

PC - I FORM (Revised 2005)

**PRODUCTION SECTORS
(Agriculture Production)**

**PILOT TESTING OF INNOVATIVE TECHNOLOGIES TO
IMPROVE WATER USE EFFICIENCY**

(ADP Funded)

**Project Cost:
Govt. Share:**

**Rs. 50.88 Million
Rs. 50.88 Million**



(2019-20 to 2021-22)

**DIRECTORATE GENERAL AGRICULTURE
(WATER MANAGEMENT) PUNJAB, LAHORE**

July, 2019

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Acronyms and Abbreviations

DGA(WM)	Director General Agriculture (Water Management)
OFWM	On Farm Water Management
PGS	Punjab Growth Strategy
NCCP	National Climate Change Policy
PASP	Punjab Agricultural Sectoral Plan
SSCs	Supply & Service Companies
FAO	Food and Agriculture Organization of the United Nation
ADB	Asian Development Bank
P&DD	Planning and Development Department
MAF	Million Acre Feet
ERR	Economic Rate of Return
ADP	Annual Development Program
LBDC	Lower Bari Doab Canal
PIPIP	Punjab Irrigated-Agriculture Productivity Improvement Project
WMRF	Water Management Research Farm
WUE	Water Use Efficiency

1. NAME OF THE PROJECT

Pilot Testing of Innovative Technologies to Improve Water Use Efficiency.

2. LOCATION

The proposed project interventions will be implemented in Lower Bari Doab Canal (LBDC) command area. It is planned that the efficacy of the soil moisture measurement gadgets will be evaluated at Water Management Research Farm (WMRF), Renala Khurd, district Okara while demonstration of climate smart interventions will be carried out at 18 technology transfer centers (TTCs) to be established at nine (09) tehsil (Pattoki, Okara, Renalakhurd, Sahiwal, Chichawatni, Khanewal, Mianchannu, Jahanian and Kabirwala) of four (04) districts (Kasur, Okara, Sahiwal and Khanewal) in entire LBDC command. The location map is attached as **Annexure-A**.

3. AUTHORITIES RESPONSIBLE FOR

a) Sponsoring

Government of the Punjab, Agriculture Department through Annual Development Program.

b) Execution

- i) Punjab Agriculture Department through Directorate General Agriculture (Water Management) Punjab, Lahore.
- ii) Director, Water Management Training Institute, Lahore.
- iii) Director Agriculture (OFWM) at divisional level.
- iv) Deputy Director Agriculture (OFWM) at district level.
- v) Deputy Director Farm, Water Management Research Farm, Renala Khurd, Okara.
- vi) Supply & Services Companies (SSCs).
- vii) Participating farmers.

c) Monitoring

- i) Directorate General Agriculture (Water Management) Punjab, Lahore
- ii) Director, Agriculture (OFWM) concerned
- iii) Director, Water Management Training Institute, Lahore

d) Operation and Maintenance

Beneficiary farmers

e) Concerned Federal Ministry

Not Applicable

4. PLAN PROVISION

a) If the project is included in the medium term/ five-year plan, specify actual allocation

The proposed project is inline with the national and provincial development plans. National Water Policy 2018 envisages that concept of "More Crop per Drop" shall be pursued and conservation plan of "*adoption of water conservation techniques/technologies at the farm level*". The Punjab Government vision for agriculture sector encompasses water conservation and enhancing water productivity through efficient water conveyance, application, and optimal use. The proposed project is in line with the development plans of the Punjab Government and has strong relationship with the Punjab Growth Strategy 2018, which envisages On Farm Water Management (OFWM) as one of the components for achieving the targeted agricultural growth, which would be achieved through water conservation at the farm level by adopting the climate smart interventions to enhance the water use efficiency.

The government's vision for agriculture sector, alongwith other initiatives, encompasses water conservation and water productivity through enhancing water use efficiency by using soil moisture monitoring gadgets. The proposed project aims at evaluation of climate smart interventions and their demonstration for enhancing the water use efficiency at farm level vis-à-vis improving water productivity and crop yield. Enhancing water use efficiency will significantly contribute towards improving the water productivity and resultantly trigger the growth of rural economy.

b) If not included in the current plan, how is it now proposed to be accommodated (Inter/Intra-Sectoral adjustment in allocation of or other resources may be indicated)

Not applicable.

c) If the project is proposed to be financed out of block provision for a program or PSDP/ADP, indicate in Pak-Rupees?

Not applicable.

d) If the project is not in the plan, what warrants its inclusion in the plan?

Not applicable.

5. PROJECT OBJECTIVES

a) Sectoral objectives as indicated in the medium term/ five year plan

Sustainable Development Goals (SDGs) are comprehensive universal set of 17 goals and 169 targets/ indicators around which future development agenda of the world have been framed till 2030. Recognizing the key role of water in sustainable development, a standalone goal six of the SDGs has been dedicated to water unfolded as "*ensure availability and sustainable management of water and sanitation for all*". Goal six also speaks about substantial increase in

water use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity by 2030. Another target is to support and strengthen the participation of local communities for improving water management. The strategies for conservation of water provided in the Punjab Growth Strategy (PGS), 2018 envisage “*Water conservation at farm level*”.

