PROJECT COMPLETION REPORT

OF

MOWR SPONSORED ADHOC RESEARCH SCHEME

ON

EXTENSION OF SOME LOW COST LINING MATERIALS FOR INCREASING THE AREA OF IRRIGATION COMMANDS

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PROJECT COMPLETION REPORT

1. Title of the Scheme:

EXTENSION OF SOME LOW COST LINING MATERIALS FOR INCREASING THE AREA OF IRRIGATION COMMANDS

2. Principal Investigator:

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P.O.Krishi Viswavidyalaya-741252,
Dist. Nadia, West Bengal

4. Date of commencement : 01.04.2006

5. Planned date of completion : 31.03.2009

6. Actual date of completion : 31.03.2009

7. Objectives as stated in the proposal:

(i) To examine the hydraulic characteristics of the channels made of identified low cost lining materials

(ii) To demonstrate the performance of the lined channels in farmers' fields

(iii) To educate and train the farmers/users towards selection and use of lining materials

(iv) To evaluate overall impact of interventions on irrigation commands

8. Deviation made from the proposal: No significant deviation was made

9. Experimental works:

9.1 Introduction:

Up to 2002-03 the State of West Bengal could have created irrigation potential of 5.12 mha out of which 1.53 mha under major irrigation system, 3.58 mha under surface minor and groundwater sources. Ground water source is extensively used to irrigate

41.3% of the total irrigated land till 2004 by 4753 deep tube well, 36,753 dug well and 5,79,853 registered shallow tube wells besides a large number of private tube wells are in operation.

A deep tube well in the State of West Bengal has an average discharge of 2 cusecs and made to irrigate 40 ha land. In an irrigation command the cropping sequence followed by a farmer depends on crops suitable for that area, socio-economic status of farmer and market demand. Tube wells are usually idle in *kharif* season excepting some supplemental irrigation for winter paddy, but in much use during non-monsoon seasons. However, the utilization pattern of a tube well mostly depends on the cropping system followed in *rabi*- summer months. It is observed that total days of operation in whole area decrease with increases in area under summer paddy though the total running hours gradually increases. Assuming gross water requirement of summer paddy as 125 cm, it is calculated that a deep tube well can irrigate only up to 65% of the irrigation command. Under such situation, the farmers usually keep the remaining portion of land as command fallow on rotational basis, thereby, decreasing the use efficiency of the system. For higher productivity, farmers usually prefer medium and long duration paddy varieties where irrigation is required till the last week of April when water table recedes to an alarming depth. For irrigation under such condition, farmers usually lower their shallow machine to a depth of 2-3 m below the ground level. In our country overall seepage loss from field channels has been estimated to be between 20 to 30% of the water diverted. The excess loss through the unlined field channel in an irrigation command reduces the irrigated area, causes the excess water demand and thereby increases the cost of cultivation. In West Bengal, high seepage through the earthen channel, zig-zag distribution system after the spouts and in appropriate application of water has decreased the irrigation command roughly 40 ha to 25-30 ha for a DTW.

Unless the loss of irrigation water as stated above could not be reduced to considerable extent by appropriate measures there will be a great shortfall of irrigation water resulting much fall in agricultural production since 80% of the total water are being utilized in irrigating the crop fields. A comparatively better operating tube well in Nadia district of West Bengal recorded 17.82% seepage loss (Biswas et al, 1995). The

conveyance, application, application, storage and distribution efficiencies were found 70.80, 90.49, 51.03 and 97.47% respectively.

Different type of materials suitably used as lining to the wetted bed and side of the channel may significantly reduce the seepage loss. Conventional lining materials like bricks, concrete and stone are no doubt time tested for their effectiveness in reducing seepage loss significantly. But the major disadvantages with them are their higher initial cost which the small and marginal farmers can not afford. Therefore, for lining the irrigation channels it is relevant to select, try out and evaluate locally available and low cost lining materials which can be successfully used by the local skilled and semi-skilled workers. Some lining materials of this kind have been identified and evaluated by the researchers (Biswas, 1999 & Khair & Datta, 1987). These are:

(i) Bamboo-reinforced precast concrete

(ii) Bamboo-reinforced precast concrete with local sand and blast furnace slag as aggregate (25, 36.4 & 50cm diameter)

(iii) Burnt clay tiles (half round channel of 30-33cm diameter).

