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And here it must be pointed out that the essential need is plant-cover, protection and something equivalent to a forest floor and not primarily a marketable product. Another need is to introduce into the rotation an adequate period in humus-forming vegetation and in a covering that will be impervious to erosion. In short, to endeavour to establish a closely-knit ground covering vegetation of a character as similar as possible to the grass and clover ley that counts for so much in the rotation in temperate regions.

Anti-Erosion Measures In most regions of the British Empire the dangers of erosion are now realised. Thus, Australia set up its Soil Conservation Board in 1941, and Kenya created a Soil Conservation Service in 1938. Anti-erosion measures are being pushed forward in Grenada, West Indies, Barbados, Basutoland, Uganda and Nyasaland, to mention but a few examples.

Taking the world as a whole, it is, however, to be doubted if the extreme perils of soil erosion are anywhere fully appreciated. Man is not yet trained to take more interest in and care of posterity than in his own immediate affairs and difficulties.

Soil erosion is the longest of long-range problems, it must be expected everywhere and countered everywhere. The problem is basic, and is fundamentally one of point of view. It must be realised that soil takes thousands of years to develop and can be squandered and lost in a decade. No system of farming should be tolerated that does not first and foremost take care of the soil. The prime need of taking care of the soil must dictate the crops that are grown and the rotation followed and all the methods of cultivation adopted—not economics

Soil erosion is a world problem. Man must obey the demands of the soil or perish. International trade and international relationships must needs be such as to cry halt to soil erosion and not as in the past to invite it.

Organisation of Agricultural Research in India

By RAO BAHADUR B. VISWANATH, C.I.E., F.I.C., F.N.I.

I am glad to accept the invitation of the National Institute of Sciences to participate in the symposium on the post-war organisation of research and to contribute my views in respect of agricultural research in India.

Agricultural Research has been in progress in India for forty years. During this period an Indian school of Agricultural research with a large body of workers has gradually grown up. In recent years agricultural research and the organisation for it were under review and readjustment. The Royal Commission on Agriculture reviewed in great detail between the years 1926 to 1928 and Sir John Russell and Norman Wright in the year 1937. In examining again in reference to post-war requirements, it is necessary to consider first the nature of post-war agriculture and its problems that are likely to arise and then the research organisation to meet the requirements.

Research has never been more popular and more in demand than now. There is, therefore, no need to expatiate either on the value of research or on its practical contributions to agricultural development in India. We may assume that as in the past research is one of the agencies that can assist agriculture and proceed straight to the consideration of post-war problems and research.

Post-war Agriculture and its Problems The effect of war is dislocation and change in the existing system in varying degrees. Some crops and commodities have lost their export markets. Food crops have exchanged places with indu-

strial and commercial crops. Ways of life and modes of thought have changed, following the war time changes in the agricultural, industrial, commercial and economic fabric of the country. The restoration to peace is not necessarily and in every case the return to pre-war life. The masses of people require to be fed and clothed and housed better than before. The peasant soldier, will emerge with wings from his khaki casing and will demand occupation and instruction in agricultural, domestic and village matters. Post-war problems will not be the usual crop and live-stock husbandry only but also concern the production of healthy farmers and retaining them on the land. The peasant farmer staying at home has become more self-conscious. He has begun to think in a different manner and he needs more income, more buying power and better standard of living.

There will thus be two sets of problems. One set of problems may be described as 'immediate' and will be those arising directly out of current war conditions such as changes in cropping systems, effects of inadequate nutrition and the return of the demobilised farmer soldier. The other set of problems are those concerned with the larger economic national reconstruction in which agriculture constitutes the key problem. The two sets of problems which are in the main agro-economic and psycho-economic are closely inter-related and require scientific approach and solution.

Comparison with other countries—Agriculture is an enterprise which is still dominated by Nature and environment, and more so in India. There can, therefore, be no complete break with the old and building anew, but it can have any style of super-structure, exotic or indigenous. The important point is that agriculture gives shape to research and research in turn determines the pattern of agriculture. It is, therefore, natural to look to other more advanced countries for inspiration and for imitation of whatever appeals as the most progressive and the most suitable. Such a procedure, besides providing a short cut to progress, holds the country and the system as an ideal to work up to. But idealism should not ignore realism if risks and disappointments are to be avoided.

Countries like Great Britain, America, Australia and Russia and their departments of agriculture and research are held up by some as examples for imitation in India. Apart from differences in climatic conditions, the agricultural history of those countries is very short compared to that of India and has been largely concerned with opening up virgin lands which are agriculturally much younger than those in India. Although the basic science of agriculture is the same everywhere and much of the knowledge of the temparate countries would be expected to be applicable to Indian conditions, it has been discovered from experience that it is by no means the case with all such knowledge. Compared to India, those countries have very much easier tasks. The farming communities of those countries consist of large sections of people who are mainly immigrants either through love of adventure or hopes of making fortunes. They farm large farms the smallest of which is many times larger in size than the largest average holding of this country. The new-comers either did not originally have any or only indifferent knowledge of agriculture. They were, therefore, in need of advice and were anxious to have it. There science and research contributed largely to the shaping of new agricultural ventures and having succeeded with science and scientific advice the cultivator is anxious to have it. In India the position in the long established agricultural areas is otherwise. We may expect similar work and results in India also in utilising uncultivated lands.

