CHAPTER III

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CHAPTER III

3.0 QUALITY CONSCIOUSNESS W.R.T. DIESEL ENGINES FOR AGRICULTURAL USE

3.1 BACKGROUND

As already concluded in Chapter II, Govt. of India had found out the root causes of inefficiencies resulting wasteful costs of diesel engine pumpsets for agricultural application. In order to elevate the quality & performance standards of D.P. sets, Bureau of Indian Standards (BIS) previously known as Indian Standards Institution (ISI) had introduced different IS standards for diesel engine, and subsequently for centrifugal pump, footvalve, pipes & ultimately for complete pumping system. Ministry of Power directed NABARD to supplement the efforts taken by BIS in implementation of new IS 10804 Standard for financing D.P. sets through financial institutions.

As newer and advanced quality control standards and techniques in elevating manufacturing standards became need of the hour, in the industrial sector to improve industrial productivity, similarly in the agricultural sector also Govt. of India had planned developments in agriculture by using quality
techniques to increase agricultural productivity of the country. Although the effects of quality techniques in Industrial sector are seen rapidly and vividly, at least the beginning has been made in agricultural sector.

As more and more industries in the country and in the world have been following Japanese quality management techniques by using various concepts of quality control, quality assurance, quality audit, quality circles etc. for overall growth in the industrial productivity, similarly for improvement and growth in agricultural productivity such techniques used in industrial sector can also be thought of.

In this chapter, quality aspects of a complete pumping system, various IS marks and their significance in the context of diesel engine and other components of D.P. sets and NABARD's effort in monitoring quality norms of BIS which financing D.P. sets have been highlighted. The aim is to emphasise the need felt by Govt. of India and other organisations bringing quality consciousness and creating quality atmosphere for improving the agricultural productivity w.r.t. diesel engines, a vital tool of water management. Thus the quality consciousness must become a way of life for increasing the agricultural productivity.
5.2 QUALITY ASPECTS OF A COMPLETE PUMPING SYSTEM

Generally a complete diesel pumping system is not manufactured by any one manufacturer in the country. There are separate manufacturers for diesel engine pump, baseframe, coupling and other accessories such as pipes, footvalve to make a complete pumping system.

A dealer collects all such items/units of a diesel pumping system from different manufacturers, assemblers, complete pumping system and supplies same to a farmer. To understand quality aspects of complete pumping system, quality considerations of each of the item/unit of pumping system is essential.

3.2.1 Diesel engine

Diesel engine is the most important and costly unit in the whole pumping system. A quality engine should be able to give the following results:

A] Low diesel consumption.
B] Low lub oil consumption.
C] Low exhaust/smoke level.
D] High reliability [i.e. less wear & tear of parts]
A) Low diesel consumption

For low diesel consumption to be maintained over a longer period, firstly the basic combustion design and repeatability in manufacturing the components to quality standards are very essential. The factors like raw materials used for making each component, manufacturing to tolerances, surface finishes, the heat treatments of different components, balancing of rotating and reciprocating masses etc. are very important factors for maintaining the quality and reliability of all engine components. Once the engine components are made to these rigid standards, the diesel engine produced with proper care in assembly testing etc. can give the results mentioned above.

Once diesel consumption is low, it is an indication that fuel is burnt efficiently, producing optimum heat and thus keeping the component temperature at optimum design level and giving increased life to the components. The efficient combustion produces less carbon which helps keep the piston rings free from seizure and lub oil clean which inturn gives better life for components like bearings, crankshafts, longer oil change periods etc. Smoke level is also a measure of better combustion.

A diesel engine produced out of quality components
mentioned above should give low diesel consumption, low lub oil consumption and high reliability.

The engine which gives all such benefits can be termed as a quality engine. Such engine has got the life of about 12 to 14 years. Anything below these standards deteriorates quality and naturally reduces the life period of an engine.

The fuel consumption is generally specified in terms of SFC. The diesel engines available today have a very wide range of SFC from 185 gms/bhp-hr to 260 gms/bhp-hr. NABARD, Bureau of Indian Standards [BIS] Local State level technical committee, Financial Institutions decided to recommend diesel engines with lower SFC. The detailed norms about SFC figures w.r.t. various designs, speed of engines were asked to design to Bureau of Indian Standards.

Such stringent norms alone would save millions of litres of diesel and crores of rupees in foreign exchange.

B] Low lubricating oil consumption

The second norms of Lub oil consumption should be 1% of fuel consumption. It is however, seen that the lub oil consumption particularly is slow speed vertical engines is as high as 3% to 4% of their
diesel fuel consumption which is also very high. For a quality diesel engine lub oil consumption should be 1% of fuel consumption limit as per SFC specified by in IS standard by BIS.

