TECHNOLOGY AND FARM SUPPLY BEHAVIOUR : A CASE STUDY OF WHEAT CULTIVATION · 1896—1933

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KISHORE JETHANANDANI

CENTRE FOR HISTORICAL STUDIES
SCHOOL OF SOCIAL SCIENCES
JAWAHARLAL NEHRU UNIVERSITY
NEW DELHI—110067
INDIA
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I, however, remain responsible for the conclusions drawn in this dissertation and for any errors.

KISHORE JETHANANDANI

JAWAHARLAL NEHRU UNIVERSITY
New Mehrauli Road : New Delhi-110067
Centre for Historical Studies
School of Social Sciences

Grams : JAYENU
Telephones : 652282
652114

January 5, 1985

CERTIFICATE

This is to certify that the dissertation entitled, "TECHNOLOGY AND FARM SUPPLY BEHAVIOUR: A CASE STUDY OF WHEAT CULTIVATION 1896-1933", submitted by MR. KISHORE JETHANANDANI for the award of MASTER OF PHILOSOPHY degree, has not been previously submitted for the award of any degree of this or any other University. This is his own work.

We recommend that the dissertation be placed before the examiners for evaluation.

(S. Bhattacharya)
Supervisor

(Suvira Jaiswal)
Chairperson

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CHAPTER I

INTRODUCTION

An attempt has been made in this work to study the influence of technical change on peasant supply decisions with special reference to wheat cultivation in India. This thesis is intended to be a small contribution to the larger concern with understanding the process of commercialisation of agriculture in India. An important analytical feature of our study is that we have tried to draw insights about the rationale of peasant economic behaviour in a capitalist or a market economy by comparing the impact of technical change on supply of wheat in India with that of other major wheat producing countries of the world.

In the discussions on commercialisation of agriculture in India, the question of rationality or irrationality of peasant economic behaviour has been a major concern for historians. Peasant behaviour is considered to be rational in an ideal sense, if it is governed by the profit motive. On the other hand, an irrational peasant behaviour, in an ideal sense, is governed by motives like family consumption, need for security, etc. Three major implications follow from the above mentioned definition of the rationality of the peasantry. Prices in different

regions of an economy would tend to equalise in a society where peasant behaviour is governed by the profit motive. Secondly, the supply of agricultural commodities will be positively correlated to fluctuations in relative prices. Conversely, the supply of agricultural commodities by irrational peasants is inversely related to fluctuations in relative prices. Finally, an agricultural economy which is governed by the profit motive would give rise to a class of rich peasantry which has the freedom to make economic choices and to profit from economic pressures and business fluctuations.[1]

The rational behaviour of peasants has interested historians for a number of reasons. The existence of rational peasants signifies a society subject to the compulsions of the market or the capitalist system while the

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1. Our understanding of rich peasantry is similar to that of Neil Charlesworth, 'Rich peasants and poor peasants in late Nineteenth Century Maharashtra' in Clive Dewey and A.C. Hopkins (ed) The Imperial Impact: Studies in the Economic History of Africa and India, The Athlone Press, 1978.

existence of irrational peasants is a mark of a more primitive or feudal times when a peasant produced for his own or his master's consumption requirements. In under-developed societies, the study of the rationality irrationality of peasants is a way of determining the extent of development of capitalism or commercialisation in such societies.

The production behaviour of the peasantry is also of practical interest to the extent that allocation of agricultural resources for production varies with the nature of motivation of a peasant. An irrational peasant is content to produce only as much as is required for his own subsistence requirements while a rational peasant also produces a surplus for sale in the market. A rational peasant, therefore, produces more, has larger requirements for manufactured commodities and he can show interest in growing non-foodgrain crops.

VIEWS ON COMMERCIALISATION OF AGRICULTURE IN INDIA

The debate on the commercialisation of agriculture in India has taken place at three different levels. At one level, the tendency towards commercialisation of agriculture has been shown in terms of equalisation of prices of agricultural commodities.[2] At this level of the discussion on commercialisation of agriculture in India, the concerned authors expect that the working of the profit mechanism would equalise prices in different regions of an economy. Classical economic theory predicts that traders would move goods from one place to another if opportunities for making profits exist. Traders will move goods from a place where prices are low to another where prices are higher. At the second level of the discussion on commercia-

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2. Contributions to the theme of equalisation of prices have been made by:

   (a) John Hurd II, "Railways and the Expansion of Markets in India, 1861-1921", Explorations in Economic History, Vol.XII, No. 3, July, 1975, pp. 263-288.

   (b) Michelle Burge McAlpin, "Price movements and Fluctuations in Economic Activity (1860-1947) in/Cambridge Economic History of India, Vol.II, Cambridge University Press, London, 1982. /Dharma Kumar (ed.)

lisation of agriculture in India, it is argued that the working of the profit mechanism will ensure that the supply of agricultural commodities will be positively correlated with fluctuations in relative prices. By implication, peasants will shift from the production of foodgrains to non-foodgrains if the price of the latter is more than the former.[3] At the third level of the discussion on commercialisation of agriculture in India, the working of the profit mechanism is expected to give rise to a class of rich peasants who sell a large proportion of their produce in the market. The rich peasantry does not utilise its surplus earnings for conspicuous consump-

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3. (a) Dharm Narain, The Impact of Price Movements on Areas under Selected Crops in India: 1900-1939 (Cambridge: Cambridge University Press, 1965).

   (b) Raj Krishna, "Farm Supply Response in India-Pakistan - A Case Study of the Punjab Region," Economic Journal, LXXII, Sept. 1973, pp. 477-87.

   (c) Michele Burge McAlpin, op.cit., 1989.

tion but it invests in productive assets in order to realise higher incomes. The rise of the rich peasantry, theory predicts, will lead to concentration of land and other assets with this class and thereby create a class of landless peasants who sell their labour to the owners of capital.[4]

EVIDENCE ON COMMERCIALISATION OF AGRICULTURE IN INDIA

The quality of evidence used by scholars at each of these levels of discussion varies considerably. Hurd et al have shown, unambiguously, that price differentials between different regions of the national economy decreased with the expansion of railway mileage in India between 1861 and 1921. The work of these scholars has not been challenged so far. To be sure, Hurd admits that the prices determined at the local level may well have been different from those at the national level.[5] McAlpin's work, which

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4. Lenin, Development of Capitalism in Russia, Foreign Languages Publishing House, Moscow, 1956.

5. John Hurd II, 1975, op.cit., p. 265.

is complimentary to Hurd's study, shows the convergence of prices in India and the world economy with the decline in ocean freight rates.[6] McAlpin, thus, shows that rational profit maximising economic behaviour was as important in India as in the rest of the world economy. McAlpin's work, therefore, seriously questions the assumption that India was in some sense special and differentiated by its cultural traditions, past history etc.

At the second level of discussion, the conclusions drawn by Dharm Narain et al are more ambiguous. These scholars are able to show in some cases that the peasantry in India does respond positively to relative price fluctuations. On the other hand, non-price factors such as the spread of irrigation, railway transportation, rainfall and a host of other forces influenced the extent of monetisation and commercialisation of agriculture. These influences sometimes increased acreage under cultivation even when prices actually fell. The limited influence

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6. McAlpin, op.cit., 1982, p. 879.

that relative prices had on acreage expansion has been clearly recognised by McAlpin. She shows that the impact of relative price movements on acreage under cultivation is much less in the nineteenth century than in the early twentieth century[7] and is less for commodities like jowar and rice than for wheat and cotton.[8] We will discuss, in detail, the reasons for the varying price responsiveness of the peasantry later.

It is at the third level of the discussion on the commercialisation of agriculture in India that arguments put forth by scholars are clearly ambiguous. At this level of the discussion, the data is disaggregated and deals with numerous farm households. It is, therefore, understandable that the problems of definition and the validity of the evidence are far more at this level of the discussion. Even the Russian debate on the strati-

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7. Michele Burge McAlpin, "Railroads, Prices and Peasant Rationality 1860-1900", Journal of Economic History, April-June, 1974, pp 666-669

8. McAplin, op.cit., 1989, pp. 880-882.

fication, in the agrarian economy which has inspired the Indian discussion on the differentiation of the peasantry, was not conclusive in spite of the fact that statistical information in Russia in the late nineteenth century and early twentieth century is the richest available so far for any underdeveloped country.

Lenin used information on unequal distribution of property to show the tendency towards commercialisation in Russia.[9] He did not look at the time series data on distribution of sown land which would be necessary to show whether Russian agriculture was getting increasingly commercialised. In defense of his standpoint, Lenin also cited the importance of cash incomes and productive expenditures among richer households as an indicator of commercialisation of agriculture in Russia.[10]

Lenin's theory on differentiation of the peasantry

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9. V.I. Lenin, Ibid., pp. 50-134.

10. V.I. Lenin, Ibid., pp. 143-172.

was contested by Chayanov.[11] He questioned Lenin's contention that farm production, in Russia, was, in general, influenced by the profit motive. He pointed out that ninety percent of peasant households in Russia did not employ wage labour.[12] These households employed family labour and produced for self consumption. Since wage labour was not used by these peasant households, a commercial category like profit was meaningless. Differentiation in a peasant economy reflected the varying consumption requirements of farm households and the corresponding size of necessary sown land for meeting these needs.[13] Chayanov, to be sure, saw family farms only as a component of a larger capitalist economy[14] and did not altogether deny that the profit mechanism did play an important role in the working of the agricultural economy in Russia.

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11. A.V. Chayanov, "The Theory of Peasant Economy", The American Economic Association, Homewood, 1966.

12. A.V. Chayanov, Ibid., p. xiii.

13. A.V. Chayanov, Ibid., Chapter 1.

14. A.V. Chayanov, Ibid., Chapter 7.

Chayanov and Lenin represented two sharply opposed schools of thought and they did not engage in a dialogue so that the limitations of their ideas and empirical evidence were not identified. Lenin did recognise the fact that capitalist farmers were in a numerical minority in Russia but he emphasised more the amount of land cultivated by them. On the other hand, Chayanov was more concerned with the numerical strength of family farms and the logic of their operation at the level of each of these units. He was not concerned with the development of capitalist production in Russia at the national level as Lenin was. While Lenin did convincingly show the unequal distribution of wealth in Russia, he ignored time series data on distribution of wealth which would have to be analysed to validate the theoretical postulate that capitalist farming leads to increased differentiation of the peasantry. While Chayanov did show a strong positive correlation between family size and sown land, he was not able to altogether refute the possibility that household wealth as shown by size of sown land could influence family size.

Shanin who reviewed the Russian debate on the differentiation of the peasantry emphasised the long term

stability in the agricultural economy of Russia.[15] He identified both forces which lead to unequal distribution of wealth (centrifugal forces) as well as tendencies towards equalisation of the distribution of property (centripetal forces) in Russia. These two opposed tendencies formed a cyclical pattern of distribution of peasant wealth over time. Shanin found that a peasant household could improve its status by merger or by utilising its surplus to invest in new assets. On the other hand, the status of a peasant household could decline as a result of partitioning of land.[16] Migration was another factor which lead to equalisation in the distribution of property.[17] While Shanin is able to explain the multi-directional mobility of the peasantry, he was not able to draw any conclusions about the long term direction of distribution of property.[18]

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15. Teodor Shanin, The Awkward Class , Oxford University Press, London, 1972.

16. Shanin, Ibid., pp. 85-88.

17. Shanin, Ibid., pp. 92-95.

18. Shanin, Ibid., pp. 96-101.

The Russian debate on the differentiation of the peasantry was inconclusive even though the data collected in Russia was quite extensive. The information available could yield contradictory results. Divergent theoretical conclusions were drawn by different participants in the debate on the differentiation of the peasantry. Till date, a consensus has not emerged on these issues.

The Indian discussion on the differentiation of the peasantry, in the late nineteenth century and early twentieth century, which was inspired by the Russian debate has also been as or more inconclusive as the latter. Indian data on land ownership suffers from serious errors. Land-ownership, for revenue purposes, was often recorded under different property rights i.e. ryotwari, zamindari, etc. When land was transferred to another person, the change in ownership often went unrecorded. Furthermore, landownership was often understated to save taxes. When Indian scholars use data made available from land revenue records, the unrecorded land transfers become a source of

error.[20] Land revenue records, moreover, do not provide information on sown land. The structure of operated holdings was often more unequal than that of owned land.[21]

Apart from the deficiencies of the available data, large variations in the structure of landholdings have been observed in India in different regions and over time. However, some Indian scholars seem to agree that commercialisation of agriculture in India did not lead to any marked increase in the inequality of ownership of wealth. These scholars feel that in some periods and some regions there was an increase in inequality although for the entire period of British rule in India as a whole there wasn't any drastic change in distribution of property.[22] However,

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20. Dharma Kumar, "Landownership and Inequality in Madras Presidency: 1853-54 to 1946-47", The Indian Economic & Social History Review, Vol. XII, No. 3, July-September, 1975, pp. 231-234.

21. Neeladri Bhattacharya, "The Logic of Tenancy Cultivation - Central and South-East Punjab, 1870-1935", The Indian Economic & Social History Review, Vol.XX, No. 2, April-June, 1983, pp. 134-136.

22. Some of the scholars who do not see any marked increase in inequality of landholdings are:

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a large body of evidence is available to demonstrate that a layer of rich peasantry did emerge in colonial India.[23] Punjab is often cited as an instance of the relative stability of the landholding structure in the colonial era. Kissinger has written an influential paper, inspired by Chayanov's ideas, to show the stability in distribution of wealth in Vilyatpur in Punjab.[24] On the other hand, there are other scholars who assert that the British land revenue policy lead to the domination of merchant capital, increasing inequality in the distribution of property and ~~th~~

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(i) Dharma Kumar, Ibid., pp. 224 to 261.

(ii) Eric Stokes, "The Structure of Landholdings in Uttar Pradesh 1860-1948", The Indian Economic & Social History Review, Vol.XII, No. 2, April-June, 1975.

23. Some studies which investigate the emergence of a rich peasantry are:

(i) Ravinder Kumar, Western India in the Nineteenth Century, Australian National University Press, Canberra, 1969.

(ii) Eric Stokes, op.cit.

(iii) Neil Charlesworth, op.cit.

24. Tom G. Kessinger, "The Peasant Farm in North India 1848-1968", Explorations in Economic History, Vol. XII, No. 3, July 1975, pp. 303-323.

the dispossession of the peasantry.[25] The scholars who emphasise overall equality or inequality of agricultural wealth seem to be in a minority. The larger majority of scholars, however, believe that the distribution of wealth in agrarian India in the colonial period passed through cyclical phases of increasing and decreasing inequality.[26]

To conclude the discussion on the emergence of the rich peasantry in colonial India and its implications for rational economic behaviour, we will say that the attempt to see reality at such a level of disaggregation necessarily involves formidable problems of interpretation of

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25. Some of the scholars who emphasise the domination of merchant capital and the dispossession of the peasantry are:

    (i) Satish Chandra Mishra, "Commercialisation, Peasant Differentiation and Merchant Capital in Late Nineteenth Century Bombay and Punjab", The Journal of Peasant Studies, Vol. X, No.1, Oct. 1982, pp. 3-51.

    (ii) Naved Hamid, "Dispossession and Differentiation of the Peasantry in the Punjab during Colonial Rule", The Journal of Peasant Studies, Vol. X, No. 1, Oct. 1982, pp. 52-72.

26. Neil Charlesworth, op.cit., pp. 92-93.

data. The disparate conclusions reached by different scholars who have studied different regions and time periods preclude the possibility of any generalisation about the trends in the distribution of property. In our thesis, therefore, we will not at this stage make any attempt to study the problem of commercialisation of agriculture at this level of disaggregation. Our study will be limited to the relationship between fluctuations in relative prices and the supply of farm produce.

CONSTRAINTS ON PROFIT MAXIMISING PEASANT RATIONALITY

We have already observed that some scholars have been able to show that the peasantry in India does take advantage of relative price fluctuations. However, the evidence is some times contradictory especially when non-price factors play an important role. This has often led to a situation where scholars argue opposed positions without reaching a consensus.[27] However, a careful study

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27. Dharm Narain, op.cit., 1965 and Raj Krishna, op.cit., 1963 have presented evidence to show that the peasantry in India does behave rationally. The scholars

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of the work of these scholars shows that there is only a small margin of difference in their positions. Raj Krishna, for example, who has empirically demonstrated the rationality of peasant behaviour shows that the price elasticity of acreage brought under cultivation is positive but these magnitudes are small.[28] On the other hand, Neale who argues a case diametrically opposed to that of Raj Krishna admits that ".... it is not intended to imply that there are no market oriented reactions among the

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who have argued opposed positions are Walter C. Neale "Economic Accounting and Family Farming in India", Economic Development and Cultural Change, Part I, April 1959, pp. 297-98 and Michael Lipton "The Theory of the Optimising Peasant", The Journal of Development Studies, April, 1968.

