Land Reclamation Through WUA's/Farmers' Participation In Maharashtra –Ghod Irrigation Project

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ABSTRACT:
Land Reclamation and Farmers Participation-A Success Story: The drainage problems in agricultural lands have always been followed after irrigation. In the command areas of irrigation projects the land damages occurred due to water logging and salinity. In Maharashtra the Land Reclamation activities are carried out by Directorate of Irrigation Research & Development, Pune (DIRD). Recently new drainage schemes have been constructed by DIRD through farmers'/WUA's participation in terms of their land contribution at free of cost as well as existing drainage schemes are renovated through 10% involvement of the beneficiaries. In this paper the problems created due to excess use of flow irrigation water in agricultural land under the command area of Ghod Irrigation Project is discussed on the basis of annual damage reports since over last 50 years. The monitoring and evaluation of damage area process adopted is also described here. DIRD has a wide organization setup in Maharashtra to research, reclaim and suggest the remedies to the farmers to recover their land from water logging and salinity. Till the date more than 50 open drainage schemes have been constructed in the command area of this project to reclaim the damaged land and carried out its maintenance & Repairs as possible. The average land reclaimed is found 80% due to these schemes. On Ghod Left bank canal 6 new drainage schemes have been constructed in last two years. The paper describes the land reclamation with the help of farmer's contribution in terms of their valuable land through Water User Association. This is very significant because they did not take any kind of compensation for their land under new drainage schemes. For renovation of existing drainage schemes farmers put their 10% share before execution of work. This shows how the land damage is going a serious problem. Govt. of Maharashtra had paid compensation of their land before 2001.Due to higher land cost, execution of drains were not possible but DIRD has taken efforts to guide the farmers through various agro-exhibitions & personal communication and output is that, farmers got awareness about the future worseness of their land. The trend of increase in damaged area is presented graphically in this paper and one representative success story is discussed here with economical benefits against the investment in construction of the said drain, gain in quality of crops as well as yield. Farmers are satisfied not only with these achievements but also the gain in land cost is also an additional benefit.

1.0: BACKGROUND:

The significant socio-economical developments are noticed in the command area of major irrigation projects, various private and co-operative industries like sugar factories are playing vital role in these developments by virtue of providing jobs, education and infrastructure developments of the surrounding. The drainage problems in agricultural lands have always followed after irrigation. In the command areas of large scale irrigation projects the land damages occurred due to water logging and salinity. In June 1916, the Special Irrigation Division was opened at Pune to investigate the causes and remedies to these land damage problems. Now the Land Reclamation activities by Directorate of Irrigation Research & Development, Pune (DIRD) takes place during pre and post irrigation periods of major and medium irrigation projects in Maharashtra State. Cultivable land per capita is limited and land costs are growing on higher side hence though farmers need to reclaim their damaged land by excavating open drain through it they are unable to waste their land under

drainage scheme. Recently in Maharashtra new drainage schemes have been constructed by (DIRD) through farmer's/WUA's participation in terms of their land contribution at free of cost as well as existing drainage schemes are renovated by taking 10% involvement of beneficiaries.

2.0: ROLE OF DIRD:

2.1: Organization and its activities:

DIRD has a wide organization in Maharashtra for research and land reclamation, it also publishes detailed annual land damage report of the state. It performs activities like pre and post irrigation soil survey, post irrigation periodical observations of the command area and prepares canal wise land damage report. On the basis of these reports various land drainage schemes are executed in the command area for reclamation of damaged land as well as guidance and suggestions are provided to farmers through various agro-exhibitions in the state, and national level also.
Following preventive measures are suggested for controlling and preventing the affected area.

- Regular cleaning of natural nalla in canal command area.
- Timely maintenance of completed drainage schemes.
- Restriction of perennial crops as per soil suitability.
- Sowing of crops as per soil suitability's.
- Adoption of modern techniques such as sprinkler, drip etc. wherever possible and especially in deep black cotton soil.
- Seepage losses through distribution system i.e. Canals/distributors need to be minimized.
- Lands should be leveled properly so that uniform application of water is possible and it will help in preventing the pending of water.
  Encroachments on natural nallas to be removed immediately.
- Nalla regarding works such as deepening and widening of natural nallas in canal command areas need to be taken in hand whenever required.
- Conjunctive use of surface and ground water need to be encouraged whenever possible.
  Farmer's involvement in water management system and also in maintaining the drains and nallas is essential.