C) Low exhaust/smoke level

The exhaust smoke level is an indication of good or bad combustion. Normally, the smoke level is checked with Bosch meter and as per this meter it should not be more than 2.5 Bosch. In case of absence of Bosch meter examination of smokelevel could be done visually. It should be barely visible. This is a practical way of knowing the better combustion.

D) High reliability

For measuring less wear and tear of the parts standards have to laid down by BIS in order check the high reliability of less wear and tear of the parts. Such wear and tear can be checked only in laboratories and very few manufacturers have this facility. But one thing is certain that the engine which gives low diesel consumption, low lub oil consumption and low exhaust smoke also automatically gives high reliability. Therefore, only the measureable factors like low diesel consumption and low lub oil consumption may be considered.
3.2.2 **Centrifugal pump**

A good quality pump should have reliability and high mechanical/hydraulic efficiency. The reliability in pump also can be achieved by better material inputs, heat treatments, surface finish, proper design of bearing supports and close manufacturing tolerances. When the proper bearings are not used, the radial and axial loads will eventually overcome normal bearing action resulting in either a pump with jammed bearings or one with excessive friction. Impellers and volute casings are important parts of design, engineering foundry technology and hydrodynamics. For selection of pump the main consideration is of power, i.e. diesel engine in case of diesel pumpsets. Pump with minimum efficiency of 60% to 70% is recommended and pumps therefore more than 70% efficiency should be preferred.

3.2.3 **Foot valve**

Ordinary cheap foot valves start leaking and resulting into effect of priming arrangement of the pump after some use. It causes considerable suction head loss due to friction as their flaps do not open fully to give full flow of water. The strainers of such footvalves are very small with less number of holes than required. It is therefore, necessary to
install at the end of each opening fully so as to allow full flow of water without any obstructions. The strainer of such foot valve is recommended to have total open area through its holes equal to 2.5 times of the area of its opening or the size of the pipe to which it is connected. This is necessary to keep head loss across strainer within a reasonable limit. Thus the foot valve has to meet requirements of almost leakage free operation while closed and almost zero resistance to flow while open.

3.2.4 Coupling

There should be minimum power losses in transmission through coupling. The quality of rubber coupling bolts has to be good to provide longer life. It should have homogeneity and flexibility to absorb torsional stresses.

3.2.5 Suction and delivery hoses

Flexibility of the hoses is one of the most important factors and specially in selection of suction hoses. It has already been observed during survey reports findings that the number of hoses were found to be cracked and resulting into leakages. In cheaper quality of hoses, inflammation is likely to take place resulting into unnatural union of inside surfaces and thus clogging the passage of
water. The manufacturer of hoses is supposed to test the hoses for working temperatures and the pressures before releasing to markets. The testing pressure has to be double that of the working pressure while the bursting pressure should double that of test pressure.

Many farmers select wrong hoses for connecting to pump. The sizes suction and delivery pipes of the pump are generally kept as per size of the pump but technically it is not always correct. Quite often it makes farmer in paying higher charges for diesel due excess fuel consumption. There could be saving of approximately 29% in fuel if one size larger suction and delivery pipes are selected e.g. for pump with suction and delivery sizes of 65 mm x 50 mm resp. It is recommended that suction and delivery pipe sizes of 80 mm and 65 mm are used. The farmer of course has to spend slightly more amount for purchasing larger size pipes, bends, footvalves etc. but he would recover this extra cost in a few months by saving in the cost of diesel.

3.3 IS MARKS AND THEIR SIGNIFICANCE TO MONITOR QUALITY PERFORMANCE

Indian Standards Institution, [ISI] now nomenclatured as Bureau of Indian Standards [BIS] came into existence to give minimum quality standards for producing any consumable or an engineering products.
The evaluation various IS standards for diesel engines is as follows:

3.3.1 IS1601;1961 for general purpose application

ISI did not specify any quality standard for diesel engine. Till recently, they did not specify any limit for diesel consumption, lub oil consumption etc. ISI certificate was given to the diesel engine, if diesel engine conformed to the value of diesel consumption lub oil consumption etc. were found to be in accordance to the declaration made by the manufacturer. Hence there was wider variation in diesel consumption of different brand of engines ranging from 185 gms/bhp-hr to 260 gms/bhp-hr and even with such wide variation in the specific diesel consumption any manufacturer used to get ISI certification mark. Thus, the assumption made by bankers that any ISI marked diesel engine has same quality was incorrect. Thus standard of IS 1601-1961 did not specify maximum SFC to be eligible to get ISI certification.

3.3.2 * IS10001;1981 for general purpose applications

ISI then realised the need of specifying the SFC limits for ISI certification mark. Thus IS 10001/1981 had distinct maximum SFC limits, depending on the rated speed of diesel engines, as follows:
<table>
<thead>
<tr>
<th>Rated engine speed [in RPM]</th>
<th>SFC maximum [gms/KW-hr] [gms/bhp-hr]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto 500</td>
<td>332.5  245</td>
</tr>
<tr>
<td>Above 500 upto 1000</td>
<td>275.5  203</td>
</tr>
<tr>
<td>Above 1000 upto 2000</td>
<td>251.75 185</td>
</tr>
<tr>
<td>Above 2000</td>
<td>308.75 227</td>
</tr>
</tbody>
</table>

This new standard was to be made effective from 1-8-1982, however, the implementation had been deferred due to resistance of the small scale diesel engine manufacturers and thus was made effective from 1-4-83.

