does any one of these items by itself result in great benefit: it is the combination of all of them that gives the big improvement.

In this connection, it is further recommended that all laboratories under the Soil Conservation Board work cooperatively with the soil testing scheme. All soil conservation officers working with cultivators should be thoroughly familiar with the soil testing program and help develop its further use by cultivators. And, of course, those working with soil tests should explain the needs for water control and other soil conservation measures.

### 28. *Conservation Research Needs*

It is recommended that specific arrangements be made among the Indian Council of Agricultural Research, the Soil Conservation Board, and other appropriate agencies for periodic field appraisals of the additional research needed in all phases of agriculture to make soil conservation work as efficient and effective as possible and that formal reports, including specific research needs, be fully considered in giving priority to research projects and grants. Such researches would be intended to remove any limiting factors, including improved plants, new methods of water management, livestock management, farm management, and so on.

### 29. *Travel Allowances*

Allowances for field workers who travel must be fully adequate to cover living expenses while travelling if able men are to be attracted to this work.

### 30. *Cost Sharing*

It is strongly recommended that additional study be given to the sharing of costs and risks with the cultivators who are adopting difficult soil conservation measures such as large terraces, diversions, consolidation of holdings, and the like. The inability of the cultivator to take heavy risk is often wrongly called "conservatism". Where practices are relatively new and strange to him, the State should protect his interest by guarantees or insurance against loss of income. Further, much of the need for changed practices for run-off control arises from the public need to protect streams, reservoirs, harbors, highways, towns, and other works of improvement and from the public need for food, fibre, and timber, as well as from the needs of the cultivators.

Near Ootacamund, for example, where erosion control is critical, cultivators are asked to contribute 75 per cent of the cost of very expensive works, including the time of the technicians, and to pay interest on deferred payments of their share of the total cost. I strongly believe that the public share in this area should be considerably larger than 25 per cent. I would suggest at least a 50—50 sharing of costs or a 60 per cent. share for the cultivator without considering the costs of technicians. This I regard as the minimum that is fair to the cultivators in such situations. When the costs are much lower, a 25%—75% ratio may be appropriate, although this is a high burden to the cultivator. All India, both city and country alike, depend on agriculture and the public must bear a considerable part of the cost and share the risk in such situations.

### 30-A. *Drainage in Relation to Irrigation*

Generally in India, inadequate attention is given to drainage in connection with all types of irrigation I have seen, in both large areas and small ones. In many places the lower layers of the soils are not permeable enough to allow the extra water supplied by irrigation to pass through. As a result, temporarily high water tables develop and excess salts accumulate. Much soil that would have been highly productive with adequate drainage has been lost to agriculture. This soil-destroying process is now going on in both large and small areas in many parts of India. With proper drainage some of these soils can still be reclaimed; but others are so badly damaged that reclamation, although possible, will be laborious and costly. Certainly new projects need to be carefully studied and designed to prevent further losses.

### 31. *Soil Destruction for Brick Making*

It is *highly* recommended that a high-level group of soil scientists, engineers, and geologists with legal assistance, study the very serious problem of soil destruction through removal of material for making bricks. Lakhs of acres of some of the best soil in India have been ruined, needlessly by the removal of 2 or 3 feet of surface soil from large areas. This highly destructive process now goes on at an accelerated rate. Large areas in the great plain of Northern India have been so ruined the surface soil has been removed down nearly to the water table. Salts accumulate and the soil becomes worthless for any use. Reclamation would require deep drainage ditches and reworking of the soil into raised beds.

Certainly places can be found for taking out material to far greater depths, thus disturbing much less total surface and leaving useful ponds for water storage and for fish.

It is recommended that a special technical service be developed for locating suitable places for taking material for bricks without the destruction of such vast areas of excellent soils. The good agricultural soils should be protected from destruction by appropriate use of the police power and taxing power of the State. The problem is serious because many of the soils being destroyed are among the most productive, potentially, in the world.

### 32. *Borrow Pits for Roads and Canals*

It is recommended that the attention of responsible agencies of the Center and the State be called to the damage done, unnecessarily, to wide strips on either side of many highways and canals. In many places, the surface soil has been removed from wide strips to build the grade, thus spoiling large areas of good soil. Where the water table is near the surface the soils become salty and worthless. By making deeper and narrower ditches, or borrow pits, much soil could be saved.

