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GUIDELINES FOR SAMPLE SURVEY FOR MINOR IRRIGATION WORKS

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ABSTRACT

Water balance study means the book keeping of water of a region/basin in relation to the components of entire hydrologic cycle or part of it, done over a specified period. It is an effective tool for estimating the available water potential both surface and sub-surface and is also useful for assessing the existing utilization pattern for optimal planning and efficient management of water resources. In water balance study, draft from ground water is a major component which needs to be evaluated. In most of the cases figures relating to each of the minor irrigation works i.e. area irrigated by each well, unit draft of well, pumping hours etc. are not collected in systematic and rational manner and thus the statistics relating to minor irrigation works suffers from inadequacy of details. Hence for the above reason, the sample survey for minor irrigation works is to be conducted.

This report deals with the guidelines for such sample survey on the basis of complete inventory of wells operating in the area both for irrigation and water supply, their classification, area irrigated, mode of water supply etc. From the data, thus, collected, the methods for calculating draft from ground water for minor irrigation works are also indicated.

1.0 INTRODUCTION

India is a vast agricultural country, the estimated ultimate irrigation potential being 133 m.ha. Out of this 55 m.ha.accounts for minor irrigation projects. The irrigation potential created up to VI plan was 30.5 m.ha. In the seventh plan it is expected to add 4.3 m.ha. to the irrigation potential created up to VI plan. The ultimate irrigation potential of 133 m.ha. is planned to be harnessed by the turn of this century.

At the end of VI plan, the gap between the irrigatio potential created and its utilization has been widening. In respect of minor irrigation projects it was presumed earlier that there was no gap between potential and utilization but it is now recognized that there is a gap(Ref.16). To know the actual widening of this gap,irrigation potential utilization need to be determined. So to bridge this gap, proper planning and development of irrigation is imperative. Water balance of the area will determine the gap between potential created and that utilized and will provide useful information for planning and development of irrigation.

1.1 Ground Water Balance Study

Water balance study is the book keeping of water of a region/ basin in relation to the components of entire hydrologic cycle or part of it, done over a specified period. It serves the following purposes.

1. To evaluate the available water resources.
2. To assess the existing water utilization pattern and practices.

This information will help in planning optimal and efficient

management of water resources.

Dealing with the ground water balance of the area,we come across ground water balance equation of the form,

$$R_P+R_C+R_S \pm I_G + R_u+R_I = E_T \pm S_R+P_G+S_G+\varepsilon$$

R_P= Recharge from precipitation

R_C= Recharge from canals and field channels

R_U= Recharge from unirrigated and fallow fields and with other areas

R_I= Recharge from areas irrigated by canal,wells and tanks

I_G= Net inflow/outflow from and to other basins

E_T= Evapotranspiration from ground water,trees,water logged areas

P_G= Draft from ground water from wells and tubewells

S_R= Net influent/effluent seepage from and to streams

S_G= Ground water storage

ε= Unaccounted water

The scope of this report is mainly concerned with the term P_G i.e. draft from ground water. The main source of draft from ground water are minor irrigation works. For ground water balance study of an area, this needs to be evaluated properly.

1.2 Scope

Often, for calculating monthly draft from ground water, proper care is not taken to obtain information for each of the minor irrigation works in respect of crop areas irrigated. Draft system, unit draft and hours for which wells are operated etc. are not collected in a systematic and rational manner. Thus, the statistics relating to minor irrigation works suffer

from inadequacy of details. Wells used for irrigation are of different types. Some are operated by electricity or diesel engines, for others the lift is done by other devices like a persian wheel or Rohat. Reliable statistics are required to be collected in respect of number of wells for different types. Their discharge should be ascertained and the period for which they are operated should be determined. Figures for the area served by each of the minor irrigation work and crop grown should be collected. For collecting these adequate statistics, it is necessary that the sample surveys should be conducted. This report deals with the guidelines for such sample survey.

2.0 SAMPLING AND DATA GATHERING PROCEDURES

2.1 Sampling Procedure

In a sample survey, one has, first of all, to select a sample. In selecting a sample, the following points are considered important.

