PAPER No. 15

AGRICULTURAL ECONOMICS WITH SPECIAL REFERENCE TO IRRIGATION PROBLEMS IN THE PUNJAB.

By W. Roberts.

In a paper the author submitted in 1918 to the Congress, the economies of the cultivation of wheat *vs.* cotton were discussed at some length and the plea put forward for an increase in Kharif irrigation, with a view to increasing the area under cotton.

In the present paper along similar lines, an attempt will be made to indicate the lines along which economies in the distribution of water are possible from the point of view of a large Estate and also to indicate future possibilities as regards increase of Kharif supplies.

The author controls over a lakh of acres of irrigated land in the Punjab, Sind and Baluchistan, and certain general lines which affect the economy of irrigation of water, have been adopted as a result of practical experience.

The points may be given briefly as under :—

(*a*) *No. of Kiaris per acre.*—Up to date, the Irrigation Department have always recommended 8 Kiaris per acre. This system while eminently suitable for supplies of about one cusec or less, is unsuitable where two, three or even more cusecs have to be dealt with at one outlet. In the B.C.G.A. Farms, the number of Kiaris per Killa is laid down according to the supply of water which has to be managed. Generally speaking, with a supply of between 2 and 3 cusecs not more than four Kiaris per acre are made, and when dealing with three or four cusecs, this number may even be reduced to two. The levelling and grading of the land is carefully attended to, in all cases.

(*b*) *Strict Rotation.* The system of rotation as followed on the B.C.G.A. Farms is based on the division of the squares into ten lines of $2\frac{1}{2}$ acres each. Each square, as far as possible, is uniformly cropped, and the cotton, say, in any particular area will be on the same lines throughout, that is, in one year Lines 4, 5 and 6 and in another year 7, 8 and 9, etc. Any other Kharif crops will be on adjoining lines, if possible. This enables the Irrigation water once it has reached the land, to always flow in the crop. It is well known to Irrigation Officers that in a sandy soil like that in the Punjab the losses by percolation amount to

a very high percentage of the water entering Canal Head. If care is taken in adopting the above practice such losses, once the water enters the area controlled, are reduced to a minimum. The crop is also able to benefit from being near the Irrigation Channel.

A good illustration of the benefit of this system was forcibly brought to author's attention when taking over a Court of Wards Estate recently. In the latter it was the practice to grow cotton and other crops in various scattered acre plots in the square with the result that an enormous amount of irrigation water was wasted when flowing through empty land. The cropping area has already been increased, and the condition of the crop has improved by at least 25 per cent mainly from this one improvement alone. This is probably an extreme case, but no doubt, plenty of worse cases of lack of organization may be found in many parts of the Province.

(c) *Economy through better implements.*—There are of course a number of other ways in which large estates can be managed more efficiently than the small areas of owners who own only one or two acres, are example, implements which cannot be afforded for, say, 25 acres well within the means of some one controlling 250 acres, or even as in the case of reapers, 500 acres. A rough idea of the implements' organization is given below :—

25 acres	.. Two Desi Ploughs and two pairs of cattle, plus Kassies, Drantis, yokes, etc., as per usual cultivator's minimum and one Meston Iron Plough.
100 acres	.. Bar Harrow, Cultivator for interculture of cotton special yokes for same.
250 acres	.. One cart.
500 acres	.. Reaper for harvesting wheat and possibly an automatic drill. One Nahan Sugarcane Crusher (if minimum of 20 acres cane grown.)

Many of these implements assist in the conservation of soil moisture and cause a better return of crop from each unit of water used.

(d) *Overwhelming importance of land quality on economy.*—One of the most important factors in the best utilization of water is the quality of land being irrigated. There are plenty of areas in the Punjab capable of giving an average of 25 maunds of wheat and 12 to 15 maunds of kappas per acre, whereas other areas may give only five maunds kappas and

8 to 10 maunds of wheat. This comparative yield holds, when the amount of water supplied is the same in both the cases. It is obvious, therefore, that wherever possible, the available water should be used on the best land. The policy of the Irrigation Department and of the Government in the past has been to spread the irrigation on the largest possible area of ground. This policy can be extremely wasteful, and in reality what should be the unit, is the amount of cotton or wheat which can be raised by one cusec. Water at present is far more a limiting factor than land.

