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In selecting a suitable vaccine one should see that it is:

(1) Efficacious (early conferment of durable immunity after vaccination).

(2) Safe (properly attenuated, producing no injurious effects such as the development of the disease or post vaccinal paralysis, etc.).

(3) Easy to manufacture

(4) Easy to use (one-dose vaccine preferable to others).

(5) Of fairly long keeping quality (to enable transhipment in a potent state, from the place of manufacture to far off places).

Umeno and Doi's single dose vaccine (glycerinated carbolized) referred to above fulfils these conditions, but its manufacture and quality have yet to be tried in India using the local strain or strains of the virus and with such modifications as may be necessary to suit local conditions. In the absence of this vaccine the following vaccines which are available in the market and have been extensively used by the author with satisfactory results are recommended:—

(1) Anti-rabic vaccine prepared at the Central Research Institute, Kasauli.

The oldest method is that of Pasteur which consists of a number of injections, usually seven with a 6 per cent brain emulsion prepared from sheep's brain with ½ per cent carbolic. The writer has used this method both as curative and prophylactic for years with encouraging results. Post vaccinal paralysis has been reported in certain cases by others, but I have never come across one in my many years' experience. The immunity lasts for six months.

(2) Mulfor's rabies vaccine prepared in America.

It is chloroform killed rabies vaccine containing 33⅓ per cent of rabid brain and cord tissue. This is a single dose treatment and the immunity is claimed to last for a year. The writer has carried this out on a large scale for years with very good results.

(3) Anti-rabic vaccine prepared at the Punjab Veterinary College, Lahore.

It is a simple and suitable vaccine prepared from an emulsion of a rabbit's brain and consisting of a 2 per cent brain emulsion in normal saline with carbolic acid.—*Indian Farming*, Vol. 3, No. 4, April 1942.

Agricultural Engineering in India.

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Who is an agricultural engineer? By American practice the term is applied only to those who have pursued a definite course of training in engineering and its application to agriculture. In England, apparently so far as I can judge by literature coming to me, an agricultural engineer is one who is engaged in the marketing of agricultural implements or in their manufacture and the term does not depend on what training the individual may have had, if any at all, other than experience. So far as I can determine, in India the term is applied to any engineer without regard to the branch of engineering in which he may have been trained who is assigned to a post carrying the title of 'Agricultural Engineer' usually in Government service.

Early experiments. The early agricultural departmental organization made no provision for agricultural engineering. The men appointed were administrators from the civil service, biologists and plant breeders, or agriculturists. Many of them were exceedingly capable men and laid very fine foundations for the splendid work which has been done since. None of them was an engineer and indeed the idea of the Agricultural Engineer, had not yet emerged in the west.

While the early officials of these newly created Agricultural Departments were not primarily trained to deal with implements, they interested themselves early in the introduction and trial of foreign implements, particularly iron ploughs. N. G. Charley, in his excellent paper presented to the Crops and Soils wing in 1937, makes reference to some of the early introductions about 1882 to 1885. Collectors and private individuals also experimented with imported and locally made ploughs and other implements.

Perhaps the improved device which has been most widely adopted throughout India and which has more effectively than any other displaced the indegenous method is the iron roller sugarcane crusher. The exact history of the iron roller crusher seems shrouded in mystery. This is perhaps the most outstanding instance of an agricultural engineering improvement developed by manufacturers and dealers in India.

Aside from the cane crusher, the one other thing which seems to have spontaneously taken hold over a large part of the country is the small chaff-cutter. Originally imported from England, it has in recent years been manufactured in large numbers by a number of different firms, particularly in the Punjab but elsewhere also. After a period of very poor machines, it appears that public demand is now stabilizing on a machine of reasonably good quality, and competition between firms is keeping the price as low as is consistent with the quality demanded.

The Indian Plough. Various people have in the past reviewed the development of ploughs in India. N. G. Charley in his paper in 1937 dealt with the history of the improved plough in India at some length.

Local factors favoured the adoption of cast iron ploughs in India, factors having nothing to do with the merits of cast iron for the purpose. The process of fabrication was simple. A little sand moistened with the water could be shaped into the mould and used repeatedly. Cast iron in the form of new pig and in the form of scrap was more easily available than steel. With a pit furnace, little more than a hole in the ground, a hand-operated fan which could be and often was made locally, a supply of coke and a crucible which while imported was not very costly, a foundry could be set up. Foundry skill is relatively simple as compared with the working of steel. A few months' working in an engineering workshop where casting was done was sufficient training for a moulder to start work. The amount of hard labour required was much less in the case of cast iron parts as compared with the making of steel parts by hand. The forming of steel by machines was only developing in the west and there and in India as much as possible of all machines was still made of cast iron. The advantage of cast iron was particularly great in the case of parts of complicated shape.

