4. Adjustment in the Discount Rate

An alternative to the limit on the period of analysis is the introduction of a risk premium into the interest rate. A risk premium of the order of 1-2 per cent may be added to the basic interest rate used for evaluating a riskless project. All projects whether their life is longer or shorter than some arbitrary limit will be subject to the adjustment, yet the increasing risk of long lives is reflected.

5. Safety Allowances

Another alternative for handling the problem of risk and uncertainty is the safety allowance—a flat percentage reduction of benefits or increase of costs. The extent of the safety margin would naturally vary with the riskiness of the project(s) under consideration.

CONCLUSION

The special characteristics, such as externalities, collective goods, intangible benefits and risk and uncertainty which distinguish agricultural projects from the projects in other sectors, should be given due consideration in the formulation and evaluation of agricultural development projects. The problem of externalities could be tackled by the Government either by undertaking the management of the project or by means of taxes, subsidies, regulation, etc. Collective goods produced by agricultural projects create problems in project formulation and evaluation and even in financing the project. By imposing tax in the project area, the problem of financing could be tackled. Similarly, intangible benefits produced by the project should be given due weightage, either explicitly or implicitly. The agricultural projects are subject to greater risk and uncertainty due to biological nature of production. The risk and uncertainty problems could be handled by sensitivity analysis, mathematical expectation, shortening the period of analysis, adjustment in the rate of interest and safety allowance.

FORMULATION OF MINOR IRRIGATION SCHEMES—DATA REQUIREMENTS AND PROBLEMS

S. A. Radhakrishnan*

The concept of project formulation for regional development is gaining importance inasmuch as the planned approach in executing development activities pays greater dividends. By project approach the development activities envisaged could be supervised more closely by technical personnel and problems encountered during execution can be solved then and there. After the formation of Agricultural Refinance and Development Corporation

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in consonance with the recommendation of the All-India Rural Credit Survey (1954) and the entry of the World Bank in refinancing a number of schemes for agricultural development, area-based schemes had to be formulated by the financing institution. Though project formulation was being practised for the past one decade, the methodology still needs improvement and it should be oriented to suit the needs of the area. The present study is an enquiry into the problem and data deficiencies in formulating minor irrigation schemes in Tamil Nadu State. The study is based on a scheme to be prepared for minor irrigation investments in Kattankolathur block of Chingleput district, Tamil Nadu State.

**Stages in Formulation of Minor Irrigation Schemes**

One could identify the following four stages, while formulating minor irrigation schemes.

1. Assessment of groundwater potential available in the area.
2. Determining the types of minor irrigation installations, their number which should be commensurate with the groundwater potential.
3. Designing minor irrigation installations, viz., wells, pumps, etc., and estimating unit cost. Designing of installations should be commensurate with the average rate of extraction expected from each type of installation.
4. Assessment of the economic viability of the scheme and fixing repayment period.

**Assessment of Groundwater Potential**

The assessment of groundwater potential involves (a) estimation of groundwater recharge, (b) estimation of present level of extraction and (c) determining the potential available for further extraction. Groundwater extraction should be equal to its recharge. Otherwise there will be mining of water and the water table in the area will recede year after year leading to failure of wells.

**Recharge to groundwater reservoir:**— The factors that contribute to the groundwater recharge are: (i) recharge through rainfall, (ii) recharge from return flow of irrigation water, (iii) recharge from water spread area or surface water bodies and (iv) recharge from surface flows like canals, rivers, streams, etc.

**Extraction of groundwater:**— The factors considered for determining the extraction at a point of time are: (i) extraction through minor irrigation installations, (ii) extraction for domestic and industrial use and (iii) unavoidable losses by evapo-transpiration, sub-soil seepage, etc.