2.2: Methodology adopted for land damage report:

Water logging and soil salinity are the irrigation hazards for which prevention is better than cure. These hazards are closely related to status of ground water level. Water logging occurs when ground water saturates the plant root zone. When the ground water table reaches within 1 to 2 meters of the ground surface, the ground water adds to the moisture in the root zone through capillary action. Capillary water increases the saturation in the root zone to the point that oxygen exchange is hindered. Due to this, crops do not get sufficient nutrients and their growth is hampered, ultimately productivity reduces. The impact becomes more severe when water logging is coupled with salinity. When this occurs, as the ground water table rises under water logging conditions, salt concentrated beneath the root zone are dissolved and carried to the root zone interfere with movement of soil water in to the roots, plaints begin to wither and die when salt concentration is beyond limit. Water logging and salinity may also change the texture of soil. Thus, if the ground water levels are monitored continuously, the canal commands can be prevented in time. Hence, importance of monitoring of ground water can be prevented in time. Hence, importance of monitoring of ground water levels should neither be under estimated nor be neglected at any stage and level.

Water levels in open wells, in the command areas of canal are best indicators to judge the ground water table. The ground water is recharged due to irrigation water as well as through rainfall and other surface runoffs. The water level in the open well is influenced by such ground recharge in its vicinity. Hence, observation of water level in open well can decipher the ground water status in canal commands.

DIRD, Pune regularly monitors well-water levels of about 1.72 lakh wells in 80 canal command areas of Maharashtra State. The procedure for monitoring of well water level is as below.
a) The position of well in the field is marked on village map in the respective Survey No./Gut No. with respect to field boundaries orientation etc. by verifying on ground.

b) Well numbers are marked on the constructed permanent structure on/near the well by oil paint including Survey No./Gut No. etc. The marking of well Nos. is village wise.
c) .The depths of sub-soil layers are noted from the ground level, from the cross section at the well and recorded in the well observation book,
d) The information regarding whether the well is constructed or otherwise is to be recorded along with type of construction of well in the well observation book.
e) Well observations are carried out twice a year i.e. pre monsoon during March, April and May, and post monsoon November, December and January.
f) Marking of ground water levels of wells on village map command map is as per post Monsoon water levels and it is as follows.

0.0 m to 1.20 m	Red Colour-
1.21 to 3.0 m	Green Colour
3.01 m & beyond	Yellow Colour
Dry wells	Blank circle.

Water logged area is calculated by taking 4 berma pits around the well in danger zone and as per water level observed in these pits, area is determined by graphical method. Water logged area on the basis of Hydro-ISO baths (HIB) is marked on the command area map.

g).In every leap year pre-monsoon water samples from the wells are collected in plastic bottle for testing in the laboratory for its electrical conductivity and pH value. If the water sample result in leap year are found as pH <7 or pH> 9.00 and EC value > 1.5 Mmhos/cm, the water samples for such wells form the command area is taken for succeeding three years for testing.
h) Soil samples are taken every year in April-May from damaged area visually observed throughout the year. With the help of auger bore (See Fig-1) each pit is taken up to 1.20 m depth. Four soil samples are classified 0 to 0.20m, 0.20 to 0.40 m, 0.4 to 0.80 m and 0.80 to 1.20 m. from every pit and collected in polythene bag with marking Survey/Gut No. Village/Lab. No./pit No. etc. These soil samples are sent to soil testing laboratory for Ec & pH. After receiving test results fully as well as partially saline area is calculated by contour method.

2.2.1: Water logging:

The ground water levels in the existing wells in the command area are regularly observed during post-monsoon and pre-monsoon seasons. (See fig-1.) The wells are grouped under following categories:

a) Wells with ground water level in the range of 0.0 m to 2.00 m from ground surface.
b) Wells with ground water level in the range of 2.00 m to 3.00 m from ground surface.
c) Wells with ground water level in the range of 3.01 m and beyond, from ground water level.