From the maximum SFC value given above it is observed that -

a] Maximum SFC values are different for different RPM engines.

b] The lowest maximum value of SFC is specified for engines rated speed between 1000 to 2000 RPM.

c] Diesel engines having lower than 500 RPM [Slow speed Lister type engines] are having the maximum SFC value followed by the SFC value recommended for higher than 2000 RPM [High speed diesel engines]. The Lister type engine having lower than 500 RPM when compared to Petter type
engines have higher diesel consumption by 60 to 63 gms/bhp-hr.

It will be very interesting to note that though ISI has now specified upper limit of SFC the engines having ISI approval will have different SFC values even amongst the engines of same family, i.e. engines upto 500 RPM, engines between 500 to 1000 RPM. For example 3 different engines in the RPM range of 1000 to 2000 RPM having ISI approval can have different SFC values as below:

<table>
<thead>
<tr>
<th>Brand</th>
<th>SFC Value (gms/bhp-hr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>195</td>
</tr>
<tr>
<td>B</td>
<td>185</td>
</tr>
<tr>
<td>C</td>
<td>172</td>
</tr>
</tbody>
</table>

It can be noted that prior to implementation of this IS 10001/1981 [i.e. prior to actual implementation date of 1-4-83] how many diesel engines must have been produced in the country over which there was no control on SFC values. Moreover, after enforcing new IS 10001/1981 on 1-4-83 also state of affair is certainly changed but not to the extent it would have been to make available quality diesel engine/pumpset to a farmer.

There was a marked change or shift in favour of purchases of pumpsets through bank finance against
cash purchases, during past two decades due to Government policies to bring more and more land under irrigation. Financing Agencies were just disbursing the loans to farmers by only considering ISI mark for diesel engine irrespective of SFC Value. The time was ripe to have a national dialogue covering all aspects with a view to evolve meaningful solution to look into efficiency of each of the element of pumpset in the ultimate interest of the farmer, the banker, or the manufacturer. The basic problem was of collossal waste of precious resources and finance.

The imperative answer is to upgrade the quality of engines by improving quality of engines manufactured at around 1000 points spread all over the country was an uphill task. Unless Govt. could have evolved a national policy for conserving fuel no patch work by a few organisations or manufacturers was of any use.

Some of the State Govts. had appointed technical committees to go through various aspects at this subject and prepared a fresh list of approved brands of pumpsets and decided loan amounts to be disbursed to farmers by buying such pumpsets.

Many State Govts. had earlier prepared lists of approved makes of diesel engine pumpsets without
going into the details and lead banks, particularly L.D.B.s operated on these lists with a result that the choice of a borrower was restricted to the brands on the approved lists. An attempt was made to fix the price/loan ceiling probably with the objective of protecting the interest of the farmers in terms of loan investments. In reality, the results were contrary to this objective as seen from the surveys findings on the diesel pumpsets installations.

The engine pump and other units/items of pumpset manufacturers having high manufacturing standards were bound to have higher prices. Many of the reputed manufacturers had even used advanced technologies by spending millions of rupees on R&D activities, in order to give better product to farmers. Any price fixation or limiting the loan finance for diesel engine/pumpset in total disregard to the quality, reliability of performance was artificial, arbitrary and against the interest of country and the farmer.

3.3.3 *IS11170/1985 for agricultural purposes

SFC values have been fixed with respect to speed, type of fuel injection, method of cooling to cover all types of diesel engines manufactured in the country and used for agricultural purposes.
The SFC values are as follows:

<table>
<thead>
<tr>
<th>Rated engine speed</th>
<th>SFC max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>[rev./min.]</td>
<td>[g/KW-h]</td>
</tr>
</tbody>
</table>

a) Direct injection engines

- Upto 1000: 241
- Above 1000 upto 2000: 252
- Above 2000 [Water cooled]: 282
- Above 2000 [Air cooled]: 309

b) Indirect injection engines

- Upto 1000: 268
- Above 1000 upto 2000: 252
- Above 2000 [Water cooled]: 282
- Above 2000 [Air cooled]: 309

3.3.4 *Details of IS10804/1986 Standard for Complete Pumping System [C.P.S.]*

This standard is formulated in such a way that the farmer should get an efficient diesel pumping system resulting into economy in operation. It is comprised in basic 3 parts, which covers entire recommendation as per IS10804 for complete pumping system.
3.3.4 *Details of IS10804/1986 Standard for Complete Pumping System (C.P.S.)*

This standard is formulated in such a way that the farmer should get an efficient diesel pumping system resulting into economy in operation. It is comprised in basic 3 parts, which covers entire recommendation as per IS10804 for complete pumping system.

i] To study site conditions and select suitable diesel pumping system.

ii] To supply each component of pumping system exactly as per individual IS standard prescribed in IS10804 for each of the diesel engine centrifugal pump, foot valve, pipes, pipe fittings matching with each other to form efficient pumping system.

iii] To install and commission the selected complete pumping system and measure the actual fuel consumption and discharge by. The measurement & discharge of water can be done by empty oil drum or by scale method and comparing with specified in the tables of IS10804/1986.