28. Raj Krishna, op.cit., 1963, p..486. Barley and Gram acreage shows a negative price elasticity while all other crops studied showed a positive relationship. All other crops studied showed small positive short run price elasticity of acreage ranged from 0.1 in the case of wheat and bajra to medium figures of 0.2 to 0.4 in the case of maize and sugarcane and 0.6 for rice, while for cotton the figure was 0.7. The corresponding long run elasticity ranged from 0.15 to 1.6 and it was only for cotton that price elasticity of acreage is more than unity.

Indian peasantry or that they pay no attention to prices. They do when the prices are meaningful or when the opportunities are clear. These are areas where adjustment to the money economy is great."[29]

Scholars, on both sides, do notice the paradox that the peasantry can behave both rationally or irrationally but they do not make an attempt to understand this phenomena. It is indeed a curious paradox that these two groups of scholars argue contradictory positions even though the area of differences between them is very small. When one looks at economic reality in an "either/or" dichotomy, one will notice either rational or irrational behaviour among the peasantry. We expect that our comparisons between India and major wheat producing countries would show similar mix of rational/irrational behaviour in all countries. The point that we are making is not entirely original and has been made by Kula.[30] He writes: "The

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29. W.C. Neale, op.cit., 1959, p. 293.

30. Witold Kula, "An Economic Theory of the Feudal System", New Left Books, 1976, London, pp. 165-75.

question of the possibility or impossibility of rational economic activity is a matter of degree, not of absolute alternatives. Every economic activity is traditional to a certain extent and rational to a certain extent. In the course of economic development, we observe an increase in rationality".[31] Kula adds that "the disagreements among scholars often come down to the fact that some placed their emphasis on one line of argument, others on the other".[32]

A review of the existing studies on peasant rationality shows that there is an implicit acceptance of the fact that the profit maximising impulse of farmers is limited by non-price constraints. When these non-price constraints are removed, the peasantry does show more rational behaviour. Dharm Narain, for example, observes in the case of wheat cultivation in United Provinces, "This stimulus to expansion (of wheat cultivation) lay in the profitable character of the wheat crop. But the assertion of its profitability waited on the emergence of

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31. Witold Kula, op.cit., p. 167.

32. Witold Kula, op.cit., p. 167.

forces (such as foreign trade, development of transport etc.) that led to the monetisation and commercialisation of agriculture. They brought, as it were, latent possibilities within the reach of the farmer and egged him to their realisation"[33] (emphasis added).

McAlpin makes an explicit recognition of the influence of non-price factors especially the expansion of railways in India.[34] She explains the divergent response to fluctuations of relative prices in terms of a commodity's market structure i.e. the extent of trade (national and international) which was low in the case of Jowar and rice and high in the case of wheat and cotton. Since the peasantry had a wider choice of markets in wheat and more so in cotton, it was able to respond positively to market incentives while the opposite was true for jowar and rice. A related aspect was the influence of railway expansion in India. As long as the spread of railways was limited in India, the range of

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33. Dharm Narain, op.cit., p. 150.

34. McAlpin, op.cit., pp. 884-885.

choices that the peasantry had to sell its product was limited. Furthermore, in the absence of railways, farmers had to produce and store grain to provide for bad harvests so that their ability to grow more profitable crops was limited. When it became possible to obtain grain from a wider range of markets with the expansion of railways, the peasantry could grow more of profitable crops. In other words, the rational behaviour of the peasantry was restricted by the extent of development of railways.

Logically, it is possible to argue that the extent of development of railways is not the only possible constraint on the rational behaviour of the peasantry. It is also possible that the technical means available with farmers can limit the rational behaviour among the peasants in an under-developed economy. Kula agrees with us when he says "Economic activity is more rational, the broader the range of theoretically known and actually practicable alternatives among which a choice can be made. The relative range of alternatives depends on social phenomena, on interdependent factors such as the development of scientific

knowledge and society's elasticity (its capacity to absorb innovations). Neither of these factors is ever equal to zero, nor are they ever limited".[35]

In fact, it can be logically shown that technological development and rationality are two inseparable concepts. The rational behaviour of the peasantry can be looked at in terms of the following scheme:

$$GI - (ME + WC) \geqslant C. \frac{a}{100}$$

Where
- GI = Gross Income or Gross Product X Price
- ME = Expenditure on Materials used
- WC = Wage Costs
- C = Constant and circulating capital
- a = Total amount of interest paid

The level of technical development will determine the productivity and the gross product when the availability of inputs is constant. If the availability of inputs is restricted, the ability of the peasantry to respond rationally

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35. Kula, op.cit., 1976, p. 167.

would depend on productivity or the level of development of the relevant technology. Technical change can improve the quality of the output produced by farmers and this would allow them to sell their commodities at a premium. If the market desires products of a certain type or of a certain quality only, then farmers who are not able to grow that product would not be in a position to take advantage of market opportunities. Where farmers are able to sell a commodity of a relatively poorer quality, they can do so at prices lower than the average in the market and this can limit their rational behaviour. The prices that farmers receive for their produce depends on the time when they sell. Where storage capacity is limited, farmers can sell only when prices are low in a season. Technical development, in the form of bulk handling facilities for storage and movement of grains, can increase the prices received by farmers. Finally, profitability of farm production can increase if the costs of production are reduced by technical change. We can already see that low productivity, poor quality of output and high costs of production can act as a constraint on a farmer's ability to respond rationally to market opportunities.

Schultz has also posed the problem of peasant rationality in a way that is similar to our formulation.[36] For him, the question of the rationality of the peasantry is not limited to the choices farmers can make in response to relative price changes. Rationality also involves a choice between different levels of permanent incomes. Increase in income requires the use of new factors of production which are more productive i.e. technically superior and profitable.[37] To the extent that the use of new factors of production involve costs, a rational choice in favour of new factors of production would require an evaluation of costs and expected benefits. Schultz finds that the peasantry in under-developed countries does use existing

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36. Theodore W. Schultz, Transforming Traditional Agriculture , Yale University Press, New Haven and London, 1964.

37. Schultz writes "Suppose there were some reproducible factors of production in other communities that differ from the traditional factors on which a particular community is dependent and that these differences make them both more productive and profitable. Why is it that farm people now dependent upon traditional agriculture do not take advantage of these more productive and more profitable factors?", op.cit., p. 34.

factors of production efficiently but it remains poor.[38] The peasantry continues to use primitive technology which yields low incomes and profits. To this extent, farmers in under-developed countries do seem to show irrational behaviour. If peasants show an irrational behaviour, this is because they are not able to bear the high costs of development of new technology.

In our thesis, we make a distinction between incremental technical change which improves the functioning of existing factors of production and new techniques of production.[39] For example, ploughing methods can be improved either by replacement of a wooden plough by a tractor or by substitution of a wooden plough by an iron plough. Insofar as increased productivity depends both on technical advances and on their absorption by a society, both incremental change and new technical developments are important. It can be readily imagined that progress

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38. Schultz, op.cit., 1964, pp. 36-52.

39. For a lucid discussion on types of technical changes see Nathan Rosenberg "Inside the Black Box: Technology and Economics", Cambridge University Press, Cambridge, 1982, Chapter I.

from the use of wooden plough to an iron plough will be more easily absorbed in traditional agriculture than an advance from a wooden plough to a tractor. We will, therefore, consider both these types of technical changes in our thesis.

In the case of the wheat economy, we will consider three different types of technical changes. In the area of utilisation of wheat, we will consider the influence of changes in milling and baking technology on the acreage brought under cultivation in major wheat producing countries of the world. Milling technology changed in this period wherein roller milling replaced stone milling. Baking technology changed as a result of the use of electrical motors for mixing of water in flour. Secondly, we will investigate the influence improved wheat seeds, developed by agricultural experimental stations, had on prices received by farmers and acreage brought under cultivation. Finally, we will study the influence bulk handling facilities in the form of elevators had on the prices received by farmers and the seasonal supply of wheat.

We have compared, wherever it has been possible, the peasant economic behaviour in different countries for we feel that international comparisons can yield an insight which an exclusive emphasis on a particular country will not. When we make international comparisons, we begin with the assumption that specificity is a relative notion which can be defined only when we compare. When specificity of a country is defined without making international comparisons, it is probably assumed.

The period, we have chosen for our study, is one in which an integrated world wheat economy was formed with its centre in Great Britain. We will see later that the prices in Great Britain in this period, exerted a powerful influence on the supply decisions of wheat farmers all over the world. By the late 1890s, ocean freight rates fell to their lowest level. Thus, the cost of transporting a ton of wheat from Calcutta to London from £ 2-7-6 to £ 3 in 1873 to £ 0-7-6 to £ 0-12-6 in 1897.[40] Low transport costs made wheat, supplied from distant sources, attractive to European countries. However, by the early 30s the world wheat economy had disintegrated. Our study covers the period from the initial formation of the world wheat economy to the time when it disintegrated

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40. McAlpin, Op.cit., 1982, p 889

CHAPTER - II

THE IMPACT OF TECHNICAL CHANGE IN MILLING AND BAKING ON REGIONAL DISTRIBUTION OF WORLD WHEAT ACREAGE

In this chapter, we will explore the influence technical change in the milling of wheat and in bread making had on the demand for wheat and the sources of its supply from different regions of the world. In Section I, we will describe the technical changes which took place in the methods of milling of wheat and in baking in the last decades of the nineteenth century and in the early twentieth century. We will also discuss the impact these technical changes had on the demand for wheat. In Section II, we will discuss the kind of ideal climatic conditions under which the varieties of wheat, in greater demand in the world market, could be grown. In Section III, we will analyse the impact changes in milling and baking technology had on the regional distribution of world acreage. In Section IV, we will explain why India could not increase its share of world wheat acreage and take advantage of trade opportunities available in the world wheat market.

I. TECHNICAL CHANGES IN MILLING AND BAKING

Milling of wheat essentially involves the separation of flour cont ined inside the kernel of the grain in the endosperm and the skin or bran that covers

it. In the first stage, the skin on the berry of the grain is removed so that the endosperm is separated. Thereafter, the endosperm inside the berry is reduced to extract flour. While the endosperm contains the white flour, the protein content of the wheat, which determines its strength and capacity to absorb water, lies close to the skin. In the process of milling, the protein that lies close to the skin can be lost as the bran is removed. Improvements in milling technology have sought to separate the skin from the inner germ in such a way that the loss of protein is reduced.

Beginning from the 1880s, the process of milling of wheat improved with increasing use of roller milling. In stone milling, which was widely used till 1875[1], only two stages were involved in the milling of wheat. In the first stage, wheat was reduced to flour by passing it between two stones. Thereafter, the milled product was bolted i.e. shaken inside a bag by a machine so that the flour was separated from undesirable material like bran. In the process of passing wheat through a group of stones, some bran was invariably pulverised so

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1. Peter Tracy Dondlinger: "The Book of Wheat - An Economic History and Practical Manual of the Wheat Industry" Kegan Paul, Trench, Trubner and Co., Ltd. London, 1988, pg. 208.
For a discussion on changes in milling and baking technology, also see Alfred Mark Carleton 'Hard Wheats Winning Their Way', USDA Year Book, 1914. pp 391-340 and also Carl. L. Alsberg The Objectives of Wheat Breeding in Wheat Studies, Vol. IV, No.7, June, 1928.

that it could not be separated from flour. Moreover, protein rich content of wheat could not be retained in the flour because it was lost as the bran was removed. Roller milling introduced a larger number of stages in the process of extraction of flour. In the first major process involved in this process of milling, wheat was cleaned so that it was free from all dust and foreign matter mixed with it. In the second stage, the grain was tempered i.e. the berry was toughened so that the skin could flake out easily in one large piece when grinding took place and a large portion of flour inside could be extracted. In the third stage, wheat was milled by passing the berry through steel rolls and not stones. These rolls did not crush the berry but ruptured and flattened it so that the portion inside the skin called 'middlings' could be drawn out in large pieces. The 'middlings' were passed through a purifier to remove bran or any other cellulose material present in the interior of the berry. Thereafter, the middlings were again crushed and purified several times to extract flour. Since wheat was gradually reduced to flour in several stages by the process of roller milling, less protein was lost in the process of separation of the skin from the flour inside.

The first roller mill was erected in Budapest, around 1870s, and for years the mills of this city produced a large proportion of world's flour. In Great Britain, the first roller mill was installed in 1878. It was only by the middle 80s that a respectable number of roller mills were installed. These types of mills numbered 400 to 500 in 1891, 664 in 1893 and in 1908, they were 900 in number.[2]

Technical changes in baking seek to increase the water absorbed by flour. The size of the bread, a baker can produce, depends on the quantity of water absorbed by flour. Bakers, in this period, began using more of mechanical high speed mixers for kneading dough which absorbed more water than was possible with earlier methods of baking. This was facilitated by an increasing use of electrical motors in the mixing of water in flour. The new mechanical method of kneading exerted a more severe strain upon the elastic properties of dough than hand kneading. The stronger hard varieties of wheat could withstand greater stress than what the soft varieties of wheat could.[3]

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2. Dondlinger, op. cit., p . 28.

3. Discussion on baking is based on Alsberg, op.cit., 1928, pg. 275.

The changes in both milling and baking technology increased the demand for protein rich hard varieties of wheat. The protein content of flour determines its strength and its ability to absorb water. The capacity of protein to absorb water is high because it contains a substance called gluten which has a very high capacity to absorb water.[4] Since flour from hard varieties had a higher protein content, these varieties became more popular with bakers in this period.[5] Because roller milling reduced the loss of protein, greater use of harder varieties became possible.

Since harder varieties were preferred by bakers, the value of these varieties of wheat in the chief wheat market of the world, Great Britain, also increased. A survey of price spreads of wheats in the London market, received from different regions of the world, showed that Canadian wheats, which were richest in protein content, obtained the highest price. European wheats, which were soft, were the lowest priced in the

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4. Carl L. Alsberg, "Starch and Flour Quality" Wheat Studies, Vol. XI, No. 6, Feb. 1935, pp. 232-235.

5. Carl L. Alsberg. "Protein Content: A Neglected Factor in Wheat Grades", Wheat Studies, Vol. II No. 4, Feb. 1926.

London Market. From among the Canadian varieties of wheat the No. 1 Manitobo wheat, known for its high protein content, was consistently the highest priced wheat variety for nearly ten years.[6]

While harder varieties of wheat were preferred for making bread, this was not true for other uses of wheat. Wheat, in this period, could also be used for making cakes, crackers, biscuits and alimentary pastes of the macaroni and spaghetti types as well as of noodle types. For such uses of wheat, soft varieties of wheat were more suitable. Changes in milling and baking technolology affected only the demand for wheat required for making bread.

II. THE INFLUENCE OF CLIMATIC FACTORS ON THE CULTIVATION OF HARD VARIETIES OF WHEAT

The regions which had short growing seasons were ideally suited for the cultivation of hard varieties of wheat. Shorter growing seasons encouraged the growth of wheat which had high protein content and lower yields while longer growing seasons could yield

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6. Alozo E. Taylor: "Spreads Between Wheat Prices in England", Wheat Studies, Vol. XI, No. 8, pg. 315-317.

higher quantity of wheat per acre cultivated while the quality of wheat was poorer. Scientific experiments carried out by Lawes and Gilbert (1984)[7] with wheat had shown the increase in the weight of wheat is accounted for by an increase in starch content which is deposited in the grain later in the season. On the other hand, increase in protein content of wheat plant takes place only in the early stages of the formation of the wheat plant. The data on the inverse relationship between the protein content and starch or carbohydrates at various stages of the development of a wheat plant in a season is given in Appendix I. In the same series of experiments, it was shown that the yield of wheat decreases as the nitrogen or protein content increases. The data on the inverse relationship between yield and the quality of wheat is given in Appendix II. Therefore, the regions which had short growing seasons grew wheat of a high quality while the per acre yield was relatively less compared to countries where growing seasons were longer.

Climatic factors such as moisture and temperature influence the length of the growing season particularly

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7. Quoted in C.O. Swanson: Wheat and Flour Quality Burgess Publishing Co., Minneapolis, 1936, pg.83-84.

at a time when the kernel is developing. A moderately cool season with a liberal supply of moisture has the effect of prolonging the period during which the kernal is developing. On the other hand, a hot dry season shortens the period of kernel development. Climatic factors especially in Canada favoured short growing seasons and the cultivation of wheat with high protein content.[8] The length of the growing seasons were especially short in Canada followed by United States, Russia, Australia, and Argentina and India. On the other hand, seasons were longer in Europe.