The Russian system of collectivisation is sometimes held up as an example for imitation. This is primarily based on the belief arising from the large exports of wheat from U. S. S. R. in 1930–31 after a few years following the introduction of the systems of collective farming as part of the planning system. The

increase was only in the total out-turn and not an increase per acre. It is the result of an increase in the cultivated area from 279 million acres in 1922 to 336 million acres in 1931, an increase of 57 million acres. There has been no increase in yield per acre, as will be seen from the following figures quoted from the Stanford University Reports:—

Crop yields in Russia, in units of 60 lbs. per acre.

	1909-13	1925-29	1928-32	1933-35
All grains	11·0	11·7	11·2	11·6
Winter wheat ...	12·9	12·7	12·7	12·6
Spring wheat ...	9·2	10·5	9·0	10·6
Rye	11·0	12·1	12·1	12·0
Oats	11·8	13·0	12·2	13·2
Barley	12·7	11·8	12·2	12·6

These yields are no better than those for India. Collectivisation alone cannot be expected to result in increasing the yield per acre in India. It should be mentioned here that it is doubtful, if in other countries the net result of modern agricultural practices is increase in gross production. In India soil fertility and productivity is largely the work of Nature and to a small extent the skill of man, while in the temperate countries productivity is largely the work of man and less of Nature. Superimposition of skill over Nature's bounty without careful examination is risky.

In contrast to these countries India is a country situated in the zone of dry tropics and sub-tropics. The size of the average holding is tiny. The agricultural systems are several centuries old and are worked by farmers whose knowledge and practice are inherited from generation to generation. The knowledge and the ability of the average Indian farmer is such that he can get the most out of his land if only he were independent of financial considerations.

It follows from what has been said just now that in India so much practical knowledge has already been discovered through experience of generations that the scope for advance at a rapid pace is less than in the new countries and by methods adopted there. Whatever ills of agriculture there are in those countries they are only ailments of youth and are easier to cure than the diseases of age. In India, it is the disease of age and general debility and what is required is rejuvenation, and enrichment of soils and systems for greater efficiency.

It is not difficult to see that this inherited expert knowledge of the Indian cultivator and the settled Indian agricultural systems are not to be despised as they are capable of quick adaptation. If fresh proof is wanted in support of this it can be found in the recent experience with the 'grow more food' campaign which has brought out prominently to the view the fact that quick adaptability is an inherent feature of the Indian farming systems and of the Indian farmer. Nevertheless, this precious gift is of no use in assimilating quickly the systems and methods borrowed from other countries and superimposed on the existing one. The philosophy of the Indian farmer which is misnamed conservatism stands in the way. Conservatism is not peculiar and special to the Indian farmer. It is a characteristic common to farmers all over the world, but the Indian cultivator is admittedly more conservative. It used to be the fashion to blame the conservatism of the farmer for failure to register more rapid and more spectacular advance in the improvement of Indian agriculture. That is all gone now. Experience has shown that the Indian cultivator is not at all incapable of appreciating or unwilling to take up a new thing if it is a real improvement and is within his means. He is quick to see improvement but he is not accustomed to deduce his practice from theory. He wants definite advice in clear and unambiguous terms. He does not even need and insist on

demonstration. If a new crop is to be tried, he wants clear instructions on the soil conditions required, on the exact time to sow or transplantation, when and what amount of manure to be given, and on the after-care and treatment of the crop. He wants and naturally so, infallible advice. We are still far from being able to give such advice. That is because, unlike in other countries, the Indian cultivator and his agricultural practices have been far ahead of the advent of modern science into Indian agriculture. The science underlying the practices of the cultivator must first be learnt before we can teach him.

Outlook and Philosophy of the Agriculturist—With conservatism there is also poverty. As Bernard Shaw has said, the trouble with the poor is their poverty. It may also be said that they are poor because they are illiterate and they are illiterate because they are poor. Conservatism and poverty and the conditions of his profession have combined to develop in the Indian farmer an outlook and philosophy which are different from those of the farmers of the other countries. Occupations and experiences play a large part in moulding character, outlook and philosophy. In the new countries success with science has been largely responsible in shaping their agriculture. The circumventing of the phenomena of Nature (which are much less arbitrary than in India) has developed faith in science and scientific outlook with a materialist philosophy. On the other hand, the Indian farmer has been accustomed to witness season after season and year after year the majestic march of natural phenomena. At one time Nature is so bountiful that he need do little. At other times Nature adopts so arbitrary a mien that all his efforts are set at naught. He has learnt to accept Nature's gift with philosophical resignation.

Unless the mass philosophy of the receptor country is as nearly similar to that of the donor country, successful imitation of exotic systems and methods are attendant with uncertainty and risk.

