THE ROLE OF CO-OPERATIVE CREDIT IN SMALL FARMER
ADOPTION OF THE NEW CEREAL VARIETIES IN INDIA

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I. Introduction

A large number of micro studies have shown that small farmers have
lagged in adoption of the new seed varieties, and that there is a close
relationship between adoption by small farmers and use of co-operative
credit in many areas.[1] Co-operatives are also becoming the most important
source of agricultural credit.[2] However, the importance of co-operative
credit in adoption is not universal and many aspects of this relationship
are ill-defined. This paper will examine four main questions to bring
the issues more sharply into focus.

1. How important is co-operative credit relative to other
    factors in the adoption process?

2. Under what conditions, or at what stage of the adoption
    process, does credit become a critical factor in adoption?

3. Why are small farmers dependent on co-operative credit
    for adoption rather than on credit from moneylenders or
    other traditional sources?

4. Are demand or supply constraints critical in expansion
    of co-operative credit to small farmers for adoption
    of new varieties?

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[1]For a summary of findings of studies by the Agro-Economic Research
Centres and the Programme Evaluation Organization see M. Schluter and
J.W. Mellor, "New Seed Varieties and the Small Farm", Economic and
Political Weekly, Review of Agriculture, Vol. VII, No. 13, March 25, 1972,
p. A-35.

[2]Between 1961-66 and 1970-71, the share of institutional credit
in total agricultural credit increased from 18.7% to 40%. See H.C. Jain,
"Growth and Recent Trends in Institutional Credit in India", papers,
Indian Journal of Agricultural Economics, Vol. 26, No. 4, Oct.-Dec.,
1971, p. 555.

First, we examine the role of co-operative credit in the overall demand and supply of capital, to understand conceptually why and when co-operative credit is likely to be important in the adoption process. Then, to answer question 1, we examine at a micro level factors governing the adoption of hybrid bajra and high-yielding wheat varieties in North Gujarat, and those influencing adoption of high-yielding paddy and wheat varieties in South Gujarat. Survey data for cropping pattern, use of inputs and use of co-operative credit, collected from 225 farmers in Mehsana District, North Gujarat in 1969-70,[1] and from 120 farmers in Surat District, South Gujarat in 1971-72,[2] form the basis of this part of the analysis. For questions 2 and 3, the results of a large number of micro studies will be examined in an attempt to establish some tentative macro propositions. Some comments on question 4 are made in the conclusions.

Attention is confined to the role of short-term co-operative credit for farmers with the necessary infrastructure to adopt new varieties. The provision of medium or long-term credit to small farmers, so that they may obtain the necessary infrastructure and thus adopt, is a separate issue not handled in this paper.

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[1]Data used in this analysis are taken from an unpublished paper, Michael G.G. Schluter and Gokul O. Parikh, "The Interaction of Co-operative Credit and Uncertainty in Small Farmer Adoption of the New Cereal Varieties".

[2]Data collected as part of doctoral research from Cornell University on the subject, "Raising Incomes of Small Farmers in India".

II. The Conceptual Framework

The situation faced by the individual farmer is illustrated in figure 1.

We assume here that farmers use what is available from other sources before using co-operative credit. Also we assume that the supply from sources other than co-operatives is perfectly inelastic with increasing costs of cultivation. The realism of these assumptions is discussed in Sections IV and V.

BS_2 which represents the supply of co-operative credit slopes upwards because under the crop loan system, the amount a farmer can borrow is related to cost of cultivation. However, the slope of BS_2 is not as steep as OC because co-operative crop loans are inadequate to meet full cash costs of cultivation.

Prior to adoption, we suggest small farmers lie to the left of A, so that there is no demand for co-operative credit. A farmer can meet costs of cultivation from own funds and traditional sources of credit, as he has in the past. There is evidence from both Surat and Mehsana to support this. In Mehsana, only 50% of small farmers[1] had joined the co-operative, and only 29% had taken loans.[2] The main reasons given by small farmers both for non-membership and non-borrowing was adequate income and past-saving, and non-farm sources of income (See Appendix Table 10). In Surat, two adjacent areas were surveyed, both well covered by efficient co-operatives, but with the difference that in one and not the other there were irrigation facilities and the new technology had been introduced. In the irrigated area, 77% of small farmers had joined the co-operative, whereas only 28% had joined in the other area. This suggests that with adoption of the new technology, which results in a high percentage increase in costs of cultivation (See Tables 7 and 8 following), the demand for capital moves to the right of A, so that small farmers as well as large farmers then demand co-operative credit.

We suggest that the decision to adopt the new varieties is based mainly on a farmer's assessment of the degree of profitability and uncertainty, but ability to adopt may be influenced by the supply of co-operative credit. In areas of inefficient co-operative societies, or where societies discriminate against small farmers in distribution of loans, a farmer's supply of capital may be relatively inelastic. In these situations and where there is still a high degree of uncertainty so that the profitability is not firmly established, we suggest small farmers with access to adequate institutional credit will adopt more rapidly than those without.

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[1]Defined here arbitarily as those less than five acres.

[2]See Appendix Table 9.