(e) *Vested Interests.*—It may be argued that this is unfair to the owner of the poor land. This is a false argument which clear thinking should be able to dispel. Let us suppose that in two areas of 100 acres cropping 20 acres of cotton, respective yields are 300 maunds and 100 maunds. It is surely better that the cultivator of the poor 100 acres should have a share in the good land, for with 10 acres land he can get 150 maunds of kappas. This also reduces his standing charges, that is, cost of seed, cultivation, the cost of his animals and his own labour besides the fixed amount which has to be paid for water and for land revenue.

The objection may be made that if one were to increase the amount of water available for good land, it would only lead to waste of water and a decrease in Government Revenue, which is based on the area irrigated. This to some extent, is possible, but the intensity of cropping at present practised in the Punjab can be very easily increased by at least sixty per cent. with benefit to the condition of the soil. It must not be forgotten that in Egypt, which at present gives a greater yield per acre of cotton than any other country in the world, the intensity of cropping is well over 200 per cent. In a big department like the Irrigation Department, it will be impossible to adopt a new policy of this kind on a wholesale scale at once. There should, however, be, in the interest of the future of the Punjab, some liberty for experimenting with different intensities (with at least say, 10 per cent. of the supply).

As an instance of the economic side of this question, the author would gladly pay double the present charges for an extra supply equal to what he is entitled to, for certain Chaks. This means that where, for example, irrigation bills at present amount to Rs. 5,000 for a certain village he would be prepared to pay Rs. 15,000 provided the supply is double. This must not be taken as indicating that the present irrigation charges are low. Taking the average fertility of irrigated tracts into account, they are probably on the high side, and definitely a very severe handicap for those who possess land below the average margin of fertility. The question of using available water on the best land is of very great importance, and it would be in the interest of future generations if a correct view could be taken of the real factors governing this very important point.

Future expansion of Irrigation and Storage.—As to the future expansion of irrigation, we are within sight of the end of possible developments, which are based on canals similar to those constructed in the past. After the completion of Haveli and Thal Projects, all available Rabi supplies will have been used up. The main hope of the future is in the increase of Kharif supplies and in the making of this available for the agriculturists. It is well known that most of the Punjab rivers carry supplies between June and September many times equal to the normal winter supply.

Necessity of combining Storage with extra Kharif supplies.—While it is admitted that the extra water if given in late June upto early September may not enable much in the way of profitable crops, such as cotton, to be grown, it should be feasible to combine increased Kharif irrigation along with storage reservoirs allocated for supplementing Kharif supplies and not dissipated in the present canal system. This would go a very long way to solve this question. In recent years, it has become more and more evident that cotton can be safely sown upto the end of June, and in the present season, some of the author's best crops on the Nili Bar were sown after the 15th June.

Danger of Water-logging.—Some critics will, no doubt, say that a higher delta of irrigation would accentuate the water-logging evil. While not wishing to minimize this evil, I would plead for a better general sense of perspective. The danger of water-logging affects less than 5 per cent. of the total canal irrigated area now. The great bulk of the irrigated area of the Province would be perfectly safe from this evil if three times the present supply was given. The areas most liable to water-logging are situated near or between large canals or where a canal flows parallel to a river. The author maintains in spite of Mr. Wilsdon's theories, that the main cause of water-logging is percolation from the large canals and the rivers. As this subject is a big one, it is impossible to go into it deeper in this paper.

Nature more active in Summer Season.—Another factor tending to force attention to increased Kharif supplies is the fact that the production of food crops is much more efficient in Kharif season than it is in the winter. The main food crop of the Punjab, *i.e.*, wheat, is grown during the winter season, whereas in most of the rest of the world, it is a summer season crop. In the hot season in this country, the food Kharif crops are millets, *bajra* and Indian corn. The food value of *bajra*, *jowar* and other millets and Indian corns is only slightly inferior to if at all that of wheat, as the following analysis will show :—

ANALYSIS { Refee : Agri. Research Institute : Pusa Bulletin No. 70.....

