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adoption of HYVs. These requirements ranged from Rs. 241 to Rs. 666 in the different zones. Excluding the deltaic zone I and upland zones V and VIII, the average additional capital requirements are nearly Rs. 300 per hectare of cropped land. This seems to be reasonable in view of the additional fertilizer requirements and plant protection measures required for growing the HYVs. The high requirements in the deltaic zone I and upland zone V may be due to the existence of capital intensive cash crops like sugarcane and banana. In the case of upland zone VIII the highest requirement is due to the fact that it is a tribal zone and the farming is more of subsistence nature. The per hectare gross returns in this zone is lowest compared to the rest of the zones in this district. These factors may to some extent explain the low capital base and hence the highest credit requirement.

CONCLUSIONS AND POLICY IMPLICATIONS

(1) The provision of credit for the small farms in most cases results in the introduction of HYVs of paddy into optimum crop plans. This is subject to the availability of suitable technology (varieties) for the agro-climatic regions and other inputs like irrigation.

(2) The provision of credit helps in increasing the area of HYVs of paddy on the farms where they are already grown.

(3) Credit requirements differ between different agro-climatic zones due to differences in the cropping patterns and capital base. Credit policy should take this into account and consider credit requirements for the farm as a whole and not restrict it solely to the existing or prospective areas of HYVs of paddy.

IDENTIFICATION OF SMALL FARMERS IN CHANDAULI TEHSIL, DISTRICT VARANASI

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The majority of the Indian farmers have very small holdings and live near the subsistence margin. According to the 1971 Census, the number of operational small holdings of 2 hectares and less is 62 per cent of the total number, though the area cultivated by them is less than 20 per cent of the total. Any development plan for the rural mass should aim to enable all sections of rural population to reap its benefits. The participation of small farmers in the agricultural programme is essential both because they constitute a large number and the total area occupied by them is not insignificant

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from the production point of view. Apart from these, the studies on farm economics have proved that in terms of productivity the small farmers can do well and even better than the large farmers. If the modern inputs and production requisites are provided to them, it is also possible for a considerable proportion of the small farmers to be converted into viable units. But no concerted effort had been made to uplift the economic situations of this huge mass. It is with this rationale in mind that the All-India Rural Credit Review Committee recommended the establishment of Small Farmers Development Agency (SFDA). But unfortunately, the small farmers had never been defined rigidly or identified properly and as a result a large number of farmers are excluded from assistance under the development programmes. Even the performance of the SFDA has also not been satisfactory. Therefore, an attempt has been made in this paper to identify and determine the size of viable holding.

METHODOLOGY

The district Varanasi was purposively selected from Eastern Uttar Pradesh because this part is dominated by small farmers. Chandauli tehsil which has similar soil, climate and other general conditions of the district, was purposively selected. All the villages of the tehsil were classified into four groups on the basis of consolidation, irrigation and infrastructure as (1) consolidated, canal plus tubewell irrigated and developed infrastructure; (2) unconsolidated, canal plus tubewell irrigated and developed infrastructure; (3) unconsolidated, canal irrigated and developed infrastructure; and (4) unconsolidated, tubewell irrigated and less developed infrastructure. The fourth group was further divided into two sub-groups, namely, (*a*) farms near the tubewell, and (*b*) farms away from the tubewell which had less assured irrigation facilities. Thus, in all five resource situations were developed and written as stratum I, stratum II, stratum III, stratum IV(a) and stratum IV(b), respectively. One village from each of the four groups was randomly selected and all the farmers were selected for the study. The data were collected by the survey method. Each farmer was personally interviewed and the input-output data were collected for the year 1971-72 with the help of questionnaire prepared for the purpose.

The total farming group was classified into "non-viable" small farmer and "viable" farmer. Non-viable small farmers were defined in this study as those who were not in a position to earn farm business income needed to meet their farm family requirements. To arrive at a standard and less flexible values information from two sources was obtained. Information on food requirements was obtained from the data published by Swaminathan and Bhagavan on Balanced Diet for Industrial and Agricultural Workers. These physical food requirements were multiplied by the prices (1971-72) prevailing

1. M. Swaminathan and Bhagavan: Our Food, Central Food Technological Institute, Mysore, 1960.

in the district for the food articles to obtain the expenditure requirement for foods. The data on requirements for clothing, housing, lighting, health and education, maintenance cost of a pair of bullock, etc., were obtained directly from the farmers by interviewing them. Since the standard of the farmers in the area was relatively low, the average figure for the village which had relatively better standard of living was used for the analysis. The expenditure on food per adult was then added to this average expenditure per adult due to items other than food. The average farm family size taken was equivalent to four adult units (the farmer, his wife and three childern). By multiplying the average family size by the average per adult, the household expenditure for an average family was worked out. In addition to these expenditures, the household had to maintain a pair of bullock on its farm. The average maintenance cost of a pair of bullock, therefore, was added to the family expenditure of the household. This figure was then used to determine the size of holding at and above which the farmers could be identified as a "viable" farmer.