(iv) Roof tiles (40cmx25cmx2.2cm)

(v) Gunny reinforced asphalt mat.

All these lining materials were found useful and cost effective. However, scope is there for improvement in technique in use, optimization of the size and shape of the channel sections, improvement in hydraulic characteristics beside to adapt the activities to popularize these lining materials.

With the above in view, the low cost lining materials like bamboo-reinforced precast half round concrete sections, earthen tiles (half-round), earthen tiles (trapezoidal) & bricks have been extensively used in reducing the water losses and popularizing among the farmers in the tube well irrigation commands of Nadia district of West Bengal.

9.2 Description of the study area

Location

In consultation of the local bodies *(Panchayat)* and the Water Beneficiary Committees (WBC) the Deep Tube Well (DTW) Commands were selected in villages of Atlia-Komarpur, Chandirampur, Birohi, Narayanpur of Haringhata Block of Nadia

district along with D- Block Farm, Gayeshpur and Students' Instructional Farm of Faculty of Agricultural Engineering of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia.

Soil

The area falls under New Alluvial Agro-climatic zone and is the part of the physiographic region of alluvial flood plain. The soils of the experimental sites are under the Gayeshpur Series in the order of Entisols and the great group is under Fluvaquents. The Gayeshpur series is a member of fine loamy mixed hyper thermic family of typic Fluvaquents. The soils are olive grey mottled, slightly acidic, sandy loam. The relevant soil physico-chemical properties are given in **Table1**.

Table 1. Physico-chemical properties of the soils

Soil properties	Values
A. Physical properties	
1. Bulk density $(gm/cm)^3$	
0-15cm	1.44-1.49
15-30cm	1.51-1.58
30-45cm	1.53-1.60
45-60cm	1.56-1.60
2. Particle density $(gm/cm)^3$	2.49-2.64
3. Mechanical analysis	
a. Sand	45.80-74.25%
b. Silt	14.25-29.00%
c. Clay	11.50-16.20%
4. Cumulative infiltration	$I = 0.181t^{0.427}$ (1 in cm, t in min)
5. Basic infiltration, cm/h	1.0
6. Porosity (0-30cm)	40.1-47.51%
7.Volume of expansion of 100gm of soil cm^3	9.81-12.03
8. Field capacity (%)	35%
9. Saturated hydraulic capacity (m/day)	0.84

10. Chemical properties	
a. Organic carbon (%)	0.54
b. Total nitrogen (kg/ha)	11.80
c. Available P_2O_5 (kg/ha)	15.65
d. Available K_2O (kg/ha)	153.57
e. Soil p^H	6.75

Cropping pattern

Rice, jute and vegetables are the major crops grown in this region. The area is progressive in cultivation practices. The cropping intensity is about 300% and most of the area is irrigated mainly by the DTW or STW.

9.3 Methodology

The major works of this project were making the field irrigation channels in the tube well command areas in collaboration with stake holders (farmers/water users) by the identified low cost materials. The process of making sections, cost effectiveness and the hydraulic performance of these materials had been tested and established earlier. The irrigation commands of deep tube wells and shallow tube wells were selected in consideration to crops grown, management practices and socio-economic status of the users to have the exact representation of the irrigation system of the region. The details of works are described below.