Description.	Moisture.	Ether extract.	Soluble Carbohydrates.	Albuminoids Nitrogen.	Albuminoids Ratio.	Food Units.
Pennisetum Typhoideum (Bajra) Punjab	10·08	4·93	71·07	1·78	7·41	111·2
Sorghum Vulgare (Jowar white) Punjab	12·04	3·13	73·44	1·31	9·85	101·7
Maize (Zea May) white	11·83	4·53	72·03	1·32	9·99	104·0
Wheat Punjab (Triticum Vulgare) Ambala Sample	10·76	1·90	64·61	1·32	8·39	89·9
Soya Bean (Glycine) (Soja) Japan	6·70	10·88	29·75	..	1·41	153·8

Yet it will be generally said that whereas the average crop of wheat would yield 12 maunds, we can get average crops of 20 to 25 maunds of *jowar* or *bajra* and even still higher yields of Indian corn.

Scarcity of Leguminous Crops (*Soya Bean.*)—One of the gravest defects of Punjab agriculture in irrigated tracts is the paucity of leguminous crops. These crops, *e.g.*, gram, pulses, *jowara*, soya bean, etc., enrich the soil. These crops now form less than 6 per cent. of the cropping area. Wheat, cotton and toria exhaust the soil. It will be almost impossible to establish a permanent system of agriculture unless we can increase the proportion of recuperating crops. The soya bean is the foundation on which the agriculture of large tracts in Manchukuo and North China is based. This is a leguminous oil seed which will grow well in the Punjab, but present world prices are too low to enable it to flourish, and upto the present there is no market for it in India. In the

New Agriculture envisaged in this paper, the author feels this crop or some substitute must have an increasingly important influence. Soya bean is also a first-class food crop.

Prejudice in favour of wheat for human consumption.—There is a prejudice in the Punjab against the use of cheaper grains for food. It is not perhaps realized that in the U.S.A. which is probably the richest country in the world, maize bread is regularly present on the table at practically every meal. It has many qualities which make it in some respects quite as useful as wheat as a human food. Nature, therefore, both as regards the rivers and as regards the manufacturing of food for human consumption is more active in the summer season than in the winter, and it is to be hoped that human energy and intelligence will be forthcoming in the future to harness this available water supply, so that proper use may be made of it by the future farmers of the Punjab.

DISCUSSION.

MR. **Roberts** in introducing his Paper said that as an instance of the efficiency of Summer plant growth, some recent Pot culture experiments by the Punjab Agricultural Department at Rohtak were interesting. These tests were conducted under controlled conditions as supplied to the Author by Prof. Jai Chand Luthra. In these tests under optimum soil moisture conditions, it took 295 cubic centimetres of water to produce one gramme of dry matter in the case of Jawar and Bajra. When artificial soil drought was produced from 1st September the average amount of water required was just under 280 lb. of water. Wheat under similar conditions at Pusa required about 300 lb. or more water for every pound of dry water. Water in terms of dry matter would appear therefore to be equally as efficient in summer as in winter.

The Author, referring to Intensity of Cropping, said that experiments showed that wheat on an average of 4 years gave the highest yield for 133 per cent. and 166 per cent. intensity, and Cotton on 66 per cent. The actual average yield was 12·91 when cotton followed fallow and only 66 per cent. intensity, and 11·47 and 11·54 maunds respectively under 133 per cent. and 166 per cent. intensity.

Percentage of Leguminous Crops in Punjab Cropping.—On this subject the Author quoted from the Season and Crop Report for 1935-36 and cited the following figures :—

		Total area sown.		*Total per year.*
		Kharif	Rabi.	
Irrigated ..		5,684,000	9,000,000	14,800,000
Unirrigated ..		7,174,030	7,674,000	15,200,000
Fodder ..	Irrigated ..	2·8 Million.		
	Unirrigated ..	2·0 Million.		
Gram ..	*Irrigated*	%	*Unirrigated*	%
	1,001,015		2,620,202	
	65,629	8%	458,782	24%
Other pulses ..	114,814		586,196	

Fodders, which generally meant Jawar with various proportions of Guara was not included in the above analysis.

MR. **Kanwar Sain** remarked that Mr. Roberts deserved the gratitude of the Congress for presenting a lot of new information in a small Paper for the benefit of irrigation engineers. Some important

points had been advocated. These points coming, as they did, from a leading and expert agriculturist of Mr. Robert's eminence, who had unique experience of agriculture in the Province, merited a most careful consideration from irrigation officers. It was with a certain amount of diffidence, said the speaker, that he had criticized some of the points brought out by the Author and asked certain questions in order to have further elucidation of some of the points.