It was natural, therefore, perhaps all but inevitable under the conditions, that the Agricultural Departments should standardize on cast iron ploughs. In many cases, however, the cultivators refused to use the cast iron shares, having poor ones made of steel by their own blacksmiths when the Department failed to furnish steel ones as desired. It was natural that early manufacturers should look to the Agricultural Departments for help in getting sales and from this it was only a step to the Departments undertaking the sales directly through departmental agencies. To the Departments this appeared to have advantages, they were thus able to control types offered to the public according to their views of what the public should want; they were able to control prices, allowing the maker such profit as they thought fit and in some cases absorbing the cost of sales in the departmental accounts, making the price to the cultivators low indeed, but thereby cutting out the possibility of independent competition with them.

Private enterprise. In some parts of India, these conditions did not exist. Kirloskar Brothers, starting with the manufacture of a chaff-cutter, soon added ploughs, copies of models which had some measure of local acceptance if not popularity. They made arrangements for local stockists and for repair service and they pushed the sales as a business. As demand grew, they improved the quality and finish of their implements and added new models from time to time to meet additional needs. In contrast to this, I am convinced that the hold the Departments in other provinces have had on the trade in implements coupled with the insistence on the sale of what I consider unsuitable types of ploughs, has resulted in not only not fostering the introduction of better implements but actually delaying such introduction. At least so far as North India conditions are concerned, designs distributed have often been faulty in that they only provided often inadequately, for one part of a season or operation and did not fit in well into the whole series of operations necessary to produce a crop; material has often not been the best available, quality and workmanship have often been sacrificed to cheapness (low first cost has been made a veritable fetish in some cases, without regard to ultimate costs or to efficient working). In fairness to agricultural engineers, it should be stated that little of this condition is their fault.

Suggestions for the future. The first suggestion I would make for the future development of agricultural engineering in India is the urgent necessity for training agricultural engineers in India for Indian conditions.

In other lines of work we employ specialists trained for their job. It would be no more absurd to employ a chemist to do research in plant breeding than it is to employ a civil engineer trained to design and construct canals, roads and buildings, or a mechanical engineer trained in the operation of big power plant or in manufacturing methods, to conduct research on improved implements or their application to agricultural practices. Doubtless sound scientific training in any subject is a help in mastering any other and it is also true that a soundly trained science graduate given sufficient time, should be able to master after a fashion an unfamiliar branch of science but the practice of employing specially trained men is too common to need more emphasis here.

A sound professional training in agricultural engineering should include three phases. First, it should include a sound basic training in agricultural principles, particularly the knowledge of chemistry, botany, soils and animal husbandry, necessary to understand the fundamentals of plant growth.

Secondly, it should include a sound training in engineering fundamentals and processes. It should cover such subjects as manufacturing methods, particularly those applying to the manufacture of implements along modern lines, engineering drawing and structural design including special attention to design of agricultural buildings, a sound training in mechanics and statics, elementary training in electricity and its application particularly to motors and to distribution systems for rural electrification, and the applications of engineering principles to the construction and operation of agricultural implements and machinery as engineering devices.

Thirdly, the training of agricultural engineers including some intensive training in the application of engineering principles should be kept in mind at every stage. While the engineering training should be sound engineering, it should not be taught abstractly but as an applied science.

Some real difficulties:— There are certain real factors in the situation of the cultivator which are very great difficulties in his way. While he may not be excessively conservative as an individual, it is true that religion and social custom are against change. Indian social life in general is built around group control

and does not encourage innovations. The individual is not free to do as he pleases in many phases of his life. At least in North India the zemindari system has often been a brake on progress, the zemindar tending to take in one way or another any benefit accruing from any innovation in crop or practice and quite generally discouraging innovations.

The mistake of failing to understand and utilize the *jajmani haq* system under which indigenous implements and tools are made and repaired, has been a deterrent to the introduction of better ploughs in many cases.

My first suggestion for the future is that a thorough study be made of the social customs, village organizations and economic factors which may affect the introduction of implements.

The second suggestion is that agricultural engineering research be on a more comprehensive scale than hitherto. We should not set out to develop a small soil inverting plough but rather to study the problem of seed bed preparation throughout the year.