Fig. 1 Mouth of a DTW

Fig. 2 Mouth of a DTW spout (outlet)

9.3.1 Manufacture of channel sections/tiles by using the dies/moulds

(a) Bamboo- reinforced precast concrete sections

The available moulds for bamboo reinforced precsat concrete section consisted of two half circle sections of which one suitably match inside the other with annular gap of 2.54cm in between them. G.I. sheet of 29 gauges rolled to half circle to cover the section structure from outside for the inner section and inside for the outer section **(Fig. 2).** While casting the section a light coat of used mobil was used to the inside surface of the outer section and outside surface to the inner section to avoid the sticking of the mixture with the G.I. surface. The bamboo-reinforced nets were placed in between the mould sections and concrete (1:2:4) were pored in it and compacted. After one or two days the concrete sections were removed from the mould and cured with water for another 4-5 days to get it usable.

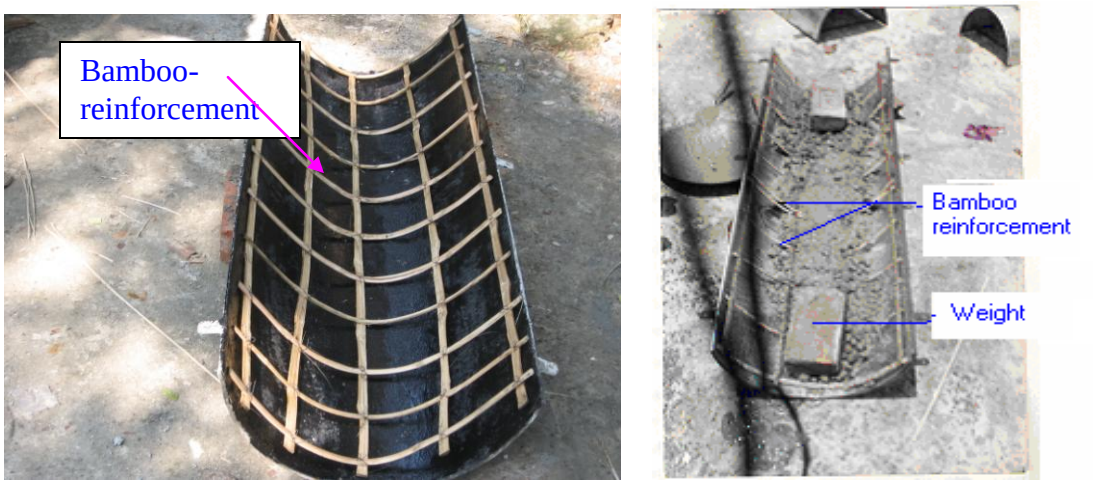

Fig. 3 Bamboo-reinforcement & concrete placed in the moulds

Fig. 4 Progress of casting the half round bamboo- reinforced precast section

Fig.5 Concrete sections is ready for use

Bamboo-reinforcement & mixtures

The bamboo-reinforcements were the bamboo sticks of 5mmx10mm cross-section with the length of 150cm each and maintained spacing 10cmx15cm while placed in moulds. After binding the reinforcements by wires following the spacing these became the net structure of required length and breadths to fit in the moulds. The concrete mixture used was 1:2:4 of cement: sand: aggregate ratio. The quarter size stone chips and medium pit sands were used in mix as coarse and fine aggregates respectively.

(b) Half round burnt clay tiles

i) Mould making and fabrication of earthen tiles

The moulds were nothing but the soils gathered in the shape of approximately 30-33cm diameters and about 55cm length of each type over the leveled ground in open air **(Fig 1).** There are some difficulties in maintaining the exact shape and size of the tiles as because it get deformed to some extent during handling at its drying stage when the tiles are soft. The variation of diameter in tiles in particular create problem in jointing them to one another to make the channels. The moulds made of wood on iron frame structure have been used. These moulds have provided comparatively better shape and size tiles of 35cm diameter and 55cm length **(Fig 2)**

Fig. 6 Earthen mould for half round burnt clay tiles

Fig. 7 Wooden mould for half round burnt clay tiles

Fig.8 Tiles are burnt in indigenous kiln

(c). Earthen roof tiles

Fig.9 Air dried earthen roof tiles ready for burning

Fig.10 Laying of the earthen tiles in the channels

The conventional earthen roof tiles have the usual articulations which favour the purpose of roofing but when it is used in irrigation channels it provide obstruction to flows. Therefore, the mould were designed and the tiles were fabricated by removing the articulations and providing grooves and channels in the tiles in appropriate places which favoured better jointing and leaving little rough surfaces and obstruction in flows after placing it in the irrigation channels.