Mr. Kanwar Sain continued that the unit for giving water should be the amount of cotton or wheat which could be raised by one cusec, rather than the area to be irrigated. The suggestion therefore was that the entire water should be used on a smaller area of good land rather than a bigger area of mixed good and poor land. On the one hand, the Author of the Paper said that in this way a reduction was to be effected in the cultivator's water and land revenue while, on the other hand, the Author was prepared to pay double the charges for an extra supply to his good land, to make up the Government revenue.

The Irrigation Department had always been ready to sell water on a volumetric basis and thus give the cultivator a free-hand in the use of such water anywhere on his land ; but in spite of the persuasions of the Co-operative Department, comparatively few people had taken any advantage of this offer. Was it practicable for the Department, said the speaker, to allocate water by the amount of cotton or wheat that could be raised in any one acre of land? This would mean that the water-rates would vary for every acre. To Mr. Kanwar Sain's mind, such a system would be open to great abuse. It was possible that influential and rich cultivators might get all the richer by this means but the poor were bound to get poorer. Was Mr. Roberts prepared to share his good land with the owner of the poor land? The Punjab cultivator was not to be confused with the farmer of England, America or Denmark. He was hardly a farmer in that sense of the word. He was a small holder, the size of his holding having been determined partly by historical developments and partly by state action. Mr. Roberts' suggestion might be practicable if the entire land were regarded as belonging to the State and were treated as public property to be used to the best advantage of the Province ; but short of a revolution, the distribution of land amongst the people was to be accepted as outside future political activity.

Again, said the speaker, it could be questioned that the increase of yield per acre would not necessarily indicate an increase in profits per acre. The scientific expert was constantly pointing to the higher yields per acre obtainable from the use of his seed, his manure, his methods of cultivation and his labour-saving devices and machinery and wondered why practical farmers did not rush to follow his advice. The speaker thought that they would do so if assured that this policy would result in greater profits to them. In comparing systems of agriculture, it was also important to distinguish between production per acre and

production per man. In this connexion, the speaker said that he would refer to a well-known authority like Carver. In his book, *Principles of Rural Economics*, Carver said, " Where the land is abundant a large product per man is most easily secured by extensive farming. A large product per acre is desirable as a means of getting a large product per man and is not desirable in any other sense whatsoever. A large product per acre with a very small product per man is always accompanied by squalor and misery and we find this to be the actual situation in these countries which can point to the largest produce per acre." Several other American writers also claimed that extensive cultivation on a large area gave a higher return per farmer than intensive cultivation on a small area ; but in the Punjab, where the land had been fragmented into small pieces by the local customs of inheritance, no one could advocate cultivation on extensive methods. The problem was difficult but one on which future prosperity of this Province depended. The speaker requested Mr. Roberts to explain his point in greater detail as to how he proposed that the Irrigation Department should bring the suggestion into practice. The speaker drew the attention of Mr. W. Roberts to the minute of Mr. Owen Roberts in connexion with the report of the Abiana Committee of 1934. In discussing the factors on which the water charge was based Mr. Owen Roberts had stated :—

" In respect of the class of the soil to which water is applied, unless owing to some special physical property, more or less water is required to bring a given crop to maturity on one soil than is required to bring a similar crop to maturity on any other soil, this feature should be excluded from rate construction and more especially since character of soil is taken into account and very properly so in land revenue assessments. It would seem, therefore, that in the absence of a charge based on the actual quantity of water supplied that the only proper features to be taken into account in rate construction are class of crop and the area over which it is grown."

Regarding the pitch of water-rates prevalent at present, the speaker referred to Mr. Roberts' remarks : " Taking the average fertility of irrigated area into account water charges are probably on the high side and definitely a very severe handicap for those who possess land below the average margin of fertility." He said that he had just quoted from the Abiana Committee Report that the only basis for water charges should be the class of crop and the area over which it is grown. How would, then, the Department lower the water-rates on land which was below the average? If it could not, then it led to the first suggestion of Mr. Roberts which had already been examined and found to be impracticable. Regarding the water-rates being high, the speaker suggested that a careful perusal of the Abiana Committee Report of 1934 would repay. Mr. Kanwar Sain continued that in this connexion it was to be borne in mind that the State had the monopoly of the waters of the Punjab rivers and it was morally bound to use this monopoly in the

nterest of the people at large. Physical conditions prevented everyone being benefited directly and only a minority of the owners or cultivators received irrigation from State canals; the majority had thus a claim against those who benefitted and this could best be met by fixing the water-rate high enough to provide a share for those who could not receive the water.