Percentage of wells in each of the above category is calculated with respect to total number of wells in command area. From the point of view of water logging conditions, the benchmark indicators with reference to above categories are defined as below :

Figure-1: Observation of Wells for deriving waterlogged area.

i. **Wells in danger zone** :
The wells with the ground water levels in the range of 0.0m to 1.20m from ground are considered to be Danger Zone. If the percentage of wells in the danger Zone is substantially higher, the command area is under heavy threat of water logging.
ii.**Wells in Alarming Zone** :
The wells with the ground water levels in the range of 1.21m to 3.0m from ground are considered to be Alarming Zone. The command area is considered to be prone to water logging if the percentage of wells in Alarming Zone is substantially higher.
iii.**Wells in Safe Zone :**The wells with ground water levels in the range of 3.01 m and higher from ground level can be considered to be indicative of safe zone. If the percentage of wells in this zone is more, the command area can be considered to be relatively free of threat of water logging.

Indication of slightly water logged areas is also possible on the basis of visual inspection of Vegetation like bull- rush Pankanis, kubabhul, Kunda etc.

2.2.2: Salinity:

Water logging gives birth to salinity. Soil salinity problems in irrigation command develop whenever soil and hydrological conditions favor the accumulation of soluble salts in the root zone. The rise of water table in the semi-arid and arid areas mobilizes the salt percent in the soil profile and ground water. Once the ground water table rises within 2 – 3 meter of the soil surface, it contributes substantially to evaporation from the soil surface and water uptake by plants. The upward flux of the water due to evaporation and water uptake by plants, result in gradual concentration of salts in the root zone. Salt affected soil may develop from normal soil through the accumulation of salts in one of the following ways. A combination of these processes could be operative at several places.

i. Accumulation of salts from applied irrigation water.
ii. Movement of salts from lower layers.
iii. Upward movement of salty ground water through capillary rise.

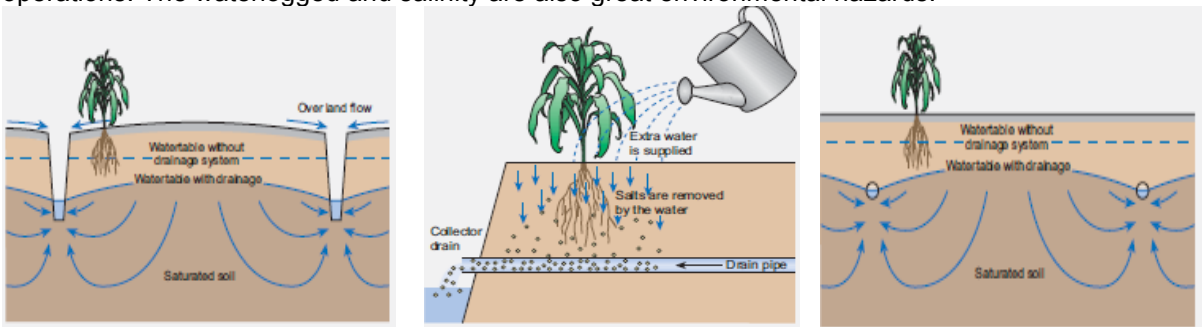
Figure-2: Taking Auger bores for Ec,/ pH.

Soil samples are collected from damaged patches by auger bore in required quantity as per area affected. The sample is collected up to 1.20 m. depth and classified in four categories 0-20 m, 0.20 to 0.40m 0.4 to 0.80 m & 0.80 to 1.20 m (See Fig-2) and gets tested in soil testing laboratory for Electrical conductivity (Ec) and Hydrogen Ion Concentration (pH) value. Land can be classified for further treatment as per Salinity /Ec values results given below...