**Procedure for Estimating Groundwater Potential and Problems**

Water potential in an area is estimated by the State Groundwater Directorate based on certain assumptions. The details of estimate, as prepared by the State Groundwater Directorate for Kattankolathur block of Chingleput district, Tamil Nadu State are given in Appendix 1 and abstracted below:
EVALUATION OF AGRICULTURAL PROJECTS

Recharge

1. Recharge through rainfall ........................................ 34,621 acre-feet
2. Recharge from return flow of irrigation water .......... 69,268 acre-feet
3. Recharge from water spread area ....................... 16,286 acre-feet
4. Recharge from surface water flows ....................... 11,830 acre-feet

Total recharge .................................................. 132,005 acre-feet

Deduct for unavoidable losses .................................. 132,005 — 39,600 acre-feet
Net quantity available for extraction ......................... 92,405 acre-feet

Present extraction

1. Extraction through electrified wells ....................... 54,800 acre-feet
2. Extraction through oil engine wells .................... 3,500 acre-feet
3. Extraction by bullock bailing wells ..................... 16,231 acre-feet

Total present extraction ........................................ 74,531 acre-feet

Potential for future extraction

Net quantity available for further extraction or additional potential available for extraction ........ 92,405 — 74,531 acre-feet
=17,874 acre-feet

Average extraction for one unit of minor irrigation installation will be 20 acre-feet.
Therefore, number of units recommended = 17,874 ÷ 20 = 893 or 800 units.

While working out the groundwater potential and the probable number of additional units that can be safely installed the following problems are being encountered. The recharge through rainfall is assumed to be uniform throughout the State, i.e., 10 per cent of the rainfall of the area is considered as the recharge. Soil types of Tamil Nadu vary very widely from place to place. There are coastal alluvium, laterite soils, river alluvium and crystalline areas of various intensity. The recharge from rainfall is likely to vary, depending upon the soil characteristics of the area. The recharge will be high in laterite and coastal alluvium soils and less in crystalline areas. There should be adequate research and data base for determining the recharge from rainfall.

The return flow from irrigation is considered for paddy crop only. Further, the return flow from paddy land is assumed to be uniform throughout the State and irrespective of the season in which the crop is grown. In addition to the spatial variations due to soil strata, there may be variations in the
return flow on account of seasons. In monsoon period when the crop is already in the field the capacity of the return flow will be more, when compared to the return flow during the summer season. The return flow from irrigated crops, other than paddy, should also be considered. There should be a detailed study on the return flows based on crops, seasons and soil strata.

The recharge from water spread area is assumed to be 23.8 mm. per day and restricted to 24 acre-inches. The recharge from surface water bodies depends upon the number of days water is stored and seasonwise water spread area. Likewise, for recharge from surface flow, the number of days water will be flowing in the stream or river should be estimated. The recharge from the water body or water course will also depend upon the soil type, the quantum of flow, the number of days water will be flowing.

From the total recharge thus arrived at, 30 per cent is excluded for unavoidable losses due to evapo-transpiration, sub-soil seepage, etc. There is no authentic field study for establishing loss of water on account of the above factors. The evapo-transpiration and sub-soil seepage losses are to be estimated regionwise, under Indian field conditions.

The present level of extraction in an area is assessed by enlisting the number of minor irrigation installations used for agriculture, domestic and industrial purposes. The number of wells which exists in an area is determined from secondary source, i.e., official records maintained in the Revenue Offices, Panchayat Union Offices and the Director of Statistics. The data requirements are the number of electric motor energised wells, oil engine energised wells and bullock bailing wells catering to the needs of agriculture, the number of domestic wells in individual households and community wells maintained by the Panchayat Union, etc. After estimating the number of wells sourcewise the extraction is determined.

In the case of electric motor wells, the extraction is calculated from the total electrical energy consumed in the area. The energy consumption figures are obtained from the State Electricity Board. In the case of oil engine wells a sample survey is made to estimate the command area and the extraction of water from a well. So also in the case of bullock bailing wells, the extraction is arrived at on the basis of sample studies in which the command area, cropping pattern and the water requirements of crop are estimated. The water requirements of crops are assumed uniformly at the rate of 4 acre-feet for paddy and one acre-feet for other irrigated crops. After assessing the water requirement, depending upon the command area and cropping pattern, the contribution of rainfall at 75 per cent of the rainfall during the growth period of the crop is deducted and the net extraction is assessed.