At national level, Pakistan Vision 2025 of the Ministry of Planning, Development and Reforms, Government of Pakistan recognizes sufficient, reliable, clean and cost-effective availability of energy and water for ensuring sustainable economic growth and development. It has been envisaged therein that *Pakistan needs a comprehensive water strategy that must combine the building of a substantial amount of additional water storage, minimization of losses in the conveyance system, and strengthening of the governance to implement effective policies to maximize crop yields per unit of water*. It has also been planned in Pakistan Vision 2025 to “*invest in proven methods and technologies to minimize wastage (e.g. in the agricultural sector), promote conservation and gain efficiencies*”. Similarly, National Water Policy (NWP) 2018 envisages that “*adoption of water conservation techniques/technologies at the farm level*”. The proposed project is also inline with the National Climate Change Policy (NCCP) which envisages “*ensure water conservation, reduce irrigation system losses and provide incentives for adoption of more efficient irrigation techniques*” as one of the policy measures under water conservation strategies.

As such, the proposed project activities are completely inline with the sectoral objectives outlined in the SGDs, Pakistan Vision 2025, NWP, NCCP, PGS and PASP.

b) Project Objectives

The main objective of the project is to enhance water use efficiency for harnessing maximum benefits of water as agriculture inputs for socio-economic uplift of the farming community. The key objectives of the project would include, interalia, the followings.

- i) Enhance water use efficiency (WUE) of flood irrigation method by using soil moisture gadgets, Alternate Wetting and Drying (AWD) method and Direct Seeding Rice (DSR) technique
- ii) To calibrate and demonstrate the impact of soil moisture gadgets on improving water productivity as compared to conventional method of irrigation scheduling
- iii) To indigenize/ standardize the soil moisture monitoring gadgets under local environment
- iv) Capacity development of the professionals and farmers for enhancing WUE through different innovative techniques

c) Sectoral Linkages/Relationship

The proposed project has a strong relationship with the objectives of the National Water Policy, National Climate Change Policy and Punjab Growth Strategy (PGS). Increasing efficiency/productivity of the available water at the farm level is one of key objectives of the PGS. The proposed interventions aim at enhancing water use efficiency through climate smart interventions in LBDC command and at WMRF using soil moisture monitoring gadgets at the farm level so that maximum attainable benefits of interventions may be harnessed to maintain a climate resilient water application at the farm level.

The interventions evaluated and pilot tested under the proposed project, if successful, would become part of the on-going on farm water management (OFWM) program for enhancing water use efficiency at the farm level for improving the water productivity. The underlying objectives of envisaged initiative are consistent with those of the agriculture sector that aim at increasing water productivity at the farm, ensuring food security, economic uplift of small farmers, community empowerment and improving the economy of the country as a whole.

d) In case of revised project, indicate objectives of the project if different from original PC-I

Not applicable.

6. DESCRIPTION AND JUSTIFICATION OF THE PROJECT

I) Background/Justification

a) Irrigated Agriculture Significance

Agriculture is a crucial driver of economic development in Pakistan. It is primarily dependent on water as it consumes about 95 percent of available water supplies. The Punjab is Pakistan's agricultural and economic heartland that contributes about 80 percent to country's food requirements by producing 80 percent cotton, almost 70 percent wheat, nearly 60 percent sugarcane, and 50 percent rice. More than 70 percent cropped area of the Pakistan's Indus food machine is situated in the Punjab and over 90 percent of province's agricultural production comes from irrigated lands.

Due to predominantly arid and semi-arid climate, more than 80 percent of the cropped area is irrigated by one of the largest contiguous gravity flow network in the world called as Indus Basin Irrigation System (IBIS). About 60 percent of the area commanded by IBIS is located in the Punjab i.e. 8.4 million hectares (21 million acres) served through about 58,500 outlets. Irrigated agriculture is in fact the spearhead of Punjab's agro-based economy accounting for about 28

percent of GDP and employing over 50 percent of its labor force. About two third of the population resides in rural areas relying directly or indirectly on this sector for their livelihood. Despite critical significance of irrigated agriculture to national as well as provincial development, it could not perform sustainably mainly due to lack of modernization of irrigation operations leading to colossal loss of water because of conventional in-efficient irrigation practices.

b) Water Availability and Challenges

Amid various emerging challenges to irrigated agriculture like food security and climate change, inadequate water availability for crop production, poor irrigation efficiency, and over/under irrigation are the main impediments to low water productivity from otherwise highly productive agricultural lands. According to Water Apportionment Accord of 1991, Punjab's share in total surface water availability is 55.94 million acres feet (MAF). The groundwater abstraction for crop production is about 33 MAF per annum whereas approximately 7 MAF is contributed by the rainfall. On the other hand, there are huge water losses (37 MAF) in the system including 12 MAF in the distribution network of main/branch canals, distributaries, minors, and tertiary conveyance system comprising of about 58,500 watercourses.