The photographs of measurements of fuel consumption, discharge by drum method and scale method is in Annexure III-A.
ANNEXURE-I 111A

MEASUREMENTS OF DIESEL CONSUMPTION AND
WATER DISCHARGE AT SITE AS PER IS 10804, 1986

Measurement of diesel consumption

Measurement of water discharge by drum method
APPROXIMATE METHOD FOR MEASURING THE DISCHARGE OF WATER PUMP

**FIELD APPROXIMATING**

Discharge from the pipe may either vertical or horizontal is measured by trajectory method. The difficulty in the method is to measure the coordinates of the flowing stream accurately.

**CAPACITY, G.P.M.**

\[
\sqrt{\frac{x}{D}}
\]

WHERE

- **D** = PIPE DIAMETER, IN.
- **x** = FLOW DISTANCE, FEET
- **y** = VERTE DIST., FEET

The above method is simplified by always using \( y = 0.17 \) and measuring the distance \( x \).

**TABLE FOR FIG. 1**

<table>
<thead>
<tr>
<th>PIPE DIAMETER IN</th>
<th>DISTANCE X, IN WHEN Y=10</th>
<th>APPROXIMATE CAPACITY, G.P.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3.063</td>
<td>15.4</td>
</tr>
<tr>
<td>2.5</td>
<td>2.469</td>
<td>13.8</td>
</tr>
<tr>
<td>3</td>
<td>2.068</td>
<td>12.3</td>
</tr>
<tr>
<td>4</td>
<td>1.026</td>
<td>10.1</td>
</tr>
<tr>
<td>5</td>
<td>0.847</td>
<td>8.9</td>
</tr>
<tr>
<td>6</td>
<td>0.665</td>
<td>7.8</td>
</tr>
<tr>
<td>7</td>
<td>0.581</td>
<td>6.8</td>
</tr>
<tr>
<td>10</td>
<td>0.602</td>
<td>5.8</td>
</tr>
<tr>
<td>12</td>
<td>0.706</td>
<td>4.9</td>
</tr>
</tbody>
</table>

**TABLE FOR FIG. 2**

<table>
<thead>
<tr>
<th>ID PIPE, IN</th>
<th>VERTICAL HEIGHT, H, OF WATER</th>
<th>CAPACITY, G.P.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3.063</td>
<td>15.4</td>
</tr>
<tr>
<td>3</td>
<td>2.469</td>
<td>13.8</td>
</tr>
<tr>
<td>4</td>
<td>1.026</td>
<td>10.1</td>
</tr>
<tr>
<td>5</td>
<td>0.847</td>
<td>8.9</td>
</tr>
<tr>
<td>6</td>
<td>0.665</td>
<td>7.8</td>
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<td>7</td>
<td>0.581</td>
<td>6.8</td>
</tr>
<tr>
<td>10</td>
<td>0.602</td>
<td>5.8</td>
</tr>
<tr>
<td>12</td>
<td>0.706</td>
<td>4.9</td>
</tr>
</tbody>
</table>

**NOTE:** Table values in brackets denote flow rates in feet per second (f.p.s.).
All above three steps are to be followed by a manufacturer by their dealers under supervision of bank officials to conform with IS10804 Standard.

The individual components of diesel engine pumping system has been thoroughly studied by BIS for its energy, efficiency and following IS codes were allocated. In Annexure III-B in this Chapter photographs of each component of D.P. sets is shown.

a] **Diesel engine - IS-11170-1985**

The horse power/kw rating of diesel engine should be matching with the power needed by the pump.

b] **Centrifugal pump - IS-6595-1980**

The pump shall be selected in such way that it shall operate at near maximum pump efficiency during peak demand period in the range of discharge and head.

c] **Foot valve - IS-10805-1984**

The foot valve should be frictionless and its size should match the size of suction pipe.

d] **Pipe**

- GI - IS-1239-1979
- HDPE - IS-4984-1978
ANNEXURE I I I-B

BIS/NABARD'S RECOMMENDATIONS ON EACH COMPONENT OF DIESEL PUMPING SYSTEM AS PER IS 10804/1986

NABARD Recommendations On Selection Of Diesel Engines

S.F.C. of the engine should not exceed the limits prescribed in IS-11170-1985.
The diesel engine should have a BIS mark as per IS-11170-1985.
Engines with low S.F.C. values should be preferred. The lub. oil consumption should be about 1% and should not exceed 1.5% volume of diesel consumed.