While assessing the present level of extraction on the above method, a number of problems crop up. The data on the number of wells are not always accurate. There were wide variations in figures reported at different levels.

In Tamil Nadu, statistics on irrigation wells are compiled and maintained by the revenue authorities. The village Karnam is the officer collecting information at the grass-root level. The taluk level data were compiled by
the Revenue Inspectors from the village records (sometimes orally). The reporting of these statistics by the Revenue Inspectors was firkawise consisting of a group of about 20 to 30 revenue villages. At taluk office an assistant will be compiling the data and forward it to the District Collector who will compile and maintain the district figures. The State Department of Statistics collects the data at the taluk and district level and publishes the district figures in the Season and Crop Report.

The village Karam maintains a register (Village Account No. 2) in which he is expected to record, against each survey number, the particulars such as the existence of well, type of well, whether the well is fitted with a pumpset operated with electric motor or oil engine, whether the well is in use or abandoned, etc. Since the existence or non-existence of a well makes no difference for revenue assessment, except for the surface area covered by the well, the details of wells are mostly neglected and not properly up-dated. Many wells abandoned for years continue to find a place in Village Account whereas newly constructed wells are not entered in time. As regards information on the type of well and energisation it is not recorded in certain villages.

In this connection it is worthwhile to mention about a study conducted to verify the reporting system and the actual number of wells. Published data at State, district, taluk and village levels were collected. Five villages in Cheyyar taluk of North Arcot district were selected and actual enumeration of wells was done. The results showed wide variations as follows. The data relate to 1975-76 Fasli year.

(i) Number of wells in North Arcot district as reported in Season and Crop Report published by the Director of Statistics 2,78,371
(ii) Figures as maintained in the office of the District Collector 2,75,786
(iii) Percentage of variation 0.94%
(iv) Number of wells in Cheyyar taluk (where the study was conducted)—figures as maintained in the Office of the District Collector 19,787
(v) Number of wells as per figures maintained in the taluk office 18,782
(vi) Percentage of variation 5.35%
(vii) Number of wells in the five villages selected for the study as per figures maintained in the taluk office 1,783
(viii) Number of wells as revealed in the actual enumeration 1,351
(ix) Percentage of variation 31.98%

It is seen that sufficient care is not bestowed in the compilation and forwarding of data from one office to the other and consequently the data are rendered unrealistic.

Electrical energy consumed in an area may not be a correct measure to decide the extraction from wells. Electric motor pumpsets are very often used for purposes other than irrigation. There are also cases of unauthorised use of pumpsets for purposes other than agriculture. If so the electrical energy consumed per well and consequently the estimated draft from the wells will show an unrealistic high figure.
To quote an example, the following are the extractions per well calculated by the State Groundwater Directorate (SGD) for minor irrigation scheme in Madurantakam block of Chingleput district.

(i) Extraction per electric motor well calculated on the basis of electrical energy consumed in the area (for a 5 HP EMP) ... 23.0 acre-feet

(ii) Extraction per oil engine pumpset well calculated on the basis of the command area and cropping pattern (for a 5 HP oil engine—data collected by oral enquiry) ... 14.1 acre-feet

(iii) Extraction per bullock bailing well calculated on the basis of cropping pattern adopted ... 11.5 acre-feet

It is seen that for the same horse power the extraction from an electric motor well is twice from an oil engine well. Basically, there should not be any difference between the two. The difference in efficiency, if any, can be compensated by working more number of hours. Further, in the case of electric motor there is a constraint of the number of hours electrical energy available. As against this, oil engines can be used as per the will of the farmer without any restrictions. If so, it is relevant to think that the extraction in the case of oil engines well should be more than the electric motor pumpset wells.

In the case of oil engines and bullock bailing wells the water requirement is very often not worked out realistically. The water requirement should be worked out individually for each type of cropping pattern. Assuming an uniform rate of water requirement for paddy and other irrigated crops should not be practised. The water requirements of various irrigated crops differ very widely from each other.