Pertinently, a substantial amount of irrigation water (15 MAF) is also lost during its application to undulated fields and without irrigation scheduling using soil moisture monitoring gadgets. This leads to over & under irrigation of crops which reduces the crop yields. Over-irrigation leaches soluble nutrients from the crop root zone, makes the soil less productive, and degrades groundwater quality. On the other hand, under-irrigation of elevated parts of the fields results in accumulation of salts in such patches besides causing water stress and injurious effects of applied fertilizer. The fields not properly leveled cause wastage of land, result in low irrigation efficiencies, and ultimately much lesser yields are obtained than the potential.

Overall, about 53 MAF of water is available for crop use against 65 MAF of irrigation requirements of current cropped area/ cropping patterns. As such, there exists a gap of nearly 12 MAF to meet crop water requirements for present cropping intensity of nearly 135 percent as shown in **Figure-1**.

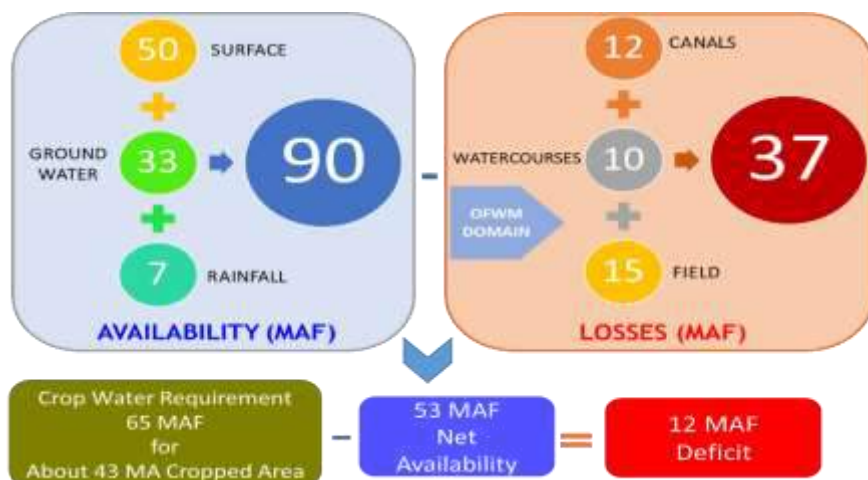


Figure-1: Punjab Water Budget

Another emerging threat to the sustainability of irrigated agriculture is over exploitation of groundwater. The groundwater is a strategic resource for the Punjab as it contributes almost 50 percent out of total water utilization for crop production in the Punjab. The unchecked and unsustainable pumpage of this precious resource is a serious threat for sustainability of irrigated agriculture in the province, particularly in water scarce areas. The number of tubewells has increased from less than 10,000 in 1960 to more than one million (1,050,000) in 2017, which are causing depletion of groundwater at alarming rates.

The above situation evidently highlights proper management of scarcely available water and its judicious & efficient use for sustainable irrigated agriculture. There is, therefore, a dire need to use this precious resource wisely and efficiently by adopting the water conservation technologies to conserve it for future generations.

c) Farm Level Water Conservations Initiatives

There has been no incremental water resource development during last four decades in the country. The only source of increased water availability at the farm level has, however, been through adoption of conservation measures e.g. barrages modernization, canals rehabilitation, lining of distributaries/ minors, improvement of watercourses, LASER land leveling, high efficiency irrigation systems etc. Strenuous efforts are already underway to mitigate irrigation related issues at the farm level, which include rehabilitation of farm level irrigation conveyance network for minimizing conveyance loss to improve water availability and provision of LASER land leveling units to farmers/service providers to reduce water application losses as well as

promotion of drip and sprinkler irrigation systems for conservation and efficient use of irrigation water at farmers' fields.

Currently, a comprehensive development initiative titled "Punjab Irrigated-Agriculture Productivity Improvement Project (PIPIP)", is under implementation, which includes rehabilitation of farm level irrigation conveyance network for minimizing conveyance loss, reducing water application losses and enhancing water use efficiency through provision of LASER land levelers to farmers/service providers together with promotion of drip and sprinkler irrigation. The combined effect of these advancements would lead to maximize productivity of available water by minimizing water losses to ensure its adequacy, reliability, and effectiveness at the farm level.

The proposed project would also contribute to water saving and enhancing water use efficiency at farmers' fields leading to enhanced crop and water productivity and ultimately resulting in better farm returns.

d) Water Productivity

Irrigation efficiency or water use efficiency was previously used to describe the performance of irrigation systems. More recently, the term water productivity is being used, which is the magnitude of output / benefit acquired from input quantum of water applied on a unit base. It is usually expressed as 'kg per cubic meter of water' or 'rupees per unit volume of water.

There is substantial variation in crop yields and corresponding water productivities of different crops as well as for the same crop grown in different parts of the world. For example, the water productivity of wheat and rice is much less in Punjab (Pakistan) than India and USA as shown in **Figure-2**. This gap can be attributed to many factors including improved irrigation management, use of soil moisture monitoring gadgets, better quality seeds, increased fertilizer applications, effective insect/ pest control etc. The efficacy of all of these measures, however, largely depends upon improved water availability and its efficient use.