(d) Brick channels

Brick channels were made inside bottom width 25cm and height 35cm and thickness of the side walls 15cm. The channels were made on the plain concrete base of 7.5cm thickness at the bottom. The brick bats were used as the coarse aggregate of the concrete. The inside walls and bottom of the channels were plastered by cement mortar for thickness of 2.0 and 2.5cm respectively. The top of the channels walls were also plastered and the outside walls were pointed suitably by cement mortar. The plastered portions of the channels were also provided with neat cement coating.

Fig. 11 Brick bats used in brick channels **Fig.12 Brick channel in progress**

9.3.2 Laying the sections/tiles in the channels

The existing irrigation channels which were found more susceptible to water losses were selected for lining. The undulation along the existing irrigation channels were determined by leveling operations at 5m interval. Avoiding the zig-zag direction, the straight and desired slope channels were made. Necessary earth filling was done to get the flat soil formation of appropriate slope throughout the proposed channel lengths.

The tiles were placed one after another on the earth filled properly leveled channel bed. These were then jointed together by cement mortar at the faces to get the continuous channel.

9.3.3 Determination of seepage losses of the channels

The seepage losses of the channels were determined by ponding water in the channels. The evaporation losses of water from the open surface of the ponded water in the channels were taken in to account in determining the seepage losses.

9.3.4 Channels made in different sites

Atlia-Komarpur

Fig.13 Bamboo-reinforced concrete section in the process of making at Atlia-Komarpur

Fig. 14 Concrete sections are carried in the Site through van-rickshaw

Fig.15 Channel made in mustard crop field


Fig.16 Completed bamboo-reinforced concrete channels


Chandirampur

Fig. 17 Mouth of DTW at Chandirampur

Fig.18 Preparation of channel for laying sections

Fig.19 Construction workshop at DTW site

Fig.20 Stock of concrete sections

Fig.21 Channels under the process of construction

Fig. 22 Channels in use

Fig. 23 Channel bed preparation of for brick channel

Fig.24 Concreted bed for brick channel

Fig. 25 Brick channels are in progress

Fig. 26 Complete brick channels

Birohi

Fig. 27 Spout of DTW

Fig.28Channels to be lined

Fig. 29 Construction workshop at DTW site

Fig.30 Stock of sections

Fig. 31 Channels are in use


Fig. 32 Channels are in use

D-Block Farm


Fig. 33 Channel to be lined

Fig. 34 Channels are in use


Fig. 36 Channels are in use

Instructional Farm (Engg)

Fig. 37 Water reservoir is in progress

Fig.38 Water reservoir is in progress

Fig, 39 Completed water reservoir

Fig. 40 Brick channel in progress

Fig. 41 Completed brick channel

10. Detail analysis of results

10.1 Modification of moulds

The modified moulds used for making earthen sections for both half rounds and flats worked well. The half round sections were more uniform in diameter and in shape

after burning. The flat tiles provided better opportunity in jointing together and smooth inside with less resistance to flow of water. The earthen tiles have proved durable and performance in controlling seepage losses and are even better than concrete sections. However, these sections are susceptible to damage to cattle traffic which has caused to less preference to the farmers. Therefore, earthen tiles of desired lengths could not be made in farmers' fields. They preferred concrete and brick channels.

10.1 Construction of channel

The farmers have shown great interest to the bamboo reinforced concrete channels and brick channels. Since, the intention of this project was to popularize the low cost technique in making irrigation channels, and giving due consideration to the farmers liking, the bamboo reinforced concrete channels were made more in length than the proposed at the proposal and accordingly the length of earthen channels were modified **(Table 2)**.