The optimum range of precipitation, to get high yields of wheat although poorer in quality was estimated at 25-35 inches per annum and the corresponding pre-harvest rain-fall was 4-6 inches. Better quality of wheat could be grown in regions where rain-fall was less than this optimum. The optimum annual temperature was generally estimated at 12-16°F below the pre-harvest average. The optimum pre-harvest temperatures were estimated to be 58°F-60°F.[9]

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8. W.P.Rutter: Wheat Growing in Canada, the United States and the Argentina , Adam and Charles Black 1911, London.

9. M.K.Benett and Helene C. Farnsworth: "World Wheat Acreages, Yields and Climates", Wheat Studies Vol. XIII, No.6, March, 1937.

Better quality of wheat could be grown in regions where the temperatures were above the optimum. Canada, U.S.A., Argentina, Russia, Australia and India grew wheat in conditions where either the rainfall was less than optimum or temperatures were more than optimum or both. On the other hand, wheat in Europe was grown in conditions where rainfall was more than optimum while the temperature was less than optimum (Table 2).

Climatic conditions, therefore, favoured the cultivation of hard varieties of wheat in Canada, U.S.A., Russia, Australia, Argentina and India while in Europe only soft varieties of wheat could be grown.

III. REGIONAL DISTRIBUTION OF WORLD WHEAT ACREAGE

In the period between 1896-1933, British wheat import price were "world prices" and Great Britain served as the largest distributional centre for international wheat trade. The demand for wheat in the British market and the movement of prices in this market exerted a powerful influence on the production decisions of wheat cultivators of the entire world.[10] To this

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10. Wilfred Malenbaum: The World Wheat Economy-1885-1939 Harvard University Press, Cambridge, Massachusetts, 1953. pg. 104.

extent, the producers of wheat in this period were influenced by a single "world price"[11] determined in the British wheat market. However, we do recognise that markets are fragmented and the perception of the boundaries of markets depend on information available with individuals. For a farmer, who sells in a village or nearest town and in familiar with prices in these markets, the market is the village or the town market. A trader, who buys from a local town and sells in a port city or elsewhere in a country and knows the prices in these markets, the market is a national market. Finally, a London grain broker, who, is familiar with prices all over the world, the market is a world market.

Malenbaum has already shown that both the short run and long run price movements in the British wheat market were positively correlated with acreage brought under the cultivation of wheat in various parts of the world. Moreover, in the entire period from 1896 to

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11. "World Price" is a concept rather an actuality. There are many different wheat prices simultaneously throughout the world, each approximate to the particular location. Because of importance of British trade in wheat, the average parcel price for any period is probably the nearest actual approximation to the world price concept (See M.K.Bennett: "British Parcel Prices" Wheat Studies, Vol. IV, No. 8, July, 1928.

1933, the exporting countries i.e. Canada, Australia, United States, Argentina, India and Russia increased their acreage under cultivation at the rate of 1.8 million acres per annum while the importing countries in Europe saw a decline in the acreage brought under wheat cultivation.[12] The expansion of wheat acreage in Canada and other places, Malenbaum explains, was due to the availability of new lands which could be cultivated at low cost. However, he admits that comparable cost data across countries is more often than not inadequate, unreliable and incomplete. The data he does cite refer to individual years and those show that the cost of production in importing countries was higher than in exporting countries.[13] The data cited does not compare the prices of individual varieties of wheat and the corresponding cost of production. Malenbaum also does not attempt to explain why the increased mechanisation of European agriculture and the protectionist measures taken in the period after the war were not able to stop the inflow the imports, especially Canadian imports, throughout this period. Finally, cost comparisons would be relevant if European

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12. Malenbaum, Op.cit, Chapters 7 and 8.

13. Malenbaum, Op.cit. Pg. 155.

countries and the exporting countries produced wheat which was technically equally desirable for baking purposes. We will see later that the varieties of wheat produced by exporting countries were qualitatively different from those produced by importing countries.

We will now make a detailed review of the participation of major producers of wheat in the world wheat economy. We have calculated the shares of acreage of individual countries in the total wheat acreage.[14] (See Table I). Data shows that Russia, Canada, Argentina, Australia increased their share of acreage in the total world wheat acreage while France, Italy and Germany witnessed a decline in their share of world wheat acreage. The share of U.S.A. was irregular; it declined till 1912, increased to its previous level by 1922 and declined again. However, USA's share in world wheat acreage was very high. India's share in world wheat acreage was constant throughout this period. British Isles and other North-Western European countries had very low shares which remained more or less constant

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14. The shares of acreages of various countries have been calculated from the data collected and published by M.K.Bennett, World Wheat Crops 1885-1931, Wheat Studies, Vol. XI, No. 7, April 1933.

The share of "all other countries" was small and shows an irregular trend which declined for a short period between 1912 and 1920 and was restored to its original level by the late 1920s and early 1930s. Russia's share in the total world wheat acreage increased rapidly from 22.64% to 30.05% between 1895 and 1914. Thereafter,, the participation of Russia in the world's wheat economy declined as a result of the war and economic dislocation caused by civil war. Participation of Canada in the world's wheat economy did not show significant increases till 1905 after which its share increased from 1.98% in 1905 to 8.4% in 1922 after which it declined somewhat. Increase of Argentina's wheat acreage was also significant and it increased from 2.63% in 1895 to a peak of 7.37% in 1928. Australia's share in the world's sheat acreage increased only in the post-war period when it rose from 2.30% in 1919 to 5.56% in 1930. By contrast, France's share in world's acreage declined from 8.28% in 1895 to 4.04% in 1930. In the same period, Italy's share declined from 5.40% in 1896 to 3.65% in 1930 and Germany's share declined from 2.26% in 1895 to 1.25% in 1929. British and other North-Western European countries had very low shares which did not change much in this period. The share of acreage brought under wheat cultivation in USA showed an irregular behaviour wherein

it declined from 24.12% of total world wheat acreage in 1897 to 16.83% in 1912 after which its share rose 24.47% in 1922 and fell again to 18.71% by 1930. India was the only major wheat producer in this period whose share in world's wheat acreage remained constant. It s share declined from 13.52% in 1897 to 11.32% in 1896 and remained at more or less at this level throughout this period except for periodic fluctuations. These fluctuations in acreage under wheat cultivation were small and regular which suggests that these variations were not rooted in long term causes.

Some characteristic features distinguished the regions where wheat acreage increased as well as others where it did not. Acreage under wheat cultivation increased in regions where the per acre yield of wheat was lower compared to areas where the share of wheat acreage was either stagnant or declined. Thus, 59% of the world's acreage was in regions where the yield rate was in the range of 10-12 bushels per acre, 24% in regions where the per acre yield was in the range of 16-18 bushels per acre, 3% in regions where yield rates were less than 10 bushels per acre, 7% in regions where yields were between 13-15 bushels per acre and only 7% in areas where yield was 19 bushels per acre or more.[15]

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15. M.K.Bennett and Helene C. Farnsworth: "World Wheat Acreage, Yields and Climates", Wheat Studies, Vol. XIII, No. 6, March 1937, pg. 270-272.

Moreover, the regions where the share of wheat acreage increased were also the areas where rainfall was meagre as compared to those areas where the share of acreage declined. More than half the world's wheat acreage increased in regions where annual rainfall averaged between 15-25 inches of which only 10% of the acreage was in the regions where annual precipitation was less than 15 inches and these regions were supplied water by artificial irrigation. Nearly three fourths of the area under wheat cultivation was in regions where annual rainfall was within the range of 15-35 inches, 15% was in zones where rainfall was more than 35 inches and 10% where rainfall was lower than 15 inches.[16]

It is indeed a curious paradox that expansion of wheat acreage, in this period, took place in dry regions where farmers could get only lower yields as compared to European countries which imported wheat. Why did the expansion of wheat acreage take place in regions where the conditions of cultivation were difficult?

We have already seen that changes in milling and baking technology shifted the demand from soft varieties of wheat to hard varieties of wheat. These types of

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16. Beneett and Farnsworth, Op.cit., 1937, pp 272-273.

wheat contained more protein which has a higher capacity to absorb water and to produce larger size loaves of bread. That better quality of wheat could be grown in climatic conditions where the per acre yield was low. In this perspective, it can be seen why acreage expansion took place in regions where rainfall was meagre and per acre yield of wheat was low. These regions, where expansion of wheat acreage took place, could cultivate better quality of wheat which was favoured in the British wheat market. Data on the quality of wheat supplied from various wheat producing countries of the world is indicated in Table 3.[17]

The only exception to this pattern of acreage expansion in dry regions was India where acreage under wheat cultivation remained constant. In India, the seasons were short and the climate in wheat growing areas was dry. In spite of the fact that India was endowed with climatic conditions to grow hard varieties of wheat and to take advantages of trade opportunities in Great Britain, this country was unable to increase its share

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17. Data on milling and baking quality of world's wheat has been obtained from D.A.Coleman: "Milling and Baking Qualities of World Wheat", United States Department of Agriculture, Technical Bulletin No. 197, 1928. The table provides information on the protein content of wheat, from various countries, and the size of bread produced from the flour extracted from them.

of wheat acreage in the total world wheat acreage. We will see, in the next chapter, that the share of acreage under the cultivation of hard varieties of wheat in India was very small.

IV. INDIA AND THE WORLD WHEAT ECONOMY

The main reason why India could not take advantage of opportunities for trade created in the Great Britain market was that it was not able to change over to the cultivation of hard varieties of wheat. India continued to supply soft varieties of wheat. In the Great Britain market, Indian wheat was found useful to mix with the more moist varieties of wheat supplied by English farms or by Russia. Moreover, Indian wheats could be used for biscuit making in which soft varieties of wheat were more useful.[18] Soft varieties of wheat were grown in India in spite of the fact that climatic conditions were suited for cultivation of hard varieties. In fact, Marquis (the variety which played a major role in expansion of wheat cultivation in Canada) was discovered in India and taken for cultivation to Canada.[19]

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18. C.P.Wright: "India as Producer and Exporter of Wheat", Wheat Studies, Vol. III, No. 8, July 1927.

19. C.P.Wright: Op.cit., 1927.

It has often asserted that the widespread cultivation of soft varieties of wheat in India in this period was due to the recommendations of a British flour milling firm, the McDougall Brothers.[20] This firm was entrusted with the responsibility of finding out the quality of Indian wheat. On the basis of tests carried out by this firm, the cultivation of soft varieties was recommended in India. Howard , the botanical specialist in the Pusa Institute had the view that the Indian climatic conditions were ideal for cultivation of hard varieties and in some parts of India very high quality of wheat was grown. He, therefore, felt that the recommendations of McDoughll Brothers were wrong.

While it is true that the early milling and baking tests of Indian wheats held a poor view of the quality of Indian wheats, this was not true of the later tests undertaken of especially Pusa varieties of wheat. Tests undertaken by Mr A.E. H mphries in 1908 for example found that the Pusa 6 variety of wheat was of a good quality.[21] Still later, in 1911, Pusa 12

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20. For the most influential exponent of this view point, Albert Howard, "The Milling and Baking Qualities of Indian Wheats", Agricultural Research Institute, Pusa, Bulletin No. 14,17 & 22.

21. Albert Howard and G.L.C. Howard: "The varietal characters of Indian wheats", Memoirs of the Department of Agriculture in India (Botanical Series) Vol. II, No. 7, May 1909, pg.45.

was also found to be a satisfactory variety of wheat.[22] Hence, we cannot conclude that the English millers had consistently made a mistake in recommending the cultivation of any particular variety of wheat.

The availability of a particular seed variety and the existence of suitable climatic conditions for its cultivation does not guarantee that it will be grown in a country. A variety of wheat must be grown on a large scale before it becomes commercially acceptable. If soft varieties of wheat were preferred by exporters in India, this may be because wheat produced from these varieties was available in larger quantities. Explaining his reason for preference for soft varieties, a trader said in 1906: "The reason why we pay a better price for soft white wheat is that Great Britain and the North-European continent which take the bulk of Karachi wheat, generally prefer soft wheats. However, if purely hard wheat were produced in the Punjab in sufficiently large quantities to make it a merchantable description, and if the quality kept its characteristics from year to year and could be relied on to be matched at any time, an outlet for it could readily be found and possibly such wheat

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22. Albert Howard and H.M. Leake and G.L.C. Howard "The Influence of the environment on the milling and baking qualities of wheat in India" Memoirs of Dept. of Agriculture in India (Botanical Series Vol. V, No. 8, June 1912.

could command a premium. At present, purely hard wheat without an admixture of soft grain, reaches the Punjab markets in such small quantities that we are precluded from buying it on its own merits, and it has to be mixed in the so called soft description".[23]

The large scale cultivation of wheat in a country requires a seed variety which can be grown in varying climatic conditions of a country. In India, the environment especially the duration of the period of cultivation and availability of moisture varied a lot and a large number of wheat varieties were grown. Furthermore, the quality of wheat produced by a particular variety of wheat could change as a result of change in the environment in which it was grown.[24] Only some varieties had some inherent hereditary strength which allowed them to be grown under wide range of environmental conditions. However, these varieties had to be discovered by the selection process

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23. A.E.Anastasiades, Esq. Manager of M/s. Ralli Bros, Agency, Lyallpur, to the Imperial Economic Botanist, Pusa, dated Lyallpur, 12 May 1906 quoted in Howard and Howard Op.cit. 1909. See also Sir John Russell: Report on the work of the Imperial Council of Agricultural Research, in applying science to Crop production in India" Government of India Press, Simla, 1939.

24. Albert Howard, H.M. Leake, G.L.C. Howard, Op.cit. 1912, pp. 57 & 85.

undertaken by agricultural experiment stations. In the second chapter, we will discuss the limitations of the work done by agricultural experiment stations in India in this period. We will see that, in Indian conditions, there were several barriers to finding a variety of wheat which could be grown over large tracts of land.

CONCLUSION

In this chapter, we made an attempt to find the reason for the disparate rates of acreage to a common price signal in the British wheat market. We have shown that changes in milling and baking technology encouraged the cultivation of hard varieties of wheat. That these varieties were ideally grown in dry regions of the world where the growing seasons were short. The high protein content of hard varieties of wheat grown in these regions brought them relatively higher prices compared to soft varieties grown in Europe. It is for this reason that acreage under wheat cultivation increased in dry regions while it declined in Europe where the climate was cooler and wet.

India was unable to take advantage of the trade opportunities created in the British market because it was not able to produce wheat of good quality on a large scale. The cultivation of hard varieties of wheat over large tracts of land would have required the identification of a variety of wheat, by agricultural experiment stations, which could be grown under varying climatic conditions.

Table 1: Share of Production and Acreage of Individual Wheat Producing Countries in Total World Wheat Acreage 1895-1930. (Percentage)

	Russia		U.S.A.		Canada	
	Production	Acreage	Production	Acreage	Production	Acreage
1895	17.08	22.64	24.49	22.88	1.50	1.65
1896	17.52	24.22	23.21	23.23	1.25	1.70
1897	15.96	24.54	28.67	24.12	1.97	1.77
1898	16.283	23.37	26.17	22.62	1.99	1.73
1899	17.35	23.94	23.29	24.28	1.93	1.75
1900	17.27	25.70	23.39	24.07	2.03	1.86
1901	15.84	25.98	27.59	23.79	2.84	1.73
1902	20.97	26.75	22.90	22.04	2.90	1.72
1903	20.49	26.86	20.25	22.33	2.33	1.86
1904	22.97	27.33	18.07	19.37	2.14	1.84
1905	20.80	27.55	21.53	19.85	3.14	1.98
1906	16.07	28.14	21.77	19.28	3.59	2.44
1907	17.95	27.34	20.03	18.53	2.92	2.50
1908	19.79	28.05	20.64	19.19	3.54	2.71
1909	23.32	28.76	19.64	18.09	4.59	3.10
1910	23.32	29.44	18.40	17.68	3.68	3.34
1911	15.83	29.02	17.46	17.93	6.48	4.02
1912	20.89	28.60	19.04	16.83	5.84	4.04
1913	25.25	29.62	18.75	18.00	5.69	3.95
1914	23.04	30.05	24.62	19.16	4.45	3.68

Contd....

Table 1 (Contd....)