0to 1.0 Mmhos/cm : Non Saline area
1.00 to 3.0 Mmhos/cm : Partial saline area
More than 3.0 Mmhos/cm : Fully saline area
(Mmhos/cm- Millihos per centimetre)

3.0: DRAINAGE SCHEMES AND LAND RECLAIMATION:

Agricultural land under the large scale irrigation projects have been continuously irrigated through flow and lift irrigation. Perennial crops like sugarcane need more water and due to frequent watering, inefficient irrigation practices and deep soil structure, land under these crops observed started water logging and saline and resulted in arid land. Water table rises due to poor subsurface draining in black cotton soil and inefficient flow in natural nalla and if it is 2.0 m below from the ground level (as per recent central government's guidelines) we treat it as partial water logging. The continuous water logging due to number of waterings and heavy rainfall this land starts saline. The irrigated lands get affected due to water logging and soil salinity. The irrigated area forms the base strength for agriculture production. Any type of damage to the irrigated area in the form of water logging & soil salinity will reduce the agriculture production, because of impaired crop growth and impaired farm operations. The waterlogged and salinity are also great environmental hazards.



a b c

Figure-3 Objectives of drainage are: (a) to remove excess water, (b) to control salinity and (c) to maintain the water table at a desired level

3.1 Drains:

Drainage plays an essential part in food production while safeguarding the investments in irrigation and conserving land resources. Drainage systems are man-made systems that are only implemented when natural drainage is insufficient for a satisfactory form of agriculture. The overall objective of agricultural drainage, as part of agricultural water management, is to enhance crop growth and to maintain the soil productivity. The immediate objectives of agriculture drainage are….

- To remove excess surface and subsurface water;
- To remove excess soluble salts with the (excess) water from the drained soil profile;
- To maintain groundwater levels at a desired level

Drainage of agricultural lands is an instrument for production growth, a safeguard for sustainable investment in irrigation and a tool for conservation of land resources. To bring again the arid land under cultivation it needs to increase the water conductivity of the sub-soil and permit the excess water draining by excavating the field drains. Surface drainage can eliminate ponded water and reduce the amount of water entering the soil profile. Sub-surface drainage can lower the water table to provide an aerated root zone. Many soils having poor natural drainage when properly drained turns put to be productive. There are various types of sub surface drains closed or buried drains like pipe drain, rubble drain, earthenware, chimney drains and open drains but as compared to pipe drains open drainage schemes are more economical except the factor of loss of land under drains. But open drains can easily maintained and have larger capacity to reclaim the heavily damaged land in short period.
Land Damage Index for command area is defined as a percentage ratio of damaged area and irrigable command area.

$$\text{Land Damage Index} = \frac{\text{Damaged area in Ha.}}{\text{Irrigable command area in Ha.}} \times 100$$

Figure- No.4: Farmer watching his saline land at Kawathe Village

The damaged area (in Ha.) in the above definition includes both, waterlogged area and area affected due to soil salinity. See Fig-5 for damage area observed in 2011-12 on Ghod L B C .