Table 2. Channel constructed at different sites by using different materials

Sl. No.	Lining materials	Proposed channel lengths (m)	Channel length constructed(m)
1	Bamboo-reinforced precast concrete	1000	2560
2	Burnt clay tiles (half round)	1000	360
3	Earthen roof tiles	1000	290
4	Bricks	1000	475
	Total	4000m	3685

The interest of the farmers in using the proposed technique was judged by their intention in contributing some amount to the cost of the channel construction. The farmers of different sites have contributed an amount of Rs.22, 500/- (Rupees twenty two thousand five hundred) only. Even after completion of work at their site, they have taken our moulds for making sections on their costs. The channels of half round sections have appeared optimum capacity to the requirement in the channels of deep tube well outlets.

10.2 Hydraulic performance of the channels

The hydraulic performance and the repair and maintenance of the channels were observed regularly. It has been found that after modification of moulds so to better

smoothness in inside surfaces of the channels in the fields and additional care to repair the small cracks in joints which usually develops in dry channels just after construction provided less seepage losses than the previous. The average hydraulic performances in respect of Manning's n and seepage losses are shown in **Table 3**.

Table 3. Hydraulic performances of the channels

Sl. No.	Type of channel	Manning's n	Seepage loss, $cm^3/cm^2/day$
1	Bamboo reinforced half-round precast concrete	0.028	5.65
2	Half round earthen tile	0.024	5.36
3	Trapezoidal channels made of flat earthen roof tiles	0.032	6.58
4	Brick	0.021	3.75

The brick channels were found better in respect of hydraulic performances because the inside surfaces were plastered by 2cm followed by neat cement and joint pointed nicely. However, the performances of other channels are also comparable. All the channels could have reduced the conveyance loss of water less than to one percent.

Economy of channels under study and its longevity

Among the conventional lining materials brick is the most popular one in the locality. Therefore, the cost of fabrication of precast bamboo-reinforced sections and earthen tiles, carrying to the sites and laying it properly were compared to the cost of construction of brick channels of comparable area of construction. **(Table 4).**

Table 4. Cost and saving in construction of channels made of selected lining materials compared to brick lined channel

Sl. No.	Type of channel	X-sectional of the channels,	Cost of construction, Rs./m length		Saving in cost for the channels in
			Channel	Brick lined	

		cm^2	of Col.2	channel of same sectional area	Col.2, %
1	Bamboo reinforced half – round precast concrete	521	95	210	54.76
2	Half round earthen tile	480	70	200	65.0
3	Trapezoidal channels made of flat earthen roof tiles	675	90	355	74.65

The saving in cost of construction was highest 74.65% in earthen trapezoidal channel followed by half round earthen channel (65%) and bamboo reinforced half-round precast concrete channel (54.76%). However, in respect of management and durability the half round precast concrete channel and half round earthen channels were found better. The trapezoidal channels made of earthen tiles require more attention in regular earthen up of two of its sides to provide required support.

The channels constructed by the earthen tiles and bamboo- reinforced precast concrete have been in use in the university farm for about 12 years. So far, no considerable damage was recorded. However, some cracks to the joints of the sections of both the types were observed. Sometimes, temporary vegetations grow in the bed of the channels due to the deposition of earth materials within the channels. The earth materials are being in use to block the outlets in the diversion boxes which in turn get deposited in the channel bed carried by the flowing water. To avoid these problems, little care and maintenance are required. Considering all the relevant aspects, it could be estimated that the maintenance cost should not be more that 5.0% of the construction cost and longevity 15 and 20 years for earthen tiles and precast bamboo- reinforced concrete channel.