	Russia		U.S.A.		Canada	
	Production	Acreage	Production	Acreage	Production	Acreage
1915	19.32	26.40	23.97	20.69	9.19	5.16
1916	19.56	26.30	19.31	19.21	7.97	5.64
1917	18.69	27.06	19.56	17.19	7.18	5.62
1918	18.79	24.67	25.73	20.86	5.28	6.18
1919	18.49	24.42	27.94	26.47	5.67	6.87
1920	14.09	24.07	25.06	22.76	7.82	6.65
1921	8.44	19.46	24.19	24.17	8.88	8.70
1922	11.49	13.55	24.03	24.47	11.34	8.93
1923	10.85	16.69	19.75	21.89	12.33	8.43
1924	13.23	19.94	23.46	19.49	7.32	8.19
1925	19.19	22.40	16.41	18.60	9.70	7.38
1926	21.41	24.60	19.53	18.91	9.53	7.62
1927	18.03	24.98	20.09	19.23	11.02	7.24
1928	17.13	22.16	19.65	19.19	12.02	7.80
1929	16.93	23.37	19.83	19.94	7.43	8.03
1930	21.25	24.65	18.42	18.71	9.04	7.62

Table 1 (Contd...)

	Argentina		Australia		India	
	Production	Acreage	Production	Acreage	Production	Acreage
1895	1.69	2.63	0.67	1.67	9.56	13.52
1896	1.19	2.90	0.79	2.01	7.61	11.32
1897	2.23	3.01	1.18	2.04	8.37	9.63
1898	3.30	3.50	1.30	2.42	8.47	10.86
1899	3.47	3.45	1.36	2.41	8.71	10.92
1900	2.73	3.68	1.77	2.50	7.32	8.24
1901	1.87	3.50	1.28	2.20	8.81	10.26
1902	3.22	3.98	0.38	2.25	7.05	10.23
1903	3.85	4.51	2.20	2.35	8.84	9.89
1904	4.68	5.05	1.69	2.61	11.19	11.83
1905	3.99	5.62	2.02	2.45	8.38	11.41
1906	4.47	5.64	1.90	2.39	9.17	10.56
1907	6.05	5.83	1.40	2.20	9.97	11.97
1908	4.92	6.14	1.97	2.15	7.21	9.39
1909	3.61	5.78	2.49	2.64	7.86	10.52
1910	4.07	5.83	2.65	2.78	10.03	10.62
1911	4.67	6.17	2.01	2.69	10.55	11.07
1912	4.88	6.28	2.39	2.69	9.65	11.44
1913	2.57	5.89	2.53	3.33	9.04	10.78
1914	4.67	5.54	0.68	3.45	8.63	10.20

Contd...

Table 1 (Contd....)

	Argentina		Australia		India	
	Production	Acreage	Production	Acreage	Production	Acreage
1915	3.94	5.61	4.18	4.26	8.80	11.10
1916	2.54	5.91	4.62	4.23	9.80	11.93
1917	7.22	6.81	3.52	3.72	11.74	12.55
1918	5.02	5.98	2.11	2.81	10.34	12.50
1919	6.36	6.25	1.35	2.30	8.22	8.54
1920	4.64	5.47	4.33	3.30	11.23	10.92
1921	5.64	5.32	3.81	3.63	7.39	9.64
1922	5.55	6.47	3.10	3.88	10.41	11.24
1923	6.44	6.61	3.25	3.67	9.68	11.86
1924	5.33	6.60	4.59	4.01	10.07	11.57
1925	4.68	6.81	2.80	3.62	8.12	11.28
1926	5.39	6.41	3.76	3.89	7.60	10.14
1927	6.48	6.67	2.71	3.96	7.46	10.10
1928	7.40	7.37	3.38	4.80	6.17	10.41
1929	3.96	6.19	3.09	4.76	7.82	10.16
1930	4.99	6.51	4.59	5.56	6.39	9.33

Table 1 (Contd....)

	France		Italy		Germany	
	Production	Acreage	Production	Acreage	Production	Acreage
1895	12.43	8.23	5.31	5.39	4.26	2.26
1896	12.88	7.98	6.78	5.40	4.76	2.23
1897	10.13	7.62	4.48	5.43	5.01	2.22
1898	11.48	7.61	5.32	5.17	4.17	2.15
1899	12.48	7.38	5.80	5.06	4.82	2.14
1900	11.92	7.47	5.39	5.20	5.16	2.23
1901	10.35	7.22	6.04	5.12	3.05	1.68
1902	10.17	7.07	4.67	5.12	4.44	2.06
1903	10.79	6.77	6.04	5.06	3.88	1.89
1904	9.31	6.72	5.74	4.89	4.34	1.97
1905	9.91	6.45	5.23	4.71	4.02	1.90
1906	9.42	6.45	5.57	4.71	4.15	1.91
1907	11.99	6.66	6.15	4.31	4.02	1.77
1908	9.98	6.65	5.29	4.81	4.36	1.91
1909	9.90	6.53	5.24	4.66	3.80	1.81
1910	7.05	6.12	4.27	4.44	3.95	1.81
1911	9.05	5.76	5.40	4.25	4.19	1.76
1912	8.71	5.97	4.32	4.31	4.17	1.75
1913	7.84	5.79	5.27	4.20	4.20	1.75
1914	7.25	5.36	4.35	4.27	3.74	1.76

Contd....

Table 1 (Contd....)

	France		Italy		Germany	
	Production	Acreage	Production	Acreage	Production	Acreage
1915	5.20	4.62	3.98	4.27	3.31	1.69
1916	6.21	4.56	5.38	4.29	3.44	1.52
1917	4.14	3.94	4.30	4.00	2.57	1.42
1918	6.30	3.84	5.11	3.80	2.60	1.31
1919	5.49	4.17	4.98	3.80	2.31	1.15
1920	7.04	4.59	4.20	4.11	2.45	1.24
1921	9.55	4.97	5.69	4.40	3.18	1.33
1922	6.90	5.20	4.58	4.57	2.04	1.35
1923	7.16	5.25	5.84	4.44	2.76	1.40
1924	7.99	5.05	4.83	4.18	2.53	1.34
1925	8.10	4.92	5.90	4.14	2.90	1.36
1926	5.43	4.31	5.16	4.04	2.23	1.31
1927	6.34	4.21	4.49	3.97	2.76	1.39
1928	5.96	4.19	4.85	3.96	3.00	1.38
1929	8.23	4.24	6.34	3.75	3.00	1.25
1930	4.90	4.04	4.51	3.65	2.99	1.34

Table 1 (Contd....)

	British Isles		Other North Western EHWAC Europe		All other countries	
	Production	Acreage	Production	Acreage	Production	Acreage
1895	1.44	0.68	1.23	0.49	18.85	17.90
1896	2.27	0.81	1.32	0.48	18.10	17.65
1897	2.42	0.90	1.31	0.47	15.79	18.20
1898	2.42	0.96	1.04	0.46	18.06	19.10
1899	2.36	0.88	1.10	0.45	17.28	17.27
1900	2.04	0.83	1.19	0.45	19.73	17.72
1901	1.84	0.74	0.91	0.41	19.51	17.30
1902	1.86	0.77	1.02	0.45	20.35	17.49
1903	1.49	0.68	0.92	0.41	18.87	17.33
1904	1.21	0.58	0.98	0.41	17.60	17.35
1905	1.83	0.73	0.90	0.41	18.19	16.87
1906	1.82	0.72	0.91	0.37	23.01	17.35
1907	1.82	0.68	1.09	0.39	16.54	17.27
1908	1.75	0.68	1.05	0.39	19.44	17.07
1909	1.76	0.75	0.93	0.38	16.80	16.92
1910	1.91	0.70	0.96	0.37	19.95	16.81
1911	1.91	0.70	1.09	0.36	21.29	16.22
1912	1.49	0.72	1.04	0.38	17.59	16.13
1913	1.44	0.64	0.99	0.38	16.37	15.68
1914	1.67	0.68	1.07	0.39	14.45	15.47

Contd....

Table 1 (Contd....)

	British Isles		Other North Western Europe		All other countries	
	Production	Acreage	Production	Acreage	Production	Acreage
1915	2.64	0.79	0.85	0.35	15.42	14.98
1916	1.85	0.75	0.92	0.36	18.36	16.04
1917	2.01	0.80	0.76	0.37	18.25	16.42
1918	2.68	0.98	0.88	0.38	15.10	16.63
1919	2.09	0.85	1.07	0.41	15.97	14.71
1920	1.72	0.72	1.14	0.42	16.23	15.69
1921	2.27	0.77	1.51	0.47	19.37	17.07
1922	1.88	0.82	1.09	0.47	17.52	18.99
1923	1.57	0.70	1.14	0.46	19.17	18.55
1924	1.53	0.60	0.96	0.39	16.97	18.65
1925	1.32	0.55	1.16	0.42	19.65	22.13
1926	1.22	0.55	1.03	0.42	17.65	17.72
1927	1.31	0.56	1.19	0.49	17.82	17.14
1928	1.08	0.48	1.27	0.49	18.03	17.72
1929	1.24	0.44	1.33	0.46	20.73	17.32
1930	0.93	0.43	1.22	0.50	18.72	17.60

Source: M.K. Bennett: "World Wheat Crops: 1885-1932" Wheat Studies, Vol. IX, No. 7, April, 1933.

TABLE 2

CLIMATIC CONDITIONS IN WHEAT PRODUCING COUNTRIES OF THE WORLD

S.No.	Country	Precipitation (Inches) Annual	Preharvest	Temperature (^{o}F) Annual	Preharvest
1.	Canada	22.7 (12.5-44.0)	5.6 (4.1-7.2)	36.7 (30.0-44.0)	61.9 (57.5-65.2)
2.	U.S.A.	24.7 (8.0-50.0)	5.7 (0.7-9.6)	49.2 (37.0-66.0)	62.2 (57-70.0)
3.	Argentina	26.3 (19.7-37.4)	5.5 (4.7-6.5)	63.2 (60.1-68.0)	66.5 (62.8-68.5)
4.	India	40.8 (31.0-70.0)	1.3 (0.5-2.4)	80.1 (76.0-82.5)	71.2 (73.4-79.7)
5.	Australia	22.1 (16.0-29.5)	3.2 (2.4-5.0)	62.1 (54.0-67.5)	63.5 (58.6-67.0)
6.	Russia	21.3 (7.9-24.6)	4.85 (1.8-6.7)	41.1 (32.9-60.8)	64.5 (60.8-77.0)
7.	Italy	30.1 (23.0-39.4)	5.4 (2.9-9.4)	58.7 (54.5-63.5)	61.7 (61.5-62.2)
8.	Germany	25.6 (22.2-29.5)	6.0 (4.9-8.3)	47.5 (44.6-49.1)	62.2 (59.4-64.9)

continued.....

Table 2 contd..

S.No.	Country	Precipitation (Inches) Annual	Precipitation (Inches) Preharvest	Temperature (^{o}F) Annual	Temperature (^{o}F) Preharvest
9.	Great Britain	30.3 (26.0-34.0)	5.1 (4.6-5.5)	47.5 (46.0-48.5)	58.9 (57.8-60.5)
10.	France	31.0 (27.2-34.0)	5.9 (4.6-7.5)	52.8 (50.0-57.2)	60.7 (58.3-64.4)
11.	Norway	25.6	5.2	42.8	61.5
12.	Sweden	22.6	4.5	44.2	60.4
13.	Denmark	24.6	4.8	45.3	59.0

Source - M.K. Bennett and Helen C. Farnsworth, World Wheat acreage, Yields and Climates, Wheat Studies, Vol. XIII, No. 6, March 1937.

Notes: Figures in brackets indicate thevariations in the climate in different regions of a country.

TABLE 3

MILLING AND BAKING PROPERTIES OF WORLD'S WHEAT

Country/ Milling property	Number of varieties grown	Crude protein in wheat(%)	Volume of loaf Cubic centi-meters
(1)	(2)	(3)	(4)
Canada			
1. Very hard	2	13.29 to 15.59	1,910 to 2,060
2. Hard	5	12.19 to 15.59	1,880 to 2,220
3. Semi hard	1	8.14	1,710
4. Soft	2	7.87 to 13.04	1,640 to 1,970
United States of America			
1. Very hard (Durum)	5	14.21 to 16.31	1,890 to 2,000
2. Hard	21	13.41 to 17.96	1,870 to 2,840
3. Semi hard	3	10.65 to 16.27	1,910 to 2,350
4. Soft	25	9.69 to 19.91	1,850 to 2,330
Russia			
1. Very hard (Durum)	5	12.01 to 17.98	1,990 to 2,470
2. Hard	16	11.12 to 19.45	1,780 to 2,430
3. Semi hard	3	10.49 to 16.36	1,920 to 2,420
4. Soft	9	9.21 to 16.04	1,730 to 2,480

contdd.....

(1)	(2)	(3)	(4)
Argentina			
1. Very hard (Durum)	None	-	-
2. Hard	3	10.59 to 12.74	1,680 to 2,060
3. Semi hard	1	11.82	1,870
4. Soft	9	8.30 to 12.95	1,600 to 2,480
Australia			
1. Very hard (Durum)	1	16.21	1,840
2. Hard	2	11.33 to 13.05	1,880 to 1,900
3. Semi hard	4	7.34 to 13.44	1,820 to 2,000
4. Soft	24	6.47 to 13.54	1,610 to 2,890
India			
1. Very hard	3	9.61 to 14.10	1,550 to 2,070
2. Hard	22	7.56 to 13.97	1,530 to 2,390
Semihard	4	7.40 to 11.31	1,450 to 1,740
Soft	None	-	-
England			
1. Very hard	None	-	-
2. Hard	None	-	-
3. Semi hard	2	9.77 to 11.28	1,580 to 1,600
4. Soft	14	7.64 tp 10.52	1,460 to 1,810
Germany			
1. Very hard	None	-	-

(1)	(2)	(3)	(4)
2. Hard	2	13.13 to 14.45	1,780 to 1,960
3. Semi hard	None	-	-
4. Soft	4	7.79 to 10.62	1,690 to 1,820
Italy			
1. Very hard	5	8.39 to 11.93	1,370 to 1,830
2. Hard	1	8.50	1,310
3. Semi hard	1	10.19	1,890
4. Soft	25	9.27 to 14.02	1,610 to 1,940

Source - D.A. Coleman, 'Milling and Baking Qualities of World wheats, United States Department of Agriculture Technical Bulletin No. 197.

Notes: (1) Basis 340 grams of flour at a moisture content of 13.5 per cent.

(2) The wheats surveyed for India were chosen from agricultural experiment stations and from improved varieties in Punjab.

(3) Durum wheat is not used for making bread.

CHAPTER - III

THE IMPACT OF SELECTION AND HYBRIDIZATION OF IMPROVED VARIETIES OF WHEAT ON ACREAGE BROUGHT UNDER WHEAT CULTIVATION

Beginning from especially the early twentieth century, efforts were made by agricultural experiment stations to develop improved quality of wheat by means of selection and hybridization. These agricultural experiment stations developed a small number of seed varieties which could be grown on large tracts of land under varying climatic conditions of a country. In this chapter, we will study the influence improved varieties of wheat had on the earnings of farmers and the expansion of acreage brought under wheat cultivation. In Section I, we will describe the nature of work done by agricultural experiment stations and trace the significant stages in their development. In Section II, we will describe the experience of Canada where agricultural experiment stations could successfully develop a new variety of which could be grown over large tracts of land under varying climatic conditions. In Section III, we will discuss the problems and experience in the development of Pusa wheat varieties in India. In Section IV, we will discuss the trends in the expansion of acreage under the cultivation of Pusa varieties of wheat and the influence of these varieties on the returns received by farmers.

I. SELECTION AND HYBRIDIZATION OF IMPROVED WHEAT VARIETIES BY AGRICULTURAL EXPERIMENT STATIONS

In the valuation of wheat, an important consideration is the size and the uniformity of the quality of the crop grown. Thus, Alsberg writes: "The more perfectly a wheat region can standardise its wheat, the more uniform and invariable it is, the greater the sense of security of the buyer. Anything that lessens this uniformity lessens the sense of security of the buyer and induces a correspondingly unfavourable reaction in regard to the price he is willing to pay."[1] Grading of wheat according to its quality and the determination of of its price is also facilitated by the size and the uniformity of the quality of crop grown. Finally, economies of bulk handling can be realised when the size of crop is large and is of uniform quality.

Variations in the quality of wheat grown are a result of the influence of the environmental conditions on the cultivation of wheat. Most varieties of wheat

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1. Carl C. Alsberg: "The objectives of wheat breeding" Wheat Studies, Vol. IV, No. 7, June 1928, pg. 235.

can be grown only under specific climatic and soil conditions. If they are grown under conditions not ideally suited to them, they yield wheat of a poorer quality. However, some varieties have some hereditary strengths which allow them to be grown under varying climatic conditions without any change in the quality of their output. Some of these varieties of wheat are available in nature mixed with many other varieties of wheat while others can be developed by the process of cross fertilization in artificial conditions. The process of isolation of a variety of wheat from among a myriad others available in nature, for widespread cultivation, is called selection. The process of cross fertilization of two different breeds of wheat selected to form a new variety, is called hybridization.