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FIGURE 1. THE PLACE OF COOPERATIVE CREDIT IN THE
            SMALL FARMERS DEMAND AND SUPPLY OF
            CAPITAL
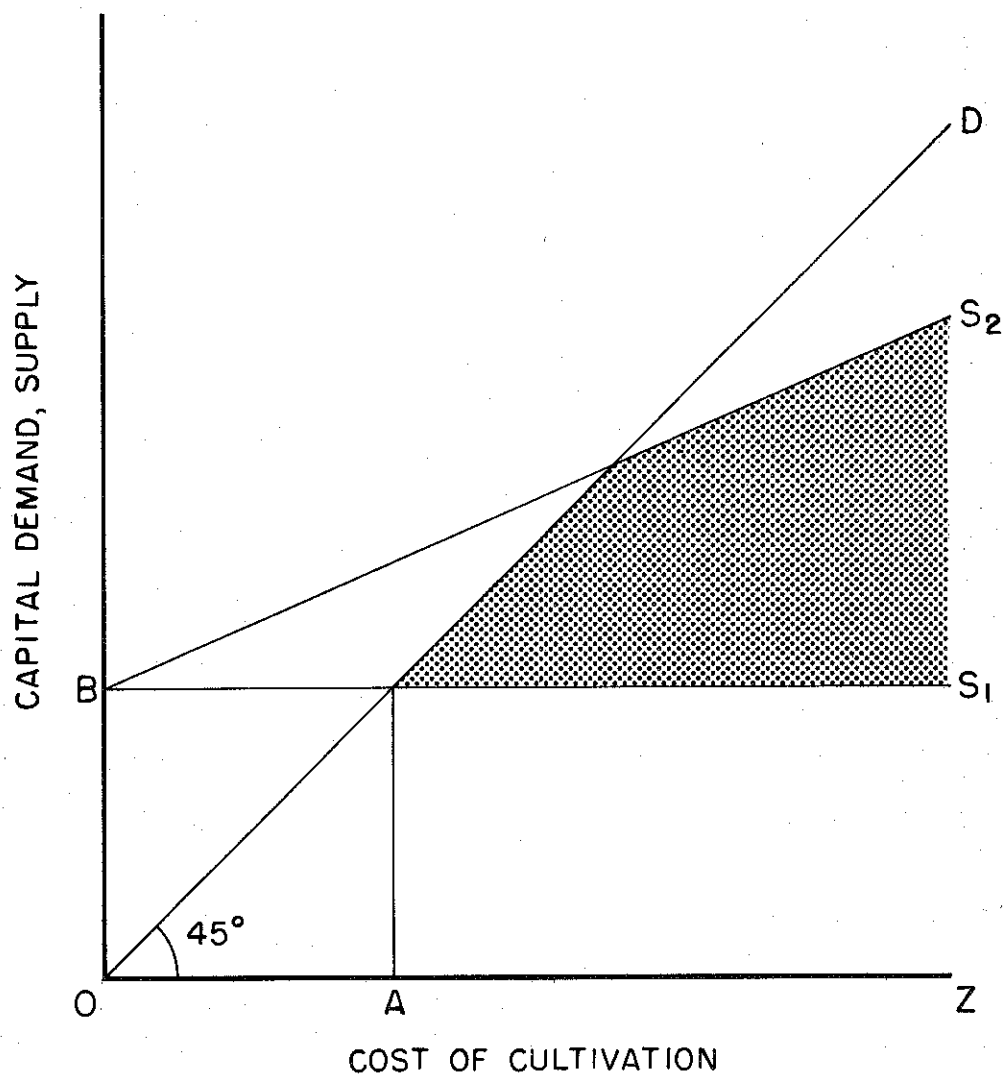
Where, OD   is demand for capital

       BS_1 is the supply of funds available from savings, and
             borrowable for production from friends, relatives,
             moneylenders and traders

       OBS_2 is the total supply of capital, including what is
             available from the co-operatives

The shaded area shows the demand for co-operative credit.

III. Factors Governing Adoption

South and North Gujarat form a contrast in terms of agro-climatic conditions, cropping pattern and development of infrastructure. In Mehsana District in North Gujarat, farmers depend for water on well-irrigation and uncertain rainfall, and principal crops are bajra, wheat and spices; in Surat District in South Gujarat, with canal irrigation and heavy and relatively assured rainfall, paddy and sugarcane predominate. In both regions, some of the villages were well served by co-operatives, and others not.

Th high-yielding rice variety, Masuri, was first grown by farmers in Surat District in 1968-69 and by the year of survey, 1971-72, it had spread over a major part of the irrigated rice area. High-yielding wheat varieties had been introduced as early as 1966-67 but by 1971-72, only 30% of farmers were growing these varieties, although most farmers had changed from local to local improved varieties. Differences in costs of cultivation and rates of returns between desi and improved varieties of wheat were negligible, so we examine here adoption of S-227 and Sonakalyan for which costs of cultivation and returns were substantially greater than those for the other varieties.[1] In the case of both hybrid bajra and high-yielding wheat varieties in Mehsana district, the new varieties had been introduced in 1966-67. By 1969-70, 50% of bajra growers were growing hybrid bajra whereas only 21% of wheat growers had adopted the new wheat varieties.

The Regression Model

The model used for the analysis was as follows:

$$Y = A + b_1 X_1 + b_2 X_2 + b_3 X_3 \ldots \ldots + b_{10} X_{10}$$

where,

Y = Area under the New variety (in acres)
X_1 = Area under the Crop (in acres)
X_2 = Gross Cropped Area (in acres)
X_3 = Credit Available from the Co-operative (in '000Rs.)
X_4 = Non-Agricultural Income (in '000 Rs.)
X_5 = Dairying Income (in '000 Rs.)
X_6 = Non-Farm Assets (in '000 Rs.)
X_7 = Availability of Family Labour for Farm Work (No. of adult equivalents)
X_8 = Education of Family Decision-Maker (in years)
X_9 = Home Consumption Requirements (in units of 20 kg.)
X_{10} = Value of Kharif Crop Sales (only for HYV wheat, Surat)

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[1] A study of Saharanpur District in Uttar Pradesh with respect to local improved varieties had similar findings. See D.P. Gupta, "A Study of Maxican Wheat in Saharanpur District, (U.P.), Rabi 1967-68", Agro-Economic Research Centre, University of Delhi, 1968.

and A and the b_is are unknown parameters to be estimated.

The obvious dependent variable for an analysis of differences in adoption behaviour between farmers is the percentage of a crop's acreage put under the varieties. But since most farmers have either 0% under the new varieties or 100%, this variable does not follow a normal distribution and hence cannot be used as the dependent variable in a regression framework. To overcome this problem, acreage under the new variety has been made the dependent variable, with X_1 acreage potentially available for the new variety.

Implicit is the assumption that acreage under a new variety is independent of acreage put under other crops. To test this, we examined the relationship of acreage under new varieties in Surat with acreage under sugarcane, the chief alternative to a paddy and wheat combination. Since no relationship was found, we excluded this from the final model.

Gross cropped acreage and net cultivated acreage gave similar results in the regression analysis. The former is used as it is more closely correlated with farms' income-generating capacity.