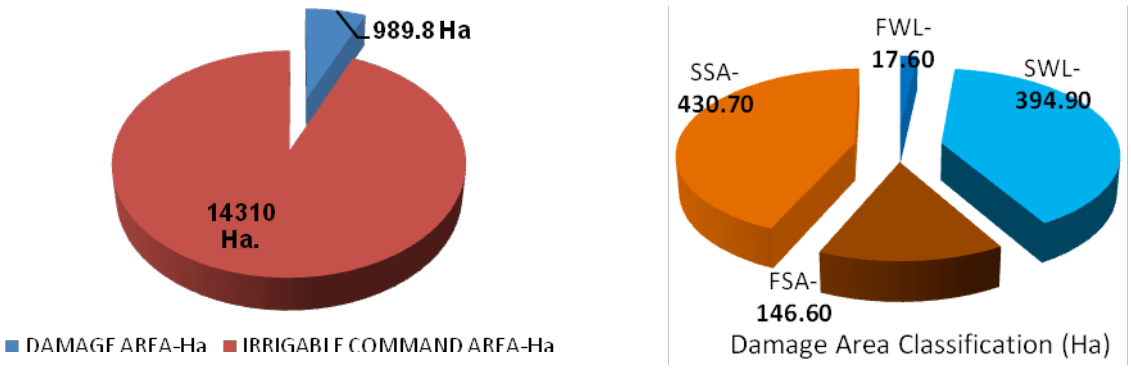


Figure-5: Damage Area of Ghod Left Bank canal in- 2011-12

4.0: ADDITIONAL KAWATHE DRAINAGE SCHEME ON GHOD PROJECT- A CASE STORY---

4.1 History :

Ghod project was constructed in 1946 on Ghod river, a tributary of Bhima, at Chinchani Tal; Shirur, Dist. Ahmednagar (Maharashtra). Over the period of 50 years of continuous irrigation in the command area and constant cropping pattern damaged land was observed in the 80th decade. To reclaim these land 40 open drains and 2 underground drains were executed upto 1996 to protect the 12000 ha damaged area. Till the date average 75% land is reclaimed due to these schemes. These drains were constructed by paying the land compensation to owners but now land costs are going on higher side and it costs many times than drain cost and due to this reason new drainage schemes were not taken in hand after 1996, it resulted in increase in damage land. On Ghod LBC 15 New drainage schemes were proposed in 2000,out of these 8 schemes have been deleted due to land objection and 7 schemes have been taken into hand at free of cost land contribution of the farmers. Additional Kawathe drainage scheme of 5.56 km length with two sub-drains protecting 364 ha. land in deep soil structure is recently completed in 2012 with the contribution of farmers under MMISF Act 2005 (Maharashtra Management of Irrigation System by Farmers).

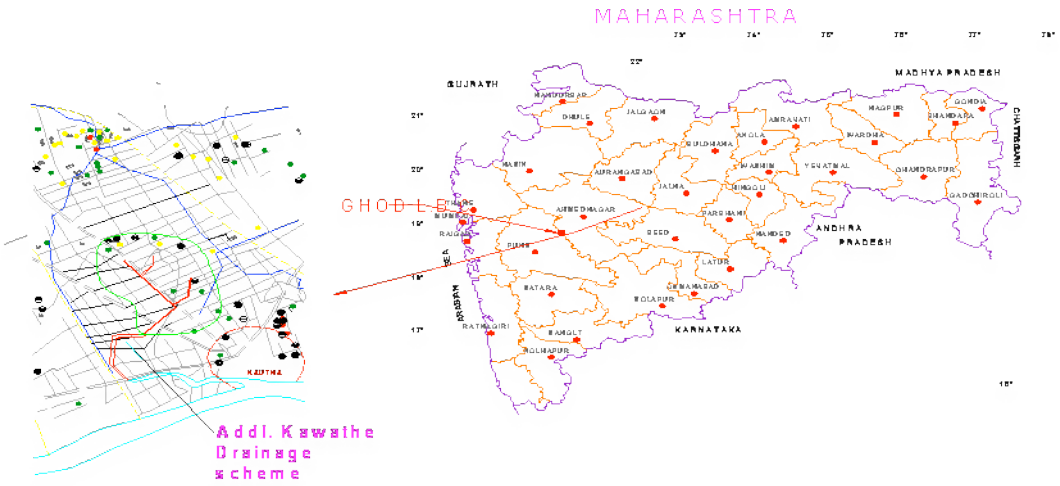


Figure-6: Location Map & Scheme Plan of Additional Drainage Scheme on Ghod LBC

4.2: Water User Associations (WUA):

In 2005, Maharashtra government has established Maharashtra Water Regulatory Authority to regulate water resources within the state of Maharashtra, facilitate and ensure judicious, equitable and sustainable management, allocation and utilization of water resources, fix the rates of use of.water for agriculture, industrial, drinking and other purposes and matters connected therewith or incidental thereto Rehabilitation of existing irrigation projects and construction of new projects were proposed with the contribution of beneficiaries under MMISF Act 2005. On Ghod Left bank canal total 36 Water user associations are established to execute the above said program. Existing drainage Schemes are renovated through WUA's contribution. 10 % amount of the renovation cost is contributed by WUA for execution. After completion of work these schemes are handed over to concerned WUA for further

maintenance.Additional Kawathe drainage scheme costing Rs. 3.57 Million for work portion and 5.0 million for land cost against 10 Hector under the drain. Farmers were promoted and guided through various site visits as well as effective communication with WUA representatives/ farmers and finally they agreed to contribute their valuable land free of cost. (see Fig-6). There are two WUA's involved in this scheme. 1. Nageshwar WUA, Shipalkarwadi with their 60% involvement and 2. Shri. Hanuman WUA, Kawathe with 40% share in the scheme to conduct joint inspection and ensure repairs and renovations works in consultation to operate and maintain after completion. with Water Users' Association

Figure-7- Irrigation Officers' visits & communication with Farmers/WUA members

TABLE-1: Farmers' Contribution on Ghod Project (Overall).