Agricultural Research vis-a-vis Practice—When agricultural research began in this country forty years ago, there was available the report of Voelker, who at the invitation of the Government of India spent two years examining Indian agriculture and agricultural practices in the light of scientific knowledge. He paid a tribute to the Indian agricultural systems and to the skill of the Indian cultivator and stressed throughout his report the importance of the scientific study of the existing systems and practices. The urge then, as now, being for quick results, it appeared logical to begin with the application of the results found successful in the more advanced countries and also to adopt their lines of research.

Although the application of borrowed knowledge had often the disconcerting habit of failing, collateral research has helped to make substantial contributions to knowledge and materially benefited the cultivator through increased yield per acre and in other ways. The most tangible economic results have arisen from plant breeding which was effectively supplemented by better informed use of manures and fertilisers and irrigation water and control over diseases of live-stock. The introduction of sugarcane mills and chaff cutters are excellent examples on the implement side which appealed to the farmer. In other directions it has been largely acquiring new knowledge on soils, crops and of pests and diseases occuring in the country.

While it is true that valuable results in soil, plant and pest sciences have accumulated, more has yet to be learnt before making more tangible contributions to practical agriculture either by way of developing new practices or by modifying old ones. It should be borne in mind, that under the dominating influence of new theoretical knowledge and concepts, most of us are apt to forget or ignore the necessity to first apply such knowledge to ascertain the principles underlying or governing existing practices otherwise interpretations and hypo-

theses cause confusion instead of clarification and the results have generally to be described as disappointing.

Collateral laboratory research and field experience have been slowly but steadily clarifying knowledge. The various environmental and scientific factors underlying our agricultural practices are becoming clearer. Each of the concerned sciences is taking its place as important but not as all-important. There is shaping a new outlook born of the realisation that in dealing with our agricultural problems research should concern itself more with the study of the existing practices and methods with a view to further improvement.

Modern Agriculture and its ancillary needs:— I have devoted some attention to the comparative examination of the agricultural histories and the agriculturist philosophies of India and other countries, to show that Indian agriculture constitutes a problem of its own and that improvement should come from within and not from without. Many years of experiment and research are required fully to understand the agricultural systems and practices of the Indian cultivator and to build up new Indian agriculture on the solid foudations of real knowledge.

Agricultural research reduced to simple terms, has to deal all along the line, with problems concerned primarily with growth and competition. In crops there is growth and there is competition arising from many plants growing together; there is growth and competition between insect life and disease-causing life on the one hand and between these and plant life on the other; there is also growth and competition in respect of animal life; and above all, there is growth of human populations and fierce competition in all spheres of activity. Added to this, there is growth and competition in ideas, values and standards and the impact of these on agriculture brings about changes in the economic significance of agriculture itself, and research has had to adjust itself accordingly. Within this generation we have witnessed the oscillation of the emphasis between food and industrial crop production and on the stress on qualities and standards,—all due to growth and competition in ideas.

There is, therefore, need for the systematic and continuous ascertainment of facts and problems in their local and general aspects to provide clearly defined objectives and a base line for research in the shape of reliable statistical and other information worked and classified by agricultural departments. Otherwise, ideas and schemes of research and development in the wake of research cannot emerge from the sphere of supposition and controversy into the sphere of reasonable certainty and constructive effort. It is in published record that about ten years ago the Director of Agriculture and the Rice Specialist of a major province came to the conclusion that the province was producing sufficient rice, if not more, and that endeavour should be made to restrict rice cultivation. We know today that there is actually a high deficit. If accurate statistics were available these authorities would not have come to the conclusion they did. Even today we are in no better position with regard to accurate statistics. Consider the oft-repeated cry which deplores the miserably low yields in India compared to those in other countries. There is no information whether yields from a single crop in a year are compared with the yields of a crop which form part of two or three crops in a year; nor is there accurate information of the extent of areas compared. All that it implies is the urge for increased production per acre. That is right so far as it goes. But for the aid of research there must be accurate information about regions of maximum, medium and minimum productivity.

Another point is that research can only indicate the means of development. The paths for progress must be marked by the economist and laid by the State. Here again lack of accurate statistical information hampers progress. Research must know to what type of agriculture it has to cater (peasant and subsistence

farming, collectivised and power farming by Government or to commercialised and mechanised farming by syndicates). The significance of this observation will be appreciated when it is realised that knowledge and application in the different branches of agricultural science have not developed and cannot develop at the same rate and to the same degree, although there have been advances in all the branches. Only by providing authoritative and reliable information for initiating research for the application of the results of research and on the results of such application can we hope to derive the maximum benefit from research.

Agricultural research is expensive and takes time. The advances in knowledge and technique and the results of application open out new approaches. It is, therefore, endless and has no finality. The demand for quick results is impracticable. Such demand has often resulted in short cuts with less important and temporary results, and has been responsible for the origin of terms like 'long range' and 'short range', 'fundamental' and basic' researches. These expressions have really no meaning. Research is research, whether applied or pure. We must learn to differentiate between research and experiment. Some of the principles of science can be applied in their general and simpler forms in many problems; several others are not capable of direct and immediate application, but such knowledge is necessary to partly or wholly bridge the gap between ideal and actual conditions and to build up a rational system of agriculture suited to the needs of the country.