Since data for the value of farmers' savings available for production purposes could not be estimated reliably, we used credit availability from co-operatives rather than capital availability in the model. The close relationship observed in many areas between borrowings from co-operatives and adoption does not reveal whether those with access to this credit adopted, or whether those willing to adopt obtain this credit.[1] In this analysis, we examine specifically the former; with acreage under the new variety as the dependent variable, and availability of co-operative credit as an independent variable, we examine the influence of co-operative credit on the degree of adoption.

Non-agricultural income and dairying are both thought to influence adoption.[2] The supplementary income they provide is a source of both capital and risk-bearing capacity. Non-farm assets[3], however, add

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[1] See Michael Schluter and John W. Mellor, op.cit.

[2] See Michael G.G. Schluter and Richard W. Longhurst, "Some Aspects of the Suitability of High-Yielding Rice and Bajra Varieties for the Small Farm, Thanjavur and Mehsana Districts, India", Occasional Paper No. 57, Department of Agricultural Economics, Cornell University USAID-Employment and Income Distribution Project, 1972.

[3] The correlation of non-farm assets with total assets is 0.95.

only to risk-bearing capacity while the value of kharif crop sales adds
only to capital availability.[1] New varieties also result in an increased
demand for labour,[2] so that the availability of family labour may influ-
ence adoption. There is a prima facie case for including all these
variables in the model.

Farmers with a relatively large home consumption requirement who
are willing to consume inferior varieties of cereals benefit substantially
from the new technology, especially when the prices of the new varieties
are considerably lower than for traditional varieties. This may be
illustrated for Kollam (local improved) and Masuri (high-yielding)
varieties for Surat district as follows:

	Yield/acre in kgs.	Price per 100 kgs. (Rs.)
Masuri	1500	70
Kollam	1000	90

Gross Income from Crop Sales	Kollam	Masuri
If no home consumption	9,000	10,500
If 500 kg. for home consumption	4,500	7,000
If 1000 kg. for home consumption	0	3,500

The greater the market orientation of the local economy, the less
this holds as farmers may sell the higher quality cereal and buy the
inferior variety.

Educational level is included as it determines a farmer's ability to
understand the complex changes in agronomic practices required for adop-
tion to be profitable. Farmers' age was found to bear no relation to
adoption in any of areas studied and was excluded from the final model.

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[1] 95% of crop sales of sample farmers in Surat in 1971-72 took place
at the end of the kharif season.

[2] See for example, R.N. Tripathy and B. Samuel, "Economics of
high-yielding varieties in IADP; a study in Orissa", Economic and
Political Weekly, Oct. 25, 1969, p. 1719-1724.

A. Adoption of High-yielding Rice Varieties in Surat District, 1971-72.

The results of the estimated equation for adoption of high-yielding rice varieties (Masuri and two cases of IR-8) are shown in Table 1.

Table 1. Estimated Linear Regression for Factors Influencing Adoption of High Yielding Rice Varieties in Surat District 1971-72.

Factors	Regression coefficient	Std. error of coefficient	t-value
Acreage under Irrigated Rice[1]	0.6607	0.1003	6.59**
Gross Cropped Acreage	-0.0563	0.0259	-2.17*
Credit Available from Co-operatives[2]	0.1822	0.0902	2.02*
Non-agricultural Income	0.0886	0.0644	1.38
Dairying Income	0.1001	0.0662	1.54
Non-farm Assets	0.0200	0.0079	2.52**
No. of Family Members Available for Farm Work	0.0113	0.1085	0.10
Education of Family Decision-maker	0.0054	0.0461	-0.12
Home Consumption Requirement	0.0051	0.0097	0.53

$R^2 = 0.76$ No. of observations (farmers) = 58

*Significant at 5% level.   **Significant at 1% level.

[1]Only farmers using canal irrigation were included. Masuri as a long duration variety has a very high water requirement so that no farmer using well irrigation, or pumping water directly from the main canal, found it profitable to adopt Masuri.

[2]Defined here and in Table 3 as the maximum amount the co-operative society said it would be willing to lend the farmer for variable inputs, based on acreage, cropping pattern, assets, and character of the farmer.

There is an inverse relationship between adoption of Masuri and gross cropped acreage (or net cultivated acreage). This relationship did not exist in the early stages of adoption, as is clear from Table 2.

Table 2. Percentage of Farmers Adopting High-yielding Rice Varieties by Farm Size, 1968-69 to 1972-73.

Net Cultivated Acreage	1968-69	1969-70	1970-71	1971-72	1972-73
0 - 1.99	0%	0%	50%	65%	55%
2.0 - 4.99	4%	46%	74%	65%	74%
5.0 - 9.99	21%	43%	61%	61%	71%
10 and above	20%	36%	82%	82%	82%

At a relatively late stage in the adoption process, small farmers may be more willing to adopt than large farmers as they have a greater propensity to consume inferior cereal varieties. Adoption will also represent a greater proportional increase in their income, since a greater part of their acreage is devoted to foodgrains.[1]

Availability of co-operative credit was a significant factor in the decision to adopt, even when all other relevant factors are considered simultaneously. From Table 11 in Appendix A, which gives data for the percentage of farmers adopting over time in villages where almost every farmer had access to co-operative credit, it is clear that there was a marked positive relationship between adoption and farm size in the first year the new varieties were introduced. It is only after small farmers have assessed the uncertainty involved in adoption, that they become willing to adopt and availability of co-operative credit becomes a significant factor in adoption behaviour.

The farmer's risk-bearing capacity reflected by the value of his non-farm assets, was also important in adoption. Masuri involves uncertainty because, being a late variety, farmers are uncertain whether they

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[1]J.H. Adhvarya and Gokul O. Parikh, "Studies into the Economics of Farm Management in the I.A.D.P. Region of Surat and Bulsar. Report for the Year 1967-68", Farm Management Centre, Sardar Patel University, Vallabh Vidyanager, 1969.

will be able to sow in time the rabi crops (especially wheat and val[1]).
However, both dairying and non-agricultural income had positive but not
significant relationships with adoption.

B. Adoption of High-yielding Wheat Varieties in Surat District 1971-72

The estimated linear regression for adoption of high-yielding wheat
varieties (S-227 and Sonalika) are shown in Table 3.

Table 3. Estimated Linear Regression for Factors Influencing Adoption of
High Yielding Wheat Varieties in Surat District 1971-72.