10.3 Impact on cultivation practices of tube well commands

In the deep tube well commands there is usually 8-9 numbers of spouts or water outlets. The project works were undertaken in 4-5 worst outlets of it in consideration to water losses and poor management. Somewhere excessive seepage losses caused constant wetting the large tract of channel side fields lead to uncultivable situation or water even did not reach to down stream due to this. On making the channels in such situation water was saved to considerable extent, as a result, in some deep tube wells the area of the commands or cropping intensity or both were increased. It did not only make available the water but decrease significantly the time of irrigation and improved the water application efficiency in the fields.

10.4 Overall impact of lining the channels to the farmers and society

The way of making the channels have been visited by the farmers, personnel of NGOs, scientists and researchers, officers of the Govt. Departments, the students, research scholars and the dignitaries of the university. In fact, the visit of the farmers of different localities was a regular occurrence. The then Chairman, CWC, along with one consultant Engineer has visited the tube well sites. They went in detailed interaction to the farmers of the Atlia-Komarpur and Chandirampur village about the benefits, assistance from the Govt., participation and responsibilities of the beneficiaries, and expressed their satisfaction to the overall progress of the work.

Fig.42 Students visiting the channels

Fig. 43 Vice-Chancellor, Director of Res. & other dignitaries visiting the channels

Fig. 44 Chairman, CWC visiting the sites

Fig.45 Farmers visiting the sites

Fig.46 Visitors at site

Fig.47 Awareness campaigning

The performance of the channels in respect of controlling seepage losses and maintenance were observed regularly by the farmers from different tube well commands.

There was infighting among them for getting the project works implemented in their tube well command. The utility and economy of using these channels were focused in different forum/seminars towards getting wider acceptance and utilized by the farmers and the irrigation department. The technology of using these materials for lining the irrigation channels has been proposed for adapting in action policy of Agricultural Commission of West Bengal. A bulletin has been published with the title ***A Few Low Cost Lining Materials*** which describes all that related to technology of using the materials in lining the irrigation channels as well as its performances for controlling water losses.

11. Conclusion & summarizing the achievements and scope of future work

The results are summarized below:

The ad-hoc research project entitled "*Extension of some low cost lining materials for increasing the area of irrigation commands*" was approved by the Govt. of India, Ministry of water Resources (MoWR), P.P. Wing R&D Division, New Delhi-110066 with a budget provision of 12, 37,000/- for three years including University Overhead charges of Rs.1, 12, 434/-. The objectives of the works were "*To examine the hydraulic characteristics of the channels made of identified low cost lining materials, to demonstrate the of the lined channels in farmers fields, to educate the farmers/users towards selection of use of lining materials and to evaluate overall impact of inventions on irrigation commands"*. The project work was carried out at farmers' fields at Atlia-Komarpur, Chandirampur and Birohi villages in Haringhata Block of Nadia district and at the D-Block Farm (Kalyani) and Instructional Farm, Faculty of Agricultural Engineering of Bidhan Chandra Krishi Viswavidyalaya.

There were four types of materials for making the channel sections and laying out channels using the sections, following by tests for evaluating their performance and acceptance among the farmers. These were the bamboo-reinforced precast concrete, earthen tiles (half round), earthen roof tiles and bricks. Hydraulic performance was evaluated through Manning's roughness coefficient, experimentally determined for the available range of discharges and also through seepage loss determination.

Bamboo-reinforced precast concrete

The bamboo-reinforced precast sections were fabricated by using the moulds of 36.4cm diameter and 152.4cm (5 ft) length. Bamboo-reinforcements were used to substitute the costly iron reinforcements. The cement:sand:aggregate were mostly used as 1:2:4 to construct the field irrigation channels. In most of the cases the existing direction and bed slope of the fields were followed during lining them. The channels were in use round the year.

The 36.4cm diameter channel was found optimum in size to the requirement in outlets of the DTW commands. The farmers were satisfied and accepted this channel since it is found economical, durable, control the water losses effectively, and channels can be constructed in short time. The average seepage loss and Manning's roughness coefficient n were found 5.65 $cm^3cm^{-2}day^{-1}$ and 0.028 respectively. The proposed channel length in the project was 1000m. However, considering the farmers' likings this channel was made for the length of 2560m in different tube well commands.