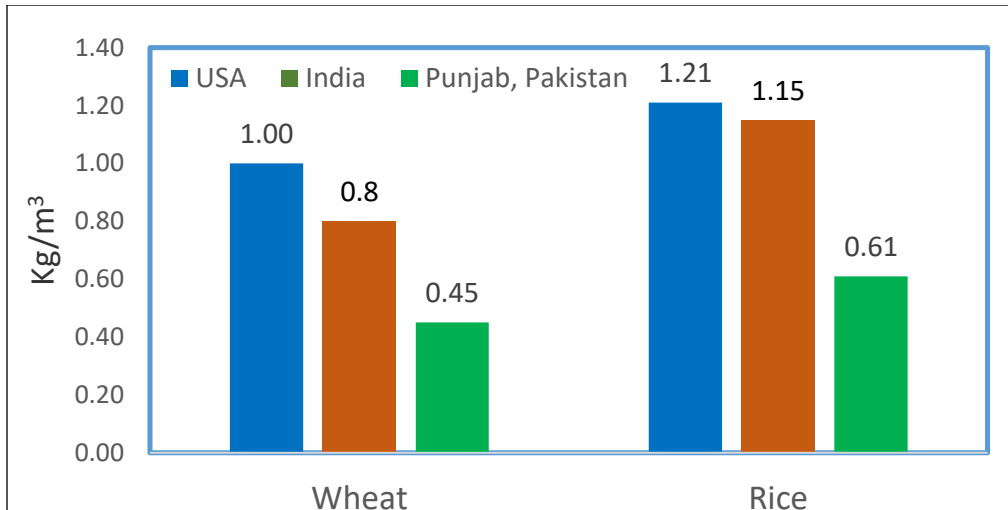


Figure-2: Water Productivity Scenario

It is pertinent to point out that the agriculture is mostly practiced using traditional non-scientific irrigation methods in in Pakistan, which cause low crop productivity per unit of water used. There is a huge scope for improving water productivity at the farm level through adoption of modern and more productive irrigation technologies by optimal use of inputs, particularly water.

e) Lower Bari Doab Canal (LBDC)

The proposed project activities will be carried out in two irrigation divisions viz. Sahiwal and Khanewal in the command area of LBDC irrigation system which covers 0.8 million hectares (Mha) along Bari Doab and is the second largest irrigation system of the Punjab. Rice-Wheat, Cotton-Wheat, Maize-Maize, Potato-Maize and Maize-Wheat are the major cropping systems of this canal command. In LBDC command area, Cotton–Wheat is the dominant cropping system as majority of the farmers grow cotton (47 percent in Khanewal and 20 percent in Sahiwal) and Wheat (51 percent in Khanewal and 46 percent in Sahiwal) as major crops during Kharif and Rabi seasons. The production of cotton is adversely affected by climate change, soil salinity, drought prone, water shortage & its quality, lowering depth of watertable and massive extraction of groundwater due to arid and semi-arid geographic location. The surface and groundwater are used by the farmers to fulfill the irrigation water requirement for crops in LBDC command.

f) Soil Moisture Measurement/ Monitoring

i) Existing Practices

Soil moisture is the most critical and highly variable component of the crop root zone environment. It directly affects the plant growth through its controlling effect on availability and

uptake of almost all nutrients. Application of too much water not only causes its wastage but also that of other nutrients, energy, and labor. Furthermore, excess water in the root zone reduces soil aeration retarding plant growth. Likewise, under irrigation stresses the crop by constraining availability of water as well as non-water nutrients. As such, under or over application of water, both lead to reduced crop yields and poor quality of produce. The water shortage at any stage of plant growth retards its development and hampers photosynthesis process. The over and under irrigation adverse impacts on plant growth is given in **Table-1**.

Table-1: Over and Under Irrigation Adverse Impacts on Crop Growth

Over Irrigation	Under Irrigation
◆ Losses of precious water	◆ Minimize nutrients uptake
◆ Restricts plant growth	◆ Stresses crop growth
◆ Leaches soil nutrients	◆ Lowers produce quality
◆ Retards root development	◆ Affects plant health
◆ Wastes energy	◆ Reduces crop yield
◆ Lowers produce quality	

ii) **Feel and Appearance Method**

This method is based on appearance of soil and plant in response to water stress. This is the oldest and most commonly employed way for guessing soil moisture content for irrigation purposes. It is based on personal experience of the irrigator by observing the crop condition e.g. change in color of the plant canopy, curling of the leaves, plant wilting condition etc. as shown in **Figure-3**. These changes can only be detected by looking at the crop as a whole, rather than at individual plants.

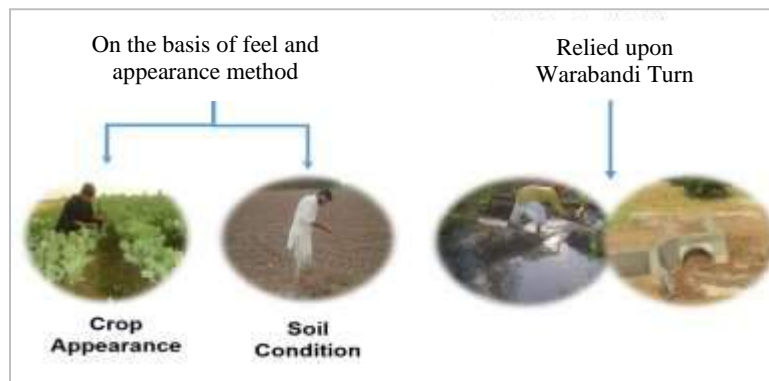


Figure-3: Existing Irrigation Scheduling Practices

iii) Warabandi Operation

The warabandi starts at the head and proceeds to the tail of the watercourse according to a prefixed schedule. A certain time allowance is given to a farmer to irrigate the fields at allocated turn without considering the fact that whether crop needs water or not and how much. The groundwater is, however, playing a vital role in irrigated agriculture of the Punjab with about 50 percent contribution in overall irrigation applications. Contrary to the warabandi irrigation system, farmers irrigating fields with groundwater have the flexibility and high potential for implementation of irrigation scheduling.