2.1.1 Selecting a sample

When the area for which the information is to be collected is small, all the wells lying in the area can be surveyed and information can be obtained about each of them. In case, the area is large or the wells are more in number, it would become too expensive and time consuming to survey all of them. Therefore, instead, it is usually decided to select some representative wells and survey is carried out to obtain data. The information is then analysed and deduced from the entire system basing it on the data collected and analysed. The wells selected for this purpose are known as sample wells.

2.1.2 A representative sample

A sample is selected when it is either impossible or unnecessary to survey the entire population. The result of a survey made with a sample is then regarded to represent the data that would have been obtained if the entire population had been surveyed. Generalization made in this way is only valid if the sample has been selected in such a manner that it represents the population as closely as possible. Such a sample

is called representative sample.

In practice, it is impossible to select a sample that represents the population perforectly in all its characteristics. Nevertheless, the surveys need only to be representative of the poupulation.

2.1.3 Size of sample

The larger the sample, the more representative it is of population. A perfect representative sample would consist of entire population. To save time and money, however, the sample is chosen as small as possible, with an expected margin of errors that is acceptable for the objectives of the survey. Keeping the above points in view, sample is selected.Depending upon the nonsimilarity of the elements to be surveyed, more than one representatives sample should be chosen.

2.2 Data Gathering Procedures

The data that enumerators will be required to gather can be obtained in two different ways.

i) By interviewing the farmers/owners

ii) By observing and recording the information at site.

Information obtained by interviewing is likely to be less accurate than that obtained by observation, because the farmer may not remember or do not with to tell complete information. On the other hand, the quantity of information gathered by interviewing is much greater. In practice, it is common to combine interviews and field-observations for gathering informations. In this way more and reliable data can be obtained.

2.2.1 Type of questions

As regard to interviews, if the survey requires detailed information, which the farmer can not possibly remember for a long time,repeated interviews need to be conducted in order to get more information. It will also help in conforming the information obtained earlier.

While gathering information by interview, an enumerator is likely to forget some of the topics that he should talk about. On the other hand, for the ease in the processing of the data, it should be collected in a specified format. For this reason, the questions that the enumerator will ask should be written down in advance in an appropriate format. These questions can be posed to the farmers in two different ways.

a) As open-ended questions

b)As multiple type questions

2.2.1(a) Open ended questions

These type of questions are printed on the survey forms and are read to the cultivator exactly as they are written and his answer is copied on the form exactly as he says it. Open-ended questions make the survey rather time consuming, herefore, they are only practical for a site visit survey or a reconnaissance survey(which obtains basic information on which a more detailed and long-term survey will be designed).

2.2.1(b) Multiple choice questions

In this type of questions, the questions are printed on the survey forms along with the list of their possible answer.

The enumerator reads a question to the farmer, who answers in his own words, and enumerator makes on the forms, the answers that best covers what farmer has said. The enumerator can also read the question and its list of possible answers and ask the farmer to choose the right answer, which the enumerator then encircles or mark with across.

Advantage of this type of questioning is that it has always an alternative "others" so that any unusual answer can be written down. Second advantage is that farmer remembers the possible answers and choosen the appropriate reply, which otherwise may become difficult for him to think. Also due to this type of question data processing becomes easy because answers to these question are easy to read, check and tabulate.

The points considered important in data gathering are listed below.

i) In a long term survey, open-ended questions could be used in the first period, and afterwards the information they provide could be used to compile multiple choice questions and their list of possible answers.

ii) The farmer should only be asked questions that he is willing and able to answer. The questions should be worded in such a way that they are easy for him to understand and simple for him to answer. Also, it is required that the questions should not upset the farmers or influence his answers; the questions must be simple and natural.

iii) The attitude of the authorities(conducting survey)

towards survey will influence the attitude of the farmers to answer. Therefore proper care must be taken. If the cultivators understand the reasons for conducting the survey and are in favour of it, then only they can provide valuable information.

iv) Whatever procedure is followed, it is important to keep every thing in open. Acting in this way will help to prevent the spread of rumours (that the information to be collected will be used for tax purpose etc.)

3.0 VARIABLE INVOLVED AND DATA TO BE COLLECTED

The sample survey for minor irrigation works involves a large number of variables that need proper attention. For ease, information to be collected is grouped as given below:

1. General information about the minor irrigation wells.
2. Information based on the type of purpose for which extracted water is being utilized.
3. Information relating to the type of lifting devices used for extracting groundwater.