Earthen tiles (half round)

The local artisans were engaged for making the tiles following the designed moulds. The modified moulds were 35cm diameter and 55cm length. The moulds were made of wood on iron frame structure. The 35cm diameter channel instead of previously used 33cm diameter could overcome the risk of overflow in place of higher channel slope or decrease of effective capacity due to defective construction of tiles or channels made of bad works man ship. The economy of the channels was very good but susceptible to cattle & sometime other willful disturbances. The farmers who don't have protected fields did not prefer burnt clay tiles. Therefore, giving due consideration to farmers' choice the constructed length of this channel was 360m.

Earthen roof tiles

The earthen roof tiles were made by using the moulds made of wood for 45cm length, 25cm breadth and 2cm thickness. The surfaces of the tiles were made plane & smooth excepting the straight grooves to the edge of the tiles which facilitated jointing the tiles while laying in the channels. These tiles were found much better in carrying water than the usual roof tiles available in the locality. The average seepage loss and Manning's n were found 6.58 $cm^3cm^{-2}day^{-1}$ and 0.032 respectively.

Similar to earthen tiles (half round) the farmers had limited choice to these tiles due to susceptibility to damage by cattle & other disturbances and conviction to age old tradition. The constructed channel lengths were 290m.

Bricks

Brick is a conventional lining material used extensively in making irrigation channels. It has got considerable salvage value. But, it is much costlier when used as channel lining material and adapted all measures like plastering, neat cementing etc., to reduce the seepage losses effectively. The cost of the brick channels were about 2-3 time of comparable cross section to the other materials used in this project. The farmers have great likings to the brick channel. The brick channels were made with all its measures to have controlled the seepage loss at maximum extent. The length of the channels was 475m. The average seepage loss and Mannig's n were found3.75 $cm^3cm^{-2}day^{-1}$ and 0.021 respectively. However, the farmers were also convinced to the point that low cost lining materials are affordable alternative to the common farmers as substitute to brick or concrete and are necessary if huge wastage of water through irrigation channels to be controlled in reasonable short time.

Conclusion

1. The costs of conventional lining materials, viz. bricks, steel reinforced concrete, stone, etc. keep away the average Indian farmers in lining their irrigation channels by using these materials. The bamboo-reinforced precast concrete of appropriate diameter can be suitably used in irrigation & drainage channels. The channel sections are suggested to be fabricated at close as possible to the channel site to avoid the chances of breakage during transportation. The maximum diameter section of 50cm can be constructed by using the moulds used here and these sections can permit the discharge of 40l/s at 0.35% slope. However, in DTW & STW commands 36.4cm (14 inches) diameter sections are of sufficient capacity. The farmers have preference to bamboo-reinforced concrete channels over other channels made of non-conventional materials.

2. The burnt clay tiles (half round) of 35cm diameter and trapezoidal section made of 45cm length, 25cm breadth and 2cm thick flat earthen roof tiles are of sufficient capacity for carrying the water for average condition in DTW & STW commands. The seepage loss of these channels improves with the passage of time due to fill up of the pore spaces

in it by finer particles. It is less costly & easily can be made by the local artisans; however, farmers don't have the preference unless their fields are protected against cattle traffic or other disturbances.

3. The utility and economy of these lining materials need to be more focused to the concerned departments of the Govt. associated with financial & technical assistance to the irrigation or drainage channels. Unless it is accepted in principle and incorporated in regular works schedule of the departments it is difficult to get wider acceptance. The CWC may take initiative to this.

4. On an average the 15-20% of area or cropping intensity or both have increased in irrigation commands where the project works are implemented.