### 33. *Training in Soil Science*

The training of soil conservationists and soil conservation engineers in elementary soil science should be greatly strengthened. Several of the staff people interviewed consider only the characteristics of the surface soil whereas the permeability and other physical characteristics of the subsoils and substrata are even more important to water control and to the hazard of erosion. A sloping soil with a permeable surface soil, a very slowly permeable subsoil, and a soft, highly erosive substratum has an enormous erosion hazard even on gentle slopes, especially to deep U-shaped gulleying wherever water is concentrated. Level bunds on soils with slowly permeable subsoils leads to waterlogging just behind the bunds and poor crops. On such soils graded terraces to *protected* outlets are necessary.

These relationships need greater emphasis to both senior and junior staff at soil conservation research stations and in project areas.

### 34. *Use of Bullock Power*

It is recommended that wherever possible, even at research stations, terrace construction and other earthmoving be done by bullocks rather than tractors. Tractor-made terraces will be considered wholly academic by Indian cultivators in most parts of the country for some time to come.

### 35. *Cooperation with State Highway Officials*

It is urgently recommended that the cooperation of State highway officials be sought for better control of water. Inadequately located and constructed ditches and culverts have resulted in enormous new gulleys in highly erosive soils. Such new gullies can be seen, for example, near Bangalore where an old undulating landscape is already being cut down by a new (geological) erosion cycle. Any concentration of flowing water is bound to bring devastating results with losses of valuable soil from cultivation.

### 36. *Soil Conservation Director*

It is highly recommended that the Soil Conservation Board have one top, high-ranking officer responsible for the entire program of the Center in soil conservation and soil survey. Certainly he should be someone with experience in both soil science or soil conservation and administration.

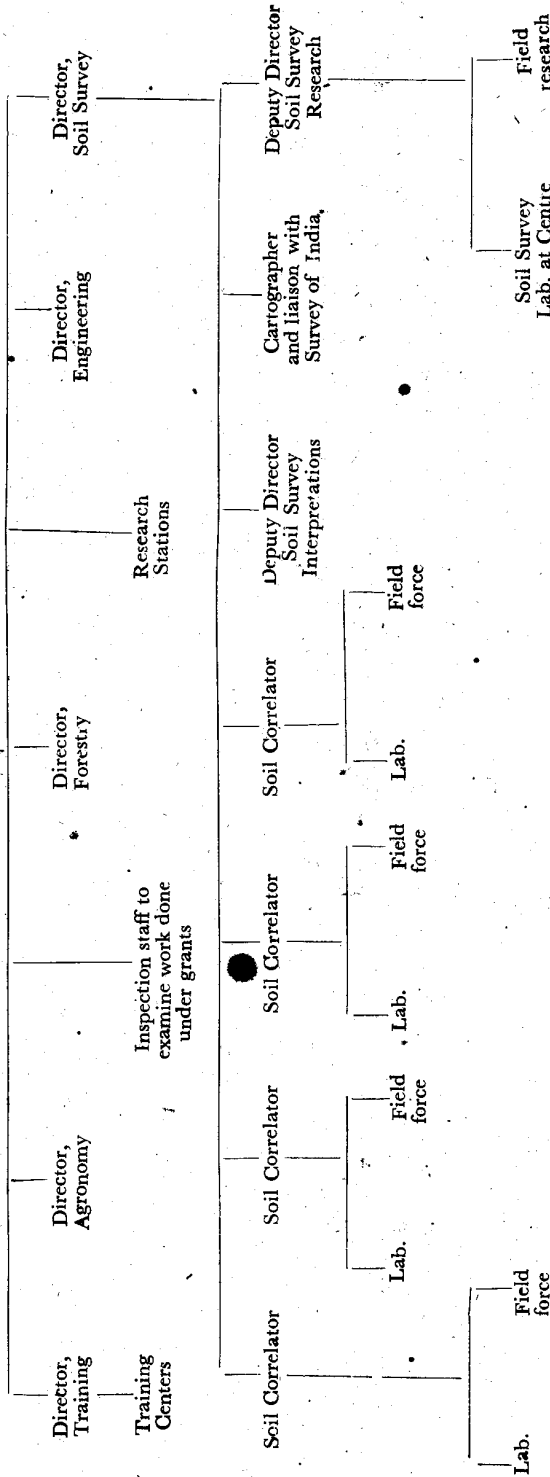
### 37. *Organizational Pattern*

It is highly recommended that the Director of the Soil Survey be responsible directly to the Officer suggested in 36 above as a part of the Soil Conservation agency of the Center.