For assessing the domestic water requirement, the population of the village may be taken as the criterion. In the case of industries the actual water consumption of each industry can be assessed.

From the net recharge the present extraction is deducted and the potential for further extraction is determined. A target for scheme finance is fixed after allowing a portion of the potential to be tapped by individuals using their own (private) resources.

**Spacing of Wells**

The spacing between two minor irrigation installations is determined on the basis of the World Bank formula, given below:

\[
S_m = 100 \sqrt{\frac{R_{mm} \cdot C \cdot A}{r_{mm}}} 
\]

where

- \( R \) = water requirement of crops in mm,
- \( A \) = area of command of well in hectares,
- \( C \) = cropping intensity and
- \( r \) = groundwater recharge in the scheme area in mm.
The formula is derived from the basic concept of water balance, i.e., by equating input into groundwater reservoir (recharge) to well output (draft). The well is imagined to be getting its supply from an imaginary square with an area of Sm² around it.

Based on the above formula, the SGD works out the spacing between two minor irrigation installations. The derivation of spacing is furnished in Appendix 2. While working out the spacing, the SGD assumes that (i) the cropping intensity is 1, (ii) the command area of an energised well is 2.5 acres, (iii) recharge is 10 per cent of rainfall +24 inches of return flow of irrigation water and (iv) water requirement is 48 acre-inches for paddy and 12 acre-inches for other crops.

It is not correct to assume an uniform water requirement for all crops (other than paddy). The cropping intensity is always more than one, especially when there is good groundwater potential. The land use pattern of the area indicates that the cropping intensity is 2.25. While assuming the recharge for the block, two crops of paddy were assumed and the return flow was found to be 48 inches per acre. The recharge from surface water storages and surface flows is not considered. These aspects vitiate the spacing.

The spacing fixed by the SGD is to be adopted uniformly throughout the area. The topographical constraints that prohibit sinking of wells in certain pockets are not considered. The problem of spacing is severely felt in areas where there are out-crops of hillocks and where the terrain is undulating. In the valley portions, since concentration of wells is already more and no additional well could be located, wells have to be dug in the ridge portions. Assuming that the water table is constant throughout the area, the depth of the well is to be more and consequently the cost of the project will be high, creating diseconomies. Where there are out-crops of hillocks, etc., the geographical area available for digging wells is reduced and in such places it becomes extremely difficult to utilize the available water potential, duly observing the spacing condition.

Sometimes, by observing spacing conditions, wells are to be located in isolated places rendering their energisation difficult and uneconomical for the State Electricity Board to lay lines or provide additional load for these installations. The units cleared are for composite unit of a well with pumpset. Some farmers, especially small farmers, may prefer to have bullock bailing wells in which case the well is to be considered as 0.25 unit. The number of installations will be four times the number of units. However, spacing is assumed to be constant and, therefore, the number of wells that could be accommodated in the area will be reduced.

There is a problem for the small farm. The average size of holding in Chingleput district is 3.16 acres. The average size of holdings of small, medium and large farmers is 2.15 acres, 14.43 acres and 42.94 acres respectively. If the spacing to be fixed is 110 metres for the ayacut area and 150 metres for the non-ayacut area, the area requirement of a farmer has to be 2.75 acres for the ayacut and 5.68 acres for the non-ayacut area. Because of the spacing condition a small farmer if in turn surrounded by small farmers
could not have a well independently but every alternate small farmer will only get a well. Further, the social custom in Tamil Nadu is such that digging a new well with joint ownership is not preferred.

Yet another factor is that wells are mostly dug in non-ayacut areas to convert rainfed dry lands into irrigated lands. The problem of spacing is therefore severe in the case of small farmers.