Factor	Regression coeffient	St. error of coefficient	t-value
Acreage under wheat	0.5408	0.1410	3.84**
Gross cropped acreage	0.0056	0.0191	0.29
Credit available from co-operative	-0.1142	0.0727	-1.57
Non-agricultural income	-0.0161	0.0126	-1.28
Dairying income	0.0731	0.0748	1.53
Non-farm assets	0.0049	0.0055	-0.89
No. of family members available for farm work	0.0094	0.0127	-0.74
Education of family decision-maker	0.0763	0.0236	3.23**
Home consumption requirement	0.0090	0.0162	0.55
Value of kharif crop sales	-0.0301	0.0403	-0.75

r^2 = 0.54   No. of observations (farmers) = 54

** Significant at 1% level

[1]A pulse crop grown mainly in South Gujarat and Maharashtra.

Acreage under high-yielding wheat varieties is not significantly related with non-farm assets as in the case of paddy, nor with non-agricultural income. New wheat varieties grown under rabi conditions involve a much lower element of uncertainty than new paddy or bajra varieties under kharif conditions. The vagaries of the monsoon add an element of uncertainty to kharif paddy which is not present in the cultivation of rabi wheat. The relative absence of risk is probably the main reason for the lack of relationship between acreage under new wheat varieties and farm size, here again measured as gross cropped acreage.[1]

Availability of co-operative credit, significant in adoption of Masuri, is not significant in adoption of the new wheat varieties. The amount of additional credit needed to change from traditional to new varieties in the case of wheat is greater than in the case of paddy. (See data for costs of cultivation in Table 8 following.) But credit availability is of much less importance for rabi crops, as farmers can generally rely on their own funds after recent sales of the kharif crop. Also, since new wheat varieties involve relatively little risk, farmers may be more willing to commit their own funds to the innovation. The lack of a significant relationship between the value of kharif sales and acreage under S-277 probably indicates that for all farmers the value of sales from crops was adequate to finance the new variety.

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[1]Over a large number of studies, a lack of relationship between adoption and farm size has been observed in the case of new wheat varieties. See Michael Schluter and John W. Mellor, op.cit.

C. Adoption of Hybrid Bajra in Mehsana District in 1969-70

The results of the estimated linear regression for adoption of hybrid bajra are shown in Table 4.

Table 4. Estimated Linear Regression for Factors Influencing Adoption of Hybrid Bajra in Mehsana District 1969-70

Factor	Regression coefficient	St. error of coefficient	t - value
Acreage under bajra	0.2810	0.0546	5.14**
Gross cropped irrigated acreage	0.0860	0.0361	2.24*
Credit available from co-operative[1]	0.2542	0.0813	3.13**
Non-agricultural income	0.2233	0.1594	1.40
Dairying income	0.0547	0.0174	3.15**
Number of family members available for farm work	0.1616	0.1689	0.96
Literacy of family decision-maker[2]	0.5589	0.3759	1.49
Home consumption requirement for bajra	0.0059	0.0016	3.77**

r^2 = 0.43   No. of observation (farmers) = 212

* Significant at 5% level   ** Significant at 1% level

[1] Defined here and in Table 5 as the maximum amount a farmer can borrow from the co-operative under the crop loan system with his existing cropping pattern, assuming he puts his whole bajra (wheat) acreage under bajra (high-yielding wheat).

[2] For computations, literate = 1, illiterate = 0.

These data indicate that dairying income was a significant factor in adoption of hybrid bajra whereas the influence of non-agricultural income is not as clearly defined. The difference between these two sources of income lies in their relationship with the farming enterprise. Farmers with a dairy herd have greater availability of organic manure, facilitating the use of higher doses of chemical fertilizers, and benefit more from the increased bye-product of a higher yield. Perhaps more important, they are more committed to making a success of their farming enterprise; those with non-agricultural income may have greater opportunities to invest off the farm.

Availability of co-operative credit was closely related to adoption of hybrid bajra. As with paddy, there was a high degree of risk involved in adoption of this variety, owing both to weather uncertainity and the relatively recent introduction of the variety. We may note that co-operative credit plays a particularly important role in situations of a high degree of uncertainity, when small farmers have begun to adopt.[1]

Gross cropped irrigated acreage was significantly related to adoption of hybrid bajra, although gross cropped acreage was found to be non-significant in an earlier model. The variables differ in that while both are correlated with the size of farm income, the former indicates what may be expected with some degree of certainty. The certainty of income from whatever source is crucial in adoption of new varieties.

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[1]To be discussed in greater detail in Sections IV and V.

D. Adoption of High-yielding Wheat Varieties in Mehsana District 1969-70

The results of the estimated linear regression for adoption of high-yielding wheat varieties in Mehsana are shown in Table 5.

Table 5. Estimated Linear Regression for Factors Influencing Adoption of High-yielding Wheat Varieties in Mehsana District, 1969-70

Factor	Regression coefficient	St. error of coefficient	t-value
Acreage under wheat	1.4113	0.3660	3.86 **
Gross cropped acreage	-0.0757	0.0580	-1.29
Credit available from co-operative	0.2280	0.2682	0.85
Non-agricultural income	0.0645	0.0512	0.13
Dairying income	0.1359	0.0558	2.44 **
No. of family members available for farm work	-0.1726	0.5159	-0.33
Literacy of family decision-maker	0.0300	1.2070	0.02
Home consumption requirement	0.0157	0.0074	2.12 *

$r^2 = 0.12$ No. of observations (farmers) = 165

* Significant at 5% level   ** Significant at 1% level

Availability of co-operative credit was not a significant variable in explaining adoption of the new wheat varieties in either Mehsana or Surat. Nor is there a significant relationship between adoption and gross cropped acreage in either area; if anything, there is an inverse relationship. The greater availability of funds in the rabi season after recent kharif sales, so that farmers can rely on their own funds to a great extent, probably accounts for these findings. The risk element, however, cannot be ruled out even by 1969-70. Farmers were still wary of adoption, as indicated by the fact that only 21% of wheat growers had adopted the new varieties. It is in this context that we may understand the signi- ficance of the coefficient for dairying income; inter alia, the

supplementary income from dairying helps farmers bear risk in their crop enterprises.