Another point on which the speaker said that he had to say something was regarding the future expansion of irrigation. The Haveli and the Thal Projects might possibly be taken up and completed within the next ten years and it was hoped that these two Projects would be able to cope with the increase of population in this period. Side by side, there was a possibility of augmenting the rabi supplies by means of tube wells. There was a third important source of supply which had not been given serious consideration, so far, partly because of the expense involved and partly for want of reliable information. At present according to the Statistics of 1934-35, about 1,800 cusecs of water were lost by absorption from the main canals of the Punjab excluding the S. V. P. Canals. If the Sutlej Valley Main Canals were also included, the figure of water lost by absorption would go up to 4,200 cusecs. Now, if the main canals only could be lined with some material which would reduce the absorption to, say, about one quarter, there would be available on the average 1,700 cusecs in the Rabi and 3,000 cusecs in the Kharif from this source alone. The Irrigation Research Institute would do the Province a very great service indeed if it could discover a cheap and effective material for reducing this absorption in the canals. The fourth source of supply was, as pointed out by Mr. Roberts, storage of monsoon water. There are any number of good storage sites in the Punjab, as brought out in the Wiley Committee Report of 1929. Before tube well irrigation was taken up on an extensive scale in the Punjab on the lines of the U. P., these two sources of supply should, said the speaker, be given serious consideration and compared with the initial and working costs of doing irrigation by tube-wells. The supplies stored between June and September could, of course, be used during the Rabi as well. The lining of main canals would not only increase the supply by reduction in absorption losses but would also enable these canals to carry additional supplies in the same sections. The distribution of water, however, had become a very complicated affair. Before the Punjab could withdraw any further supplies from its rivers the consent of the Sind Province was required to be obtained.

Fourthly, said Mr. Kanwar Sain, Mr. Roberts had advocated the use of cheaper grains such as bajra and maize for food in place of wheat. Before the advent of canals in this Province, bajra, and maize formed a very common diet of the Punjabis. With canals, the growth of wheat increased and as wheat became cheaper more and more people used it for their daily food. Mr. Roberts could well ask the question whether a nation ate wheat because it lived in a wheat growing area or whether it

grew wheat because it was a wheat-eating nation, or whether another nation ate rice because it lived in a rice growing area or grew rice because it was a rice-eating nation. A well-to-do Bengali in Lahore sent to his own Province for rice as he considered it better than wheat or even rice grown in the Punjab and the experience of more than 150 years in this country had failed to convince the Englishman that the food of England was not the best to be used in the Indian climate. Prejudices of a class which could well afford to pay for any kind of food, died hard. But could this charge be laid against the starving millions of India? If the difference between the prices of wheat and bajra or maize became appreciable, the general mass of the people might again come back to these cheap foods. To a certain extent the food of a people in general depended on natural environments. The Japanese were great eaters of fish because they lived on islands which were nowhere far from the sea and which teemed with fish. The people of Australia and New Zealand ate much mutton because their industry was wool growing and mutton was a bye-product. The North of Scotland produced little more than oats and so the Northern Scotch ate largely oats and they were never tired of persuading other people that oats made very good human food. Tibet produced little more than poor barley. So barley was the staple food of Tibetans. Bengalis ate rice because their Province grew rice in abundance. It was no use Tibetans or Scotch pining for rice nor for Bengalis to sigh for barley and oats.

If people in general, said Mr. Kanwar Sain, all of a sudden replaced wheat to any material extent by these cheaper grains, what would happen to their wheat? Australian and Russian wheat had already placed Punjab wheat at a discount. It would be interesting to note that the ship freight from Australia to Bombay for wheat was less than the railway fare from Lyallpur to Bombay. With the Sukkur Barrage increasing the wheat area, the position of Punjab wheat was likely to become still more unfavourable on account of its greater distance from sea ports. The Crop Planning Conference held at Simla in June 1934 was of the opinion that the future prospects of cotton and oil-seeds were better than wheat. It would seem logical that instead of changing the food of the Province from wheat to bajra and maize it would be better to utilize any increased kharif supplies that may become available to grow cotton and oil-seeds instead of growing bajra and maize, leaving wheat to be consumed locally by the Province. Bajra was not at all suitable as a food for Summer. Cultivators would, no doubt, grow these cheap crops if they did not get water at the sowing time of more valuable crops. But to persuade people to grow bajra and maize as their principal kharif crops would, said the speaker, be a step backward in his opinion.