Engines for which original spare parts are easily available should be preferred.
Engines for which after sales service is available should be preferred.
Engines which have a reputation of giving efficient and trouble-free service should be preferred.

NABARD Recommendations On Selection Of Pumps

The pump should have a BIS certification mark vide IS 6595/1980.
The pump should operate at maximum efficiency at duty point during the major period of the year.
The pump should be selected in view of site conditions such as soil condition, size of the farm in hectares to be irrigated, crop, water availability and recharge, delivery.
The pumps for which original spare parts are easily available should be preferred.
The pumps for which after sales service is available should be preferred.
The pumps having a reputation of giving efficient and trouble-free service should be preferred.
NABARD Recommendations On Selection Of Foot Valves

Foot valve with BIS mark as per IS: 10805:1984. The open area of foot valve for entry of water should be about 2.5 times the open area of suction pipe. The foot valve should have minimum (0.5) 'K' value (K is the coefficient of friction).

Pipes with BIS mark as per IS 1239-1972 for GI, IS 4984-1974 for MS, IS 4995-1981 for PVC should be used.

ON SUCTION SIDE:
The size of suction pipe should be such that the total frictional losses do not exceed 0.5 metre. The frictional losses should not exceed 0.5 to 1.0 metre per 10-metre length. The velocity of flow should be limited to 1.5 m/sec.

ON DELIVERY SIDE:
The size should be such that the frictional losses should not exceed 0.82 to 1.0 metre per 10-metre length. The velocity of flow should be limited to 2.0 m/sec.
NABARD Recommendations On Selection Of Couplings

The transmission efficiency should be minimum 95%.
It should have longer life.
It should have homogeneity and flexibility to absorb torsional stresses.
The sizes of pipes shall be selected in such a way that the frictional head shall not exceed 10% total equivalent length of piping system upto delivery point.

e) Pipe fittings

GI - IS-1239-1982
Fabricated PVC IS-10124-1982
Alongwith the above, a suitable well designed baseplate, coupling and water cooling arrangement are incorporated to form a total pumping system as per IS-10804-1986.

The bank official has to take undertaking or certificate from dealer that the diesel pumping system supplied to a farmer is exactly as per IS10804/1986. The bank official then releases loan to a farmer. The financial institutions inturn has to give certification to NABARD about disbursement of loans for diesel pumping system is done as per IS10804 to get refinance.

The efforts of NABARD in conservation of diesel are to be percolated upto farmers through Financial Institutions, local State level Agencies, manufacturers and their dealers and various Govt. Depts. at State and National levels. The average unit
cost of the diesel pumpsets are fixed by NABARD regional offices at state levels along with convenor and lead banks, LDBs, SLTC, Govt. Depts. etc.

These average unit costs determine the loan amounts for diesel pumping system. There is discretionary power given by NABARD to Financial Institutions up to 15% to finance more amount for quality brands of D.P. Sets over and above average unit cost and less finance by 15% below average unit cost for cheap brands of D.P. Sets.

3.3.5 * IS11501/1986 : Diesel engine monoset.

This new standard although has been prepared by BIS for engine monoset pumps for clear, cold freshwater for agricultural purposes. As for agricultural purposes diesel monoset are generally used, BIS felt the need of preparing separate standard engine monoset pump. Diesel engine monoset pumps are centrifugal pumps of single suction with driving diesel engine designed and built as complete unit on one shaft. That is the crankshaft and the pumpshaft are one and same. This eliminates pumpshaft, pumps bearing and make combined unit simple and compact.

Source—The standards published by Indian Standards Institution and Bureau of Indian Standards, New Delhi.
The coupling is also not required and total efficiency of the pumpset is very high and portability helps farmer to bring pumpset home to avoid thefts.

A photograph of diesel engine mono set is shown in Annexure III-C in this Chapter. Such diesel engine monoset designed and developed by M/s. Kirloskar Oil Engines Limited, Pune for the first time in India having lowest energy index of 0.136 lit/UIW.

The basic objectives in preparing this standard are:

i) to encourage manufacturers to give efficient pumping systems to farmers,

ii) to conserve national scarce resources of raw materials, petroleum products,

iii) upgradation of obsolete technology of traditional coupled and belt drive D.P. Sets.

iv) This change was made similar to monoblock E.M. pumpsets discarding coupled E.M. Sets from Agricultural purposes. But in D.P. sets still there is no enforcement of engine monoset continuing use of coupled and belt driven inefficient D.P. Sets for Agricultural purposes.
lowering down efficiency of D.P. sets.