iv) Irrigation Scheduling

In order to scientifically schedule irrigation, accurate determination of “WHEN and HOW MUCH water to be applied to a field” thereby providing exact amount of water to crop at the right time is very much important. The timing of an irrigation event (WHEN) depends on plant need and soil water condition whereas “HOW MUCH” is contingent upon soil’s water holding capacity, crop rooting depth, soil moisture depletion level, and planned irrigation interval. The importance of irrigation scheduling has long been recognized and a wide range of scientific and practical tools have been developed to help farmers in applying water to crops more accurately.

It has been established that best crop growth occurs when the soil moisture level remains within field capacity range, locally called WATTAR, whereas crop growth slows down above or below it (**Figure-4**).

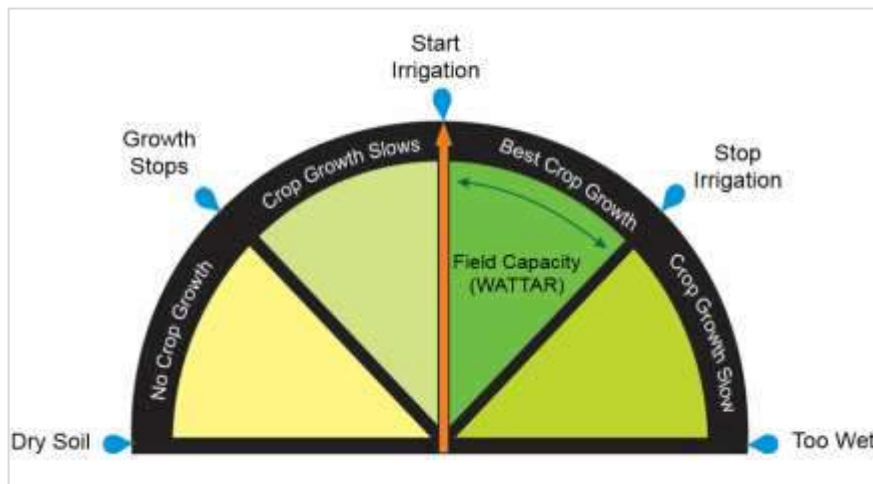


Figure-4: Irrigation Scheduling Conceptual Dial

v) Irrigation Scheduling Impact

There are a number of research studies that have been carried out for calculating irrigation scheduling impacts in terms of water saving and yield increase as well as other benefits. A summary of these impacts is given below.

- ◆ Saves water upto 35 percent
- ◆ Increases yield by 8 percent
- ◆ Reduces energy use upto 35 percent
- ◆ Improves produce quality
- ◆ Curtails nutrients cost

The quantification of irrigation scheduling impacts has been carried out for major cropping systems considering the average values of cost of production, which on an average comes to about Rs. 14,000 /acre per annum (**Table-2**).

Table-2: Irrigation Scheduling Benefits

Sr. No.	Cropping system	Benefits (Rs./Acre)
1	Wheat- Rice	11,000
2	Wheat-Cotton	13,000
3	Sugarcane	14,000
4	Maize-Rice-Potato	18,000
	Average	14,000

II) PROJECT COMPONENTS

Emerging climate change and food security for ever growing population demands productive farming systems resilient to risks, shocks and long-term climate variability. This necessitates a paradigm shift in a way that major crop production inputs e.g. land and water are managed to ensure their efficient, smart and sustainable use. Though there has been a rapid uptake of the term ‘climate smart agriculture (CSA)’ by the international community, national entities and local institutions but there is no blueprint available for CSA as its precise nature varies spatially influenced by numerous factors such as climatology, topography, crops grown, available technologies, knowledge and skills of individual farmers etc. Increasing agricultural productivity and incomes in a sustainable way alongwith adapting and building resilience to climate change are, however, the key elements of such agriculture.

The proposed project would contribute to enhance water use efficiency through climate smart interventions in LBDC command. The climate smart interventions would be evaluated at WMRF and demonstrated at farmers' fields in LBDC command for enhancing the water use efficiency as well as indigenize/ standardize the efficacy of soil moisture gadgets under changing climatic conditions. The combined effects of these interventions would contribute significantly in enhancing crop productivity, increasing farm income, improving livelihood of people, enabling farmers to adjust the agricultural practices with varying environments, and alleviating poverty in the rural areas in a sustainable manner.

The major activities to be carried out under the proposed project would include, interalia, the followings.