3.1 General Information about the minor irrigation wells.

It consists of the following variables.

1. Location :
   (a) Latitude-longtitude
   (b) Village/Block/District
2. Ownership:
   (a) Owned by cultivators i.e. private-ownership
   (b) Owned by government i.e. State-ownership
3. Date of construction
4. R.L. of well(measuring point)
5. Ground-level at well point
6. Distance of nearest sources(Well/tube wells)
7. Type of well:
   (a) Open well
   (b) Dug-cum-bore well
   (c) Bore well
8. Size of well:
   (a) Diameter of well
   (b) Depth of well

(c) Size and depth of bore

(d) Pipe and its size and length of strainer

9. Aquifer characteristics:

In this case, the information is to be collected as below:

(a) Bore-log charts or type of soil starata

(b) Sieve analysis of strata and USDA classification

(c) Details of recuperation and draw down tests for open wells and pumping tests for tube-wells along with tests procedure used.

(d) From the analysis of tests data the values for aquifer parameters i.e. Transmissibility (T) and Storage Coefficient(S/Sy).

10. Construction:

(a) Masonary Well

(b) Non-Masonary well

11. In regular use or abandoned

Information with regard to the regular use of the wellis to be ascertained as to whether the well is in regular use or abandoned. If the well is abandoned the reasons therfore are also to be gathered.

12. Capacity of well/tube well

13. Quality of water

14. Fluctuations of water table over the year.

The format for the general information as desired above is given in Annexure-I.

3.2 Information based on the purpose for which the Ground Water is Used.

The groundwater that is extracted from the well can be used for the following purposes, viz.,

a) for irrigation

b) for domestic/municipal use

c) for industrial use

d) a combination of the above

Depending upon the use of water, the following further information is required.

3.2.1 Irrigation purpose

In case a well is being used for irrigation purpose, the information to be collected is given below.

a) Command area for each well

b) Different crops and the area under each crop i.e. cropping pattern, number of irrigations applied and depth of irrigation etc.

c) Length of guls/field channels and their size, whether lined or or unlined

d) Type of soil through which these channels are laid.

3.2.2 Domestic/Municipal purpose

If the well is used for domestic purpose, the following information is to be collected.

a) Population served by each well

b) Living sdtandard of villagers/population served by well on the basis of domestic water consumption.

c) Other uses for live-stock and municipal uses.

3.2.3 Industrial Purpose

Minor irrigation works do not provide for industrial use. However, in case a well or a part of the production from it is being used for industrial use, the following information is to be gathered.

a) Type of industry for which the water is being extracted.

b) Monthly water requirement of the industry.

i) For the process

ii) For the other utilities and for colony

c) Other sources from which the water needs of the industry are being fulfilled, if any.

The information to be collected is formated and presented in Annex.-II.

3.3 Information based on Type of Lifting Device used:

There are a large variety of water-lifting devices that are in use. For convenience, they can be classified into following three groups.

a) Manual

b) Animal

c) Mechanical

3.3.1 Manual

In manual water lifting, water is applied to the field manually with the help of water-can or bucket. In this case, there are not many variables involved. A system commonly seen throughout the middle and eastern part of the country, the principle of lever is used to raise bucket from a well. The informatin to be gathered in this case is :

a) Capacity of water-can or bucket

b) Number of lifts per hour

c) Number of labour employed for water lifting

d) Lifting hours(on monthly basis)

3.3.2 Animal Lifting

Most common animal powered systems and a mote or persian wheel. The information to be collected in this case is :

a) Capacity of mote or number of buckets and capacity of persian wheel.

b) Number of animal, man power used for the purpose

c) Lifting hours on monthly basis

d) Number of lift/cycle per hour

3.3.3 Mechanical lifting

If the water is being extracted by mechanical means, the following information needs to be collected.

a) Type of pump, specification of pump and discharge capacity

b) Source of motive power(diesel/electricity)

c) Total head for which the water is being lifted(suction head and delivery head including losses)

d) Horse-power of the pump used and its efficiency

e) Pumping hours(on monthly basis)

f) Manpower used and its chargeable cost

g) Cost of repairs

h) Monthly consumption of diesel/electricity. In case of electrically operated pumps the additional information is total electrically charges paid (month-wise) and the charges/KWH of consumption.

i) Rate of diesel/electricity consumption

j) Discharge mesuring device and information w.r.t. discharge measurements.