A suggested flow chart follows :

# SOIL CONSERVATION BOARD

## PRINCIPAL DIRECTOR, SOIL CONSERVATION



**Notes :-**

1. A Director of planning may be needed to work on village planning, catchment planning, and farm planning with other staff specialists.
2. Technical standards for field laboratories should be the responsibility of the Deputy Director, Soil Survey Research.
3. As the program expands there will be need for two additional Deputy Directors of Soil Survey, one for soil correlation and one for soil survey operations.
4. It is assumed that all soil survey field work will be in cooperation with States and other agencies of Center when they have a direct interest.
5. It is assumed that the Principal Director will develop cooperative relations with the States and all agricultural and conservation agencies of the Center.

### 38. *Economic Consideration*

Finally, it should be added that the attainment of efficient soil use at a high level of sustained production which is soil conservation, depends upon a steady economic environment—stable prices, fair taxes, credit at reasonable rates, secure tenure without unreasonable rents, orderly marketing and access to the products of industry—with incentives and opportunities for the cultivators to produce, to care for the soil they cultivate, and to expand their operations as they gain skill.

#### *Training*

Continued emphasis must be given to training of soil scientists for both the soil survey and for soil conservation work. It is strongly recommended that most of the training through and including the Ph.D. degree be done within India. Each of the following phases of training should be given emphasis. Perhaps the Center should have one well qualified officer whose duties include the supervision of training done by the Center and liaison with the various agricultural schools and universities.

### 39. *Teaching of Soil Science in Agricultural Schools*

In the agricultural schools that graduate diploma holders in agriculture some of the principles of soil management and conservation should be presented in ways to show how the major kinds of soil respond to different combinations of soil and water management practices. The teaching can include the recognition of the main soil characteristics, including the color, texture, structure, consistence, and moisture content of the layers of soil down to the depth (about 6 to 8 feet) that they influence plant roots and water movement; the length, shape, and degree of soil slope; and how combinations of these characteristics influence permeability, drainage, tilth, run off, erosion hazard, hazards of salt accumulations, hazards of soil blowing, hardening of the surface soil or of other layers within the soil, and so on. Examples can be explained of suitable combinations of soil and water conservation practices for different kinds of soil, including the use of fertilizers, compost, manure, improved tillage, drainage, irrigation, level and graded terraces (or bunds), crop rotations, green manures, protection of grass and trees from overgrazing and fire, and the like, along with improved seed and other agronomic and livestock management, to the end of maximizing improvement on a sustained or long term basis for agricultural production and higher incomes to the cultivators.

Graduates with diplomas should be trained to describe soils, measure slopes, and perform the simple operations required in both soil survey and soil conservation planning.

### 40. *B.Sc. Training*

As rapidly as possible the universities should provide B.Sc. degrees in soil science, with at least basic training in geology; geomorphology; plant physiology; chemistry; farm management (as production economics applied to soil use); and the basic principles of soil physics, soil chemistry, soil morphology, soil genesis, and classification, and soil fertility and management. Of course, it is assumed that such university students will have the basic work in language and mathematics required for these science courses. Soil science is much more than agricultural chemistry and agronomy.

During their final year, university students might be given a preference for advanced courses in soil fertility and fertilizers, soil classification, or soil and water conservation, although such specialization should not be attempted at any sacrifice of the basic courses required for a good working knowledge of general soil science.

### 41. *Post-Graduate Training*

It is strongly recommended that arrangements be made for at least one center for advanced training leading to the M.Sc. and Ph.D. degrees in soil science as soon as possible. Candidates should be carefully selected from among good scholars who have demonstrated industry

and adaptability to *field work*. This requirement is important for soil scientists who may work mostly at experimental stations and in laboratories because (1) the program of these stations should be based upon analyses of limiting factors in the agriculture of India, and (2) the results should be developed for use in the field by the cultivators themselves and by those who work with them.

At such university, or graduate training center, arrangements should be made for candidates in soil science to work with the soil survey or soil conservation work in order to develop a thesis that is done partly in the field and partly in the laboratory (or in economics).

Advanced work along the same general lines suggested under 40 above should be available with somewhat more specialization in soil and water conservation, conservation engineering, range conservation, forest conservation, soil classification, and soil fertility and management. At least part of the students, especially those dealing with tropical soils south of the Ganges Plain should be encouraged to read French as well as English literature. (Much important work of direct value to India is published by the Office of Scientific Research in the French Overseas Ministry and in Belgium by the INEAC for the Belgian Congo.)