Fixing Targets and Execution

With the groundwater clearance available, the following types of minor irrigation installations are proposed in the scheme:

1. New well with pumpssets ... ... 138 numbers
2. Deepening of existing wells ... ... 215 numbers
3. Deepening of existing wells and installation of pumpssets ... ... 116 numbers
4. Installation of pumpssets alone ... ... 123 numbers

Deepening of wells or energisation of existing wells will not add to the number (well installation) in an area. As per the project report, 138 new wells would be dug, wells already in existence number 5,416 and so the number of total minor irrigation installation at the end of the project period will be 5,554. The net cultivable area and the current fallows amount to 39,431 acres which means that there will be a well for every 7.50 acres. According to the spacing criterion, the square that will hold a well is 9.5 acres in rainfed area. It is therefore evident that the number of wells as proposed in the scheme could not be sunk and the available goundwater potential could not be utilized. Thus the imposition of spacing condition along with the density is not conducive for the groundwater development. Further, depriving a farmer from digging a well on account of spacing condition will not be social justice.

In this connection, a study was made in a critical area (Arani block of North Arcot district) where groundwater is supposed to have been over-exploited. About 30 farmers having wells closely, as per the spacing criterion fixed by the SGD were enquired about the inter-well interference. Out of the 30 farmers, only four had reported interference. However, all the four farmers had also informed that they had not observed any general decline in the water table in the area.

After deciding the types and number of installations, wells and pumpssets are to be designed. The well should be so designed that it will yield the permissible level of water. The profile, static water level, recouperation, etc., of the wells in the area are to be enquired into for this purpose. The design should be such that the well should yield enough water at critical periods of crop growth. The design of the pump should be to pump the required quantity of water in consonance with the recouperation, availability of electrical energy, command area and water requirements of the crops.

Economics of the Scheme

Depending upon the design of wells and pumping machinery, the capital cost of the investment will be decided. Based on the command area and the
cropping pattern of the region the pre-development and post-development income will be worked out. The difference in income will be the incremental income on account of the investment. The economics and the repaying capacity are worked out as follows:

**Pre-development Income**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (acre)</th>
<th>Gross income (Rs.)</th>
<th>Net income (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundnut (rainfed)</td>
<td>3.00</td>
<td>2,210</td>
<td>1,260</td>
</tr>
<tr>
<td>Less short-term loan interest, kist, etc.</td>
<td></td>
<td></td>
<td>60</td>
</tr>
<tr>
<td>Net pre-development income</td>
<td></td>
<td></td>
<td>1,200</td>
</tr>
</tbody>
</table>

**Post-development Income**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Area (acre)</th>
<th>Gross income (Rs.)</th>
<th>Net income (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYV paddy—first crop</td>
<td>3.00</td>
<td>3,450</td>
<td>1,800</td>
</tr>
<tr>
<td>Groundnut—second crop (irrigated)</td>
<td>3.00</td>
<td>4,200</td>
<td>2,250</td>
</tr>
<tr>
<td>Ragi—third crop (irrigated)</td>
<td>1.00</td>
<td>890</td>
<td>490</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>4,540</td>
</tr>
<tr>
<td>Less short-term loan interest, kist, etc.</td>
<td></td>
<td></td>
<td>240</td>
</tr>
<tr>
<td>Net post-development income</td>
<td></td>
<td></td>
<td>4,300</td>
</tr>
</tbody>
</table>

Incremental income = 4,300 — 1,200 = 3,100

Loan eligibility = Rs. 14,350 or Rs. 14,000.

In most of the cases there is difference between the command area assumed and the command area realised. Farmers, as a prestige, grow paddy which is a water consuming crop. They should be educated so that they can get maximum returns by optimizing the use of water resource. The cropping pattern assumed in the project proposal, the cropping pattern adopted by the farmer and the optimum cropping pattern will be as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Proposed in the scheme (acre)</th>
<th>Adopted by the farmer (acre)</th>
<th>Optimum cropping pattern (acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy—first crop</td>
<td>3.00</td>
<td>3.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Paddy—second crop</td>
<td>—</td>
<td>2.00</td>
<td>—</td>
</tr>
<tr>
<td>Groundnut—second crop</td>
<td>3.00</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Ragi—second crop</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Groundnut—third crop</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Cambu—third crop</td>
<td>—</td>
<td>—</td>
<td>2.00</td>
</tr>
<tr>
<td>Ragi—third crop</td>
<td>1.00</td>
<td>2.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>
The farmer's preference should be to maximize the income. The repayment period of loan is fixed as follows: 7 years in the case of pumpsets irrespective of whether a farmer is a small farmer or not. For well portion, the loan period is 15 years in the case of small farmers and 9 years in the case of other farmers.