Overall Assessment

Family Labour Availability

In none of the above functions was availability of family labour found to be a significant factor in adoption behaviour. We may note that the new varieties require additional labour mainly for harvesting and threshing operations, and for transplanting in the case of paddy.[1] These are generally time-bound so that farmers have to hire the additional labour required rather than being able to take advantage of their underemployed family labour. The additional labour requirement thus becomes largely a capital cost and increases the demand for credit on all farms. Partial exceptions to this are cases such as Thanjavur where adoption of new varieties facilitates a change to double cropping, substantially increasing the opportunity for small farmers to use available family labour. With the new variety, ADT-27, also being a very hardy variety, it is not surprising that small farmers adopted very quickly and on a large part of their rice acreage in Thanjavur.[2]

Risk-bearing Capacity

The importance of both non-farm assets in adoption of Masuri in Surat District, and supplementary income from dairying for both hybrid bajra and new wheat varieties in Mehsana, underlines the importance of risk-bearing capacity as a factor in adoption. Uncertainty may arise from the weather, lack of knowledge about methods of cultivation, ignorance of yield response of a new variety under differing conditions, or even difficulty in growing a second crop as in the case of the long-duration Mauri rice variety in Surat District.

Non-agricultural Income

Non-agricultural income did not lead to higher levels of adoption in any of the four cases studied: we suggest that this may be because those with this additional income consume and therefore grow, the higher quality traditional varieties, and because other investment opportunities off the farm become available. In contrast, those with dairying income

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[1]See G.O. Parikh and R.D. Sevak, "Relative Profitability of Improved and Deshi Wheat: A Case Study," *Industrial March*, January-March 1971, pp. 48-50 and R.N. Tripathy and B. Samuel, *op. cit.*

[2]See Michael G.G. Schluter and R. Longhurst, *op. cit.*

are more inclined to adopt because they are more dependent on their
farm as a means of livelihood and owing to the complex inter-relation-
ships between dairying and crop enterprises.

Home Consumption Requirement

Home consumption requirement was a significant variable for
adoption of both new varieties in Mehsana, and for neither in Surat.
There may be two reasons for this. The Mehsana data relate to an earlier
point in the adoption process when a large home consumption requirement
gives greater incentive to take the risk of adoption. Also, the villages
in Mehsana are much more subsistence orientated than in Surat, so that
the advantage of a yield increasing technology for those willing to
consume inferior quality cereals is most clearly apparent.

Co-operative Credit

It is in the context of the factors listed above that we must
assess the importance of co-operative credit as a factor in a farmer's
decision to adopt the new varieties. Availability of co-operative
credit was found to be a significant variable for paddy and bajra,
where the risk element is most obvious. It was not significant for
wheat in either district. This suggests that co-operative credit plays
its most important role under conditions of uncertainty, and in
situations where a farmer is forced to borrow in order to adopt, and
cannot rely on his own funds. The reasons underlying this phenomenon
are discussed in Section IV.

Profitability

A much larger number of studies is required to determine how
profitability affects adoption on small farms. Table 6 shows the rela-
tionship between borrowing and profitability in the adoption behaviour
of small farmers over a number of districts.

Table 6. Profitability and Small Farmer Adoption of New Rice Varieties
1966-1968

District	Year	Main variety	% increase in capital required	Increased borrowing as % of increased capital requirement	Rate of return on additional capital employed	% of small farmers adopting
Cuttack (7)	1966	TN-1	261	NA	126	10
A district of Maharashtra (20)	1966	TN-1	54	51	-72	36
Varanasi (1)	1967	TN-1	27	50	-171	23
Thanjavur (17)	1967	ADT-27	31	248	302	High
Birbhum[1] (13)	1968	IR-8	658	34	71	75
W. Godavari (2)	1968	IR-8	54	25	33	10
E. Godavari (2)	1968	IR-8	45	42	-3	16
W. Godavari (3) (rabi)	1968	IR-8	41	-25	172	59
E. Godavari (3) (rabi)	1968	IR-8	50	53	243	39

Figures in parentheses indicate sources (See Appendix A)

In all cases except Cuttack District, in Orissa, a high rate of
return (over 30%) is associated with a medium (25%-30%) or high
(over 50%) level of participation by small farmers. Cuttack is a special
case since it was the first year of the new variety so that uncertainty
would have been the dominant factor. There is no such obvious relation-
ship between borrowing and small-farmer participation, although the
higher level of adoption amongst small farmers in East Godavari than
West Godavari in the kharif season of 1968-69 may be due to the greater
coverage of credit needs by the co-operatives. The lesser dependence on

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[1] Refers to cash costs of cultivation only.

co-operative credit in the rabi season is well illustrated by the lack
of relationship between co-operative credit and adoption by small
farmers in these two districts in the rabi season. The high costs of
cultivation and low proportion of additional costs in Birbhum did not
deter small farmers from adopting, nor did the low additional capital
requirement and greater availability of co-operative credit lead to
a high level of adoption by small farmers in Varanasi. Profitability
is a precondition for a high level of adoption by small farmers, who
want to examine returns before committing themselves to an innovation.

IV. The Importance of Credit in Adoption

Evidence for the importance of credit in adoption is conflicting at first sight. In a study which examines data for a large number of micro studies, mainly for the period 1966 and 1967, the authors conclude:

"the owned funds of the sample cultivators needed to be supplemented only marginally by borrowings in order to meet the input expenses of high-yielding varieties".[1]

On the other hand, a survey of an equally large number of micro-studies covering a slightly later period "indicate a close relation between use of co-operative credit and adoption"[2] and a survey of micro studies of new rice varieties in South India concludes:

"the increased cash expenditure on HYV paddy was met by a higher level of borrowings by participant farmers. Much of the enhanced credit requirements of the participants were supplied by the co-operatives".[3]

We suggest the hypothesis that co-operative credit plays an important role in adoption at the point when small farmers begin to adopt new varieties, and large farmers expand their acreage under new varieties beyond the initial trial stage. In Surat district, in the early stages of adoption, only large farmers experimented with the new varieties and they put only a small proportion of the crop's acreage under the new seeds. Over a two or three year period, small farmers began to adopt and large farmers expanded acreage under the new varieties considerably. Thus, initially farmers' additional credit requirements, as a per cent of the total credit used on the farm, is very small. It is only in the secondary stages of the adoption process that large and small farmers alike require a quantity of capital that represents a significantly large proportional increase.