3.4 NABARD's CONTRIBUTION IN ELEVATING AGRICULTURAL PRODUCTIVITY FROM DIESEL PUMPSETS

Along with BIS, NABARD has been also playing very important role in monitoring performance standards laid down by BIS for effective refinance to D.P. sets in the country. NABARD’s contribution therefore is indeed noteworthy in water management i.e. in minor irrigation along with all other agricultural development in the country.

3.4.1 Structure and activities of NABARD

Agricultural developments are being monitored and responsibilities are being shouldered by NABARD by formulating various norms of Refinance which are binding on various Financial Institutions. Thus NABARD has become the nucleus of all agricultural activities and growth in the country. The refinance is made to various financial agencies such as State Co-operative Banks, State Land Development Banks, Commercial Banks and Regional Rural Banks.

This can be seen from total disbursements figures shown in the following tables giving the details of agency-wise, year wise achievements of NABARD for past three years.
**NABARD'S TOTAL DISBURSEMENTS & SHARE**

**OF MINOR IRRIGATION**

[Rs. in Crores]

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Minor Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986-87</td>
<td>1334</td>
<td>486 [36%]</td>
</tr>
<tr>
<td>1987-88</td>
<td>1482</td>
<td>498 [33%]</td>
</tr>
<tr>
<td>1988-89</td>
<td>1270</td>
<td>405 [32%]</td>
</tr>
</tbody>
</table>

*Jul-Mar*

**AGENCYWISE NABARD'S DISBURSEMENTS**

<table>
<thead>
<tr>
<th>Year</th>
<th>SCBs</th>
<th>RRBs</th>
<th>SLDBs</th>
<th>CBs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1986-87</td>
<td>65</td>
<td>208</td>
<td>433</td>
<td>628</td>
<td>1334</td>
</tr>
<tr>
<td>1987-88</td>
<td>64</td>
<td>216</td>
<td>467</td>
<td>735</td>
<td>1482</td>
</tr>
<tr>
<td>1988-89</td>
<td>75</td>
<td>212</td>
<td>381</td>
<td>602</td>
<td>1270</td>
</tr>
</tbody>
</table>

*Jul-Mar*

NABARD is established in the year 1982, replacing Agricultural Refinance Development Corporation [ARDC] as a part of Reserve of Bank of India, to take care of all the activities related to developments of Agriculture in the country some of the important heads are as follows:

a) Minor Irrigation.
b) Rural Electrification.

* Source-NABARD's Annual Reports.
c] Land Development
d] Farm mechanisation.
e] Dry land farming.
f] Plantation.
h] Dairy development.
i] Fisheries [Marine & Inland]
j] Storage and Market yard.
k] Forestry.
l] Bio-gas
m] Poultry.

n] Sheep/Goat/Piggery.
o] Integrated Rural Development Programmes [IRDP]

farm sector
p] IRDP non farm sector.

Under minor irrigation head following sub-heads are covered under various schemes which are very important from point of view of bringing more and more area under irrigation and ultimately increasing agricultural productivity of the country.

a] Dugwell schemes
b] Dugwell + pumpset schemes.
c] Shallow tubewell + pumpset schemes.
d] Deep tubewell + Pumpset schemes.
e] Rural electrification schemes.
f] Lift irrigation schemes.
ANNEXURE III-C

ENGINE MONOSET PUMP AS PER IS 11501, 1986
NABARD's REFINANCE TRENDS
ALL INDIA W.R.T MINOR IRRIGATION

TOTAL REFINANCE
MINOR IRRIGATION
M'3 % W.R.T. TOTAL

YEAR

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<tr>
<td>TOTAL</td>
<td>1334</td>
<td>1482</td>
<td>1276</td>
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<tr>
<td>MINOR</td>
<td>408</td>
<td>450</td>
<td>405</td>
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<td>M'3 % W.R.T. TOTAL</td>
<td>36</td>
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NABARD's REFINANCE TRENDS
ALL INDIA AGENCY WISE

YEARS/AGENCY

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<tr>
<td>LDBs</td>
<td>433</td>
<td>467</td>
<td>301</td>
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<td>CIBs</td>
<td>626</td>
<td>735</td>
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<td>SCBs</td>
<td>65</td>
<td>64</td>
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<td>RRBs</td>
<td>299</td>
<td>216</td>
<td>212</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1334</td>
<td>1402</td>
<td>1276</td>
</tr>
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NABARD allocates the funds under each of above sub-head on the basis of schemes undertaken by each of lead bank in every district of a State turn submitted to Regional Office of NABARD at each state level. NABARD's regional office compiles all such information on the basis of Annual Action Plan [A.A.P.] and District Credit Plan [D.C.P.] prepared by individual Lead Bank allocated for each district. Annual Action Plan is for January to December one calendar year and District Credit Plan is for 3 calendar years including AAP of one year. AAP and DCP are rolling plans and updated every year.