Functional relationship between the farm size and farm business income was established to determine the operational holding which would provide the minimum required income. In addition to this, parametric programming (variable land programming) was carried out to determine the viable size. The comparison of viable size obtained with the help of these two approaches was used to determine the "Practical Critical Size" for a viable farm.

RESULTS AND DISCUSSION

The minimum requirement approach was used to determine the critical sizes of farm holdings which could yield the minimum needs of the farm family consisting of four adult units and a pair of bullock. The expenditure incurred under the various heads by the average farm family is given in Table I.

TABLE I—HOUSEHOLD EXPENDITURE PER AVERAGE FAMILY PER ANNUM

	Items	Amount (Rs.)	Percentage to the total
1.	Food	1,532.00	51.20
2.	Clothing	200.00	6.68
3.	Housing	100.00	3.34
4.	Health and education	100.00	3.34
5.	Lighting	70.00	2.33
6.	Miscellaneous costs	300.00	10.02
7.	Maintenance cost of a pair of bullocks	690.00	23.09
	Total expenditure :	2,992.00	100.00

The farmers who are unable to earn the above minimum required amount are difined as 'non-viable' small farmers. Two analytical tools, namely, regression analysis and variable land programming techniques were used to work out the viable holding.

(i) Regression Analysis

The "farm business income" was considered to be the relevant farm income variable for the farm business equations. The acreage required to yield the minimum farm business income (Rs. 2,992.00) was derived with the help of farm business equations. For this, functional relationship between the size of operational holding and farm business income was established. All the three types of functions, namely, linear, quadratic and Cobb-Douglas, were tested. The quadratic function gave the best fit, so it was selected for analysis for this study.

TABLE II—FARM BUSINESS EQUATIONS AND VIABLE FARM SIZE

Stratum	Equations	R^2 value	Farm size requirement (acres)
I	$Y = 119.52 + \underset{(316.01)}{584.21X} - \underset{(29.16)}{1.95x^2}$	0.87	5.62
II	$Y = -20.95 + \underset{(160.90)}{501.29X} - \underset{(1.52)}{4.32x^2}$	0.88	6.46
III	$Y = 1221.59 + \underset{(232.80)}{234.88X} + \underset{(16.67)}{23.66x^2}$	0.97	6.10
IV(*a*)	$Y = 1857.64 + \underset{(132.55)}{1121.25X} + \underset{(6.45)}{11.12x^2}$	0.71	7.23
IV(*b*)	$Y = 1659.91 + \underset{(79.09)}{131.16X} - \underset{(5.96)}{6.81x^2}$	0.74	7.60

where Y is the farm business income (gross return—variable costs) (exclusive of cost of bullock labour), and X is the size of operational holding.

Figures in parentheses are standard errors.

On the basis of these equations, the acreage required to yield the minimum farm business income which could support a family of four adult units and a pair of bullock was worked out for all the five strata separately. The area so obtained was the critical farm size for a viable farmer. From Table II it was clear that the minimum acreage requirement varied from stratum to stratum. The minimum size to become a farm viable ranged from 5.62 acres to 7.60 acres in the various strata. Below these limits, the farmers were identified as 'non-viable' small farmers.

(ii) Variable Land Programming

In addition to the regression analysis, variable land programming technique was also used to know the potential size of holding which would yield the required level of farm business income. The model used for parametric programming was as follows :

$$\text{Max. } Z = p_1x_1 + p_2x_2 \;\ldots\ldots\ldots\ldots\; + p_nx_n$$

subject to,

$$A_i \geqslant a_{i_1}x_1 + a_{i_2}x_2 + \ldots\ldots\ldots\ldots + a_{i_n}x_n$$

$$D_i^F \geqslant a_{i_1}x_1 + a_{i_2}x_2 + \ldots\ldots\ldots\ldots + a_{i_n}x_n$$

$$D_i^B \geqslant a_{i_1}x_1 + a_{i_2}x_2 + \ldots\ldots\ldots\ldots + a_{i_n}x_n$$

$$C_i \geqslant a_{i_1}x_1 + a_{i_2}x_2 + \ldots\ldots\ldots\ldots + a_{i_n}x_n$$

$$F_i^{(Min.)} \leqslant a_{ij}x_j$$

$$A_i^{(Max.)} \geqslant a_{ij}x_j$$

$$X_{ij} \geqslant 0,\ D \geqslant 0,\ C_i \geqslant 0$$

where, A_i is the available operational holding in acres,
D_i^F and D_i^B are the number of available family labour days and available bullock pair days, respectively,
C_i is the working capital,
$F_i^{(Min.)}$ is the minimum food and fodder requirements,
$A_j^{(Max.)}$ is the maximum controllable area under cash crops, and
a_{ij} is the input-output coefficient of i th resource and j th activity

The area under operation, *i.e.*, A_i was treated as a variable resource in the parametric programming. The optimal solutions with various levels of farm incomes for the varying ranges of land areas were thus obtained. The area which yielded the minimum targeted farm business income was taken as the "normative critical" size for a viable farm. The exact size which yielded the required income was obtained with the help of graph of planned variables obtained from parametric programming. The potential normative sizes of viable farms thus obtained for various strata are given in Table III.