- i) Calibration of efficacy of soil moisture monitoring gadgets and other climate smart OFWM interventions at Water Management Research Farm, Renala Khurd for their promotion/ upscaling
- ii) Awareness creation about benefits of soil moisture monitoring/ irrigation scheduling and social mobilization of farmers for establishment of Technology Transfer Centers (TTCs) in Lower Bari Doab Canal (LBDC) command for the demonstration of climate smart OFWM interventions.
- iii) Establishment of 18 Technology Transfer Centers (TTCs) in Lower Bari Doab Canal (LBDC) command for the demonstration to enhance water use efficiency through;
 - a) Farm layout planning/ designing, precision / LASER land leveling and water budgeting & accounting.
 - b) Provision of rapid soil testing kits to the farmers at TTCs for application of balanced fertilizer.
 - c) Fixation of pipe nakkas according to soil type and water flow for channelized stream flows.
 - d) Installation of flow measurement devices for open channels and tubewells for measuring the discharge of water for water accounting.
 - e) Installation of soil moisture monitoring gadgets.
 - f) Application of Alternate Wetting & Drying (AWD) and Direct Seeding Rice (DSR) water saving techniques in rice fields to increase the water productivity.
- iv) Training of farmers for adoption of climate smart interventions and capacity building of technical staff for providing technical support to the farmers for successful adoption of interventions

The proposed technologies will result in increased irrigation application and water use efficiencies leading to enhanced crop and water productivity and ultimately resulting in better farm

returns. Brief description of project components is offered hereunder and conceptual layout is shown in **Figure-4**.

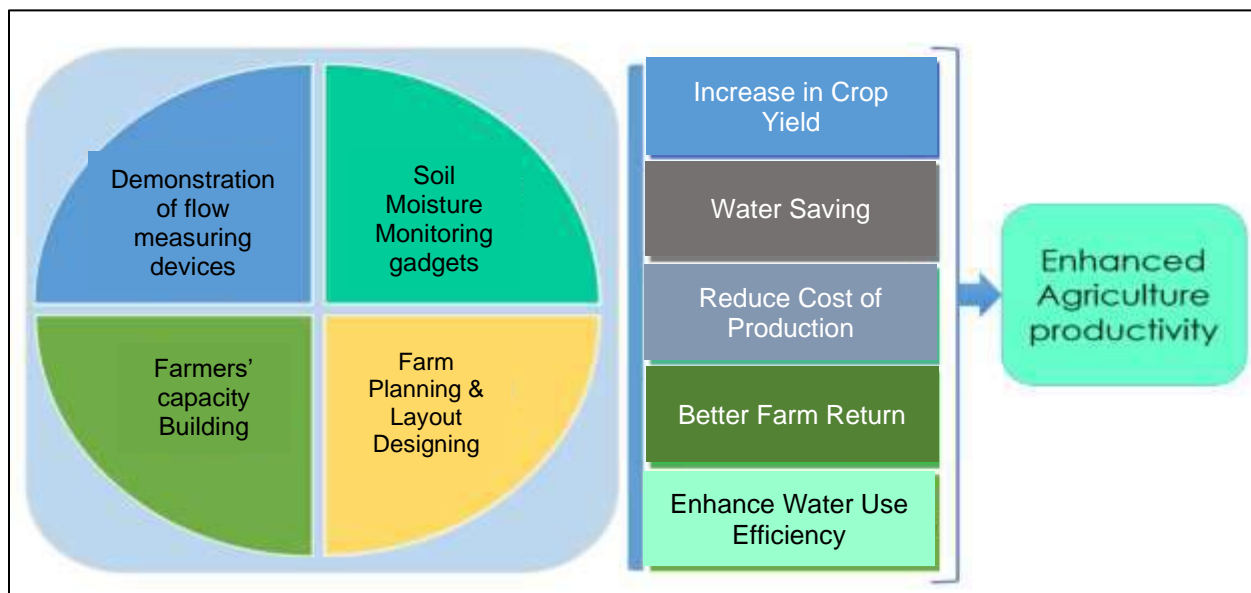


Figure-4: Project Conceptual Layout

i) Research and Development Activities for Evaluation of Climate Smart Interventions

Soil moisture is a critical and highly variable component of root zone environment. Plant growth and crop yield largely depend on timely application of water in required quantity. Its less as well as excess application affects the growth and development of plant directly and, consequently, yield and produce quality. Accordingly, irrigation scheduling (exact water application) becomes increasingly important, particularly for high value crops.

a. Calibration of Moisture Meters

It is planned that research & development activities of climate smart interventions will be carried out at Water Management Research Farm (WMRF) for recommendation to the farmers;

- ❖ To calibrate soil moisture monitoring devices for their effectiveness including digital soil moisture meters, ICT/ GSM based soil moisture meters, “FullStop” (wetting front detector), evapotranspiration gauges etc. to develop precise irrigation practices/ scheduling
- ❖ To evaluate/ indigenize these tools and techniques for estimating crop water requirements of major crops and developing correlations with water availability for better planning about what to grow and how