#### 42. *Training Centres for Workers in Soil Survey and Soil Conservation*

Training centers will also be needed by the Center for prospective workers in soil survey and soil conservation. As rapidly as possible, candidates recruited should be those with good academic training so that the courses at the training centres can emphasize primarily the application of technical knowledge to field problems and the necessary field skills. The courses should be designed for one six-months period.

As diploma holders are used in soil survey work, a special, intensive course of about six weeks may be needed for them.

A highly qualified officer should be available to the Center for overseeing such training. Part of the candidates should be given special instruction in soil survey methods and techniques and another part in soil conservation practices, as they relate to village reorganization, farm planning by individual cultivators, catchment basement planning, and range and forest conservation planning. But the potential soil survey field workers should have some training in land development and soil conservation as well as in soil survey techniques, because the soil maps are to be used for these purposes. Those working in soil conservation need some training in soil classification and the use of soil maps since these maps serve as a basis for their work.

The success of candidates should be measured by *both* academic excellence and demonstrated ability for field work.

These training centers should be available to both present and prospective junior staff in both the Center and State agencies.

Those trained for soil survey work should understand the principles and techniques for recording accurately the morphology and other characteristics of soils as areas; the principles of soil classification as applied to local areas (including the concept of soil types and phases); how to interpret laboratory data; how to obtain and use data for making practical interpretations of soil surveys; how to map soils in the field; how to read aerial photographs stereoscopically; the sources and uses of available cartographic and geological maps; how to collect proper soil samples by specific soil horizons; how to distinguish among genetic soil horizons, layers inherited from the geological materials and mixtures of the two; and how to prepare handbooks for use with soil maps that describe the soils and explain their potential uses, hazards, management requirements for high production with conservation. Such training, followed by some field work, is needed by scientists who work in the laboratories as well as by those who work mainly in the field.

Immediately following this training, the men should work under supervision in the field and careful records should be kept of their ability to carry on field work that makes full use of the training they had. Arrangements should be made to correct any weaknesses immediately. From among the most successful of these men should be selected candidates for advanced academic training under fellowships. Possibly some of these may go abroad for advanced training although it would be better to have adequate facilities available in India as suggested under 40 and 41 above.

#### 43. *Foreign Training*

Some workers in soil survey and soil conservation should have opportunity for foreign training. All such candidates should have good academic records and should have demonstrated unusual industry in successful field work. For the present, some may be selected to foreign study from among those who make excellent use in the field of their previous training as outlined under 42 above. But as rapidly as advanced graduate work in soil science can be provided in India, candidates should be selected from among those who have demonstrated that they can apply their graduate training in India to the analyses of problems of Indian agriculture in the field.

Besides the United States, consideration should be given to study visits abroad for soil scientists in the Netherlands (especially for wet soils), Belgium, the Belgian Congo, New Zealand, and Australia. Probably for soil conservation most would go to the United States except to the Netherlands for drainage and protection against sea flooding, to Italy and Southern France for torrent control, and to the Belgian Congo for improved natural fallow under "shifting cultivation". Of course, besides these places very good work is being done in other areas within many countries.

All such study trips should be carefully planned long in advance along definite lines with reference to specific problems and specific institutions. Plans should be made for each student to spend enough time in each place to become thoroughly acquainted with methods so that he can understand the principles behind the methods and thus understand how they may be adopted to India. Only rarely can detailed methods used successfully in one country be adopted exactly in the same way in another country. One may learn the *principles* of terrace construction, for example, and the terrace may be constructed by machines pulled with tractors or other machines pulled by bullocks. Rarely can soil mapping be organized and carried out in exactly the same way in two different countries having different kinds of cultivators, different kinds of technicians, different sources of transport and power, and different administrative systems. Thus, students going abroad should be able to understand principles. Most rapid study and trips are nearly fruitless except for highly experienced and skilled scientists and administrators.

#### 44. *Collateral Reading*

It is recommended that all workers in the soil survey and soil conservation work be encouraged to read more widely about (a) the work at other locations than their own in India and (b) the work on tropical soils in other countries. Many of the problems of the soils in India have already been at least partially solved in other countries on similar soils. Some additional library and bibliographical service may be necessary and somewhat more attention to the reading habits of prospective candidates for promotion.