While fixing the repaying capacity 90 per cent of the incremental income is assumed to be available for repayment of loan. The risk component on account of monsoon failure is high and 10 per cent cushion is not adequate. Various types of risks in adopting post-development cropping pattern should be quantified and the cushion should be fixed accordingly.

Another constraint prohibiting the adoption of optimum cropping pattern is the pattern of loan assistance. Loans for minor irrigation development are issued mostly for digging well and for installation of electric motor or oil engine pumpset. Immediately after digging the well the farmer has to prepare the land to receive water. Sometimes he has to spend quite a substantial sum for land levelling, compartmental bunding, laying out field channels or pipelines, etc. If farmers do not have enough of their own resources they have to bring the land to the optimum level in stages. It is therefore necessary that the projects should provide a package deal to the farmers.

Conclusion

In Tamil Nadu State, since most of the surface water resources are already tapped, there is a dire need for development of groundwater resources. The groundwater potential of an area is at present determined by the State Groundwater Directorate based on certain assumptions and field observation. It is established beyond doubt that detailed hydro-geological studies should be made for estimating groundwater potential, more precisely. There are a number of problems to be sorted out while introducing groundwater discipline.

APPENDIX 1

CALCULATION OF GROUNDWATER RECHARGE AND EXTRACTION IN KATTANKOLATHUR BLOCK OF CHINGLEPUT DISTRICT

1. Calculation of Recharge

Total area of the block = 93,235 acres

1. Recharge through rainfall

Average annual rainfall for the past 50 years = 44.56 inches

Recharge through rainfall at 10 per cent = \(44.56 \times 10 \times 93,235\)

= \(12 \times 100\)

= 34,621 acre-feet

2. Recharge from return flow of irrigation water

Gross irrigated area (paddy) = 34,634 acres

Return flow at 24 inches per acre = \(34,634 \times \frac{24}{12}\)

= 69,268 acre-feet
3. Recharge from water spread area

Total water spread area = 8,143 acres
Seepage per day = 23.8 mm./day
Number of days of standing water in the tank = 60 days
Seepage per year = \( \frac{23.8}{25.4} \times 60 = 56 \) inches

As 56 inches seems to be very high, restricted to 24 inches

\[ \text{Recharge from surface water bodies} = 8,143 \times \frac{24}{12} \]
\[ = 16,286 \text{ acre-feet} \]

4. Recharge from river beds

Total river area in the block \((1 \times b)\) = 31,152 feet \(\times\) 2,798 feet

Assumed there will be water flow for 10 days and 0.59 feet of infiltration per day

\[ \text{Recharge from river beds} = 31,152 \times 2,798 \times 0.59 \times 10 \times 23.6 \]
\[ = 11,830 \text{ acre-feet} \]

Total Recharge = 34,621 + 69,268 + 16,286 + 11,830 = 132,005 acre-feet

Deduct 30 per cent for unavoidable losses due to evapotranspiration, sub-soil seepage, etc.

\[ = 132,005 \times \frac{30}{100} \]
\[ = 39,601 \text{ acre-feet} \]

Net quantity available for extraction = 132,005 — 39,601
\[ = 92,404 \text{ acre-feet} \]

II. Present Extraction

1. Extraction through electric motor wells

Total number of electrified wells = 3,326
Total units consumed in a year = 57,429,926 kWh
Annual extraction by a single well = 2,593 gallons per kWh