Before the extensive use of seeds developed in agricultural experiment stations began, a typical wheat field consisted of a large number of varieties of wheat. The different varieties of wheat could be distinguished by their botanical and agricultural characteristics. The botanical distinctions could be made by an examination of the colour of ripe ears of a plant. Furthermore, a botanical variety could consist of a number of distinct

agricultural types. These agricultural types differed in field characters such as the length and the strength of straw, earliness or lateness of maturity, tone of the colour of chaff and straw, erectness of the ear and susceptibility to rust. Each agricultural type, in turn, is formed of a group of individual plants with minor distinctions. The process of selection involves, in the initial stages, the choice of an agricultural type which is ideally suited for cultivation in a particular country. To the extent that the average yield, quality, etc. can vary between individual units of an agricultural type, the selection process can go further and those individual units or "pure lines" which have better breeding characteristics can be chosen for wider propagation. Cross fertilization or hybridization of two or more "pure lines" for the production of a new variety came later.[2]

Before the establishment of agricultural experiment stations, the improvement of wheat took place largely by a natural process. If by some accident the pollen of two different varieties of wheat crossed each

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2. The discussion on selection and hybridization is based on G.L.C. Howard and Albert Howard. "Wheat in India", Government of India Press, Calcutta, 1909, Ch.3.

other, annew hybrid was formed with better qualities. These hybrids, it can be deduced, must have been widely cultivated if they were also adaptable in a given environment.

At a later stage of development of improved wheat varieties, the method of mass selection or the isolation of agricultural types was used. The process of selection of wheat varieties was improved when single individual plants or "pure lines" were selected for wider propagation. These were the methods used for wheat improvement in early efforts at plant breeding which began in Europe in the latter part of the 18th century and soon thereafter in America. The success of the method of selection was limited because only those plants which happened to be accidental hybrids or mutants could be selected for wider propagation.

Scientific plant breeding came of age only in the early 19th century when artificial hybridization was undertaken in agricultural experiment stations. Initial efforts at hybridization were not very successful because not enough was known about the laws of inheritance, Wheat breeders sought to understand inheritance by means of correlations i.e. finding out by empirical

observations which two or more characters were inherited in a variety of wheat. This empirical method of studying plant behaviour was not always able to anticipate the outcome of hybridization so that considerable time used for this work was wasted. However, the empirical method of studying inheritance did result in the development of wheat varieties like Federation and comeback in Australia and Marquis and Preston in Canada.

It was only later when Mendel's laws of inheritance were rediscovered and verified in 1900 that the scientific basis of plant genetics was laid. It was then possible to test many hundreds of progeny of hybrids each year and to choose some for propagation. The choice of a variety of wheat was made only after extensive testing of the breeding characteristics of a large number of wheat varieties. The work of testing a large number of hybrids involved much greater expense and effort beyond the means of an individual farmer. For this reason, the work of plant breeding was passed on to agricultural experiment stations. With the establishment of agricultural experiment stations, it was possible to develop a single variety which could be grown over large tracts of land. Once wheat varieties which could be grown over large tracts of land were

chosen, the standardisation of the wheat crop become possible.[4]

II. THE DEVELOPMENT OF NEW VARIETIES OF WHEAT IN CANADA

A remarkable feature of the boom in wheat cultivation in Canada, in the early twentiety century was that it was accompanied by the cultivation of a single variety, Marquis, in almost the entire farm belt of this country. The cultivation of a single variety over large tracts of land helped in the standardisation of wheat output, and for this reason, it could be easily graded and priced according to its quality. If Canadian farmers obtained a relatively higher price for their wheat in the world markets, this was certainly one of the reasons for this. Thus, Alsberg writes: "No doubt, one of the factors responsible for the good prices paid for the wheat of western Canada is its uniformity for it consists predominently of a few varieties only, indeed largely one".[5] Most other countries grew a

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4. Discussion on the evolution of agricultural experiment stations is based on Carl C.Alsberg: Op.cit., 1928.

5. Alsberg, Op.cit., 1928, p.285.

mixture of varieties of wheat so that grading and pricing of wheat could not easily be based on quality. A large number of experiments, with a wide range of varieties, carried out in agricultural experiment stations allowed the identification of a single variety which could be grown under different climatic conditions of wheat growing zones and yield good quality output.

One of the major requirements for the success of a variety of wheat in Canadian conditions was that it should have a short growing period. This was because Canadian wheat was exposed to the ravages of frost and rust at the end of the season. Varieties of wheat which could mature quickly could also avoid the danger of frost and rust which affected the crop only at the end of the season. Two varieties of wheat - Red Fife and Marquis - met these requirements and could also give satisfactory yields of good quality.

Of these two varieties of wheat, Red Fife was less suitable for the requirements of Canadian wheat cultivation. Red Fife did not mature early enough so that it was exposed to dangers of frost later in the

season. On the other hand, Red Fife had a hard grain and was noted for the high quality of its flour.

In the early twentieth century, the Dominion experimental farms undertook the task of developing a more suitable variety of wheat which did not face the problems Red Fife did. In 1903, a satisfactory result wasre reached when the Marquis wheat was discovered. By 1911, the new variety was widely accepted and it yielded nearly nine-tenths of the total crop in Canada.[6]

III. SCIENTIFIC WHEAT BREEDING IN INDIA

India was not unaffected by the developments in scientific breeding that were taking place elsewhere in the world. The impetus to provide better quality of wheat came as a result of the demands imposed by the export market. Indian wheat was usually a mix of various varieties; further it had other admixtures, i.e. dirt and grains of the crops, as well. For milling purposes, wheat of uniform

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6. This part of the discussion on the development of Marquis is based on C.P.Wright: "Canada as a Producer and Exporter of wheat." Wheat Studies July, 1925.

quality was required. Moreover, India needed hard varieties of wheat to cater to the increasing demand for high protein flour required for the making of bread.

Initial efforts at improved wheat breeding were made in the last quarter of the 19th century when some choice wheat varieties were imported from Australia, England and U.S.A. and grown in India.[7] Without any exception, all the imported wheat varieties proved to be a failure. The imported varieties took longer time to mature than was possible in India, they some times did not form ears at all or dried up when they were exposed to hot winds or were prone to rust attacks.[8] From Australia, India imported rust resistant hybrids. Mr. Farrer, a plant breeder in Australia, had succeeded in producing rust-resistant hybrids and this inspired the idea that these cross-bred wheats could be used in India. Indian varieties of wheat were crossed with Canandian and Australian wheat varieties in Australian agricultural experiment

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7. Albert Howard and G.L.C. Howard: "Wheat in India", Government of India Press, Calcutta 1909, p.116.

8. Howard and Howard, Op.cit., 1909, p 117.

stations and were sent for trial in Cawnpore and Nagpur experimental farms and to the Lahore botanical gardens. When grown in India, the Australian hybrids suffered from more damaging rust attacks than the indigenous varieties and ripened too late for Indian conditions. Furthermore, the Australian hybrids were not stable and took new forms when grown in India.[9] English wheats, which were grown in Madras, Punjab, Bombay, United Provinces and Central Provinces, often did not germinate at all or they yielded very small quantities of grain.[10] American varieties grown at Cawnpore in 1879-80 dried up when exposed to hot winds, suffered from rust attacks and demanded twice the amount of water Indian wheats required while they could give very poor yields.[11]

The policy of importing wheat varieties in India for experimental trials in local farms was abandoned in the early twentieth century. Beginning from 1906, efforts were made to study already available Indian wheat varieties and select the best among them

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9. Howard and Howard, Op.cit., 1909, pp 113-115.
10. Howard and Howard, Op.cit., 1909, p.115
11. Howard and Howard, Op.cit., p. 116.

for wider propagation. At a later stage, it was felt that hybrids could be developed by cross fertilization of the best wheat varieties that were selected in India. It was then that a really Indian efforts was made in scientific wheat breeding.

At the very outset, plant breeders had to face the problem of identification and testing of a large number of wheat varieties grown in India. As many as 40 different botanical varieties were identified in India.[12] Each of these botanical varieties had a number of agricultural groups distinguished by the period of their growh, quality of straw etc. So many varieties of wheat were grown in India because the conditions of cultivation encouraged natural hybridization on a much larger scale in India than in Europe. This was mainly because of the dryness of wheat growing regions and the irregular supply of moisture to the wheat plants. When the supply of water to the plant is limited, the glumes of the ears of the wheat plant open and the stigmas are

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12. Albert Howard and G.L.C. Howard. "The Improvement of Indian wheat", Agricultural Research Institute Bulletin No. 171, 1928, p.1.

exposed to the air. Under such circumstances, crops fertilization of plants can easily take place.[13]

Furthermore, varying climatic conditions in the country required a large number of wheat varieties suited for these conditions. If a wheat variety suited for a particular zone was grown in another area, its quality deteriorated. The principal factors which influenced the choice of a wheat variety were the duration of growth period of a plant and the moisture available during that period. The duration of the growth period of the wheat plant was limited by the onset of hot weather later in the season. The wheat plant ripened quickly or dried up once the temperature rose beyond a point. Wheat was harvested earliest in Bombay and the Central Provinces in February, in Bihar and Oudh in March and in Punjab from the last week of April and beginning of May.[14]

A more important climatic factor responsible for differences in wheat varieties was the supply of moisture. Wheat in India was grown in regions supplied

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13. Howard and Howard, Op.cit., 1909, p.140.

14. Albert Howard and G.L.C. Howard, The Varietal Characters of Indian Wheats. Memoirs of the Department of Agriculture in India (Botanical Series) vol. II, No.7, May, 1909, p.6.

with water from natural rainfall alone, from canal irrigation, by well irrigation or by a combination of these. Furthermore, the capacity of soils to retain water also varied between regions. Both these factors were responsible for the differences in the wheat crop in terms of its external characters such as the length and strength of straw and the quality of wheat produced.[15]

Finally, accidental variations in weather conditions were also responsible for differences in wheat varieties. These seasonal accidents could be excessively wet and cloudy weather before harvest or extremely dry weather. These changes in the weather were responsible for variations in agricultural types to a much greater extent than in Europe.[16]

The task of the plant breeders in India was to find a variety of wheat which had an inherent hereditary strength to be grown under all these climatic

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15. Howard and Howard, 1909: "Varietal characters of Indian Wheats", Op.cit., 1909, p.6. Also see Albert Howard and H.M. Leake "Yield and Quality in Wheat", The Agricultural Journal of India, April, 1913.

16. Howard and Howard: "Varietal Characters of Indian Wheat", Op.cit. 1909, p.7.

conditions. After a full investigation was made of the wheat varieties in India, it was found that some of these were of high quality.

Initial success in plant breeding was achieved with the development of the Muzaffarnagar white variety of wheat. However, this variety of wheat was suitable for cultivation in a few districts of United Provinces only. When this variety was grown in other provinces, the quality of the output was poorer. Thus, the commercial value of Muzaffarnagar was the ranked the highest in Cawnpore and the lowest in Orai.[17] In United Provinces, the Muzaffarnagar yielded 284 pounds per acre more than the local varieties of wheat which brought a farmer Rs. 10 more for every acre. Apart from the increased returns due to higher yield, Muzaffarnagar also fetched Rs 2 to 3 more per acre for its quality.[18] However, the Muzaffarnagar wheat variety had a soft grain which was not the variety best suited to the requirements of changing milling technology.

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17. Albert Howard and G.L.C. Howard: "The Influence of the Environment on the Milling and Baking Qualities of Wheat in India", Memoirs of the Department of Agriculture in India (Botanical Series), 1912, p 58.

18. Howard and Howard, "Wheat in India", Op.cit., 1909, p 121.

Thereafter, new varieties of wheat were developed at Pusa agricultural experimental station and fifty new wheat varieties were developed in this station.[19] The most noteworthy achievement of the work done at this station was the development of two varieties called Pusa 12 and Pusa 4.

Pusa 12 was the major breakthrough that early plant breeding in India achieved. This was one variety which could be grown in most wheat growing zones of India. In each of these zones, Pusa 12 could yield wheat of equally good quality. Milling and baking tests undertaken on this variety undertaken by Mr. A.E.Humphries showed that Pusa 12 yielded equally good quality wheat in Aligarh, Bankipur, Cawppore, Lyallpur and Pusa.[20] The data on the commercial ranking of the quality of wheat grown in different regions is given in table below:

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19. L.E.Howard: Sir Albert Howard in India Faber and Faber Ltd. London, 1953, p 67.

20. Howard and Howard and Leake: "The influence of the environment on the milling and baking qualities of wheat in India", Op.cit. 1912. p. 85

TABLE - 4

RANKING OF SELECTED WHEAT VARIETIES IN INDIA[21]

	Pusa 12	Pusa 22	Pusa 8	Muzaffar-nagar
Aligarh	1	1	3	4
Bankipur	1	1	3	4
Cawnpore	1	3	2	4
Lyallpur	1	2	3	4
Pusa	1	3	1	4
	5	10	12	20

The progress made by Pusa 12 over Muzaffarnagar in terms of its commercial value, is clearly shown in the table above. We can also notice the invariable ranking of Pusa 12 in different regions. The underlying reasons for the ability of Pusa 12 to grow well in all regions lay in its inherent hereditary strength. Furthermore, Pusa 12 was also capable of giving higher yields. While the average yield of traditional wheat varieties was only 8 to 10 mounds

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21. Report of Mr A.E.Humphries on 24 samples of Indian wheat grown in 1911 quoted in Howard and Howard and Leake: "The influence of the environment on the milling and baking qualities of wheat in India, Op.cit., 1912, p. 85.

an acre,[22] Pusa 12 could yield as much as 37.5 maunds an acre.[23] When both the increased yield and improved quality of wheat were taken into consideration, Pusa 12 could increase the earnings of a farmer by Rs 15 per acre.[24] Not only did Pusa 12 yield better, it could also stand up better to adverse weather conditions. In regions where there was a shortage of water, Pusa 12 could grow more easily with less water. Also, this variety had better standing strengthe on account of its stronger straw and greater rust resistance. Finally, the Pusa 12 had a bright red chaff which allowed an easier identification of this variety which was necessary for an adequate price determination.

Pusa 4 was another popular variety although it did not have as many qualities as Pusa 12 had. However, it was useful in tracts where the period of growth of the wheat plant was short. In climatic conditions where only short growing periods were possible, the

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22. Albert Howard and G.L.C. Howard: "The Improvement of Indian Wheat", Agricultural Journal of India, June, 1913, p.27.

23. Howard and Howard: "Improvement of Indian Wheat", Op.cit., 1928, p.7.

24. Report of the Agricultural Research Institute and College, 1915-16, p.23.

wheat plant had a tendency to dry up loose its standing power and to yield a poor grain. Pusa 4 solved this problem because it could grow in a short period. It was for this reason that this variety was popular in Bihar, Bundelkhand, Punjab and Sind and Gujarat.[25] This variety had also a strong straw, could resist yellow rust and it could yield as much as 37.5 maunds to an acre.[26]

Plant breeders in India had to also develop bearded wheats for those regions which suffered from the attacks of birds and other animals. Beardless wheats had their grain open so that they could be easily damaged by birds and animals. Bearded wheats covered the grain and prevented these attacks. The demand for bearded wheats was also strong in those regions like the Canal colonies in Punjab where harvesting of wheat took time due to shortage of labour.[27]

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25. L.E. Howard, Op.cit., 1953, p.71.

26. Albert Howard and G.L.C. Howard: "The Seed Supply of the New Pusa Wheats", The Agricultural Journal of India, July 1914, p. 250.

27. Howard and Howard: "Varietal Characters of Indian Wheats", Op.cit., 1909, p.9.

If a wheat variety was bearded. it would not be damaged by insects, birds etc. while the plant lay in the field. The Cawnpur 13 was popular in United Provinces for this reason.[28] For the same reason, Punjab 11 was popular in the canal colonies. Finally, Pusa 50 and Pusa 52 were adopted for widespread cultivation in some regions for the same reason.[29]

In the first phase of plant breeding done with Indian varieties, the work was essentially that of selection of high quality seeds from among those already available in India. Till 1924, this method yielded adequate results and some varieties like Pusa 12 and Pusa 4 proved successful. Thereafter, the possibilities of the method of selection were exhausted and the attention of plant breeders turned to hybridization of wheat varieties.[30] One of the major problems with wheat varieties discovered by the selection method was that they did not have straws strong enough to carry the weight

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28. Report of the Progress of Agriculture in India for 1921-22, p 8.