### STATUS AND RECRUITMENT

#### 45. *Salaries and Incentives*

It is urgently recommended that the salaries of soil scientists and soil conservationists be examined with a view to any needed advancements to make them *fully* comparable to those of the other top scientists and administrators in the public service. Otherwise it will not be possible to attract the necessary highly competent young men in the field and the essential work will not be done.

#### 46. *Survey of Available Talent*

It is recommended that a survey be made of all competent Indian soil scientists and soil conservationists, both within India and elsewhere, in order to recruit them to good posts in the soil survey and soil conservation program. Every one is needed now, while there is time to get agriculture going according to the obvious growing need.

#### 47. *Promotions*

It is strongly recommended that arrangements be made to promote young men of proved competence in field work rapidly. What a man can do is far more important to India than his previous length of service. Soil work is a relatively new field in India and industrious young men of competence and imagination who can work in the field must be attracted to the work and kept in it if any significant measure of success in agriculture improvement is to be expected.

#### 48. *Permanency of Tenure*

As quickly as possible all positions in the Center for soil scientists and soil conservationists should be put on a permanent basis. Recruitment to temporary positions is difficult and unsatisfactory to the individuals, to the Center, and to the loaning agencies from which the men are temporarily released.

#### *Summary Acknowledgement*

In trying to make specific recommendations, I have emphasized suggestions for consideration that I believe will lead to improvement. Many others have been made orally to staff workers. But I want to add at once that I have met several competent soil scientists and soil conservationists in India. I have seen some beginnings of soil survey work, of good research stations, and, most important, of good soil conservation work on cultivators' fields and in forest reserves. Considering the short time, I feel that I have learned a great deal that will be useful to me elsewhere.

India has a tremendous agricultural problem and tremendous agricultural potentialities. These potentialities can be realized by the combined development of industry to serve agriculture and of agriculture to serve industry. But every citizen of India should understand that the problems can be solved and the great potentialities realized *only* by a great deal of very hard work by many kinds of highly skilled technicians working together *and with the cultivators* as responsible fellow citizens.

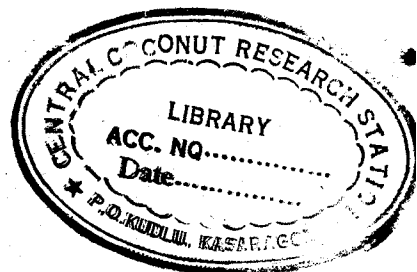
A start has been made. It is only a start but it is encouraging. Although others have helped and can help, mainly India must find within herself the spirit, the genius, and the industry to get on with the job of developing the potential abundance in her soils, water, plants, and people. These four elements of agriculture are inseparable.

I shall be eternally grateful indeed for the great courtesy and consideration shown me by officials of all classes in India. Staff of the TCM have been most helpful. And I appreciate very much the thoughtful planning of the officials and staff of the Rockefeller Foundation who have made my study in India possible.

## APPENDIX I

The following exhibits about Soil Survey work in the United States were left with the oil Survey Sub-Committee :

- 1. Principal recent administrative memoranda (in addition to the *Soil Survey Manual*)
2. The *Soil Survey Manual*.
3. Memorandum of Understanding between a State and the U.S.D.A. on soil surveys.
4. A Soil Survey Work Plan.
5. An Amendment to A Soil Survey Work Plan.
6. An initial review of a soil survey project.
7. A folder used jointly by the University of Illinois and the Soil Conservation District for all farmer cooperators with the University or the Soil Conservation Service. Each folder contains the soil map of the specific farm and the guide sheets for the soils on the farm. On the cover is a generalized soil map of the country.
8. Sample farm maps as photographs of field sheets. As these go to farmers the soils are also labelled as to capability unit, subclass, and class.
9. A new working draft of the principles for grouping soils according to capability. **THIS IS SUBJECT TO FURTHER REVIEW IN MARCH, 1958 AND IS NOT TO BE REPRODUCED.**
10. A recent published soil map and report.
11. A set of recent soil maps (Soil Maps only) **TWO COPIES.**
12. Brief description of new soil maps.