Sr. No	Nature of work/Scheme	No. of drainage schemes	Total Cost of the schemes Rs. Million	Farmers' contribution	Contribution in Rs. Million	Area Protected in Ha.	Remarks
1	Renovation Works	41	18.00	10% of the Estimated Cost	1.80	18000	20% Land Reclamation Observed. in a year.
2	New Works	23	25.00	Land in 80 ha.	80.00	5400	Land cost assumed Rs.10 Lacs/ha. as arid land.

4.3: Contract Management Committee (CMC):

Four members Committee comprising chairman and one selected member of WUA , Executive Engineer, IRD and Divisional Accountant was formed to execute the all scheduled procedures. Main aim of establishing CMC is to keep transparency, to fulfill all expectations of beneficiaries put during walkthrough survey with WUA and to carry out proper execution including design, preparation of estimate, bid document, tender procedure, fixing agency and preparation of bill etc. upto completion of handing over the scheme to WUA. 55 WUAs formed to execute total 64 drainage schemes on Ghod project.(see Table-1)

Figure-8- Formation of CMC for Execution of Drainage Scheme on Ghod LBC. Carrying walkthrough survey with WUA members before and after the work

4.4: Technical aspects of the drainage scheme:

- Project-Ghod Irrigation Project
- Canal –Left Bank Canal
- Name- Additional Kawathe Drainage scheme at Village Kawathe
- Tal : Shrigonda Dist-Ahmednagar
- Total Length-Main Drain - 2795 m
- Sub-Drain 1/1 – 080 m
- Sub Drain ½ - 760 km
- Outfall- - 930 km
- Estimated Affected Area 1992-93- 23.00 Ha.
- Total catchment area - 377 Ha.
- Total unsuitable area - 13 Ha.
- Total shallow soil area - 22 Ha.
- Total medium soil area - 246 Ha.
- Total deep soil area - 84 Ha.
- Total protected area - 364 Ha.
- Total suitable area - 330 Ha.
- Average Annual rainfall - 354 mm
- Hydraulic designed discharge- 4.95 Cusecs
- Land under drain - 10.00 Ha.
- Total Estimated cost - 35.77 Million

- Cost per Hector - Rs.9800/

Adopted Cross-Section of the drain

- Average depth--- 2.00 m
- Side slopes – 2.00 :1.00
- Bottom width- 1.00 m

Figure-9A:Well water level in the command

Figure-9B :Saline land

Figure-9C: Fully waterlogged area

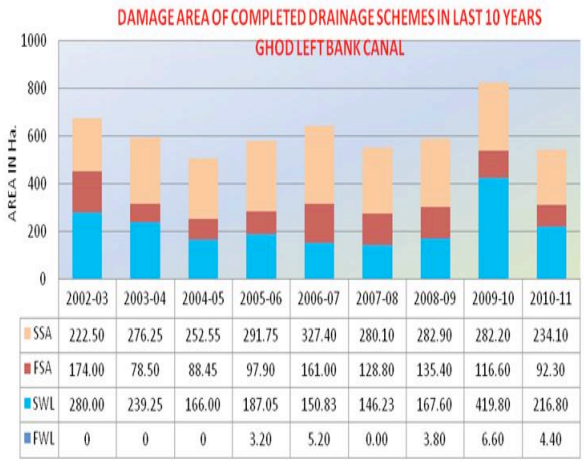
4.5: Improvement in damaged land after drain:

Figure-10A: SE visits the Kawathe Drain Before work

The total damaged land under this scheme in 1992-93 was 23.0 ha. and it was increased at the average rate of 15 % per year and it was 116 ha. in 2010-11.Scheme was commenced in May 2011 and completed in Feb 2012. The damage area in 2012 was observed 69 ha.(Fig- 9A to 10C). It has been observed that the water levels of the wells along drain side were dropped down due to well drain functioning and fully water logged area turned into partial water logging which would help to stop further salination of the said land. (see Figure 11 &12)