Attention should here be drawn to the omission of an important item in our scheme of research thus far, namely, psycho-economic research in agriculture. Research in that direction may throw light on the peasant farmer's mind and explain why co-operation succeeded or failed in some places and among some communities and also find reasons for the different degrees of thrift and outlook in different regions and in different communities and professions in the same locality. This knowledge is valuable directly in the application of the results of research and indirectly in the orientation of research in the light of the knowledge.

The Agency for the Technical Promotion of Agriculture *General consideration* —To the individual farmer agricultural research can at best mean a small improvement. In the aggregate, however, agricultural research means a large increase in the production and wealth of the country. For this reason the necessary enthusiasm and impetus to promote agriculture cannot be expected to come from individuals or groups of individuals. It has to come from the State—the authority responsible for agriculture and rural welfare.

The expression 'technical promotion' includes both research and development in the wake of research. That is to be expected as otherwise research in an applied science has no meaning and will be without purpose. Although the present discussion is confined to technical promotion it should be borne in mind that it is an important part of the larger structure of agriculture, and is profoundly influenced by the economic structure on the one hand and on the other, by the extent and influence of political representation of agricultural interests in the counsels of the Government. Discussions and controversies between agricultural and other economic groups and interests will arise and disputes are bound to occur in agricultural interests themselves.

Whatever may be the shape of post-war agriculture, its success depends on the efficiency of the agency for the technical promotion of agriculture. It is, therefore, of the greatest importance that this agency should function on two important basic considerations: (1) the agency or organisation should not be affected in any manner in the accumulation of knowledge and its technical application, (2) it should be sufficiently elastic to permit changes. Mistakes may have been

at the beginning and experience with time and more mature knowledge may show defects. The constitution and the system of working should be sufficiently flexible as to permit corrections to be made easily and rapidly. In regard to the scientific aspects, it will be advantageous to consider separately organisation *for* research and organisation *of* research.

Organization for research.—The tendency of modern agricultural research is to rely less and less on the classical old methods of selection and breeding of plants and animals, soil analyses and manurial experiments and of pest and disease control, and to place more and more emphesis on genetics, ecology, physiology and technology. Another important development is 'one crop station research' where teams of specialists concentrate attention on improving the economic efficiency of one crop. The organisation for research must be designed to cover the whole range of agricultural activity. We want more research and more and more knowledge. The demand for more research will be followed by the demand for more trained men and the organisation should be such as would provide a steady flow of such men. In addition to the main body of what may be called '*directed*' research workers with definite objectives, we should also have a large number of 'free' research workers to act as pioneers in opening up new fields of thought and research. In the category of 'directed' research workers, there should be a very large body of field workers who form the base of the 'pyramid' of the research organisation. This is the body to establish *liaison* between the research worker and the actual cultivator, big or small.

Organisation of research—Organisation of research is as difficult as it is vital in the organisation for research. It is concerned with the human element and the psychology of the workers. Research is creative and creative work is mostly of individual rather than of organisations and groups. Attempts at absolute and rigid control by individuals or committees is liable to lead to disappointment because such a control does not allow any one to grow above the limitations of the controlling individual or committee. As against this there is the fact that some investigators are competent and make their best contributions when working alone and on their initiative while some workers lack originality and initiative and are productive only under guidance. The majority are between the two extremes. And there is the necessity that the activities of the different classes of workers and of workers in different branches of science be kept directed towards the objective of the plan or scheme drawn up. Organisation of research and administrative attention are, therefore, necessary to overcome individualistic view-point, and to develop co-operation, collaboration and co-ordination.

Co-operation and collaboration are entirely personal matters to be accomplished by conferences and discussions and exchange of workers for which there should be adequate and suitable provision. Co-ordination is a difficult matter. It may be considered under two divisions: co-ordination on all-India scale, and co-ordination at research institutes or stations. The points in favour and against co-ordination of all agricultural research on all-India scale are briefly given below:—

In favour of co-ordination—(i) Unnecessary duplication is prevented or reduced, (ii) comprehensive attack on problems is possible, and (iii) disadvantages of artificial political boundaries are eliminated.

Against co-ordination—(i) Tends to suppress individual creative ability and becomes too mechanical, (ii) tends to cumbersome and unwieldy organisation and consequent waste of time and paper in preparing unnecessary reports and travel, and (iii) unless suitable leaders are available, who by their scientific eminence in that particular field can *command* instead of *demanding* respect, to bring about voluntary co-ordination.