On the basis information submitted by NABARD's regional offices to NABARD H.O. at Bombay, allocations of funds are decided against each of the subhead of minor irrigation and other different heads and Annual Plan of Allocation of refinance is finalised at each State level, purposewise and agency wise. The state level plans in further implemented and monitored by NABARD's regional offices and targets set by each of lead banks under each scheme are achieved at Taluka, and District levels.

While giving loan to any farmer the category of the farmer, whether he belongs to small, marginal schedule caste or schedule tribe is decided to avail subsidies applicable to respective category. Once
the loan is granted to a farmer, repayment period of the loan is decided by NABARD is made applicable to respective farmer.

3.4.2 Rate of interest

The refinance rate of NABARD for minor irrigation investment is 6.5% and to the ultimate borrower i.e. farmer 10%. The minimum cashdown payment is 5%.

3.4.3 Lending Norms

For small and marginal farmers the loan repayment period of a dugwell would be 15 years excluding gestation/ grace period of 23 months and for pumpset 11 years. The beneficiary, if he so desires, repay the loan instalment with interest earlier than the stipulated period for other farmers loan repayment period would be 11 years.

3.4.4 Subsidy

Subsidy is available separately for dugwell as well as pumpset. Majority of farmers about 70% are in small and marginal farmers and subsidy rate of 25% and 33.1/3% resp. of NABARD's unit cost. These subsidies are made available to such farmers to elevate their agricultural standard.
3.4.5 Economics

The scheme economics aims at the net incremental income per year, [NII] the benefit cost ratio [BCR] and also investment rate of return, [IRR]. If these 3 parameters namely :-

i) Net Incremental Income per year [NII].

ii) Benefit cost ratio [BCR] and

iii) Investment rate of return [IRR],
are acceptable, the scheme is considered to be economically viable and refinance worthy.

3.4.6 Infrastructural facilities

Adequate extension services should be available in the scheme area. The beneficiaries having irrigation facilities have to be adopted modern cultivation practices. Availability of good quality of diesel/lub oil dealer's services along with marketyard facilities are available within 5 km for marketing agricultural products.

3.4.7 Supervision and Technical guidance.

The technical officer of the sponsoring bank would look after the supervision and implementation of the proposal and also extend technical guidance wherever necessary.
3.4.8 Economical Analysis

A] Incremental income

Pre and post development incomes of a farmer are studied [i.e. prior and after digging of well and installation of D.P. set] by considering crops grown, area of each crop, cost of cultivation of each crop, yield, price and net income is calculated and repaying capacity at rate 60% is calculated.

B] Cost of investment

The total investment in 3 items namely:

a. Dugwell
b. Diesel pump set
c. Pump House

is calculated and loan amount thereof is decided. Then equated annual instalment considering 15 years repayment period for dugwell and 9 years repayment period of D.P. pumpset with 10% interest is calculated.

The repayment capacity [which is 60% net Incremental Income] should more than the equated annual instalment then proposal becomes viable.

C] Discounted cashflow statement or Benefit Cost Ratio.

By discounted cash flow statement net present worth is calculated by applying discounting factor over a
period of repayment to arrive at present worth of cost.

The benefit cost ratio should be always more than one in order to become proposal economically viable.

D) Internal rate of return [IRR]

IRR is that rate of return at which discounted value of the outflow becomes equal to discounted value of inflow.

This is also calculated over a period of credit on invested cash and their present worth by applying discounting factor, if this IRR is more than discounting factor then the proposal is economically viable.

3.4.9 * Model Scheme related to minor irrigation scheme for Dug well and D.P. set.

NABARD has given model scheme for Dugwell and diesel pumpset financing by banks.

The aspects that are necessary in scheme formulation

are ground water availability, well design, cost estimates, cropping pattern, pumpset selection and scheme economics.

A] Why Scheme formulation is necessary?

It is always desirable to formulate a scheme giving the physical programme and financial aspects over a fixed time frame for completion of project. Scheme formulation helps in following ways:

a) Planned development of ground water resources.
b) Proper planning and fixing of targets on area specific basis under a given time frame.
c) Ensuring quality of lending, systematic development assured income to beneficiary, assured repayment and recycling of funds.
d) Quality control of minor irrigation works and equipment.
e) Systematic monitoring.
f) Periodical review about achievement and shortfall and taking timely remedial measures for successful implementation of the programme.