5. CWC may undertake more & more such extension activities towards saving of scarce irrigation water**.**

12. S&T benefits accrued

(i) List of publications

Sl. No.	Authors	Title of paper	Name of the Journal/Seminar	Pages	Vol./Year
1.	R. K. Biswas	Water losses and its measure in tube well irrigation	Lead paper in Proceedings of National Seminar on ***'Eco restoration of Soil & Water Resources towards Efficient Crop Production'*** organized by Crop & Weed Society, BCKV, held at FTC, Kalyani, Nadia, West Bengal	31-45	June 6-7, 2007
2	R. K. Biswas	Water losses in tube well irrigation and its measures	Proceedings of National Symposium on ***'Environment and Water'*** (NSEW-2008) organized by Indian Association of Hydrologists at Jadabpur University, Kolkata	82-88	April 18, 2008

3.	R.K. Biswas	*Paschim banglay sesh byabostay jaler apochay* (Water losses in irrigation practices of West Bengal)	*Annadata*: UK ML Building (3rd Floor), Ramoji Film City, Hyderabad-501572 & rep	24	May, 2008
4.	R.K.Biswas	*Paschim banglay nalkup sesh byabostay jaler apochay o tar pratikar* (Water losses in tube well irrigation of West Bengal & its measures*)*	*Bardhaman Jyoti(Weekly*): A vernacular agricultural journal Published from Kanchannagar,Dist. Bardhaman, West Bengal	4	December 25, 2008

(ii) Manpower trained on the project

a) Research Scientists or Research Associates : Nil

b) No. of Ph. Ds produced : Nil

c) No. of M.Sc. produced : Nil

d) No. of B.Tech produced : 2

e) Other technical person trained : 6

13. Financial position

Head wise expenditure

Sl. No.	Head of expenditure	Fund sanctioned,	Fund released, Rs.	Expenditure,	Total use,

		Rs.		Rs.	%
1	Salary	-	-	-	-
2	Travel expenditure	75,000	25,000	22, 668	90.67
3	Experimental charges	9,25,800	9,25,800	9,27,819*	100
4	Infrastructure/Equipment	70,000	70,000	69, 650	99.50
5	Overhead	1, 12,434	-	-	-
Total		12, 37,000	10,34,000 *	***10, 20, 137***	

* An amount of Rs.22, 500 was received from farmers. Thus, total amount received =10, 34, 000+22,500 = ***Rs.10, 56, 500***

*Unspent balance=**Rs.36, 363,** Overhead expenditure of **Rs. 1, 12,434** to be borne by funding agency (MoWR). Net amount requested= **(1, 12,434-36,363) =Rs.76, 071***

Year wise receipt

Source	Year				Total
	2005-06	2006-07	2007-08	2008-09	
Funding Agency (GoI)	2,700,00	1,15,000	2,20,000	4,29,000	10,34,000
Farmers	-	15,500	7,000	-	22,500
Total	2,700,00	1,30,500	2,27,00	4,29,000	10,56,500

Year wise expenditure

Subhead	Year				Total
	2005-06	2006-07	2007-08	2008-09	
Salary	-	-	-	-	-
Travel expenditure	-	12,324	4,595	5,749	22,628
Experimental charges	-	1,89,831	3,17,688	4,20,300	9,27,819
Infrastructure/Equipment	-	69,650	-	-	69,650
Overhead	-	-	-	-	-
Total	-	2,71,805	3,22,283	4,26,049	***10,20,137***

14. (a) Procurement/Usage of Equipments

Sl. No.	Name of equipments	Make/Model	Cost (Rs.)	Date of installation	Utilization rate (%)	Remarks regarding maintenance, break down
1	PC& accessories	Assembled	39,600	04.08.2006	90	Working well
2	Moulds	Fabricated locally	30,050	04.08.2006	75	Rusted & broken

b) Plans for utilizing the equipment facilities in future

The PC may be used for departmental purpose. The moulds are in bad condition. These are either rusted badly which are not suitable for use or broken**.**

(R.K.Biswas)

Principal Investigator