TABLE III—POTENTIAL NORMATIVE ACREAGE REQUIRED FOR VIABLE FARMS

Stratum	I	II	III	IV(*a*)	IV(*b*)
Normative size (acres)	5.40	6.20	5.80	6.90	7.30

It was observed that the potential normative size of holding required to become viable ranged between 5.40 acres and 7.30 acres and varied from stratum to stratum.

(iii) Practical Critical Farm Size

The viable size of farm holding of non-viable small farmers was determined with the help of "simple regression analysis" as well as with the help of "variable land programming." The viable farm sizes obtained from parametric programming were the potential normative figures. Therefore, an allowance in terms of acreage was needed to bring these figures to a practical level. A comparison of 'normative' figures with the 'critical' figures obtained from regression analysis indicated that the 'potential normative' figures required an allowance of 4.90 per cent to bring them to practical levels. These practical figures, shown in Table IV, were then used to identify the non-viable farms.

TABLE IV—PRACTICAL CRITICAL SIZES REQUIRED FOR VIABILITY

Stratum	Potential normative size (acres)	Allowances needed (per cent)	Acreage	Practical critical size (acres)
I	5.40	4.90	0.24	5.64
II	6.20	4.90	0.30	6.50
III	5.80	4.90	0.28	6.08
IV(*a*)	6.90	4.90	0.34	7.24
IV(*b*)	7.30	4.90	0.35	7.65

It is clear from the table that the "Practical Critical Size of Viable Farms" varied from 5.64 acres to 7.65 acres from startum to stratum. The farmer having less than these sizes in the respective stratum was to be identified as a 'non-viable' small farmer.

CONCLUSION

Though it is difficult to define and identify the small farmers and any definition is likely to be somewhat arbitrary, it is only possible to demarcate a line between a 'non-viable' small farmer and a viable farmer through a careful research study. Physical measure is easy to demarcate but it does not correspond to the economic concept of viability because the income from identical pieces of land would vary from place to place and from village to village owing to consolidation, irrigation and infrastructure (*i.e.*, marketing, storage, and transport). A better approach, thus, would be to define a viable farmer as one whose farm business income is sufficient to maintain himself, his family and a pair of bullock. Clearly, the 'minimum farm family requirement' approach to viability is much more sound than the physical approach, but it requires a greater degree of competence. It will, therefore, be sophisticated if the farm business income figures are translated into physical figures and used to identify the small farmers.

The results of the present study indicated that the acreage requirement for viability varied from situation to situation. The village or stratum which was less progressive and developed in all aspects needed higher acreages to become viable than other villages or strata which were in a better situation. Thus, it can be concluded that if the villages were consolidated, irrigation facilities were provided and infrastructural situations were developed, the income of the small farmers would have increased and a lesser acreage would be needed to make them viable.

EXTERNALITIES OF NEW GROUNDWATER TECHNOLOGY ON SMALL FARMERS

B. D. Dhawan*

Introduction

Modern groundwater technology, based on power pumps, has diffused rapidly (about 17 per cent per annum) in the Indian farm sector. It is estimated that modern groundwater devices lifted about 60 per cent of the total 65 million acre-feet of groundwater lifted by all types of groundwater appliances in 1971.[1] In point of fact, the regions experiencing successful diffusion of the new bio-chemical technology also exhibit high rate of penetration of the new groundwater technology, especially tubewell technology. For example, in the States of Haryana and Punjab the traditional groundwater lifts contributed about 5 and 12 per cent, respectively, to the States' total volume of groundwater raised for irrigation in 1971, and these percentages may be even lower today.

The cost-effectiveness of the new groundwater technology vis-a-vis the traditional one has been highlighted in a number of research studies. It is not our intention to undertake a critical review of this literature. The significant aspect, to which we wish to draw attention here in the particular context of the topic of discussion in this Conference, is the exclusive concern of the researchers with demonstrating the superiority of the new technology purely from the private or individual viewpoint, without due regard to macro angle and long-term social implications. High social cost of the infrastruc-

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1. Government of India: Report of the Task Force on Groundwater Resources, Planning Commission, New Delhi, 1972, Annexure X (mimeo.).