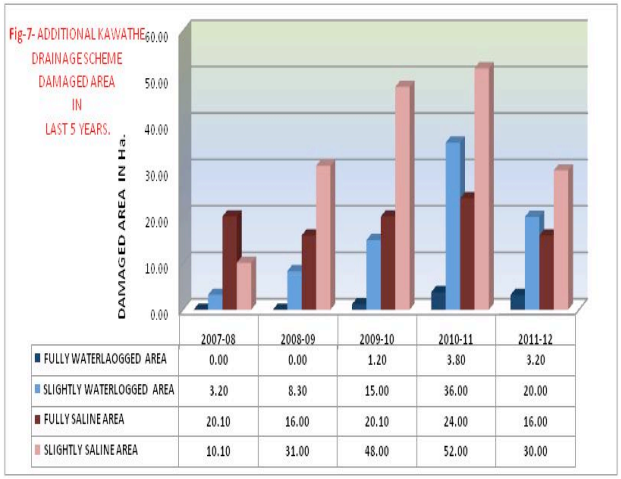
Figure-10B : Drainage Scheme Functioning After work.

Figure 10C: Main Drain After Work



	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11
SSA	222.50	276.25	252.55	291.75	327.40	280.10	282.90	282.20	234.10
FSA	174.00	78.50	88.45	97.90	161.00	128.80	135.40	116.60	92.30
SWL	280.00	239.25	166.00	187.05	150.83	146.23	167.60	419.80	216.80
FWL	0	0	0	3.20	5.20	0.00	3.80	6.60	4.40

Figure-11: Damage area of last 10 years Under – Ghod Left Bank Canal.



	2007-08	2008-09	2009-10	2010-11	2011-12
FULLY WATERLAOGGED AREA	0.00	0.00	1.20	3.80	3.20
SLIGHTLY WATERLOGGED AREA	3.20	8.30	15.00	36.00	20.00
FULLY SALINE AREA	20.10	16.00	20.10	24.00	16.00
SLIGHTLY SALINE AREA	10.10	31.00	48.00	52.00	30.00

Fig- 12: Addl. Kawathe Drainage Sch.-Damage Area in Last 5 Years.

TABLE-2: Improved Features of the Affected Area under Additional Kawathe Drainage Scheme.

	Av.Ec of Soil	Av. pH	Total Damage Area	Protected Area	Crop (sugarcane) yield / Hect	Land Under cane	Current Land Cost/ Ha	Current crop Rate/ M.ton	Total yield	Improved land cost
	Mmhos/ cm		Hector	Hector	M. ton	Hector	Rs.	Rs.	Rs. Million	Rs. Million
	1	2	3	4	5	6	7	8	9=6x8	10
Pre Drain	5.2	8.5	116	364	65	150	5.0	2300	22.42	58.0
Post Drain	2.6	8.5	69	364	100	225	10.0	2300	51.75	69.0
Improve ment	**2.6**		**47**		**35**	**75**	**5.0**		**29.33**	**11.00**

5.0 : MAJOR OUTPUTS & CONCLUSION:

- Farmers' contribution of 10 ha. land worth Rs. 5.0 Millions(see para 4.2) resulted in rectification of 47 ha area and protecting 364 ha area as well as Rs. 11.00 million gain in improved land cost.(See Table-2)
- The further improvement would be occurred after passing more rainy seasons.
- The drained water from surface carries the soluble salts in the soil and accumulates in the field drain hence salinity will be reduced.
- The above shown damaged area was observed suddenly decreased after excavation of the drain. The well water levels along the drain side were also observed immediately dropped down.
- The financial improvement due to drain is significant and arid land retained for cultivation.
- Secondary benefit is that there is a gain in cost of the improved land than arid land.
- Quality of crop can get good returns against investment in the farming.
- Rs.29 Million returns (only in sugarcane) in a year against the one time investment of Rs.3.5 Million. (Only from one drainage Scheme) See Table-2.
- Farmers are suggested to use lift and flow irrigation water efficiently to maintain the good health of the said land and to maintain the drain condition after every monsoon. The said drainage scheme has been handed over to concerned WUAs with all related documents for further annual maintenance as per MMIST Act.

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