Co-ordination either on an all-India scale or on a restricted scale should not fail and has not generally failed when the objective is specified and definite. But when it is sought to apply for research in general, even in a particular branch of science, the disadvantages outweigh the advantages. On the other hand, the conditions inherent in the agricultural research institutes and experiment stations afford scope for internal co-ordination and linking up the different branches of sciences towards a common objective. It is here that co-ordination should begin. The actual plan and programme should not be imposed by administrative fiat from above, but must be settled after discussion by the workers themselves who analyse, and dissect problems and construct such co-operative plan as will involve joining heads and hands. The administrative attention should have both vision and tact and should provide such assistance and encouragement as will co-ordinate rather than subordinate and such as will direct rather than dominate. The amount of wasteful overlapping and duplication, if there are any, are negligible. Even when two or more centres are investigating the same subject, it is usually seen that they have approached the subject from different angles and are likely to help each other. Such a conjunction of enquiries is good and not evil. As Prof. A. V. Hill, F.R.S., M.P., pointed out as recently as June 1942, co-ordination will come naturally with increase of knowledge and contact. It should be carefully tended and not just pushed into a mechanical frame work first planned from outside.

The Existing Research Organisation—The beginnings of organised experiment and improvement in Indian agriculture may be traced to the establishment of the Agri-Horticultural Society of India about the year 1820. This Society encouraged experiments with imported implements and crops, organised meetings and discussions, and published its proceedings and journal. The Dharwar-American and the Punjab-American cottons are the remains of early efforts by importing a party of American cotton growers and cotton seed for developing cotton cultivation in India.

The establishment in 1905 of the Imperial Agricultural Research Institute and of the departments of agriculture in the Provinces mark the beginning of sustained and systematic effort in scientific agriculture and research. A later development was the establishment of separate organisations for the scientific study of the problems of growing tea, coffee, cotton and jute. Following the recommendations of the Royal Commission on Agriculture, there came a further development in the establishment of the Imperial Council of Agricultural Research in 1929, to promote research, to co-ordinate the activities of the various provincial governments, in the field of agriculture and to supplement such activities as and when necessary. The Imperial Council has done much to further research and has brought into being special stations and centres for research on potatoes, sugarcane, tobacco and various fruits, instituted several co-ordinated schemes of research in crop and animal husbandry and encouraged and enlisted the co-operation of universities.

During these forty years an Indian school of agricultural research has steadily grown up, with a numerous body of agricultural scientists working in the central and provincial institutions and departments, universities and other special organisations on crop basis. The central research institutes give post-graduate training in methods of research, and are placed similarly as the universities in that the functions of both are in the main similar. Both are for post-graduate instruction and research. The difference is that in an agricultural research institute there is that direct and living contact with reality, namely crop growing and maintaining of live-stock. In an agricultural institute continuity and collaboration between several sciences are assured or can be insisted upon. Here the problem is the central and fixed point. In a university

continuity and sustained collaboration may or may not be possible, nor can they be insisted upon. There the professor is the central and fixed point. The workers are students who frequently change. There is the other and the more important consideration and that is the distinction between filling the mind and forming the mind. A research station gives the young student several opportunities of contact with day to day agricultural problems enabling him to form his mind. This is a type of training and experience which is far more advanced and special in character than could with any propriety be included in a university curriculum. The young agricultural research worker of today is making his mark because of more than passing acquaintance with the agricultural problems and methods. He cannot forget that, however scientifically sound and economically feasible his work may be, he has not completed his work unless it can be operated in the field.

In the provinces the departments of agriculture impart instruction in their agricultural colleges which are affiliated to their respective universities. The provincial institutions and their research staff are directly linked to the cultivator through the district staff. These organisations constitute what may be called the 'eyes and ears' for research and are in a position to carry out experiments and to provide intelligence from their local experience. There are the central institutions to analyse and synthesise the information with a detached and wider view and to institute further research with specific objectives. There are the universities, which can take a more completely detached view of the available knowledge and advance basic knowledge and technique. There is thus the mechanism which has in it the capacity to run research like a relay race the one group handing knowledge to the other group of workers.

A suitable framework of organisation for research is already there. I say advisedly framework, because it is nothing in size compared to the size of the country and its requirements. The framework needs considerable filling up. It should be mentioned here, that if the organisation for research should be efficient the emoluments offered, particularly to young recruits, should be much better than what they are now. Equipping oneself for research is very expensive. The worker has in the first place to go through long and expensive courses of university and post-graduate education and then another expensive course of study in some branch of agricultural science before he can think of employment as an agricultural research worker. The salaries offered to these young men are ridiculously low; there is no security of tenure; the prospects are next to nothing in most cases. An organisation packed with enthusiastic young men with no or gloomy outlook cannot be expected to produce results much less wonders. The system should be remedied at the earliest opportunity.

There is need for a central organisation with grip not only on research but also on agricultural policy. Research alone is not enough. Agriculture and research policies are mutually related and, therefore, the policies need constant examination and periodical re-orientation. There must be a central organisation whose functions should be (i) to interpret agricultural research in agricultural reconstruction and policy, (ii) to secure for the benefit of agriculture co-operation and collaboration between the different nation-building departments and to secure co-ordination for the even flow of rural life, (iii) to secure accurate statistical and other information on matters concerning agriculture as a whole, and (iv) to interpret larger agricultural and economic trends for the guidance of agricultural research and to provide a general plan for research which is at once comprehensive and sufficiently flexible to admit expansion and adaptation to changing needs, nationally and internationally.