Mr. **W. C. Chopra** said that Mr. Roberts suggested letting in the field a supply "between 2 and 3 cusecs" and "even 3 or 4 cusecs." Experience showed that a larger supply than 2 cusecs could not be conveniently handled by zemindars. He thought that the

discharge of an outlet should not exceed two cusecs, and agreed with the Author that four kiaries per acre would do quite well in that case.

Having the same crop on the same line of a series of squares, as advocated by the Author, was certainly very sound and the speaker had seen it practised by a large landholder friend of his, resulting in economy of water and efficiency of management. But this could be possible on a large scale, only if collective farming was resorted to by pooling the small holdings and entrusting the management to a Syndicate. He said the same held good in the case of the Author's suggestions regarding growing and irrigating suitable crops in suitable lands. Thus, sugarcane had the best yield in Gurdaspur and Rohtak districts for instance, rice the best in submontane districts, and wheat and cotton in the lower parts of the Upper Bari Doab Canal area and of the Jhelum and Chenab colonies, and on the Lower Bari Doab Canal. With small holdings that prevailed generally in the Province, especially in non-colony areas, the valuable suggestions of the Author could be acted upon only if collective farming methods were introduced. This was not in sight yet.

With regard to the importance of Kharif crops brought forward by Mr. Roberts, Mr. Chopra said it would be interesting to see that water-requirements of crops sown even under the present system, rose and fell on the whole, with the rise and fall of rivers and therefore with available canal supplies. In a typical area of the Upper Bari Doab Canal, *viz.*, the Kasur Branch Lower, where Kharif crops consist of about 25 per cent. cotton, 10 per cent. each of sugarcane and rice, and 55 per cent. of miscellaneous crops including Jowar, Maize and Fodder, the water-requirement index by months obtained by multiplying the percentage of a crop requiring water in a month by the number of normal waterings in that month, worked out as follows :—

April	.. ..	44	August	.. ..	130
May	.. ..	49	September	.. ..	150
June	.. ..	92	October	.. ..	160
July	.. ..	152	November	.. ..	90

The results and data on which they were based were accepted by Mr. Roberts, whose views the speaker sought as Principal of Lyallpur Agricultural College. Thus, water requirements so far as Kharif crops were concerned, kept pace with supplies available, except from the middle of September to the middle of October. It was in this short period that help from storage reservoirs would be needed for Kharif crops.

MR. **Som Nath Kapur** remarked that the Author had made certain observations which were of considerable interest as far as private estate owners were concerned but the conclusions were not in conformity with the point of view of the Irrigation Department when he discussed the quality of land. The Author, he said, desired a greater water allowance for good soils than for poor soils on the temptation of higher water rates. The Department did not function on commercial lines and, as such, its officers instead of being vendors of water had greater responsibilities towards the public. They had primarily to look after the interest of those who wanted water to earn their morsel of food and then to consider the requirements of those who wanted to make money.

The Author's desire was to exclude all such areas from Irrigation that gave 8 to 10 maunds of wheat per acre and for the rest to have a sliding scale of water allowance depending on the quality of land. It was probably not realized what effect it would have on the economic structure of the province, what unrest it would create, and what enormous areas would be excluded. The speaker asked if the owners of good areas, the Author being one, would be prepared to give away part of their good land permanently to those who are likely to be affected by these exclusion operations. This practical question which would stare every landlord in the face would show that vested interests were not a false argument as stated in para. (*e*). Not only that, but it would create enormous administrative difficulties. Every officer had his own standards upon which he differentiated soils and the water allowance might vary for similar soils under different officers and although honestly doing their job, everybody could be accused of showing favour.

Instead of asking the Irrigation Department to start experimenting with 10 per cent. of the supplies, it would have been more appropriate to show the advantages to big landlords. The speaker continued that, further, the Author wanted a greater water allowance in Kharif. He was wrong to say that the danger of water-logging affected less than 5 per cent. of the area. He probably did not realize that even in the Nili Bar, which was just opened, the rise of the water-table was about 1 ft. per year and as such it was only a question of time that, with greater intensity, the time factor would be reduced and the end would be hastened at a greater rate.