Total annual extraction of all energised wells = \( 57,429,926 \times 2,593 \times 3.68 \times 10.6 \)
\[ = 54,800 \text{ acre-feet} \]

2. Extraction through oil engine wells

Total number of wells with oil engines = 207
Annual extraction by a single wells = 16.91 acre-feet
Total annual extraction by all oil engine fitted wells = 16.91 \( \times 207 \)
\[ = 3,500 \text{ acre-feet} \]
3. Extraction through bullock bailing wells

Total number of bullock bailing wells = 1,883
Annual extraction by a single well = 8·62 acre-feet
Total annual extraction = 1,883 × 8·62
= 16,231 acre-feet

Total Present Extraction = 54,800 + 3,500 + 16,231
= 74,531 acre-feet

Net quantity available for extraction or balance potential = 92,404 − 74,531
= 17,873 acre-feet

Number of units available at the rate of 20 acre-feet
= \frac{17,870}{20}
= 893·5

Reserving some units for private use:
Number of units recommended = 800

APPENDIX 2

WORLD BANK FORMULA FOR SPACING OF WELLS

(A) Ayacut Area

Rainfall 1,132 mm.
Total rainfall from September to December (first crop period) 728 mm.
75 per cent of rainfall from September to December 546 mm.
Total rainfall from January to April (second crop period) 96 mm.
75 per cent of rainfall from January to April 72 mm.

R = 48 inches − 75 per cent rainfall from September to December
+ 12 inches − 75 per cent of rainfall from January to April.

i.e., 1,219·2 − 546 + 304·8 − 72 = 906 mm.

C = 1
A = one hectare

r = 10 per cent of rainfall + 24 inches of return flow of irrigation water

i.e., 113·2 + 609·6 = 722·8 mm.

S = 100 \sqrt{\frac{906}{722·8}} = 111·9 or 110 metres

(B) Non-Ayacut Area

R = 906·mm.
C = 1
A = one hectare
\[ r = 10 \text{ per cent of rainfall} + 24 \text{ inches of seepage from well irrigated area of } S_m^2 \]

\[ = 113.2 + \frac{609.6 \times 10^4}{S_m^2} \]

\[ S_m = 100 \times \frac{906 \times 1 \times 1}{113.2 + 609 \times 10^4} \]

\[ S_m^2 = \frac{104 \times 906 S_m^2}{113.25m^2 + 609.6 \times 10^4} \]

\[ 113.255 m^2 = 104 (906 - 609.6) \]

\[ S_m^2 = 104 (296.4/113.25) \]

\[ S_m = 10 \times \frac{296.4}{113.25} = 161 \text{ metres or 160 metres.} \]

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FORMULATION AND APPRAISAL OF PROGRAMMES UNDER THE SFDA—A CRITICAL REVIEW

D. P. Apte*

The Small Farmers' Development Agency (hereinafter referred to as the SFDA or Agency) was set up in 1970 to devote special attention to the development of small farmers in the project area. At the districts selected under the programme an Agency (SFDA) is registered at the district level. The SFDA acts as a co-ordinator between the participant small farmers, credit institutions, agriculture, animal husbandry and other development departments and extension agencies to acquaint the farmers with know-how and arrange for the supply of the necessary inputs and credit.

Since its inception, the Agencies have identified about 146 lakh participants. About 10 per cent of the identified farmers have benefited from the minor irrigation and animal husbandry programmes. From 1970 till December 1977 the small farmers, marginal farmers and agricultural labourers have obtained from co-operative and commercial banks credit to the tune of Rs. 228 crores. Between 1970-71 and 1977-78 about 170 Agencies had utilized nearly Rs. 150 crores received from the Government of India. In the years to come the number of small farmers is bound to increase at a rapid rate due to division of land among the heirs of the small farmers. Though the SFDA has been able to reach so far only a low percentage of small farmers, it is necessary to critically examine the present procedure of project formulation and appraisal of programmes under the SFDA so as to enable the Government to introduce the necessary changes in organization and working of the SFDA so that it could operate more effectively and successfully to face the problems

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