The research area of Water Management Research Farm (WMRF) will be used to calibrate, evaluate, indigenize, and demonstrate climate smart technologies and techniques. The same will

help in obtaining the accurate information on their impacts and economic returns per unit volume of water i.e. water productivity. It is also planned that water budgeting and accounting will be carried out by installing flow measuring devices called “Smart Flume” on watercourse to measure the discharge of water. A weather station will be installed at WMRF for better irrigation scheduling on the basis of evapotranspiration data. These soil moisture monitoring gadgets may be calibrated against Gravimetric method or Remote Sensing (RS)/ Global Information System (GIS) model. Detail of calibration methods are described below.

i) Gravimetric Method

Gravimetric method is the only direct mean to assess soil moisture and it is, therefore, essential for calibrating instruments used in the indirect methods. This method involves taking a soil sample from the field and determining the weight of water contained in a soil sample, relative to the weight of dry soil. The moisture contained in the soil is measured in terms of percentage. The use of this technique ensures accurate measurements at low cost and is not dependent on salinity and soil type, and relatively very easy to calculate. The main advantage of this method is that it requires relatively simple, inexpensive equipment, and one person for completing the process. On the other hand, the main disadvantage of this method is that it requires a great deal of physical effort and time to collect dry samples and calculate moisture percentage. It takes minimum 24 hours to arrive at the soil moisture measurement.

ii) Remote Sensing (RS) and Global Information System (GIS) Methods

Remote Sensing may be defined as the science and art of obtaining information about an object without being in contact with it. Remote Sensing as the noncontact recording of information from the ultraviolet, visible, infrared and microwave regions of the electromagnetic spectrum by use of instruments such as cameras, scanners, laser, liner arrays and analysis of acquired information by means of visual and digital image processing. Currently, the operational use of dense time series of remote sensing (RS)-based multispectral imagery at high spatial resolution is able to monitor the crop biophysical parameters related with crop ET and crop water use across the growing season, with suitable temporal and spatial resolutions. One most prominent and direct application of these approaches in agriculture is irrigation management. Remote sensing application in irrigation management includes crop classification, irrigated area mapping, performance evaluation of irrigation systems, and irrigation advisory services.

Geographic Information System (GIS) is defined as “an information system that is used to input, store, retrieve, manipulate, analyze and output geographically referenced data or geospatial data, to support decision making for planning and of land use, natural resources, environment, transportation, urban facilities and other administrative records". Geographic information system is as an influential tool for gathering, repossessing at will, converting and displaying spatial data for different purposes from the real world. It is also defined as a computer-based system that is used to store and manipulate geographic information, generally, GIS can also be defined as a computer-based information system which may capture, store, manipulate, analyze and display spatially references and associated tabular attributes of data for solving complex research, planning and management problems. Geographic information system has been effectively used in the management of land and water resources.

It is planned that the combined use of remote sensing and GIS may be tested for estimation of spatial and temporal variation of potential evapotranspiration and crop water requirement initially at WMRF which may be compared with crop water requirement assessed with soil moisture meters and gravimetric method for calibration of the gadgets.

ii) Awareness Creation and Social Mobilization

Effective involvement and participation of the beneficiaries acts as a catalyst for the successful implementation of any development undertaking, which has proved very successful in promotion of modern agricultural development technologies. Massive awareness campaign will be launched to create awareness among farming community about the technologies envisaged under the project i.e. soil moisture measurement techniques, their impacts for crop & water productivity enhancement, mobilization of farmers resources for cost sharing, potential returns of the investment etc. It is planned that promotional materials would also be distributed among the farming community for the purpose and posters would be displaced on places frequently visited by farmers like agricultural offices etc. Accordingly, a comprehensive awareness and publicity campaign will be launched through the staff of On Farm Water Management (OFWM) and Agricultural Extension Wings of Punjab Agriculture Department. These activities would be carried out by the Water Management Training Institute (WMTI)/ OFWM field staff with the funds allocated under this project.

iii) Establishment of Technology Transfer Centers (TTC)

It is planned that 18 Technology Transfer Centers (TTC) will be established under the proposed project in nine tehsil of LBDC command to demonstrate the advanced irrigation agronomy practices. Efforts need to be made to convert the complete layout of the farms from traditional khal kiari system into level border and level furrow irrigation system. The concept of providing measured quantities of requisite irrigation water to every crop through installation of soil moisture monitoring gadgets and pipe nakkas, digital flow meter at tubewell, irrigation scheduling and water budgeting alongwith optimum level of all the agronomic inputs needs to be introduced.

It is proposed to test and demonstrate a complete package of climate smart interventions at TTCs including following equipment/ materials.

- i) Rapid soil testing kit
- ii) Pipe nakkas of 9 inch diameter and check nakkas of 20 inch for earthen watercourse.
- iii) Cut throat flumes
- iv) Digital flow meter
- v) ICT/GSM based soil moisture gadgets
- vi) Digital moisture meter

Technical assistant would be provided to the farmers for re-shaping the field layout and irrigation system at the Technology Transfer Centers. Moreover, water scheduling equipment including water measuring devices and soil moisture monitoring gadgets would be provided at these TTCs for demonstration by the government. Area of each TTC would be 15- 25 acres. It is envisaged to develop planned Technology Transfer Centers during the gestation period of the proposed project. The cost of one TTC is attached as (**Annexure-B**).

Selection Criteria

Following selection criteria would be adopted for selection of farmers/ farms for establishment of TTCs.