## APPENDIX II

### ITINERARY

Dr. Charles E. Kellog

*January 3—February 8, 1958.*

- January 2 . . . . . Arrive New Delhi.
- January 4 . . . . . Open.
- January 5 . . . . . New Delhi. Informal discussions with Director, Soil Conservation, Ministry of Food and Agriculture, and Chief Agriculturist TCM.
- January 6 . . . . . New Delhi. Conferences with FAO Representative in India; Union Minister for Cooperation and Chairman Soil Conservation Board; Ministry of Food and Agriculture.  
Visit to Indian Agricultural Research Institute.  
Address before Pusa Agricultural Research Society.
- January 7 . . . . . New Delhi: Meeting with Soil Survey Sub-Committee. Meeting with Soil Conservation Board.
- January 8-10 . . . . . Travel to Dehra Dun and return by car, Survey of India.  
Aerial Photography Program.  
Central Soil Conservation Board Research Station & Forest Research Institute.
- January 11 . . . . . New Delhi to Agra (by car) accompanied by Director Soil Conservation (Engineering) and Soil Conservation Adviser, TCM.
- January 12 . . . . . Agra to Kanpur (by train) accompanied by The Head of the Chemistry Division, IARI and Soil Conservation Adviser, TCM.
- January 13-14 . . . . . Kanpur and vicinity,  
Conferences with Agricultural Chemist.  
Inspection of Soil Profiles.  
Soil Survey Program of U.P. Government.
- January 15 . . . . . Kanpur to Patna (plane).  
Patna to Hazaribagh (by car).
- January 16-17 . . . . . Hazaribagh and vicinity—Damodar Valley Corporation.
- January 18 . . . . . Hazaribagh to Calcutta (by car).
- January 19 . . . . . Calcutta—free  
Visits with Director of Agriculture, West Bengal and University of Missouri group leader.
- January 20 . . . . . Calcutta to Madras (plane).
- January 21 . . . . . Madras to Bangalore (plane).  
Study of soil profiles in Bangalore area.  
Visit to Soil Correlation Laboratory.  
Conferences with Agricultural Chemist.

- January 22 . . . Bangalore to Mysore (car).  
Mysore to Ootacamund (car).
- January 23 . . . Ootacamund.  
Soil Conservation Research Farm.  
Laboratory and Training Center.  
Ootacamund to Coimbatore (car).  
Coimbatore to Bangalore (plane).
- January 24 . . . Bangalore to Delhi (plane).
- January 25 . . . New Delhi.  
Central Water and Power Commission Laboratories.
- January 26 . . . New Delhi—Republic Day.
- January 27 . . . New Delhi—Republic Day Holiday.
- January 28 . . . New Delhi—Conferences—J. K. Basu.  
M. L. Wilson.  
Preparation of Report.
- January 29 . . . New Delhi—Preparation of Report.  
Tea given by Dr. J. N. Mukherjee, UPSC.  
Dinner by Mr. P. V. Acharya, FAO.
- January 30 . . . New Delhi,—  
Conferences with officers in Ministry of Agriculture, IARI,  
US Embassy.
- January 31 . . . New Delhi to Bombay (plane) accompanied by Director Soil Con-  
servation (Agriculture).  
Conferences Bombay with Director, Field Research Station and  
with Secretary of Agriculture, Bombay.  
Bombay to Poona (train).
- February 1 . . . Poona to Padegaon and return (car).  
Inspection of soil conservation and research programs at  
Padegaon.  
Conferences with Development Commissioner and Director of  
Agriculture, Bombay State.
- February 2 . . . Poona to Sholapur (car).  
Visit to Soil Conservation Research Laboratory.
- February 3. . . Research Station Laboratory, Hunmurgi.  
Discussions with Soil Conservation Officers Dry Farming Research  
Station, Sholapur.  
Sholapur to Bombay (train).
- February 4 . . . Bombay to New Delhi (plane).  
Conference with Publicity Officer, Ministry of Food & Agri-  
culture.
- February 5 . . . New Delhi—  
Conference with Shri Bishan Mansingh, U.P. farmer. Meeting  
of Soil Conservation Board. Tea given by Shri. M. S. V.  
Rama Rao.

- February 6 . . . . . New Delhi.  
Meeting of The Standard Technical Sub-Committee for All  
India Soil & Land use Survey. Luncheon given by Dr.  
Panjabrao Deshmukh, Union Minister for Cooperation.  
Tea given by Dr. J. K. Basu.
- February 7 . . . . . New Delhi—  
Conference with Ford Foundation Representative.  
Conference with Vice-Chairman, Planning Commission.  
Lecture to Institute of Engineers.  
Dinner given by Chief Agriculturist, TCM.
- February 8 . . . . . New Delhi—  
Conference with Prime Minister.  
Lecture to Pusa Agricultural Research Society and Indian  
Society of Soil Science.  
Departure for U.S.A.