The Imperial Council of Agricultural Research can be suitably altered in its structure, constitution and working system, to enable it to function as the

central organisation mentioned above. In its present form the Council if charged with only responsibility for research and has a structure and system of working which is rather too cumbersome to be of maximum utility. It has in it the capacity for advancing research and it has done admirably well, but curiously, in its success lies its failure. It is not difficult to see the weakness in its elaborate organisation. Although the Council has done a great deal to advance research in many ways it has not altogether succeeded in building up a healthy school of research. The committee system and the system of financing research on the basis of schemes have sometimes led to unhealthy competition which tends to militate against the maintenance of research spirit and research morale. The committee system, however democratic and sound it may be in theory, does not always yield the results that are expected of it.

Outline of the Picture of Future Organisation From a consideration of the foregoing, there emerge the conclusions:-

(i) that the framework of the organisation for research that has gradually grown up is capable to meet the post-war requirements, for the conduct of research when suitably strengthened, that the need is to make up the deficiency in the organisation for the accurate statistical and other information to assist the technical promotion of agriculture, and

(ii) that a central organisation which will co-ordinate agricultural policies and other policies is necessary.

Agreeably to this finding the following outlines of the picture of post-war organisation or the technical promotion of agriculture is suggested.

The existing organisations for the actual conduct of research should continue to be maintained by the respective authorities at their maximum efficiency.

Experiment stations on one crop basis should be established to cover work from growing to technology. The funds of these stations should be found from the cess realised on that crop.

The Imperial Council of Agricultural Research or the Board of Agriculture (one institution should be enough) should form the 'apex' of the organisation for the technical promotion of agriculture which includes research and development. The functions of this body should be primarily—

(i) to guard the general interests of agriculture by advising the administrative authorities in all questions relating to agriculture ;

(ii) to concern itself with laying down the larger agricultural and research policies and in fostering and watching the progress of such policies :

(iii) to assist in the formulation and development of agri-industrial policy for the benefit of agriculture and the agriculturist ;

(iv) to secure accurate statistical and other information on matters concerning agriculture and the agriculturist ;

(v) to arrange for the carrying out of surveys of resources such as water supplies, erosion and waste land and soil surveys, etc. ;

(vi) to directly aid research : It is best done by awarding research scholarships and fellowships with adequate living allowances so that research talent may be discovered and fostered ;

(vii) to encourage experimental work on the application of results in rural areas : This is best done by utilising the district staffs of the provincial agricultural departments for carrying out widely flung field experiments. The testing is to be done on land offered by the members in a given village or area and this can best be done by reviving agricultural associations. The failure of such an agency in the past should not deter renewed effort. They failed because the cultivators

were told that it was an improvement. The position would be different if they were clearly told that it was only an experiment or trial and

(viii) to foster activities which would be mostly educational in character in respect of stimulating the interest of the cultivator in scientific side of agriculture and in the matter of putting into practice in the widest area possible those results and that knowledge which have been proved to be reliable and correct in any given locality. (*Proc. Natl. Inst. Sci. India, Vol. 10, No. 1, 1944.*)

Abstracts

Why do Farmers Plough? (*Better Crops with Plant Food, Vol. XXVII, No. 6; June-July 1943*) Farmers plough the land to improve their crops, both in quality and quantity. No doubt, people in the United States of America have been doing too much ploughing. The North European origin and ancestry, common in the U. S. A. are mainly responsible for this. The tradition of Northern Europe has been literally transplanted root and branch in the U. S. A. In North Europe people would not make a living if the soils of clay and clay texture, with a liberal and regular rainfall were not ploughed to aerate and warm them. As one moves westward towards Central U.S A., a more continental climate with torrential rains is met with. The southward trek ushers a continental climate with higher and more fluctuating temperatures. Ploughing without understanding its function in relation to soil, fertility and climate has demonstrated that too much ploughing had been done in the silty loams of America, in the U. S. A., the usual frequent ploughings given in the earlier years increased biological activity in the soil, and burned out the reserve organic matter therein; this resulted of course in high crop yields, in the beginning. In course of years, the soils became less responsive to the heavier rainfall, encouraged greater runoff and damaging erosion resulted. Excessive tillage exhausted the soils of fertility that would have otherwise encouraged nature to grow readily a vegetative cover and reduce the erosion hazard.

Ploughing aerates the soil and provides additional oxygen for the respiration and growth of the large number of microbes in the soil. Carbon in the soil is oxidised to carbon-di-oxide, sulphur to sulphur-di-oxide, ammonia to nitrate and so forth and some of these become available for plant growth. But for the ploughing, the consequent aeration and soil microbial activity, the soil matter would stay 'put' and the plants would be starved of the much needed nitrates for their growth. The supply of soluble soil nitrogen increases as the temperature rises and also when the soil is aerated. It may be consumed by plants, or leached out by rainfall or be reduced to the elemental state in the absence of sufficient aeration and ploughing helps to increase the supply of soluble nitrates for plant growth. The cycle of growth, death and decay of both the plants and the microbes go on incessantly.