29. L.E. Howard, Op.cit., 1953, p. 73.

30. Report on the Marketing of wheat in India, 1937, p. 337.

of more than forty bushels per acre.[31] Apart from good quality of seed, it was also necessary to have seed varieties which could give high yields in order to be popular with farmers. Moreover, these new Pusa varieties had limited capacity to resist rust attacks.[32] Hybridization work was necessary to find solutions to these problems.

However, success in hybridization was daunted by several problems. To start with, hybridization required sufficient knowledge of breeding characteristics of wheat varieties in their pure form, i.e. in the form they were available before any natural cross breeding took place. Furthermore, it was usually difficult to anticipate the likely outcome of cross fertilization of two varieties so that repeated trials had to be undertaken before any success was achieved. The development of a new variety of wheat by the process of cross fertilization required long periods of experiments which extended to an average period of five years.[33]

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31. Albert Howard and G.L.C. Howard: "The Milling and Baking Qualities of Indian Wheats": Agricultural Research Institute Bulletin No. 17, 1910, Ch.4,pp25-30.

32. Scientific Report of the Agricultural Research Institute, Pusa, 1927-28.

33. Howard: "Wheat in India", 1909, p 138.

Two major types of hybrids were developed in Pusa: one for strengthening the straw and the other to improve their capacity to resist rust attacks.[34] Another hybrid was also developed to produce a bearded variety of wheat. None of these varieties could achieve the success that Pusa 4 and Pusa 12 did. In fact, none of them were found suitable for widespread cultivation in India.

Two sets of hybrids were developed by the process of cross fertilization with the Muzaffarnagar seed mainly for developing strong straws. Pusa 22 and Pusa 6 were crossed with Muzaffarnagar to yield Pusa 100 and Pusa 101. Pusa 101 was, for some time, grown extensively in North Bihar. However, the straw was not found to be strong enough to support heavy crops and its use was abandoned. Pusa 100 achieved partial success and it was grown extensively in Central Provinces. Later, Pusa 6 was cross with Muzaffarnagar and Pusa 104, Pusa 105, Pusa 106, Pusa 107, Pusa 108 and Pusa 110 were developed. All these varieties were unsuccessful when used in the field and the farmers found it more profitable to use Pusa 12 and Pusa 4.

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34. Discussion on hybrid seeds is based on L.E. Howard, Op.cit., 1953, pp. 11.15.

For the development of rust resistant wheat varieties, some Indian wheats were crossed with English varieties. None of these wheat varieties were successful when trials were taken in India. Hybrids developed, in the wet climate of England, were not able to provide the same rust resistance in the dry climate of India as in England.

Thus, we see that the work of plant breeding in India could achieve only a limited success. The climatic conditions in India had given rise to a very large number of wheat varieties which had to be studied carefully before any new seeds could be developed. This was a time consuming process which required an immense effort before any success was achieved. Although some success was achieved in the selection of a few varieties, the hybridization of new seeds did not meet with any success. The impact of scientific wheat breeding in India was, therefore, limited in this period.

IMPACT OF SCIENTIFIC WHEAT BREEDING ON WHEAT CULTIVATION IN INDIA

Insofaras the Pusa wheat varieties improved on the quality of flour produced and could yield more output per acre, we would expect that the acreage under wheat cultivation would increase independent of the incentive provided by the average price of wheat. That the share of acreage brought under the cultivation of improved varieties would increase over time. If the share of the acreage brought under the cultivation of improved varieties increases, we can also conclude that average price of wheat is not the only factor which affects the decision of a farmer to bring land under cultivation.

Statistical data on the extent of acreage under the cultivation of improved varieties of wheat refer to the period between 1920-21 to 1933-34. Similar information for the earlier period is not available. However, this should not affect the validity of our conclusions. This is because the new Pusa varieties like Pusa 12 passed beyond their experimental stage only after 1916-17.[35] However,

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35. Report on the progress of agriculture in India, 1916-17, p 17.

the figures of acreage under cultivation of Pusa varieties is an under-estimate.[36] The source of information that we have used refers to the acreage under the cultivation of Pusa varieties supplied by government farms. Pusa varieties were also supplied by private seed farms and information on acreage brought under the cultivation of these wheat varieties supplied by these farms is not available.[37]

In Table 5, we have calculated the share of acreage under the cultivation of Pusa varieties between 1920-21 and 1933-34. It can be seen that the share of acreage under improved varieties increased from 6.03% in 1920-21 to 17.28% in 1933-34. This is indeed a very sharp increase in the acreage under the cultivation of a few varieties which is clearly not accounted for by price fluctuations.

The increase in the acreage, under the cultivation of Pusa varieties, however, was clearly due to

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36. Scientific Reports of the Agriculture Research Institute, Pusa, 1921-22.

37. Report of the Progress of Agriculture in India, various years.

the premiums farmers received from the output produced from them. The average premium of red varieties of wheat (hard or soft) over the white (hard or soft), in northern India was in the range of one anna to two annas per maund.[38] Hard varieties were called the Sharbati and the soft varieties were called the Dara types. The difference in the prices of these hard white varieties over soft white varieties could range from an anna and three paisa per maund in producing zones like Punjab and six annas a maund for the distant consuming zones.[39] Furthermore, hard varieties of wheat, interestingly, were less suspeptible to the depressions of prices and they gained more when prices rose. In a large consuming market like Delhi, in 1930 and 1934, prices of ordinary white fell by 30%, red wheats fell by 29% but hard varieties Sharabati fell only 8%. When prices rose in 1931 and 1933, red wheats gained only 7% over the previous price level while Sharabati increased by 17%.[40]

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38. Report on the Marketing of wheat in India, Government of India Press, Simla, 1937, p. 93.

39. Report on the Marketing of Wheat in India, Op.cit., p. 97.

40. Report on the Marketing of Wheat in India, Op. cit., pp 97-98.

Indeed, the notion of the rationality of farmers becomes more complex when we look at the entire range of wheat varieties produced. Prices and the fluctuations of specific varieties go, through varied courses of movement and farmer's response differs in each case. The breeding of new varieties of wheat facilitated a keener response by farmers to opportunities created by the market. However, the overall influence of this work of plant breeding was limited due to the problems created by specific limitations of development of these varieties in India.

CONCLUSION

We have seen that the success of wheat farming in Canada and its ability to supply increasing quantities of wheat to the British market was due to the successful cultivation of Marquis varieties on large tracts of that country. That the development of improved quality of wheat was facilitated by the process of selection and hybridization of wheat varieties undertaken in agricultural experiment station. Plant breeding work was also done in India beginning

from 1906. However, only limited success was achieved in the development of new varieties by the process of selection. The work of hybridization of new varieties was almost entirely unsuccessful. The new varieties which were brought under cultivation did lead to an expansion of wheat acreage independent of the price effect. These varieties brought higher earnings to farmers, they were also less susceptible to price depressions and this lead to the expansion of acreage under the cultivation of these varieties.

Table 5

USE OF PUSA VARIETIES OF WHEAT IN INDIA

1920-21 TO 1933-34

(in acres)

	1920-21	1921-22	1922-23	1923-24	1924-25	1925-26	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33	1933-34
1. Bengal	199	256	217	241	15	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2. Bihar and Orissa	2000	505	-	238	434	726	2483	1998	5198	8462	23206	35846	37907	45484
3. United Provinces	400000	241000	272346	116626	774623	844238	1000000	1116000	1390000	1600000	1000000	1940000	2096000	2260000
4. Punjab	601384	1582570	913509	1005765	1183066	1470037	1440289	1859310	2099530	2516600	2448000	2771880	2515300	2833500
5. Central Provinces	801455	40599	60222	62473	104232	125138	135148	195171	269907	355057	377372	427992	458932	477918
6. Sind	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	84321	86052	103247	173937	35565
7. Burma	2123	210	Nil	Nil	Nil	Nil	Nil	Nil	Nil	-	8489	15726	13571	13691
8. North West Provinces	Nil	150000	200000	202000	202000	300000	330000	330500	330000	330000	280000	Nil	Nil	1523
9. Bombay	Nil	500	2885	11600	17750	13051	15945	16073	29684	205	11259	30551	20526	36894
10. Total India	1807161	2015640	1449179	1398943	2282120	2655092	2893865	3517552	4124819	4894728	5034378	5325242	5316173	5704575
11. Total Wheat Acreage of all Varieties	29950000	25780000	28210000	30850000	31180000	31780000	30470000	31300000	32190000	31970000	30470000	32190000	33750000	33000000
12. Share of Pusa Wheat as a Percentage of Total 11/12 X 100	6.03	7.81	5.13	4.53	7.31	8.35	9.49	11.23	12.81	15.31	16.52	16.54	15.75	17.28

Source: Review of agricultural operations in India, various Issues.

CHAPTER IV

THE IMPACT OF INNOVATIONS IN MARKETING METHODS ON THE SUPPLY OF WHEAT

In our thesis, so far, we assumed that the price a farmer obtains for his produce is equivalent to the average annual price of the output in the market minus a nominal discount for carriage charges and an average profit for traders. This is not necessarily true. A farmer can receive a price lower than the annual average minus the nominal discount for carriage charges and traders' profit for his product because he does not have adequate finance and storage facilities to allow him to withhold his supplies when prices are low early in the season so that he can sell to his advantage when prices rise later in the season. Inadequate availability of storage facilities can also lead to the damage of the product due to insect attacks. Finally, a peasant will not get a price commensurate with the quality of his produce if a proper grading system is not available. The returns to the farmers are, in short, affected by the efficiency of marketing methods available at a point of time.

In this chapter, we will analyse the effect of some important changes in marketing methods on the supply of wheat. In Section I, we will describe the nature of changes in marketing methods, which took place in the period, mainly wheat elevators and related facilities like the futures market, financing of wheat storage and the grading of the output. In Section II, we will look at the influence of these marketing innovations on the seasonal supply of wheat by farmers in United States of America and Russia in response to price fluctuations in Great Britain. United States of America had a well organised marketing system while the opposite was true in the case of Russia. A comparative study of the market arrivals of wheat in these two countries, we expect, would draw out the significance of a well developed marketing systems. In Section III, we will analyse some aspects of the marketing behaviour of farmers in India. Finally, in Section IV, we look at the experience with the development of the then current marketing innovations in India.

SECTION - I

INNOVATIONS IN MARKETING METHODS

One of the major developments in the marketing of wheat in the late nineteenth century and the early twentieth century was a system of elevators for the storage and movement of wheat. The physical facilities of an elevator system consisted of a combination of a conveying and a storage system. The means of storage were vertical bins constructed of steel, reinforced concrete, brick or timber. The bin or a series of bins could be circular, square, hexagonal or trapezoidal in shape. Whatever may have been the specific shape of the bins, they were so designed that they could storage wheat in quantities larger than the floor space occupied. Wheat was unloaded /* from there it was raised by an elevator gear to the top of the bin in which it was stored. The base of each bin was kept at an elevation to provide room for railway wagons, carts or conveyors. The bins had hopper bottoms which allowed grain to flow down, by the force of gravitation, when the value was opened into wagons or bags or into a conveyor belt that moved the wheat to a point where it would be cleaned,

/* from carts, wagons or whatever onto a common point and

dried, graded, bagged and then moved out.[1]

Elevators were already in common use at the beginning of the twentieth century in United States. The capacity of elevators in the principal cities of United States itself was equivalent to one third of her production and more than four times her exports in 1912.[2] The precise figures of the capacity of country elevators are not known but it was estimated at about another one third of the production in 1912.[3] The capacity of elevators in Canada increased rapidly from 31,088 thousand bushels in 1901 to 445,687 thousand bushels in 1929.[4] In other countries, the spread of the elevator system was much slower. Australia adopted the elevator system only after the first world war and the percentage of crop handled in bulk increased from 3.5% of the total in 1920-21 to 47.3% of

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1. F. Noel Paton, Indian Wheat and Grain Elevators, Calcutta, 1913, p. 62.

2. F. Noel Paton, op.cit., p. 57.

3. F. Noel Paton, op.cit., 1913, p. 56.

4. C.P. Wright, "Canada as a Producer and Exporter of Wheat", Wheat Studies, July, 1925.

the total in its principal wheat growing region of New South Wales.[5] In Russia, elevators had been developed only in some important cities and their number was only 84 in 1913.[6] However, in pre-war Russia, a system of interior grain elevators did not exist.[7] In Argentina, bulk handling of grain by elevators was available in seaports but a system of interior elevators was non-existent.[8] In India, only one elevator was constructed in Lyallpur and this operated only between 1920-26 after which it was closed.

The growth of a system of wheat elevators, or bulk handling, encouraged the growth of a complex of grain futures market which were first developed in United States of America and later in Canada in the early twentieth century. In these futures markets, "the function of

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5. J.S. Davis, "Bulk Handling in Australia", Wheat Studies, April, 1940.

6. Indian Trade Journal, Vol. XXIV, No. 370, 1st May, 1913, p. 185.

7. J.S. Davis, op.cit., 1940.

8. J.S. Davis, op.cit., 1940.

carrying wheat was taken over by speculators, through whose operations the grain merchants and millers were placed in a position to secure insurance against risks by hedging their commodity operations. The North American development of the grain trade was associated with bulk handling and the transportation facilities adopted to it!![9] The development of the futures markets was largely absent in India and Russia throughout this period while these markets developed to an extent in Argentina and Australia in the 1920s.[10]

The main utility of the grain futures market for farmers was that it gaurded them against seasonal fluctuations of prices. They could sell a certain quantity of wheat and receive a transferrable title called "Wheat Futures" for the delivery of the wheat at a future date and at a stated price.[11] The seller of wheat could be a farmer or merely a speculator while the buyer was generally

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9. Alonzo E. Taylor, "Variations in Wheat Prices", Wheat Studies, Vol. V, No. 7, June, 1929.

10. Alonzo E. Taylor, op.cit., 1929.

11. F. Noel Paton, op.cit., 1913, p. 58.

an elevator operator. In order to guard against losses from seasonal price fluctuations, buyers and sellers normally had an agreement among each other whereby every rise in price was attended by a compensation by the seller to the buyer while a fall in price was accompanied by a compensation by the buyer to the seller.

The growth of the futures market also encouraged the standardisation and gradation of wheat bought by speculators although this was not always true. In North America, where the futures market was fully developed, no middleman ever bought wheat before it was certified that it was of a certain grade. The certification for a certain lot of wheat was provided by assessors under the Railroad and Warehouse Board.[12] However, grading and bulk handling were not closely associated in Australia where the same system developed in the 1920s.[13]

Once a system of organised storage was established, banks were also prepared to advance loans against wheat

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12. F. Noel Paton, op.cit., p. 57.

13. J.S. Daris, op.cit., 1940.

stored in elevators. The farmers, who took advances against the stored grain, could use the money for meeting their immediate cash requirements and avoid any distress selling.

It is in the context of these well organised markets that we find that the return a merchant earns is normal i.e. a payment for his services. In such a situation, the difference between the price received by the farmer and the price paid by the consumer is the charge for the use of physical facilities of storage and those connected with capital utilised to store grain itself in the elevator as well as the profit of the merchant. A merchant could also earn a profit from speculation in the futures market. A trader in such conditions, however, does not profit from seasonal fluctuations of prices. Commenting on the source of profits of merchants, Working wrote: "Most large grain dealers in the United States systematically hedge their purchases of wheat. To the holder of hedged wheat, it makes little difference whether wheat prices in general rise or fall (in the season) after he has made his purchase. He hopes to see the prices of the particular classes and

grades of wheat which he holds move into a more favourable relationship to futures prices. If grain dealers exercise any concerted influence on wheat prices in order to increase their profits from carrying the grain that influence must be directed toward affecting the future spread".[14] Under these well developed market conditions, traders could earn only a modest profit if at all. The costs of storage in United States, for 15 pre-war years and 7 past-war years, were estimated at 0.8 cents per bushel per month for some dealers and as high as 1.7 cents per bushel per month for some other dealers. For the owners of large elevators, the costs were estimated in the neighbourhood of 1.11 to 1.41 cents per bushel per month. The gains of merchants from storage of wheat were estimated at 1.10 cents per bushel per month for the storage of No. 2 Hard winter wheat at Kansas City, 1.21 cents per bushel per month on the No. 2 Red Winter wheat and 0.88 cents per bushel for No. 1 Northern Spring wheat.[15] Thus, it can be seen that traders in

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14. Holbrook Working, "The Post-Harvest Depression of Wheat Prices", Wheat Studies, Vol. VI, No. 1, Nov. 1929, p. 9.

15. Working, op.cit., 1929, p. 15.

United States of America could earn only a modest profit if at all in this period.