There was, in the speaker's opinion, however, one lesson to be learnt from this Paper and to illustrate it he mentioned a concrete case, *viz.*, that of Trikhni Distributary on the Pakpattan Canal. It had a C. C. A. of 19,000 acres. Practically the whole of this area was leased out in 1929. In 1933, a study of the Irrigation figures showed that in spite of the authorized supply being allotted, the actual irrigation was in some cases hardly 10 to 15 per cent. of authorized and about 4 outlets showed a percentage remission varying from 75 to 100. Crop Statements were prepared by fields and all areas which had not been brought under

irrigation for four years in spite of their having been " allotted, " were marked. Apparently these areas were unculturable and about 10,000 acres, generally in big patches, had to be excluded. The rest of the area was not good also, and a soil survey would probably have reduced the burden further. The condition on quite a number of other distributaries on this canal was much the same. As it happened to be all Crown Waste which had been temporarily leased out, if this area had been excluded, a greater water allowance for the rest of the area would probably have resulted in greater prosperity and contentment to the colonists. On the other hand such soil, if given Kharif Irrigation only, might prosper on account of silt in the water.

The speaker thought that what was required was that before any Crown Waste was opened up for irrigation, bad areas should definitely be excluded from perennial irrigation but should be given Kharif Irrigation and where it was possible in the Nili Bar they should be excluded where there was considerable Crown Waste. But there should definitely be no sliding scale of water allowance.

R.B. **Sewak Ram**, M.L.A., thanked the Congress for allowing him to address the assembly of eminent Engineers of the Punjab. He had taken the liberty of doing so as he wished to submit some important points for the notice of the Irrigation Engineers.

He congratulated Mr. Roberts on reading such a learned Paper before the Congress. He endorsed the Author's views in entirety except when he wanted to introduce cheap crops such as millets, bajra and Indian corn to force attention to increased Kharif supplies of water. In this matter he agreed with another learned speaker, who was a capable Irrigation Engineer, in his views that cultivation of such a valuable crop as cotton should be increased. He drew the attention of the Irrigation Engineers to considering ways and means of utilizing the increased Kharif supply for increasing the area under cotton.

He submitted that rajbahs should be so designed as to carry increased supplies of water in the Kharif for the cultivation of more cotton, which would bring more wealth to the poor and hardworked zemindar and more revenue to Government.

He also added that the increased Kharif supply could also be utilized for the cultivation of Toria (an oil seed) which was grown in the Kharif season and was matured with two or three waterings. It was a very valuable drop and helped the zemindar to pay the rabi Revenue demand. He was glad that Mr. Roberts had brought to the notice of the Irrigation Engineer the paucity of leguminous crops which were needed to enrich the soil.

He said that Mr. Roberts had very ably touched on the point of the necessity of combining storage with extra Kharif supplies.

DR. **E. McKenzie Taylor** said that the Author suggested an important change in the agricultural system of the Punjab, advocating a much higher intensity of Kharif cultivation. At present, in some of the canal colony areas the Kharif cultivation already amounted to 38 per cent. of the culturable area. If this was increased still further it would result in the reduction in the summer fallow area which might have an important influence on soil fertility.

The Author had given the food values of certain food grains and suggested that as maize had a higher feeding value than wheat, it could take the place now occupied by wheat in the food of the zemindars. It was generally accepted that wheat represented a higher standard of living than maize. If this was the case, then "food value" as determined by chemical analysis was not the only criterion of suitability. An examination of the suggested change from the medical point of view would be of considerable interest.

DR. Taylor continued by saying that the Author laid stress on the need for a leguminous crop in order to maintain soil fertility. The essential need at present was the discovery of a leguminous crop that would pay for the growing during the Kharif period when the water supply was at a maximum. As an alternative, a non-revenue earning leguminous crop would be of considerable value in increasing soil fertility. For such a crop to be grown, concessions regarding water rates would have to be given.