## APPENDIX III

### LIST OF OFFICIALS MET

1. Prime Minister (Shri Jawaherlal Nehru).
2. Minister for Food & Agriculture (Shri Ajit Prasad Jain).
3. Minister for Industries & Commerce (Shri Morarji Desai).
4. Minister for Co-operation (Dr. P. S. Deshmukh).
5. Maharaja of Patiala.
6. Shri V. T. Krishnamachari, Member, Planning Commission.
7. Shri P. N. Thapar, I.C.S., Secretary to the Government of India, Ministry of Food & Agriculture.
8. Shri T. C. Puri, I.C.S., Joint Secretary to the Government of India, Ministry of Food & Agriculture.
9. Shri G. G. Takle, I.F.S., Inspector General of Forests.
10. Dr. B. N. Uppal, Agricultural Commissioner, I.C.A.R.
11. Shri Kanwar Sain, I.S.E., Chairman, Central Water & Power Commission, New Delhi.
12. Shri N. D. Gulati, I.S.E., Chief Engineer and Ex-Officio Joint Secretary to the Government of India, Ministry of Irrigation & Power.
13. Shri C.A.R. Bhadrán, I.F.S., Deputy Inspector General of Forests.
14. Shri R. D. Dhir, I.S.E., Chief Engineer, C.W. & P.C.
15. Shri P. R. Ahuja, Director of Hydrology, C.W. & P.C.
16. R. C. Hoon, Director, C.W. & P.C.
17. Dr. B. P. Pal, Director, I.A.R.I., New Delhi.
18. Shri T. S. Krishnamurti, Deputy Secretary to the Govt. of India, Ministry of Food & Agriculture.
19. Dr. J. K. Basu, Director, Soil Conservation (Agri.)
20. Shri M. S. V. Rama Rao, Director Soil Conservation (Engg.)
21. Shri U. S. Madan, Director Soil Conservation (Forests.)
22. Mr. W. M. Nixon, T.C.M. Soil Conservation Adviser & Leader.
23. Mr. L. Signell, T.C.M. Soil Conservation Adviser.
24. Mr. W. S. Speer T.C.M. Soil Conservation Adviser.
25. Mr. B. Muirheid, T.C.M. Soil Conservation Adviser.
26. Brig. Gambier Singh, Survey General of India, Dehra Dun.
27. Shri, B. D. Kapur, Secretary, Soil Conservation Board.
28. Dr. R. J. Kalamkar, Additional Agricultural Commissioner, I.C.A.R.

29. Dr. T. G. Mirchandani, Director of Agronomic Survey Experimentation, I.C.A.R.
30. Dr. S. P. Raychaudhry, Chief Soil Survey Officer, All-India Soil and Land Use Survey, I.A.R.I., New Delhi.
31. Shri S. V. Subbaiya, Deputy Director of Soil Conservation (Engg.), Ministry of Food and Agriculture, New Delhi.
32. Shri H. T. Khemchandani, Deputy Director of Soil Conservation (Agro.).
33. Dr. R. S. Gupta, Soil Conservation Officer, Soil Conservation Research Demonstration and Training Centre, Dehra Dun.
34. Shri J. S. Bali, Assistant Soil Conservation Officer, Soil Conservation Research Demonstration and Training Centre, Dehra Dun.
35. Shri R. N. Kaul, Assistant Soil Conservation Officer, Soil Conservation Research Demonstration and Training Centre, Dehra Dun.
36. Dr. N. D. Rege, Soil Conservation Officer, Soil Conservation Research Demonstration and Training Centre, Ootacamund.
37. Shri S. Narayanaswamy, Assistant Soil Conservation Officer (Engg.) Soil Conservation Research Demonstration and Training Centre, Ootacamund.
38. Dr. Ch. Krishnamoorthy, Soil Conservation Officer, Soil Conservation Research Demonstration and Training Centre, Ballary.
39. Shri A. B. Phadke, Assistant Soil Conservation Officer, Soil Conservation Research Demonstration and Training Centre, Agra.
40. Shri D. D. Sathe, I.C.S., Secretary to the Government of Bombay.
41. Dr. A. N. Puri, Director of Field Research Government of Bombay.
42. Shri G. S. Puri, Botanist, Poona.
43. Capt. S. P. Mohite, I.A.S. Director of Agriculture, Poona.
44. Shri D. H. Gokhle, Deputy Director of Agriculture, Poona.
45. Dr. Babriwala, Officer incharge, Padegaun Research Station, Bombay State.
46. Shri D. G. Kelakar, Divisional Soil Conservation Officer, Baroda, Bombay Government.
47. Shri R. V. Satpute, Divisional Soil Conservation Officer, Anand Nagar, Bombay Government.
48. Shri M. M. Kibe, Soil Physist, Bombay Government.
49. Shri B. D. Tagore, Research Officer, Bombay Government.
50. Shri D. K. Dhekne, Divisional Soil Cons. Officer, Poona.
51. Shri L. S. S. Kumar, Principal Agriculture College, Poona.
52. Dr. K. V. S. Satyanarayana, Soil Correlator, Delhi.
53. Shri S. Digar, Soil Correlator.
54. Dr. S. V. Govindarajalu, Soil Correlator.
55. Dr. A. D. Khan, Dy. Director of Soil Conservation, Government of Uttar Pradesh, Lucknow.