SECTION - II

THE INFLUENCE OF MARKETING ORGANISATION ON SUPPLY OF WHEAT FROM RUSSIA AND UNITED STATES TO GREAT BRITAIN

The availability of modern storage systems and the associated institutions in a country allowed farmers to withhold stocks when necessary. A profit maximising rational peasant could then dispose of his stocks when prices rose to a level where expected gains were equal to storage costs. In such a condition, market arrivals of wheat did not depend on the size of the crop but on fluctuations in seasonal prices. On the other hand, in a country where marketing organisation was poorly developed, market arrivals were a function of the size of the crop and not of ~~by~~ the fluctuations in seasonal prices.

A comparison of the selling behaviour of Russian wheat farmers and American farmers in response to prices in Great Britain draws out the significance of marketing

organisations for the supply of wheat. A noteworthy feature of Russian wheat supply behaviour was that Russian wheat exports and wheat production between 1890 and 1913 had a high co-efficient of correlation of r = 0.771 while American exports were less affected by the size of the crops and the co-efficient was r = 0.488. By contrast, the correlation between Russian wheat exports and the prices in the Liverpool market was as low as r = -0.007 while wheat exports from the United States were more responsive to Liverpool prices and the coefficient of correlation was as much as r = +0.133.[16]

The Russian wheat selling behaviour in Great Britain was not rational in the sense that its exports of wheat did not respond to price fluctuations as much as they did to the sheer volume of wheat production. The higher correlation of wheat exports to production of wheat in Russia points to the fact that Russian peasants were under some compulsion to sell their product whatever the returns they

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16. V.P. Timoshenko, "Wheat Prices and the World Wheat Market", Cornell University Agricultural Experiment Station Memoir No. 118, Dec. 1928, pp. 47 and 55.

obtained. The Russian peasant was compelled to sell soon after the harvest because, "The Russian farmer had less capital than the American farmer and was obliged to sell immediately after the harvest in order to pay taxes and to meet necessary expenses".[17] A more important reason for dumping of wheat was the "absence of grain elevators on the local and interior terminal markets" [18] where grain could be stored and without these elevators, "financing of stocks of grains on the interior markets was more difficult".[19] In the absence of organised methods of storage and financing of movement of grain, the sale of wheat was in the hands of a large number of small traders who entered the grain trade without much capital. These traders relied a great deal on finance of banks which they obtained as soon as the grain was loaded on the railroad cars. It was in the interest of these traders to dispose of the wheat as soon as it reached its destination so as to be able to renew

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17. V.P. Timoshenko, op.cit., p. 54.
18. V.P. Timoshenko, op.cit., p. 54.
19. V.P. Timoshenko, op.cit., p. 54.

their credit with the banks. These traders, therefore, were to a large extent, responsible for the rush of wheat arrivals soon after harvest.

The keener supply response of American farmers to price fluctuations was due to its well developed storage methods provided by elevators along with associated futures market. With a well organised markets in United States, it was feasible "to export wheat in accordance with foreign demand rather than with the pressure of surplus in the country. American exporters took advantage of his prices abroad, whereas Russian exporters sold regardless of these prices".[20]

SECTION - III

MARKETING BEHAVIOUR OF WHEAT FARMERS IN INDIA

A recurring theme in economic literature on the marketing of village produce is the choice that a peasant makes between selling his product within his village or

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20. V.P. Timoshenko, op.cit., p. 55.

in a market outside in a town. A profit maximising peasant is expected to sell his product outside his village where he can get a better return than what he gets in his own village. On the other hand, a farmer may sell within his village under the pressure to meet his cash requirements for the payment of land revenue, debt obligations and rent payments. When the product is sold under pressure, the price that the farmer receives is dictated by the buyer and is lower than what can be obtained in the town market. Since most of the product is sold soon after the harvest, the farmer has to take a consumption loan and buy goods for his own requirements when prices rise later in the season. Both distress selling and buying then ensure that farmers remain indebted and are forced to sell their product soon after the harvest at prices dictated by the buyer.[21]

Amit Bhaduri, who argues that small producers engage in distress selling and buying, has admitted that the rational rich peasantry can also sell soon after the harvest

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21. Amit Bhaduri, The Economic Structure of Backward Agriculture, Macmillan India Ltd., Delhi, 1984, Chapter 2, pp. 17-40.

as much as the indebted small producers.[22] We will see later that inadequate development of storage facilities and the associated institutions can compel even the rich peasantry to sell at a disadvantage soon after the harvest.

Actual empirical evidence does show that, in this period, the farmers were beginning to sell their produce outside their village even though the data do not show a consistent pattern in different regions. In one of the major enquiries conducted on the marketing of wheat in the mid-thirties, it was found that in some districts of Punjab, like Jullundar, Ludhiana and Montgomery, as much as four-fifths of the wheat crop was sold outside the village in the assembling markets while in a district like Attock the same proportion was insignificant. In Western United Provinces and in rural Delhi, about one-third of the crop was estimated to be taken to the assembling markets, and two thirds in Central Provinces.[23] The decision to sell directly in

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22. Amit Bhaduri, op.cit., Chapter 2.

23. Report on the Marketing of Wheat in India, Government of India Press, Simla, 1937, pp. 127-28.

in the central market, the abovementioned survey suggests, was affected by the level of development of markets and the selling charges that the cultivators had to pay in central markets. In better developed markets like Hapur and Ghaziabad, where charges were paid in cash, cultivators paid half as much as what larger merchants paid as selling charges. On the other hand, in some less developed markets in United Provinces and Bihar, the selling charges paid by farmers were one and a half times to twice of what merchants paid as selling charges.[24]

More detailed surveys were undertaken in Punjab, at the village level, in the late twenties and thirties.[25] These surveys show both the diversity of selling behaviour of peasants at the village level and the factors which affected the choice to sell either in the village or outside the village in the town market. In one of these surveys, covering eight villages each in Lyallpur, Ferozepore and Attock, it was found that 51.76 per cent of the

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24. Report on the Marketing of Wheat in India, op.cit., pp. 130-132.

25. Finance & Marketing of Cultivators' Wheat in the Punjab, Publication No. 38, Board of Economic Enquiry, Punjab, 1934.

produce in Lyallpur was sold in the village while 48.24 per cent was sold in the market. On the other hand, 83.8 per cent of the produce in Ferozepore was sold in the market while the rest was sold within the village. In Attock, as noted earlier, only an insignificant portion was sold in the market.[26] The districts which sold a high proportion of the wheat in the central market were also the ones in which the need to repay debt was less compelling than in those districts where this need was stronger. Thus, 88.63 per cent of wheat sold was for repayment of debt in Attock while the corresponding figures for Ferozepore and Lyallpur were 7.74 per cent and 13.61 per cent.

The need to repay debts cannot fully account for the tendency of farmers to sell their produce within the village. Even those farmers who were free from debt and the obligation to supply their products to their creditors, chose to sell within the village. Detailed interviews

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26. Finance and Marketing of Cultivators' Wheat in the Punjab, op.cit., 1934, p. 16.

of farmers were conducted in the early thirties in Lyallpur and Ferozepore to find out the constraints to marketing wheat directly in the central market. The results of these interviews are indicated in the table below:

TABLE - 6

PROBLEMS OF MARKETING WHEAT IN CENTRAL MARKETS

No.	Nature of Difficulties in Marketing	Percentage of the Total Complaints	
		Lyallpur	Ferozepore
1.	Heavy Deductions	69.4	34.7
2.	Low rates for good quality wheat and the system on auctioning more than one heap at a time	6.3	2.9
3.	Defective weighing	11.3	4.6
4.	Rates fixed under cover	1.8	30.0
5.	No voice in Mandi	8.1	1.7
6.	No.shady place for the bullocks to stand in the market compound	3.1	-
7.	Roads leading to Mandi bad	-	13.9
8.	Kachcha transactions unjust to the sellers	-	2.3

contd....

9.	Rulai charge in addition to karta	-	1.2
10.	Chhanai charge incurred even where there was no dirt or dust in grain	-	2.3
11.	Mehra (Hindu water carrier) deduction	-	3.5
12.	Pacca weight in maund not understood	-	2.9

Source: Finance and Marketing of Cultivators' Wheat in the Punjab, Publication No. 38, Board of Economic Enquiry, Punjab, 1934, p. 37.

The most important constraints to sale of wheat in central markets in Lyallpur were heavy deductions followed by defective weighing. In Ferozepore, the most important constraints to sale of wheat in central markets in Ferozepore were also heavy deductions followed by the fixation of prices under cover and poor quality of roads. All these factors mentioned above constituted costs which farmers had to pay when they sold their produce in the central markets. If farmers chose to sell within the village because they found it cheaper, this cannot be construed as an irrational choice.

When wheat was sold by farmers through traders, some deductions were made for their services. These deductions included arit which was charged for the services of a trader, tolai charges had to be paid for weighing of the produce, chungi which was a customary payment to traders, Dharmao was a charge for cow protection and other charitable purposes and karta was a charge to cover dust, dirt, moisture, etc.[27] These deductions varied from 8 annas 6 paisa to three rupees four annas and six paisa for every hundred rupees of output sold in Ferozepore.[28] In three of the four markets surveyed, in Ferozepore district market deductions were less than a rupee for every hundred rupees of output sold while only in one market, the deductions were in the range of two rupees seven annas and six paisa to three rupees four annas and six paisa for every hundred rupees of output.[29]

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27. Finance and Marketing of Wheat in Punjab, op.cit., p. 66.

28. Finance and Marketing of Wheat in Punjab, op.cit., p. 87.

29. The four markets under consideration are Moga, Fazilka and Muktsar on the one hand and Ferozepore Cantonment on the other.

In Lyallpur district, market deductions were always more than a rupee and they could range from a rupee five annas and three paisa to two rupee six annas and three paisa for every hundred rupees value of output sold.[30] Farmers had to make kind payments also but these have not been considered here because the units vary in different markets and are not comparable.

Farmers could also incur losses by selling in central markets due to other factors like sale under the cover system, defective weighing and high transportation costs. Two systems of sale existed in Punjab and these were the auction system and under the cover system. The auction system was generally to the advantage of sellers because there was greater competition among buyers. On the other hand, sale of produce under the cover system involved only a small number of buyers which was often to the disadvantage of the seller.[31] Competition was

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30. Finance and Marketing of Wheat in Punjab, op.cit., p. 67. The markets surveyed were Lyallpur, Chak Jhumra, Toba Tek Singh and Taranwala.

31. Finance and Marketing of Wheat in Punjab, op.cit., p. 60. In this document, the author adds a note of caution and says that the auction system was not always to the advantage of a seller because wheat was rushed to the markets and often exceeded the demand.

limited because the transaction was carried out in a closed situation which limited the access to information about the terms to a few buyers. Figures on the comparative returns to farmers by the auction system and the closed system are not available. The farmer could also loose as a result of the use of defective weighing of high produce. The figures on the loss to farmers due to under-valuation are not available. Since he was less familiar with marketing methods than a trader, a farmer could loose more. Finally, the quality of roads affected the costs of marketing. The costs of transportation could vary from 2.25 pies per maund per mile in a cart to 3.08 pies per maund per mile on a donkey and 3.01 pies per maund per mile on a camel along a metalled road. The corresponding figures for unmetalled roads were estimated at 3.31 pies, 3.75 pies and 2.9 pies per maund per mile for cart, donkey and camel.[32] Poor roads were a greater constraint in Ferozepore than in Lyallpur because in this town unmetalled roads were more predominant than in Lyallpur.[33]

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32. Finance and Marketing of Wheat in Punjab, op.cit., p. 56.

33. Finance and Marketing of Wheat in Punjab, op.cit., p. 3.

Interesting variations in the motives governing peasant selling behaviour were noticed when the Punjab Board of Economic Enquiry conducted surveys at the village level. Instances of direct sales in the central markets were some times observed in these surveys. Gaddi Thamman[34] was one of the few places where wheat was sold in the nearest central market - Lyallpur. If the farmers in this village sometimes chose to sell their wheat to the local buyers, the price obtained was close to that in the central market because the farmers were in daily communication with this market. Direct sale in the central market was encouraged by the fact that Gaddi Thamman was connected to Lyallpur by a road which was metalled for nine miles out of the eleven miles distance. However, it was also true that farmers did not have cash resources to store wheat in anticipation of better prices and were compelled, under the pressure of demands of government revenue, to sell soon after harvest.[35] Another interesting case

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34. An Economic Survey of Kala Gaddi Thamman, Board of Economic Enquiry, Punjab, 1932, pp. 87-91.

35. Gaddi Thamman, op.cit., p. 91.

study of a village where direct sales in the central markets were common was Durrana Langana.[36] In this village, cultivators sold their wheat in the nearest central market at Multan. The difference in prices in the central market and the village was equal to the cost of carriage, octroi and other selling charges and was about 4 annas a maund. Farmers in this village as opposed to peasants in Gaddi Thamman were also capable of storing grain in order to realise higher prices in the future. However, the survey mentions that it is doubtful whether the farmers gained from this insofar as there was a loss due to insect attacks and storage costs. In Tehong,[37] farmers some times chose to sell in the nearest market of Phagwara or Ludhiana when he had to also buy goods in these markets. In other cases, cultivators preferred selling in the local village at rates which were lower by one fourth to three fourths of a seer per rupee

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36. An Economic Survey of Durrana Langana, The Board of Economic Enquiry, Punjab, 1938, pp. 160-162.

37. An Economic Survey of Tehong, The Board of Economic Enquiry, Punjab, 1931, pp. 166-169.

less than in the central market. In most other cases, the cultivators in Tehong were reluctant to sell in the central markets because the village was partly connected by unmetalled roads to the local central market, the produce in the market weighed less than what it did in the village and the producer had to pay selling charges which could vary from a rupee and one anna six paisa for a hundred rupees of produce in Ludhiana to one rupee and nine annas in Phagwara. In Tehong also, producers stored grain in anticipation of a rise of prices in the future but this did not seem to bring them much gain. Another village where direct sales of wheat in the central market were observed was Naggal.[38] The produce was mostly sold in the nearby Ambala city unless the prices were favourable in the village itself. An interesting feature of this village was that the burden of debt, land revenue payments etc. was rather low. Land revenue payments were about 276 maunds of wheat which was about nineteen per cent of the

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38. An Economic Survey of Naggal, The Board of Economic Enquiry, Punjab, 1933, pp. 94-95.

total of 1,452 maunds produced in a year. Cultivators were also not bound to sell to their creditors and paid their debts in cash after the product was sold. Under these circumstances, the farmers had the choice to seek the highest returns for their produce.

While the sale of wheat directly in central markets appears to be significant in this period, this does not mean that farmers in all villages were in a position to obtain favourable terms by selling in the central markets. The survey of Bhadas[39] showed that creditors seized most of the produce soon after it was harvested. Payments were made in kind and were undervalued by the creditors. The indebted peasants remained in debt because the entire credit was never fully repaid. An interesting feature of this village was that the central markets were located in distant places about twelve to thirty miles away. But these markets could be reached by metalled roads. Another

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39. An Economic Survey of Bhadas, The Board of Economic Enquiry, Punjab, 1936, pp. 101-105.

village where s imilar conditions prevailed was Bhambus Sandila.[40] Most of the wheat produced was seized soon after the harvest at prices dictated by moneylenders of the village. The product was not sold in a central market because none existed. The nearest railway station was located as far as 35 miles away. An interesting case study of a village where farmers sold their produce at unfavourable terms without being under the compulsion to do so by their creditors was Gajju Chak.[41] The producers did not sell in the central market because they did not have carts or other means of transportation, the traders could take advantage of the farmers because there was no open bidding system and selling charges were as high as three rupees and three annas in comparison to a rupee and eight annas paid by farmers in Kala Gaddi Thamman.[42] When sold in the village, the farmers of Gajju Chak had to get their

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40. An Economic Survey of Bhambus Sandila, The Board of Economic Enquiry, Punjab, 1935, pp. 98-100.

41. An Economic Survey of Gajju Chak, The Board of Economic Enquiry, Punjab, 1934.

42. An Economic Survey of Kala Gaddi Thamman, op.cit., 1932, p. 89. This was a village where farmers sold their wheat in the central markets.

produce weighed by shop-keepers who undervalued the wheat supplied. Moreover, indebted peasants had to sell at a rate which was four fifths to a seer cheaper than the market rate. These surveys, therefore, suggest that the villages in which farmers sold their wheat in the villages at prices for below those in central markets were either at a long distance from these markets, suffered from poor quality of market services and or had inadequate means of transportation.