In view of the above NABARD insists on proper scheme formulation by banks and its techno-economic appraisal before extending any refinancing facility.
B] Scheme details

Scheme formulation for construction of dugwells or shallow tubewells against Bank loans require both technical and financial details. The important items to be included in a scheme for a dugwell and diesel pumpset are as follows:

a] Introduction

This should briefly give the location of the scheme area and its areal and topographical features.

b] Selection of area

Guidance from the State Groundwater Department should be taken into account in order to select the project area for minor irrigation development through groundwater resources. The area selected should be a compact block/taluka or watershed with adequate groundwater potential, easy accessibility by Road and adequate outlets for sale of agricultural produce. This information can be obtained from State Groundwater Depts. and Local district authorities. Brief details about area selected and the project benefits should be given in the scheme.
c] Soil

The general nature of soils prevailing in the area should be indicated. These can be classified as sandy loamy clayey, or black cotton, red soils etc. Soil also have a bearing on irrigation schedules and depth of irrigation required to meet the water requirement.

d] Climate and rainfall

Rainfall is the chief source of recharge to groundwater and groundwater availability largely depend upon it. It also governs the supplementary irrigation requirement of crops. The scheme should therefore indicate the monsoon and non-monsoon rainfall as per the Indian metrological department. It should give minimum & maximum temperatures during different seasons.

e] Hydrogeology

The geological formations in the area aquifer and its water transmitting capacity, average depth to pre-monsoon and post-monsoon water table and well design suitable for the area should also indicated. The aquifers in hard rock areas suitable tapping around water are generally weathered zones, joints, fractures etc. and their suitability from the point of view of groundwater
development may be indicated in the scheme. This information is available with the district geologist of the State Groundwater Department.

f] Groundwater availability

Before any programme of groundwater development is taken up it is essential to ascertain whether adequate potential is available in the blocks covered under the scheme. The State groundwater department evaluates groundwater resources on the blockwise basis and also keeps a record of the status of groundwater development at a given period of time. The categorisation of blocks as Dark, Grey and white is made on the basis of groundwater development expressed as a ratio of net draft to net utilised resources available for irrigation at year 5. For dark areas it is greater than 85%, Grey areas greater than 65% but less than 85% and white areas less than 65%. This information is available with the NABARD regional office/state groundwater department and banks can obtain it from them. It would be desirable to first formulate schemes in "White" and then in Grey blocks where groundwater availability is assured.

Thus the groundwater availability plays very important role in minor irrigation programmes.
g) **Groundwater quality**

Groundwater quality in the scheme area as indicated by state groundwater department should be given. Its suitability for irrigation may be indicated in terms of total dissolved solids, sodium, absorption ratio etc.

h) **Spacing**

In absence of any groundwater legislation institutional agencies provide technical discipline in the form of spacing between two minor irrigation structures for proper and efficient development of groundwater resources. Spacing is determined by pumping tests conducted by the state groundwater department. However, to avoid over capitalisation, economic spacing is also estimated and higher of the two spacings is adopted for financing of minor irrigation works under scheme.

i) **Well design**

An optional well design suited to local hydrogeological conditions is important for success of any minor irrigation scheme. The well diameter should be based on water transmitting capacity of the aquifier and the well depth on
the thickness of the saturated zone available during the summer months. Guidance from State Groundwater Department should be taken for this. The recommended well diameter and depth should be indicated in the scheme.

j) Pumpset

Proper selection of diesel pumpset is important to achieve maximum output at minimum capital and operative cost. The scheme should given the type of diesel pumpset requirement of horsepower of the pumpset size of suction delivery pipes of the required discharge and operating head as per average agronomical and hydrogeological conditions in the scheme area. If site conditions require construction of a pit or provision of a platform in the well designing for placement of the pumpset or using a beltdrive these should be given in the scheme and their cost provided for.

k) Economics

The economics of investment should be given in details to justify the loan. The scheme should also give details about subsidies, repayment schedule, rate of interest etc.
1] Checklist

A checklist should always accompany the proposal. This would help to check at a glance whether or not the essential terms of scheme formulations have been provided for. It also helps in quick appraisal by sanctioning authority.

Thus NABARD, any minor irrigation scheme submitted by financial institutions study scrutinise and approve the same for refinance.

3.5 CONCLUSIONS

3.5.1 The contribution of inefficient & poor quality diesel engine pumpsets in low agricultural productivity has indeed become a burning issue of the nation.

3.5.2 Inspite of efforts taken by BIS and NABARD the existence of inefficient D.P.sets and their adverse effects on wasteful costs of petroleum products and agricultural have been continued.

3.5.3 No attempts have however been made to relate the inefficiency of such poor quality D.P.sets with agricultural productivity of a farmer either at MICRO or MACRO level.
3.5.4 It was therefore felt very necessary, to undertake research on the subject under study. For research work, the progressive state like Maharashtra, where pioneering efforts in manufacturing diesel engines were initiated, thought to be an ideal state and therefore selected for detailed MICRO level case studies.

3.5.5 Moreover, the plight of low agricultural productivity due to diesel engines existing in all other states in India are similar to state of Maharashtra. It will be therefore easier to extend and amplify the results obtained in Maharashtra safely to other states in India.

3.5.6 In the next Chapter IV, the present scenario of diesel engines for agricultural applications in the state of Maharashtra w.r.t. efficiency, quality and wasteful costs has been highlighted to prepare the background for the MICRO level case studies.