Obviously, the role of co-operative credit is also dependent on coverage by co-operatives. In areas well covered by societies, the

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[1]Mahendra D. Desai and Bharat D. Naik, "Prospects of Demand for Short-term Institutional Credit for High-Yielding Varieties", Indian Journal of Agricultural Economics, Conference Number, Vol. XVI, No. 4

[2]M. Schluter and J.W. Mellor, op. cit.

[3]C. Muttiah, "The Green Revolution - Participation by Small Versus Large Farmers", paper presented at Seminar on Rural Development for Weaker Sections, Indian Institute of Management, Ahmedabad, October 1972.

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role of co-operative credit is likely to be considerable,[1] whereas in
areas of poor coverage the role of co-operatives is bound to be more
limited at whatever stage in the adoption process.[2]

Co-operative credit has an especially important role for the
small farmer. This is also brought out by two of the comprehensive
surveys mentioned above. Rather than reproducing the data from all the
individual studies, we again quote the main conclusions. After noting
that increased cash expenditure on high-yielding varieties were met
mainly from co-operative credit, Mr. Muttiah concludes:

"among the participants, the borrowings per acre of
HYV paddy were found to be consistently higher among small
farmers excepting in Thanjavar which has a large proportion
of tenants who are not favoured by the village co-operatives"[3]

and from the second study:

"the results of this analysis suggest that a few of
those with small farms obtain co-operative credit but those
who do meet a relatively high proportion of their cash expen-
diture from this source. It is these farms which adopt the
new varieties".[4]

In areas well served by co-operatives, their credit is especially
important for small farmers, at a secondary stage in the adoption
process when farmers have assessed the risks and returns from adoption.

[1]V.S. Vyas, D.S. Tyagi, V.N. Misra, "Significance of the New
Strategy of Agricultural Development for Small Farmers", Agro-Economic
Research Centre, Sardar Patel University, Vallabh Vidyanagar, 1969.

[2]D.S. Tyagi and V.N. Misra, "A Study of the H.Y.V.P. in Kota
District, Rajasthan (Rabi 1968-69)", Agro-Economic Research Centre,
Sardar Patel University, 1969.

[3]C. Muttiah, op. cit.

[4]M. Schluter and J.W. Mellor, op. cit.

V. Reasons for Importance of Credit in Adoption

Three possible reasons for the importance of credit in adoption will be examined in this section - first, the relatively low rate of interest on co-operative loans, second the lack of capital available from other sources and thirdly the possibility that farmers use the co-operatives as risk-bearing institutions.

A. Rate of Interest

In order to argue that the rate of interest is a significant factor, it is necessary to demonstrate that rates of return on additional capital used to grow the new varieties are consistently close to the 10% - 50% range, which represents the difference in interest rates between money lenders and co-operatives. Therefore we estimated the rates of return on additional capital employed in growing the new varieties from a large number of micro studies as shown in Tables 7 and 8 on the following pages.

It is clear that in almost all cases the new varieties are either extremely profitable or extremely unprofitable. In only 2 of the 43 cases for which data were available was the rate of return between 0% and 50%. On the basis of this evidence, it seems most unlikely that the low rate of interest is what causes farmers to rely so heavily on co-operative credit in adoption.

B. Capital Availability

The lack of importance of co-operative credit for wheat cultivation in both Surat and Mehsana districts suggests that when adequate funds are available to farmers, in this case as a result of recent kharif crop sales, co-operative credit does not play an important role in adoption. From this we may infer that it is perhaps some rigidity in the sources from which farmers normally obtain credit which compels them to rely on co-operative credit for adoption.

There are several reasons for thinking the supply of funds from sources other than the co-operative are relatively inelastic with respect to costs of cultivation. Traditional sources of credit are friends and relatives, or moneylenders and traders. A large part of this lending is for consumption purposes, and often use of the credit is not specified. It is not surprising, therfore, that in the part of Surat studied where moneylenders are still the main source of credit, over 50% of farmers indicated they could obtain little or no additional credit from their moneylender. In this area new varieties had scarcely been introduced, but as pressure from the government is causing most moneylenders in the area to try and contract their lending operations, supply from this source is unlikely to expand rapidly to meet a growing demand from adoption of new varieties.

Table 7. Rates of Return on New Rice Varieties in India, 1966-71

District and Year	Main Variety	Total expenditure per acre		Net returns per acre		Additional working capital expenditures	net returns	Rate of return
		HYV	Local	HYV	Local			
		1	2	3	4	5=1-2	6=3-4	7=6-5
1966-67								
Thanjavur (16)	ADT-27	139	118	395	227	21	168	800%
Karnal (16)	TN-1	113	54	491	348	60	143	238%
Cuttack (9)	TN-1	296	82	646	377	214	269	126%
Ernakulam (16)	TN-3	365	226	692	792	139	-100	-72%
Mahar. Dist. (20)	TN-1	194	126	261	310	68	-49	-72%
Krishna (16)	TN-1	202	101	482	565	101	-83	-82%
Mandhya (29)	TN-65	426	293	789	1124	233	-335	-101%
Kolaba (16)	TN-1	128	68	132	269	61	-157	-224%
1967-68								
Thanjavur (17)	ADT-27	183	139	NA	NA	44	133	302%
Sibsagar (17)	TN-1	NA	NA	NA	NA	62	206	252%
W. Godavari (17)	IR-8	294	138	NA	NA	156	163	104%
Saharanpur (17)	TN-1	159	87	NA	NA	72	54	75%
Birbhum[1] (17)	TN-1	401	221	NA	NA	180	-60	-33%
Varanasi (17)	TN-1	159	125	NA	NA	34	-58	-171%
Amritsar[2] (17)	TN-1	214	169	NA	NA	45	-175	-389%
Raipur (17)	TN-1	104	110	NA	NA	-6	-340	-
1968-69								
Sibsagar (Aunt.) (5)	TN-1	129	80	1195	316	49	879	1794%
Sibsagar (Rabi) (5)	TN-1	150	81	718	471	69	247	358%
E. Godavari (Rabi) (3)	IR-8	583	408	877	251	175	426	243%
Sambalpur (17)	TN-1	289	154	542	274	135	268	199%
W. Godavari (Rabi) (3)	IR-8	745	579	467	195	167	228	172%
Amritsar (28)	IR-8	284	157	618	382	127	236	126%
Birbhum (13)	IR-8	391	147	732	400	244	242	99%
Saharanpur (37)	IR-8	295	233	658	605	62	53	85%
W. Godavari (2)	IR-8	514	321	440	376	193	64	33%
E. Godavari (2)	IR-8	529	239	283	292	276	-7	-3%
1971-72								
Surat (34)	Masuri	505	432	521	472	73	49	67%

[1] Refers to all HYV. IR-8 above was considerably more profitable.
[2] Compared with Basmati.