However, it was not always true that farmers sold to their disadvantage within the village. An interesting case study of a village where the produce was sold locally at fair prices was Gaggar Bhana.[43] In this village, the job of fixing a fair price and to weigh grain fairly was given to the village dharwai. He negotiated the price with the agents of merchants in central markets. The farmers, when in debt, were not under any compulsion to sell to their creditors and could pay in cash after the

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43. An Economic Survey of Gaggar Bhana, Board of Economic Enquiry, Punjab, 1928, pp. 115-120.

produce was sold. Farmers were not under any compulsion to sell soon after the harvest because they could pay land revenue and water rates soon after the rabi harvest out of the earnings of kharif harvest of cotton and sugar. Sometimes, cultivators helped each other by lending money without charging any interest. The village produce was taken by a local trader to the central markets and sold at prices fixed by the dharwai. It is interesting to note that Gaggar Bhana was at a distance of 31 miles from the nearest central market in Amritsar and was very poorly served by roads. It appears that, in this village, the institution of a dharwai was necessary to obtain fair prices in a village which was far away from the nearest central market. Another village where producers obtained favourable prices without selling in the central markets was Gijhi.[44] Here the buyers were generally from other villages of the same district. The prices received from these buyers were close to the prices in the nearest central market except

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44. An Economic Survey of Gijhi, Board of Economic Enquiry, Punjab, 1932, pp. 145-147.

for a small difference. Indebtedness did not compel the farmers to sell at a disadvantage to their creditors. Some zamindars even stored their wheat to realise higher prices later in the season.

The village surveys undertaken in Punjab in the late twenties and early thirties did show ~~up~~ that farmers were capable of selling their produce in the nearest central markets to realise higher prices than those in their villages. That the sale of the produce within the village did not necessarily bring unfavourable prices to farmers. The villages where producers sold their product within the village ~~are~~ were generally those which ~~are~~ were either far away from well developed central markets or these markets ~~do~~ did not exist at all near such villages. These villages ~~are~~ were also ones which suffered from an inadequate or poor availability of means of transportation. On the other hand, the villages in which producers sold in central markets ~~are~~ were ones which have well developed markets nearby and ~~are~~ were served by proper means of transportation. Finally, the villages in which producers sold their produce within the village at favourable prices had some peculiar fea-

tures which allowed farmers to obtain a fair price. However, the evidence available is of a qualitative nature and our conclusions can be only tentative. Only more detailed regional studies can draw out the full significance of market organisations on the supply of wheat.

SECTION - IV

INNOVATIONS IN MARKETING METHODS IN INDIA

We have seen that farmers in India could sell wheat in a market at a time which brought them the maximum gains. However, the quality of marketing methods available could limit the ability of farmers to realise the maximum price from the sale of their produce. We will now look at the Indian experience with the development of modern marketing methods which were commonly used in United States of America and Canada in the early twentieth century.

The methods used for storage of wheat in India, in the early twentieth century, were primitive so that the stored wheat was damaged by insect attacks and deterio-

ration caused by natural factors. Modern facilities for storage of grain in elevators were not used in India at all.

Wheat in India, in this period, was stored in poorly constructed warehouses, in pits, granaries, maintained by exporting firms and the army supply departments. The best means available for storage of wheat were granaries of solid construction maintained by the exporting firms. However, these granaries were used mainly as transit points for export to the British market and did not serve really as storage bins. The army supply department also had storage bins covered by cement from inside. All openings were properly closed so as to block the entry of moisture which caused damage to grain. However, even the granaries maintained by the army supply department could not prevent insect attacks and the damage recorded was as much as twenty per cent.[45]

The more popular means used for storage of wheat in India were warehouses of poor construction and pits.

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45. F. Noel Paton, op.cit., 1913, p. 2.

Both these means of storage could not prevent the entry of moisture and the growth of weevils. Wheat stored in warehouses and pits was invariably damaged.

A number of estimates of damage caused by weevil, the common scourge of Indian wheat, in this period are available. One of the exporters of wheat in India estimated the damage caused by weevils at two and a half per cent of the crop.[46] A merchant in the Lyallpur market estimated the damage caused by weevils at "two seers in the maund" or five per cent of the crop.[47] Lyallpur had a dry climate so that the damage caused by weevils was less in this market. Laboratory experiments were also conducted in this period to observe the rate at which wheat was destroyed by weevils. In one of these experiments conducted in 1907, it was found that nearly 26 per cent of the weight of wheat was lost by the end of three months and altogether 65% of the wheat was

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46. F. Noel Paton, op.cit., 1913, p. 23.

47. F. Noel Paton, op.cit., 1913, p. 23.

affected.[48] The estimates of damage that was caused to wheat when it was stored in pits by farmers are not available but they could be more.

In a situation when enormous damage was caused to wheat by weevil attacks, the farmers had a tendency to sell their produce soon after harvest to prevent losses. As railway transportation facilities developed in the country, the tendency to sell wheat soon after harvest increased. Thus, in the early 1900s, disposal of wheat after harvest was 142¼ per cent of the annual mean reaching upto 180 in the month of June. Later, in 1910s, the corresponding figures were estimated at 163¼ per cent of the mean which increased to 228 per cent of the annual mean in June.[49] Railway mileage in this period increased from 23,628 miles in 1900 to 35,199 miles in 1920.[50]

Although there was a need to establish a system of

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48. F. Noel Paton, op.cit., p. 70.

49. F. Noel Paton, op.cit., p. 12.

50. McAlpin, op.cit., 1982, p. 886.

storage in order to prevent damage of wheat from weevils and to reduce seasonal price fluctuations, India could never install elevators. It was only in 1920 that the first elevator was constructed in Lyallpur at the behest of the Indian government. However, this elevator was shut down because it suffered losses due to its under-utilisation.

The construction of elevators for bulk handling of wheat necessarily requires a concentration of wheat traffic in some places. In three years between 1909 and 1911, it was found that there were twelve railway stations in India from which more than 20,000 tons of wheat was handled in a year and the average traffic was 35,659 tons. There were ten stations which despatched more than 10,000 tons and less than 20,000 tons with an average of 12,916 tons. Another 31 stations handled between 5,000 and 10,000 tons in a year. Considering the fact that the average capacity of elevators was 750 tons in Canada,[51] there were sufficient

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51. F. Noel Paton, op.cit., 1913, p. 108.

number of stations where there was enough wheat traffic to justify the construction of at least one elevator. The lack of concentration of wheat traffic in some areas of India did not, therefore, seem to be a constraint on the construction and operation of elevators.

However, the figures on the quantity of wheat traffic are meaningful only when the quality of the output is more or less uniform. As late as 1928, it was felt that eight different grades would be required for the type of wheat produced in India.[52] Since each elevator could store only a particular grade of wheat, it was the size of a particular type of wheat which was relevant for the construction of an elevator. Moreover, the cost of construction of elevators would go up if bins for each variety were erected. The Royal Commission on Agriculture in India estimated that the costs of construction of 78 elevators

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52. Royal Commission on Agriculture in India, Agricole Publishing Academy, New Delhi, Secheim, 1983, p. 406.

in India, each of a capacity of 3,500 tons, would be over a million pounds.[53]

Another problem in India was that of dealing with a large number of cultivators who could sell only small quantities of wheat. The problems of initiating such a large number of small cultivators to methods of modern marketing could be formidable.

Apart from modern storage methods, the growth of the futures market was also limited in this period. In the period before the first world war, large volumes of surplus wheat was bought by European firms in cash directly from the farmers. The firm located in the port towns could easily communicate directly with up-country traders by means of telegrams and this helped to stabilise the seasonal fluctuations in prices. Since a regular outlet existed for marketing of wheat in this period, no need was felt for an institution which could allow hedging of stocks as a form of insurance.[54]

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53. Royal Commission, op.cit., 1983, p. 407.

54. Report on the Marketing of Wheat in India, op.cit., pp. 267-269.

After the war, however, trading conditions were unsettled and the seasonal fluctuations of prices were erratic. In these conditions, an incipient development of the futures market did take place. The first attempt at organised trading came with the formation of the Sugar and Grain Merchants Association in 1920.[54] However, this association did not, in the beginning, take the responsibility of "futures" transactions. It was only later in 1932 that the "Sugar and Grain Merchants Association" was converted into "The Amritsar Produce Exchange Ltd." where futures transactions could be undertaken.[55]

Between 1929 and 1933, nineteen more associations were formed in Punjab. However, in the period 1934-35, half of these associations were either liquidated or existed in a moribund form.[56] In other parts of India, even this limited development of futures market did not take place.

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54. Report on the Marketing of Wheat, Ibid.

55. Report on the Marketing of Wheat in India, Ibid.

56. Report on the Marketing of Wheat in India, Ibid.

Where a limited development of futures market did take place, prices of wheat stabilised. When "spot" prices were low as in 1931 and in 1934-35, the "futures" price quotations were generally higher. On the other hand, when "spot" prices were relatively higher as in 1932 and 1933, the "futures" quotations were generally below those for "spot" wheat.[57]

Moremover, the development of future market encouraged the standardisation of the quality of wheat. Futures contracts specified the maximum percentage of dirt and other admixtures which could be tolerated in wheat. Thus, the tolerance for dirt in wheat varied from "nothing" to as much as 3%.[58] The tolerance limit for barley and other admixtures varied from 2% to 6% in Punjab's futures markets.[59]

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57. Report on the Marketing of Wheat in India, op.cit., p. 106.

58. Report on Marketing of Wheat in India, op.cit., p. 188.

59. Report on Marketing of Wheat in India, Ibid., p. 188.

In the absence of the futures market, grading of wheat was done by some crude traditional methods. Cultivators, who grew superior varieties of wheat, separated the output of these seeds from the wheat that was produced from inferior varieties. A retailer could separate grain on the basis of its cleanliness. In Punjab and Northern India, wheat of varying quality was mixed and sold as wheat of "fair average quality". There were other contracts such as the mills' contracts which specified the type of bags, terms of delivery, repacking and terms of payment. Exporters insisted on the supply of wheat by the standards specified by what were called the "Karachi Pass".[60]

The ability of banks to advance loans to farmers was also limited by the inadequate development of storage capacity. Banks could advance money against the security of wheat in storage. To the extent that wheat was damaged when stored in traditional ways, it was difficult for a

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60. Discussion on Traditional Methods of Grading is based on Report on the Marketing of Wheat in India, op.cit., pp. 183-188.

banker to advance money. A banker, at this time, assessed the situation as follows: "We do some times advance money on wheat. People come to us with this business, but as they store their wheat in kothas (ordinary rooms), we have to run the risk of the grain being weevilled and the quality and quantity is never certain, but if there are large granaries under proper management, certainly we will have more confidence than at present, and they would save us the present trouble we have in managing this business".[61]

CONCLUSION

We have seen that the centre piece of the development of new marketing methods in the early twentieth century was the elevator system. That a complex network of elevators also encouraged the development of futures markets, grading of wheat ~~of wheat~~ and financing of stocks by banks. With the development of this entire system of

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61. Report of the Wheat Elevator Committee, 1909, Appendix No. IX, Evidence of Lala Harkishan Lal, Bar-at-Law, Lahore.

marketing in especially USA and Canada, farmers were protected from losses they could incur from seasonal price fluctuations, from improper grading of quality etc. That, under these conditions, farmers could afford to stock their goods and sell them at the maximum price available in the season. Traders, under these conditions, could earn only a nominal rate of return. Where these marketing methods were absent, the quantity of goods farmers brought to the market was governed more by the quantity of wheat produced than by the available price.

In India, farmers' decision to sell in his product was not necessarily governed by the compulsions of debt and other obligations. Indian farmers were capable of selling their wheat in the nearest central markets where they could get higher prices or within the village itself if the prevailing prices brought them the desired return. If Indian farmers chose to sell their market within the village, this was often because selling charges in central markets were prohibitive or the means of communication were inadequate. In short, the lack of development of an

efficient marketing system acted as a constraint on a farmer's ability to sell his product at the maximum price possible.

In India, the modern elevator system did not develop in this period. This was, it seems, due to the lack of uniformity in the quality of the wheat supplied and the problems involved in dealing with a large number of small cultivators. Other modern marketing methods such as the futures market, grading of wheat and financing of stocks ~~was~~ also could not ~~possible~~ be used because of the inadequate development of storage methods.

CHAPTER V

CONCLUSIONS

CONCLUSION

In our thesis, we began by observing the paradox that farmers in India, in the late nineteenth century and early twentieth century, could show both rational and irrational economic behaviour. The data on the variations of farm supply to fluctuations in relative prices shows that peasants sometimes do take advantage of market opportunities while in other cases this is not true. Our study attempts to explain this contradictory economic behaviour of peasants.

In our thesis, we have argued that farmers operate under constraints which limit their choices and their capacity to take full advantage of the opportunities created by a market economy for making economic gains. That the peasantry does show an increasingly rational economic behaviour when some of the constraints are removed. The expansion of railways, for example, increased the number of markets for the purchase of foodgrains and reduced the need to produce them for self-consumption. Once the necessity to produce foodgrains for self-consumption was reduced, farmers could more freely decide to grow the most profitable crops.

In our study, we have shown the limitations imposed by available technology on the rationality of peasant economic behaviour. Technical change can increase farmers' returns by improving the quality of farm production, increase productivity, reduce costs of production and provide better means to store produced output. In our thesis, we dealt with mainly the impact of technical change on quality of wheat produced and on the means used for storage of wheat.

In the case of wheat economy, changes in milling and baking technology increased the demand for better quality hard varieties of wheats. Those countries, which could produce these types of wheat, were the ones who increased their supply in the world market for wheat in Great Britain. Secondly, we have shown that the success achieved in selection and hybridization of improved varieties in agricultural experiment stations was an important factor which influenced the capacity of a farmer to respond rationally to market opportunities. Finally, the extent of development of modern methods of bulk handling of wheat and associated institutions affected the efficiency of marketing of wheat and thereby the ability of a farmer to respond rationally to commercial opportunities.

The capacity of Indian wheat farmers to take full advantage of economic opportunities, in the world wheat market in Great Britain, was limited by their inability to grow hard varieties of wheat on a large scale. While climatic conditions existed in India for cultivation of hard varieties, farmers in India did not have a specific breed of wheat which could be grown on large tracts of land under varying climatic conditions. Under these circumstances, Indian farmers could produce only soft varieties of wheat and cater to the limited demand for these types of wheat in the market in Great Britain.

The Pusa varieties of wheat were one of the first hard varieties of wheat developed in India by means of selection which had an inherent strength to allow them to be grown over large tracts of land under varying climatic conditions. The use of Pusa varieties of wheat began only in 1916-17 and the share of acreage brought under the cultivation of these varieties in the total wheat acreage increased over time. Apart from bringing better returns to farmers, the Pusa varieties of wheat also protected farmers from price depressions. The increase in acreage under the Pusa varieties of wheat indicates the role

technical change plays in increasing the capacity for rational behaviour among farmers. However, the efforts to develop new varieties of wheat by means of hybridisation did not meet with any success in India and Pusa varieties of wheat had a limited impact on wheat cultivation in India. The increased valuation which could have come from a large standardised output could not, therefore, be realised.

In the case of marketing of wheat, we find that Indian farmers were capable of selling their wheat in markets which brought them the highest returns. However, high selling costs often prevented farmers from seeking the highest prices in central markets. Furthermore, Indian farmers sold their output soon after the harvest to prevent any damage of their crop by insect attacks. The modern means of storage did not develop in India because the wheat supplied varied a lot in its quality and would have required very high capital costs for the construction of bins to store each of these varieties of wheat. Furthermore, it would have been difficult to receive sufficiently large quantities of wheat of each grade of wheat.

APPENDIX I

THE LENGTH OF THE GROWING SEASON AND THE QUALITY OF WHEAT

Interval Number	Condition of sampling	Protein %	Carbohydrate %
1.	Grain set	35.6	52.4
2.		29.5	59.9
3.		26.8	63.2
4.	Grain in mill	21.3	69.1
5.		18.4	73.1
6.		14.9	77.5
7.		14.5	78.5
8.		12.2	80.8
9.	Grain doughy	12.2	81.8
10.		12.7	80.7
11.		11.8	81.8
12.		11.8	82.0
13.		11.7	82.0
14.	Getting hard	11.8	81.9
15		11.9	81.8
16		12.4	81.6

Source - C.O.Swanson, Wheat and Flour Quality, 1936, p83.

Notes: (1) Interval numbers indicate the number of weeks in the growing season.

(2) Carbohydrates indicates the starch content.

APPENDIX II

QUALITY AND YIELD OF A WHEAT PLANT

Yield/grams per plant	Nitrogen (%)
5.81	1.35
2.74	1.80
8.95	2.12
7.34	2.39
8.08	2.63
5.91	2.85
4.45	3.11
4.68	3.37
3.65	3.68
4.54	4.72

Source - C.O.Swanson, Wheat and Flour Quality, 1936.

Notes: (1) Nitrogen indicates the protein content

(2) The table shows the inverse relationship between protein content and the yield of wheat.

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