Studies of nitrate supply in the soil in three adjoining plots, one unploughed, one ploughed and the other ploughed and cultivated, showed clearly that ploughing provided a large supply of nitrates and that further cultivation provided extra nitrogen for the crop. The same result was obtained whether the land was cropped or left fallow. Crop growth and yield follow in the order of the level of these nitrate supplies. The farmer may not know that the large nitrate supplies contribute to greater crop growth and that ploughing is the cause of the formation of large nitrate supplies. He knows definitely, however, that ploughing increases crop growth.

Cropping a soil year after year leads to declining fertility. The stored fertility must feed the microbes inside the soil before they can leave something

for the crop above. When crops are removed continuously, without leaving any residue, the nutrients liberated by the microbes get reduced, for they merely rework only what is given them.

The nitrates in the soil are brought down to a low level by the wheat crop at the time of harvest and stay low in unploughed soil. When the stubble is ploughed in early, the soil-stirring starts the nitrate supply upwards. Early ploughing puts under only little organic matter and the microbes are obliged to oxidise the humus in the soil; much of the carbon therein is burnt and nitrogen accumulates in the soil in the form of nitrates and nourishes the next crop. This explains why early ploughed soils give a good harvest. Delay in ploughing lets the weeds grow and reduce the nitrate supply in the soil. The weeds are growing in soil that was made poor by the previous wheat crop. They depend largely on the nutrients in the atmosphere and moisture in the soil and tend to grow woody. The weeds are consequently rich in carbon, but not in nitrogen and the microbes use the soil nitrates to balance their nutritional requirements. The nitrogen is converted into insoluble complex microbial tissues which do not become available for the next crop. There is as it were competition between the crop and the microbes. The ploughing may be blamed for this state of affairs, but it is really the low fertility of the soil that is unable to supply sufficient nitrogen for the weeds.

The effects of ploughing are not limited to the production of a clean field, the aeration of the soil and the consequent processing of the plant nutrients. Other sciences connected with the study of soil can furnish an answer to the question "Why plough?" and support the plough as an important agricultural implement. V. T. S.

The Nut Grass Pest (W. B. du Preez, *Farming in South Africa, Vol. 19 (1944) (11--20)* The common Nut grass (*Cyperus rotundus)* is a grave menace to the farmer and accounts for a reduction in the yield by 25—30 per cent. Negative results were obtained in efforts for the propagation of the pest by means of seed and the major method of propagation of the weed is by means of tubers (nuts). The dormant tuber system of the plant ensures the survival of the pest after the surface system is destroyed and an effective control method must aim at the complete eradication of both systems, more especially the deep system which propagates the weed even after the surface system is destroyed.

Investigations have shown that nut grass tubers exposed to desiccation lose their sprouting capacity when their moisture content is reduced from the normal average of 50 per cent to 15 per cent and the desiccation is complete only when (1) the tubers are completely severed from the root system, (2) when the soil moisture is about 8 per cent when the mortality is very high and (3) when the humidity of the atmospheric and soil air are very low. Although the weed cannot be completely exterminated, deep cultivation with adequate mechanical traction and strong implements to penetrate the desired depth, depending upon the distribution of the tubers, by which the tubers are severed from the root system and subjected to desiccation on the dry ploughed soil, is recommended as a control measure. The desiccation process can be hastened by using after a few weeks a heavy cultivator when the clods would break up and more tubers brought to the surface. The time for cultivation should be mid-winter so that 2 or 3 dry months may follow after cultivation thus ensuring desiccation. Although spraying with a 30 per cent solution of common salt destroys nut grass, the process is too costly to be put into practice over an extensive area.

Experiments with smother crops to suppress nut grass gave negative results as also efforts for the control of the weed by repeated hoeing of the surface growth. R. A.

Studies in Rat Control R. J. Borden, in *Reports 62nd Annual Meeting Hawaiian Sugar Planters' Association, 1942, pp. 63—66.* In further studies on rat poisons zinc phoshide has appeared as an outstanding substitute for thallium sulphate hitherto the most suitable poison for rat control on Hawaiian sugar cane plantations. The zinc phosphide has proved to be as lethal as thallium sulphate, and baits poisoned with it are much more readily taken by the rats. Its action is quicker, causing death of the rat in 6-8 hours, as against 30-40 hours with thallium sulphate. It does not produce secondary poisoning; as is the case with thallium sulphate. The zinc phosphide bait is prepared by mixing the powdered phosphide with rolled oats in the proportion of 1 to 200. The powder is first added to a vegetable, such as corn oil, coconut oil, etc., the oil zinc phosphide mixture is applied to the rolled oats and thoroughly mixed. Application in the field follows the usual procedure of first prebaiting the infested area with unpoisoned grain to attract the rats and then setting out the poisoned bait. Zinc phosphide deteriorates in the presence of moisture. When kept in the open in the laboratory there was no deterioration in four months. In wet weather any phosphide treated oats left after 3 days' exposure in the field must be discarded. *Sugar December 1943.*

The Ram-ko method for the determination of fat in milk using an alkaline solution (*Indian Journal of Veterinary Science and Animal Husbandry, Vol. XIII Part II June 1943*) A simple (Ram-Ko) butyrometric method using alkaline solution is described for the determination of fat in milk and milk products. The method ensures the same degree of accuracy in results as that obtained with the Gerber test and has the added advantage that the initial cost of the equipment as well as of testing the samples is very low, since no centrifuge is required.