Note: For each variety, net returns per acre is defined as average gross returns, estimated as average price multiplied by average yield, minus average expenditure on variable inputs as defined in each study (See Appendix A).

Table 8. Rates of Return on New Wheat, Bajra and Maize Varieties in India, 1966-1971

District and Year	Main Variety	Total expenditure per acre		Net returns per acre		Additional working capital expenditures	net returns	Rate of return
		HYV	Local	HYV	Local			
		1	2	3	4	5=1-2		
Wheat								
Saharanpur (15) 1967	Mexican	197	207	533	339	-10	194	-
Amritsar (26) 1967	Lerma Rojo	137	124	353	204	13	149	1146%
Aligarh (12) 1967	HYV	334	219	781	434	115	347	301%
Tikamgadh (6) 1967	HYV	318	150	520	93	168	427	254%
Udaipur (4) 1967	HYV	434	318	707	480	116	227	196%
Karnal (36) 1967	Mexican	225	110	607	460	115	207	180%
Surat (34) 1971	S-227	233	160	350	220	73	130	178%
Kota Dist. (30) 1968	S-227	338	221	264	140	117	124	105%
Amritsar (26) 1967	S-227	390	124	247	204	266	43	16%
Bajra								
Karnal (17) 1967	Hybrid	182	17	NA	NA	165	232	140%
Kaira (17) 1967	Hybrid	249	115	NA	NA	134	138	106%
Nasik (17) 1967	Hybrid	190	47	NA	NA	143	134	94%
Mehsana (17) 1967	Hybrid	174	93	167	121	82	66	80%
Ahmedabad (11) 1968	Hybrid	254	132	180	93	122	87	71%
Maize								
Saran (10) 1968	Hybrid	197	92	231	131	105	100	95%
Aligarh (16) 1966	Hybrid	257	119	78	226	138	-148	-107%

Note: Definitions as in Table 7.

The supply of funds available from savings is also likely to be relatively inelastic on small farms owing to the high debt to income ratio. Also, the opportunity cost in terms of foregone consumption is higher on small farms. This is especially true in the kharif season, when loans have just been repaid and the greatest time period has elapsed from the year's main harvest period, so that funds are generally needed for basic consumption requirements.

The difficulty with arguing that supply of funds constitutes the main problem is the high rates of return on capital noted above. It seems probable that if farmers were certain of such high rates of return as indicated for certain areas in Table 6, they would find some way to obtain capital for the three or four month period involved. But the rates of return are not fixed; they are highly uncertain as is equally clear in the table. It will be argued below that it is the uncertainty which makes small farmers <u>unwilling</u> to use traditional sources of credit even when they are able to.

C. <u>The Co-operatives as Risk-bearing Institutions</u>

Some evidence is available from micro studies which indicate how uncertain yields of new varieties are relative to local varieties, apart from what emerges from Table 6. Cobb-Douglas production functions were estimated for hybrid and local varieties of bajra in 1966-67 for a sample from Mehsana District.[1] Variation in input levels accounted for 57% of variation in yields of traditional varieties, but only 26% for hybrid varieties. This suggests that for hybrid varieties yields fluctuated widely between farmers using similar input levels, which in turn suggests knowledge about methods of cultivation was lacking. Similar functions were fitted to data for hybrid and local bajra from a sample in Ahmedabad district Gujarat for 1968-69.[2] In this case the r^2 for the hybrid variety was 56% and for the local variety 75%, pointing to the same conclusion. There is little doubt that especially in the initial stages of the diffusion of the new varieties, there is actual as well as perceived risk in adoption.

We suggest that the risk factor is a second reason why small farmers depend on co-operative credit for adoption of new varieties. If a farmer has to borrow, he is reluctant to borrow from traditional sources of credit. If a small farmer does borrow from traditional sources and the crop fails, he has nothing to fall back on to repay the debt, to obtain

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[1]Michael G.G. Schluter and R. Longhurst, <u>op. cit.</u>

[2]V.S. Dharap, "A Study of the Hybrid Bajra Programme in the Ahmedabad District, Gujarat (Karif 1968-69)", Agro Economic Research Centre, Sardar Patel University, 1969.

money for consumption till the following harvest, and for production
inputs for the next crop year. In contrast, if he has taken a loan
from the co-operative society or some other government institution, in
the case of crop failure, the traditional sources of credit are still
open for all essential expenditure through to the harvest the following
year. In addition, there is considerable flexibility in repayment of
co-operative loans and much less pressure to repay promptly.[1] For
these reasons small farmers with access to co-operative credit have an
important advantage over those without this access in bearing the risks
of adoption of new varieties.

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[1]For example, the co-operatives often follow the policy under such
circumstances to convert short-term loans into medium-term loans.

VI. Conclusions

Main Findings

1. Credit as a Factor Influencing Adoption

Rice and Bajra Profitability was shown to be the dominant factor
in the degree of adoption by small farmers in a large number of rice-
growing areas. For new rice varieties in Surat District in 1971-72, and
hybrid bajra in Mehsana in 1969-70, both of which involved a considerable
element of risk, two factors were important - the farmer's risk bearing
capacity reflected in the size of supplementary income and non-farm
assets, and availability of co-operative credit. For wheat, in both
Surat and Mehsana Districts the availability of co-operative credit
was not a significant factor, which probably reflects the greater
availability of owned funds owing to recent kharif crop sales. It
may also reflect the lesser degree of risk of adoption in the rabi
season when one important source of uncertainty, the weather, is con-
siderably reduced.

We conclude it is in situations where adoption is profitable but
farmers face a high degree of risk, and where they find their own
funds inadequate to meet the additional expenditure so that they are
compelled to borrow, that the role of co-operative credit is of the
greatest importance.