The format for the information regarding type of lifting devices as discussed above is given in Annexure-III.

4.0 ASSESSMENT OF DRAFT

After collecting the necessary data in appropriate formats(as given in Annexure I,II and III), the assessment of draft is done in two ways. First , the draft is calculated based on the use for various purposes served by it , and second the draft is assessed from the capacity of the system used and number of hours the system works. Thus, for the first,draft assessment is based on the data obtained in the format as given in Annexure II, and that for the second, it is based on the data obtained in the format given in Annexure III.

4.1 Assessment of the Draft Based on the Use for Various purposes

4.1.1 Irrigation purpose

The basic equation used for draft estimation in this case is

draft = crop water requirements - effective rainfall + transmissioin losses

Since estimation of losses can not be done, a percentage of draft is taken as losses and the equation becomes

$$\text{draft} = \frac{\text{Crop water requirement - effective rainfall}}{(1-x)}$$

Where x is ascertained as losses represented as fraction of the flows based on the adjustment keeping in veiw the length and type of water courses and field channels, or ascertained in the field. For ascertaining crop water requirements as above, the surveys should be carried out in the field.

Using the data of number of irrigations applied for each crop, its area and depth of water applied at each irrigation, the water applied

to the crops can be estimated. Allowing for losses during transmission, the water pumped from the well over the period under consideration can be assessed. This will serve as a check for the value of draft estimated by other means.

4.1.2 Domestic/Municipal purpose

In this case knowing the population and the average water consumption per capita draft, is calculated as given below:

draft = population x per capita water consumption

The water used for livestock is estimated in the same manner.

4.1.3 Industrial pupose

The data directly gives the requirement and the same is assumed to be the draft from the wells.

4.2 Assessment of Draft Based on Capacity of System and Number of working hours

While assessing the draft, the data as obtained in Annexure III is used. The basis of estimation of draft is as given below:

Total draft = discharge x total working time or total pumping time ...(1)

Thus first, the discharge is required to be calculated. Calculation of discharge for the various types of lifting systems is presented below:

In case of manual lifting/animal lifting the draft is directly calculated from capacity of system and the working hours. In case of mechanical device basic equation used for the calculation of capacity is

$$Q = \frac{75 \times (H.P.) \times \eta}{W \times H} \qquad \ldots(2)$$

where

Q = rate of discharge in m^3/S

W = specific weight of water kgf/m^3

H = total head to be lifted in meters

η = efficiency of the pumping sets

Efficiency of pumps will be determined from power input and water pumped using the usual relationship formulae.

In case of measuring device, the discharge from the data(Annexure-III) is obtained as follows:

a) In case of sharp-created rectangular weir:

$$Q = \frac{2}{3} \cdot \sqrt{2g}.Cd.L.H^{3/2} \qquad \ldots(4)$$

Cd = coefficient of discharge

L = length of the crest(m)

H = head over the crest(m) is measured at a distance at least four times the head u/s of the crest

Q = discharge (m^3/s)

Knowing the length of crest and the head over the crest along with average value Cd, discharge can be assessed.

b) In case of venturi meter/orifice meter:

$$Q(m^3/s) = Cd.a. \sqrt{\frac{2gh}{k^2-1}} \quad , \quad k = \frac{a_1}{a_2} \qquad \ldots(5)$$

a_1 = area in m^2 at entrance

a_2= area at throat/orifice in m^2

h = difference of level in the two limbs of manometer in m

Cd= average value of coefficient of discharge

c) Triangular V-notch : Discharge is given by

$$Q(m^3/s) = \frac{8}{15} \cdot \sqrt{2g} \cdot Cd. \tan(\emptyset / 2).H^{5/2} \qquad \ldots(6)$$

where $\emptyset$ is notch angle

Simplified form

$$Q(m^3/hr) = 8.505 \times 10^3 . Cd . \tan \frac{\emptyset}{2} . H^{5/2} \quad ...(7)$$