The alkaline reagent used in this method was prepared as follows:—

Sodium salicylate	...	...	25·0 gm.
Potassium carbonate	...	...	12·5 gm.
Sodium hydroxide	...	...	5·5 gm.
Distilled water	...	...	100·0 ml.

Iso-butyl alcohol was not incorporated in this solution, as it was observed that the alcohol separated out into a layer at the top and shaking the solution before use did not bring about a thorough mixture to ensure the accurate amount of alcohol essential for the test. It has already been indicated how necessary it is that the amount of alcohol added should be accurately measured and it should be exactly 1 ml., as slight variations lead to incorrect readings. Hence the two solutions were kept separate. This also ensured a long life for the solutions.

Adopting the above, the fat estimation in milk can be carried out accurately as follows:—

First, 5·5 ml. of salicylate reagent is placed in the butyrometer. To this is then added accurately by means of a pipette 1 ml. of isobutyl alcohol and 9·7 ml. of milk. The butyrometer is then corked and the contents well shaken and thoroughly mixed. The tube is then kept in a water bath at 60°C with the cork end resting on the bottom of the water bath. After the first three minutes, the tube is taken out and shaken vigorously and returned to the bath. After another three minutes, the above process is repeated. The tube is then kept for 10 minutes in the bath, when all the fat should separate out as a clear liquid on the top. The tube is now taken out, gently turned upside down and returned to the bath keeping it in the original position for another three minutes. Then the tube is finally taken out and the column of fat then read in the neck of the butyrometer which is graduated to give the reading in percentages.

By this method, very satisfactory results were obtained with whole milk, skim milk, butter-milk and whey in the investigations carried out. Further work on this problem is still in progress, aimed at standardizing a still simpler type of butyrometer and also substituting iso-butyl alcohol by a cheaper solvent.

Gleanings

Agricultural Prosperity and Anti-inflation The anti-inflationary drive of the Government would, unless hedged in by proper safeguards, prove to be an extreme hardship upon the agricultural population of the country.....The banking statistics which are published from time to time indicate where the extra issues of paper currency have found their lodgement. For instance, on the 1st September, 1939, the total of the demand and liabilities with the scheduled banks totalled Rs. 237 crores; whereas in November, 1943 they were Rs. 637 crores, that is to say, an excess of 400 crores. Similarly, in the case of the Imperial Bank the deposits in September, 1939 were Rs. 88 crores and those in November, 1943, Rs. 207 crores giving an increase of 119 crores. Therefore, the total excess of deposits since the commencement of the war with the Imperial Bank and the Scheduled banks could be taken as Rs. 519 crores as against an excess note-issue during the same period of Rs. 622 crores.

These figures carry a very plain tale. Nearly five-sixths of the total inflation money has been concentrated with people who are capable of depositing them in big banks and these men are certainly not village cultivators. They prove more than anything else how war-earned wealth has got accumulated in the hands of a few and that surplus money could be deemed to lie with them and not with the cultivators. (*Indian Sugar, February 1944*).

Dried Bananas It is reported that a 1-ton trial shipment of dried bananas from Nigeria (British West Africa) is being arranged and that the Ministry of Food are to consider further quantities. The dried bananas, prepared from fully ripe fruit, are said to be very sweet and to have a natural flavour. They have no important vitmins, but their high sugar content—somewhere about 60 per cent—makes them an excellent source of energy. In 1942 the Germans requisitioned at extremely high prices all the dried bananas unloaded at Marseilles from French African territories, and they were sent to feed troops on the Russian front. (*Food Manufacture, January 1944.*)

Solar Method for *Jowar* Smut *Jowar* seed was infected with *Spacelotheca sorghi* Clint., soaked in water at ordinary temperature for four hours in the morning of a day in June and afterwards spread out in the sun or in the shade until it was thoroughly dry. The results are summarized as follows:

Treatment	*Per cent smutted ears*
Seed soaked and exposed to sunshine for 6 hours	19·35
Do	19·86
Seed soaked and dried in shade	0·73
Control — no treatment	26·14

Soaking the seed and drying it in shade has almost eliminated the disease.

The treatment operates in a simple manner. The spores of *jowar* grain smut are seed-borne. When the seed is soaked and dried in the shade, the spores are induced to germinate, and almost all of them are rendered harmless. In the case of seed exposed to sunshine for six and for four hours, the treatment failed because in the sun the soaked seed dries up quickly and most of the spores do not germinate for want of moisture. They survive and germinate and cause the disease later when the seed is sown in the field. (*Indian Farming, October 1943*)