My third suggestion is somewhat related to the above. We should give more attention to long range objectives in planning our research programme for implements. Of course we say that our objective in all our agricultural improvement work is to raise the standard of living of the cultivator. So far so good, but that is very general and not very definite. Some much more deginate and immediate objective would be conducive to more definite results. Just as we should not too closely restrict our objective, we should not be too diffuse. Possibly in recent years we have been frightened by the spectre of unemployment and have been unwilling to face the real objective of the introduction of better implements, *the better utilization of human labour.*

In fact, the first ganeralized objective I would suggest would be the working out of such a combination of improved implements and cultural practices as would reduce the need for the large amount of casual seasonal farm labour now required, particularly the necessity of employing large number of women and children in field work.

Technical suggestions. First, I would point out that research should be directed toward developing implements which can be utilized on areas approximating those now available to the larger cultivators in each area.

Secondly, the power for working the implement is equally as important as the implement.

Certain problems needing investigation have been mentioned as illustrating principles or statements made. The following is a suggestive list of investigations which in my opinion need to be carried out, keeping in mind the principles laid down above. It is not meant that this list is exhaustive or complete but only suggestive.

1. The relation of improved implements to soil fertility particularly in relation to dry weather ploughing and to green manuring.

2. A full investigation of the problems of fodder production and storage under village conditions, including particularly the possibility of making silage.

3. The problem of harvesting, both of *kharif* and *rabi* crops. Possibly next to weeding and interculture, the harvest is the operation which makes the biggest demand for seasonal labour.

4. Improved methods of threshing, winnowing and grain dressing should give a substantial increase in the income of the cultivator.

5. There is real need for a device for lifting water efficiently for small lifts.

6. The present persian wheel is a great improvement on the old wooden one with grass ropes and clay pots. For shallow depths, it works fairly well but in deeper wells wear on the chain is very severe. There is need for a better chain

for carrying the buckets and possibly for better bearings. There is need for the investigation of the possibility of better gearing, arranged for separation from the chain wheel so that it can be used for other purposes.

7. Attention needs to be paid to the possiblity of using bullock power for some of the power needs requiring rotary power.

8. A rich field for investigation lies in the whole subject of soil and water conservation.

9 Transportation of crops from field to farmstead and from farm to market in head loads is one of the very large wastes of agricultural labour.

10. What is the need and what is the possibility of farm fencing in India

11. While any extensive rebuilding may have to wait for some rise in the standard of income, it is not too early to begin survey studies of the building needs of the cultivators.

12. Agricultural engineers should take greater interest in developing equipment for the dairy industry, particularly for the use of the *gowalla* and small dairyman.

13. The making of new equipment available to the cultivator is equally as important as the designing and manufacture of it. Many things like smaller implements are suitable for individual ownership. Larger machines, more complicated machines requiring more training or skill for operation or requiring repairs outside the skill and facilities of the village blacksmith will, in the beginning at least have to be made available otherwise. Agricultural engineers should study and where possible experiment with solutions to these problems. (*Indian Farming* Vol. 3 No. 5, May, 1942.)

ABSTRACTS

Suitable procedure for laying out experiments in the fields of cultivators. T. G. Rama Iyer. *Mys. Agri. J.* 20 : 109 : 1942. Realising the practical difficulties such as the conservativeness, extreme cautiousness and a saftey first motto in the farmers, in the way of putting the results of agricultural research into practice the author finds that in the Mysore Agricultural Department formation of Subvention Farms, followed by Demonstration Plots which in turn are followed by Seed Farms has been found to work satisfactorily.

"The subvention farm is a small experimental farm of an acre or two in the holding of a leading and progressive *raiyat*. The several improved varieties of cane or paddy or cotton or groundnut of this State as well as from the adjoining Provinces are sown or planted along with the local in equal plots in a more or less uniform field selected for the purpose. The Departmental Fieldman supervises sowing or planting. The *raiyat* carries on cultivation according to his usual method. At the time of harvest the Fieldman again watches the operation and all inquisitive *raiyats* also watch the separate heaps harvested from the separate plots of the several varieties. The owner of the Subvention Farm naturally discusses the merits of individual varieties for earliness, yield, water requirements and the trouble and labour involved. He and his neighbours are then asked to select the best variety that suits their tract of country. They do so and there has been no occasion for any differences with the Department as the pros and cons of each variety are discussed with us also. The owner of the Subvention Farm is then paid a subvention of Rs. 100 per acre for sugarcane, Rs 50 per acre for paddy, Rs. 25 per acre for a dry crop for his trouble and attention. The seed is given free and the *raiyat* takes the whole crop. It has been found that the Subvention Farm has a high educative value. The *raiyat* is trained to compare the merits of different improved strains from all points of view. The working of the Subvention Farms is under the control of the Botanical (Plant breeding) section.