Knowing average value of discharge coefficient(Cd) notch angle $\emptyset$, and head the notch,H (head measured ata distance four times the head u/s of notch), Q is determined.

d) In case of orifice, the formula used for calculating discharge is

For small orifice

$$Q(m^3/s) = Cd . \sqrt{2gh} . a \quad ...(8)$$

where,

a is the area of orifice in m^2

h is the head over orifice

Cd is coefficient of discharge

Q is discharge $m^3 s$

e) For large rectangular orifice

$$Q = \frac{2}{3} . Cd . \sqrt{2g} . L . (H_1^{3/2} - H_2^{3/2}) \quad ...(9)$$

Q = discharge m^3/s

H_1 = head over bottom of the orifice in m

H_2 = head over top of the orifice in m

L = length of the rectangular orifice(m)

By multiplying capacity or discharge so calculated by working hours, the draft is obtained.

4.3 Draft Based on Judgement

The figures for draft obtained in para 4.1 & 4.2 are reviewed and figure is obtained based on judgement.

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ANNEXURE-I

SAMPLE QUESTIONNAIRE FOR GENERAL INFORMATION

Well No. :

Date :

Name of enumerator :

1. Owner: Block : District :

2. Village: Block: District:

3. Longitude Latitude

4. Date of construction

5. R.L. of well(measuring point):

6. Ground-level at well point:

7. Distance of nearest well:

Sl. No.	Location of well under reference	Location of neighbouring well	Radial distance of these neighbouring wells from well under reference

8. Type of well:

whether open well/dug-cum-bore well/bore well

9. Size:

a) Diameter of well _____

b) Depth of well _____

c) Size and depth of bore and details of pipe and strainer _____

10. Aquifer characteristics

a) Bore-log charts or details of soil strata

Type of soil strata	Depth from G.L.	Sieve Analysis	USDA classification	Remarks

b) Whether recuperation or draw down tests for open well and pumping tests for tube-wells have been carried out

c) If yes, give particulars about the details of tests and test procedures and values of aquifer parameters.

- type of test and test procedure _____
- details of analysis _____
- procedure used for estimating the parameters _____
- values of parameters

S/Sy = _____

T = _____

11. Construction : Put a tick mark against correct answer.

a) Masonry ( ) b) Non-masonry ( )

12. Put a tick mark against correct answer

a) In regular use ( ) b) Abandoned ( )

If abondoned, reasons therefor

_____

_____

_____

_____

14. Capacity of well/tubewell _____

15. Quality of water _____

16. Whether the charges in groundwater levels were abnormal at any time Yes/No

If yes, year of such change and extent

_____

SAMPLE QUESTIONNAIRE FOR COLLECTING INFORMATION REGARDING THE PURPOSE FOR WHICH THE WATER EXTRACTION IS DONE

Well No. :

Date :

Name of enumerator :

1. What are the purposes served by the extracted water ?

a) Irrigation ( )

b) Municipal and domestic ( )

c) Industrial ( )

d) Irrigation and domestic/muncipal ( )

e) Domestic/municipal and Industrial ( )

2. Approximate percentage distribution of water(e.g.80 percent for irrigation purposes and 20 percent for domestic/municipal)

Purpose	Approximate percentage of use
Irrigation	
Domestic/Muncipal	
Industrial	

(A) IRRIGATION PURPOSE

1.(a) Command area is _____ ha.

(b) Please give the other information in the following table

Crops grown	Area under each crop	Growing period	No. of irriga-tions	Depth of each irrigation	Source of water and quantity of such apply

2. Details of field channel : Relevant information should be given in the following table

Field Channel No.	Length	Size	Depth of flow	Type of soil *	Whether lined or lined	Area irrigation crop-wise		
						Crop I	Crop II	Crop III

* Rocky/Black cotton/Alluvial/ Loose sandy

(B) DOMESTIC/MUNICIPAL PURPOSE

1. Population and livestock served by the well _____

2. Approximate average per capita daily consumption of water

_____

(depending upon the living standard)