56. Dr. R. R. Agarwal, Agricultural Chemist, Government of U.P., Lucknow.
57. Shri B. R. Gangwar, Asstt. Agriculture Chemist, U.P., Lucknow.
58. Dr. C. L. Mehra, Asstt. Agriculture Chemist, U.P., Lucknow.
59. Shri H. C. Goel, Soil Conservation Engineer, Uttar Pradesh.
60. Dr. P. Sinha, Government Agricultural Chemist, Bihar.
61. Shri P. B. Bhattacharyya, Field Experimental Specialist, Bihar.
62. Shri S. D. Sinha, Soil Survey Officer, Bihar.
63. Shri K. K. Jha, Soil Microbiologist, Bihar.
64. Shri P. P. Jha, Asstt. Soil Survey Officer, Bihar.
65. Shri A. B. Lal, Asstt. Soil Survey Officer, Bihar.
66. Shri K. K. Prasad, Senior Research Assistant, Bihar.
67. Shri L. P. Srivastava, Senior Research Assistant, Bihar.
68. Shri P. S. Rao, Chairman, D.V.C., Calcutta.
69. Shri S. P. Singh, Member, D.V.C., Calcutta.
70. Dr. P. Sen, Director, D.V.C., Hazaribagh.
71. Mr. W. W. Hull, C.M. Soil Conservation Adviser, D.V.C.
72. Dr. S. P. Singh Teotia, Deputy Director, D.V.C.
73. Shri S. P. Sahai, D.V.C.
74. Shri P. G. Goswami, D.V.C.
75. Shri Bimal Ghosh, D.V.C.
76. Dr. H. D. Bhaumick, D.V.C.
77. Dr. P. M. Mirchandani, D.V.C.
78. Dr. Arnold Klemm, T.C.M. Soil Fertility Adviser.
79. Dr. S. K. Mukherjee, Government Agricultural Chemist, West Bengal.
80. Dr. P. K. De, Government Agriculture College, West Bengal.
81. Shri A. Mahomad Ali, Joint Director of Agriculture, Madras.
82. Shri S. E. Anantha Raman, Asstt. Agricultural Engineer, Government of Madras.
83. Shri T. Rajagopala Iyengar, State Compost Development Officer, Government of Madras.
84. Dr. A. D. Desai, Dy. Director of Agriculture Govt. of Mysore, Raichur.
85. Shri S. S. Sirur, Government Agriculture Chemist, Government of Mysore.
86. Shri B. J. Nanjundappa, Head Quarter Asstt. to the Director of Agriculture Government of Mysore.
87. Dr. G. Muhr, T.C.M. Soil Testing Adviser.
88. Dr. Roy Donohue, Ka-asa Team.
89. Dr. E. J. Long, Tennesse.

90. Dr. (Dean) Macland, Tennesse Team-Exchange Professor.
91. Shri C. R. Shanmugam, Assistant Agricultural Engineer (Soil Cons.), Government of Madras.
92. Dr. A. Mariakulandai, Government Agriculture Chemist, Government of Madras.
93. Shri F. R. Srinivasan, Asstt. Soil Chemist, Government of Madras.
94. Shri Bishanman Singh, Chairman, State Soil Conservation Board, Government of Uttar Pradesh, Lucknow.