MR. **M. D. Mithal** said that the previous speaker had covered practically all the ground that he would have liked to traverse but he would like to emphasize the past diet of the Punjabi. This used to be "Sit Rabri." Being a resident of U. P., the speaker said he did not have any practical experience of this, but he was told that this dish was prepared from butter, milk and the flour of 'bajra' and used to form the entire two or three meals of the family. Why was it, he asked, that 'Sit Rabri' had been lost to the Punjab irretrievably? It was because people became prosperous due to the advent of the canals and began to take wheat instead of the diet of their ancestors. Was wheat not a very bad diet? About it, there is a saying in the U. P. that one must possess the liver and other digestive appendages of steel to digest wheat. But this was only a saying and would not be supported by medicos. The proverb meant that people who took wheat took to luxuries easily and without compunction.

The speaker thought that if Mr. Roberts wanted the Punjabis to give up luxuries and as a result all the trade in these commodities he was welcome to advocate against the luxury-mentality producing wheat.

As soon as people followed the advice of Mr. Roberts they would hail him as a "Gandhi of the Punjab."

Wheat would then be hidden in odd corners as a memento of by-gone days by the present-day addicts or taken only in secret.

The **Author**, in replying to the discussion, said that he was very grateful for the kind reception given to the Paper and particularly to those who spoke. He realized the practical difficulties involved, but his object was to get the younger Engineers, particularly, to try to look at their problems from new angles.

Replying to Mr. Kanwar Sain, he said that as custodians of the water handled in the Canals, the Irrigation Department was responsible for seeing that its use gave the greatest possible return by way of crops for the Province. If this was admitted, the ways and means of securing this end and benefiting the greatest number of people could be gradually worked out.

Regarding the late Mr. Owen Robert's minute, the divorce of land revenue assessment from water rates had had in the past a tendency to make the Irrigation Office uninterested in the class of land on which the water was used. The late Mr. Owen Roberts was concerned with a chess board distribution only, but that was wrong. The extract from the Abiana Report was otherwise irrelevant, as it dealt with the existing practice only.

It was correct that higher water rates tend to more water being diverted to better land, and less to the poor areas, but that would be a still more severe handicap for those who possessed land below the average margin of fertility.

As to cheaper grains the Author agreed with a good deal of what had been said but if they were going to have more Kharif water, they would have to grow more summer food crops; especially if the Punjab population was to reach. say, 40 millions. He agreed also that more cotton and oil-seeds could be grown; but he maintained that the human food laboratory at present worked in the least efficient season and with the least suitable crops.

The Author agreed with all that had been said by Mr. W. C. Chopra as there was really nothing contradictory to his thesis.

Replying to Mr. Som Nath, the author said that he was grateful for this very practical illustration of his thesis as shown on the Thrikhni Distributary. There were plenty of similar examples in the Nili Bar.

The Author also agreed with most of Rai Bahadur Sewak Ram's remarks, particularly as regards cotton. He thought that the latter crop would take care of itself when more water was available.

The Author, referring to the remarks by Dr. E. McKenzie Taylor, said that the experiment at Lyallpur which had been quoted by him in the introduction seemed to support his contention, This experiment was started about sixteen years ago.

He said that he had not suggested that Maize had a higher feeding value than Wheat ; the exact words used were " The food value of Bajra, Jowar, and other millets and Indian corns is only slightly inferior, if at all, to that of wheat." The Chinese who are a virile and cheerful race subsist on summer grown crops.

The Author agreed to what had been said about the need of new leguminous crops.

The Author said that Mr. M. D. Mithal's was a fresh and humorous criticism with a lot of truth in it. As to the last paragraph, cotton also was not much used in the Punjab but it was the best paying crop at present. The world would look after any surplus.

1. The analysis of wheat on page 39 was wrongly quoted : the figures should be as follows :—

Description	Moisture.	Ether extract.	Soluable Carbohy-drates.	Albuminoids Nitrogen.	Albuminoids. Radio.	Food Units.
Mozaffarnagar white sofu ..	11·58	1·70	75·22	1·30	9·73	99·8

This did not affect the argument in the Paper.

2. The total of leguminous crops as given in the Season and Crop Reports was 7·8 %. There were besides, such crops as Guara mixed in Jowar, Senji, Berseem, Shaftal, etc., which could be estimated at 10 per cent. making a total for irrigated areas of 17·8 per cent.

For unirrigated areas the total of leguminous crops was 32 per cent. to 34 per cent. The older Agriculture of the non-irrigated areas had a better proportion of a leguminosae than the newer irrigated tracts.

3. On page 36 (c) the implements suggested only applied B.C.G.A. Farms, and might not be generally applicable.