3. Municipal uses and their users _____

(D) INDUSTRIAL PURPOSE

1. Type of industry for which the water is being supplied

_____

2. Average monthly water requirement of the industry for the process other utilities and colony

_____

Also give the monthly water requirement in the following table

Month	Consumption			
	Process	Utilities	Colony	Total
JAN				
FEB				
MAR				
MAR				
APR				
MAY				
JUNE				
JUL				
AUG				
SEP				
OCT				
NOV				
DEC				

3. Other sources, if any, from which the water needs of the industry are being fulfilled and its percentage to total requirement

SAMPLE QUESTIONNAIRE FOR COLLECTING INFORMATION
REGARDING LIFTING DE ICES USED FOR WATER EXTRACTION

Well No. :

Date :

Name of enumerator :

1. Type of lifting device used

a) Manual lifting ( )

b) Animal lifting ( )

c) Mechanical lifting ( )

2. In case of manual lifting give the following information:

a) Capacity of water-can/bucket and No. of lifts per hour

_____

b) Lifting hours: information should be given in the following table:

Month	Avberage working hours in a day based on sample survey	Total number of working days
JAN		
FEB		
MAR		
APR		
MAY		
JUN		
JUL		
AUG		
SEP		
OCT		
NOV		
DEC		

In case of irrigation well the information would be given with respect to annual cropping pattern in the following table

Crop	average working hours	Total number of working hours

3. In case of animal lifting give the following details

a) Capacity of mote/number and capacity of buckets _____

b) Number of lift per cycle per hour _____

c) The number of animal used for this purpose _____

d) Lifting hours

Month	Average working hours in a day (based on sample survey)	Total number of working days
JAN		
FEB		
MAR		
APR		
MAY		
JUN		
JUL		
AGU		
SEP		
OCT		
NOV		
DEC		

4. In case of mechanical lifting,give the following details

A) i) Type of pump used:strike-out which is not applicable

shallow-well centrifugal pump/jet pump/reciprocating piston pump/ air lift pump/any other type

ii) Specification of pumps and motors/engine _____

iii) Discharge capacity _____

iv) Discharge measurement using measuring device;

Which type of device is used for flow measurement ?

Broad-crested weir/sharp-crested weir/triangular notch/venturi meter/ orificementer/orifice/bendimeter/jet flow/timed volume(strike-out whichever is not applicable)

a) In case of Broad crested/Sharp-crested/Triangular notch give the following details:

i) Dimensions of the weir:

Length of weir = _____ m

Width of the crest = _____ m

Notch-angle(in case of triangular notch) = _____ m

ii) What is the head over the weir crest ?

_____ m

b) In case of venturimeter/orificementer,give the following details:

i) Manometric liquid used _____

ii) Area of the pipe _____ m^2

Area at the throat _____ m^2

iii) What is the difference in the level of manometric liquid in the limbs? _____

c) In case of orifice give the following details:

i) Size of orifice:

diameter = _____ m

width of orifice(in case of large rectangular orifice)

= _____ m

ii) Head over the orifice = _____ m

iii) In case of large reactanqular orifice,
Head over the top of the orifice(H_1) = _____

Head over the bottom of the orifice(H_2) = _____

d) In case of bend meter, give the following details:

i) Manometric liquid used _____

ii) What is the difference of
the levels in the two limbs ? _____

e) In case of jet flow, what is the maximum distrance travelled by jet ?

In X - direction = _____ m

In Z-direction = _____ m

f) In case of timed-volume measurement, give the following details:

Time taken = _____ sec.

Volume of water collected = _____ m^3

If the measuring device is calibrated, what is the average coefficient of discharge ?

_____

v) What is the total head for which the water is being lifted?

_____

B) Manpower used and its chargeable cost : _____

C) Cost of repairs _____

D) Consumption of diesel and electrical power: Information should be given in the following table.

Month	Diesel consumed litre	Electricity consumed	Rate Cost
JAN			
FEB			
MAR			
APR			
MAY			
JUN			
JUL			
AUG			
SEP			
OCT			
NOV			
DEC			

E) Pumping hours : Information should be given in the following table

Month	Average working hours in a day (based on sample survey)	Total number of working days
JAN		
FEB		
MAR		
APR		
MAY		
JUN		
JUL		
AUG		
SEP		
OCT		
NOV		
DEC		