2. The Importance of Co-operative Credit at Different Stages of Adoption

The data from North and South Gujarat suggest the hypothesis that
co-operative credit becomes important in diffusion of new varieties at
the point when small farmers begin to adopt and large farmers put more
than a small part of their acreage under the new varieties. At this
point, the credit requirement for the new varieties represents a
significant increase in proportional terms over what was being used
previously. A host of micro studies of the period 1966-67 to 1969-70
lend support to this hypothesis.

3. Why Co-operative Credit is Important

We suggest two reasons for the importance of co-operative credit in
adoption. First unwillingness or inability of traditional sources of
credit and savings of small farmers to expand to meet the increased
costs of cultivation, and secondly the unwillingness of small farmers
to use these sources, even if they are able to, owing to the uncertainty
involved in adoption. In the event of adoption leading to crop failure,
if a farmer has borrowed from the co-operative, he can still rely on
traditional credit sources both for consumption expenses till the next
harvest and for production credit for the following year. Also, there

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is considerable flexibility in repayment conditions for co-operative credit. In contast, if a farmer defaults on a loan from traditional credit sources which he has used to grow the new varieties, he has no other source to turn to for help to meet production and consumption expenditure prior to the following harvest. We conclude that a small farmer is likely to be willing to take the risk if he can obtain the credit from co-operative or other government agencies, or in situations when own funds are available, than when he is compelled for lack of alternative to rely upon traditional sources of finance.

Implications for Policy

In areas without technological change, the role of co-operative credit for small farmers is limited by an absence of demand. Small farmers can meet costs of cultivation from traditional sources and in many cases find the disadvantages of changing to the co-operative sector greater than the advantages. If co-operatives want a greater share of the credit cake in these areas, they must search for profitable innovations which will increase total costs of cultivation, so that the demand for capital is greater than the supply available from traditional sources.

In areas of technological change, small farmers will demand co-operative credit once the risk and profitability of the innovation have been established. It is in these areas that no effort should be spared to improve management practices, to prevent institutional constraints on the supply of credit to small farmers, as these constraints may inhibit adoption.

Our analysis suggests that co-operatives could accelerate the adoption process on small farms in areas with technological change if their facilities were restructured to take account more explicitly of the risk factor. One way this could be done is through a policy of regional crop insurance.[1]

Stimulus to demand for co-operative credit from small farmers, and more efficient management in areas where the demand exists, would make

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[1]Co-operative institutions are much better placed than individuals to bear risk, as they can balance out their levels of profit both between regions and over time. If it were not for the vast administative costs, some sort of individual crop insurance would seem an ideal solution to small farmer's problem of risk. But it might be possible for co-operatives to undertake some regional crop insurance. By raising the normal interest rate to 25%, which we have argued above would make little difference to profitability of the innovation, the co-operatives could afford to write off all crop loans for a certain crop in a given area, in the event of a crop failure due to unsuitability of a variety, weather problems or other factors, and demand no payment from the farmer.

credit co-operatives a more effective mechanism both to increase
production of foodgrains, and to reduce income disparities in rural
areas.

Appendix Table 9. Co-operative Membership and Borrowing among Sample Cultivators in Mehsana District in 1969-70.

Size of operational holding (acres)	Total number of farmers	Members			Non-members
		Borrowers	Non-borrowers	Total	
Below 5	73	21 (28.77)	16	37 (50.69)	36
Between 5 and 10	82	38 (46.34)	18	56 (68.29)	26
Above 10	65	40 (61.54)	10	50 (76.92)	15
Total	220	99 (45.00)	44	143 (65.00)	77

Figures in parenthesis indicate percentages to the respective total number of farmers.

Appendix Table 10. Reasons Given by Sample Farmers for Non-Membership and Not Borrowing from Co-operatives in Mehsana District, 1969-70

| | Percent of farmers reporting this reason for | | | | | | | |
| | Non-membership | | | | Non-borrowing | | | |
Reasons	Small	Medium	Big	Total	Small	Medium	Big	Total
I. No need								
i) Adequate income and past savings	67	69	87	72	75	78	80	77
ii) Non-farm source of income	42	23	13	30	31	-	-	11
iii) Other source of finance	8	23	27	17	13	28	20	20
iv) Land leased out	17	8	20	14	19	22	-	16
II. Dislike for co-operative credit								
i) No faith in co-operatives	-	4	7	3	-	-	-	-
ii) Inadequate finance	8	8	13	9	6	-	-	2
iii) Inefficient management	8	12	-	8	-	33	20	18
iv) Dislike for recovery procedure	36	27	33	23	23	23	20	25
v) Credit limit related to security	14	12	33	17	-	11	-	5
III. Defaulter of the society	-	-	-	-	13	17	20	16

Source of data: 14.

Appendix Table 11. Percentage of Farmers Adopting High-Yielding Rice
Varieties on any Part of their Irrigated Rice Acreage
1968 - 69 - 1972-73, in Villages Completely Covered by
Co-operatives.

Net cultivated acreage	1968-69	1969-70	1970-71	1971-72	1972-73
0-2	0%	0%	66%	100%	100%
2-5	0%	50%	100%	100%	100%
5-10	0%	60%	60%	80%	100%
10 and above	20%	25%	100%	100%	75%

Appendix A

<u>Items included in Expenditure per Acre for Tables 2 and 3</u>

Numbers refer to the list of references.

1. Studies including only <u>cash</u> costs of cultivation
    Nos. 7,8,13,29

2. Studies including variable inputs- seed, fertilizers, organic
    manure, pesticides, casual labour charges, irrigation (whether
    payment in cash or kind
        Nos. 4,16,17,26 (4,34 include imputed value of family labour)

3. Studies using definition in 2, but including land revenue and
    rent paid to landlord
        Nos. 15,28,37

4. Studies using cost A_1, as defined in the Farm Management Studies
    (i.e. all costs except interest payments and imputed value of
    family labour)
        Nos. 2,3,6,20,38,12

5. Studies using cost A_2, as defined in the Farm Management Studies
    (include all costs except imputed value of family labour)
        Nos. 5,11,39

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                        A.E.R.C. = Agro-Economic Research Centre
                        H.Y.V.P. = High-Yielding Varieties Programme