- i) The farm is located in the LBDC command.
- ii) The farmer is willing to establish TTC at his farm to demonstrate the proposed irrigation and agronomic practices.
- iii) Farmer agrees to redesign his farm as per engineering method.
- iv) Farmer have already or willing to construct on farm water storage pond from his own resources or from other OFWM projects i.e., PIPIP, NPIW-II etc.
- v) Farmer agrees to level the land with LASER land leveler.

- vi) The farm owner is fully cooperative and ready to facilitate for carrying out activities planned at the TTC.
- vii) Farmer has no conflict with any other farmer.
- viii) Farm is located on improved watercourse and easily approachable preferably located near metaled road.
- ix) Farm size is 15-25 acres and self-cultivated.
- x) Farmer is willing to sign an agreement/ undertaking and fulfill the responsibilities/ obligations.

a) Farm Layout Planning/ Designing and Precision/ LASER Land Leveling

The experience during implementation of various OFWM projects has revealed that proper farm planning and layout designing are foremost for bringing new lands under irrigated agriculture or improving irrigation water management of already developed lands. Detailed survey of the farm area is conducted for layout designing by considering various factors e.g. topography, soil types, available irrigation supplies, cropping patterns to be followed etc. Afterwards, rough and precision land leveling (PLL) of various plots is undertaken by grading and smoothing the land to a uniform plane surface at grade or no grade (zero slope). Initially, traditional method of leveling the land is used that involves earth movement with bucket type soil scrapers and tractor mounted rear blades. This is followed by bringing the plots on more uniform level with variations of less than ± 20 mm (2 cm) with LASER land leveler. Technical assistant will be provided by the OFWM staff to carry out farm layout planning & designing to the farmers and precision/ LASER land leveling of selected farm area will be carried by the farmer without any financial assistant of the government.

The impact assessment carried out by the Monitoring and Evaluation Consultants under the Punjab Irrigated-Agriculture Productivity Improvement Project (PIPIP) for LASER land levelling has shown following results.

- ◆ *Saving in irrigation time: 20-30 percent*
- ◆ *Improvement in crop yield from 9-11 percent*
- ◆ *Enhancement in fertilizer use efficiency: 11 percent*
- ◆ *Saving in farm labour: 18 percent*
- ◆ *Facilitation in better crop stand, uniform moisture availability and enhanced fertilizer use efficiency*
- ◆ *ERR 29.6%*
- ◆ *B/C Ratio 1:1.5*



Figure-5: Glimpses of LASER Land levelling

b) Provision of Rapid Soil Testing Kits

Improvement of agricultural water use efficiency is the major concern under drought/ water scarcity scenario, being one of the most important factors limiting grain production. Effective management of water for crop production in water-scarce areas requires efficient approaches. Accordingly, a number of approaches are being used to enhance water use efficiency and to minimize the detrimental effect of water stress in crop plants. Increasing crop water use efficiency and drought tolerance by genetic improvement and physiological regulation may be a mean to achieve efficient and effective use of water as limited water supply inhibits the photosynthesis of plants, causes changes in chlorophyll contents and components and damage to photosynthetic apparatus. Similarly, proper plant nutrition is a good strategy to enhance water use efficiency and productivity of crop plants. Plant nutrients play a very important role in enhancing water use efficiency under limited water supply. It is planned that rapid soil testing kits will be provided to the farmers for assessing the nutrient status of soil and balanced fertilizer application to enhance the water use efficiency of crop plants.

c) Fixation of Pipe Nakkas

After farm layout planning and LASER land leveling of fields, precast "nakkas" will be installed in the earthen watercourses as check to control water flow while pipe nakkas will be installed to divert water from the watercourse to the field to reduce channel deterioration, seepage loss and drudgery in irrigation operation as well as to improve water control for enhancing water use efficiency. These pipe and check nakkas will be provided at TTCs by the government for demonstration.

d) Installation of Flow Measuring Devices

Flow measuring devices would be installed at Technology Transfer Centers as well as at Water Management Research Farm (WMRF) for measuring the flow in open channel and pipe flow of the tubewell. It is planned that cut throat flume/ smart flumes would be installed for measuring the flow in open channel/ watercourse while digital flow measuring devices would be used to measure the flow of tubewell to apply measured quantity of irrigation water to the fields. These flow measuring devices will be provided to the farmers by the government for demonstration.

e) Installation of Soil Moisture Monitoring Gadgets

Over the years, several devices and gadgets have emerged up for accurate measurement of soil moisture leading towards efficient use of irrigation water to conserve water, enhance crop yields, and improve quality of produce. Unlike in Pakistan, the orthodox guess work of plant appearance and soil feel method for irrigation is needed to be replaced with scientific measurement and monitoring of soil moisture for accurate determination of “WHEN and HOW MUCH water to apply to a field”.

The use of irrigation scheduling devices can remove the guess work from irrigation management by providing an accurate assessment of soil moisture status. There are numerous instruments used for moisture measurement ranging from highly sophisticated such as Weather Stations, GSM based soil moisture gadgets, Time Domain Reflectometry, Time Delay Transmission to relatively simple devices like Tensiometer, Gypsum Blocks, Neutron Probes, Soil Moisture Meters/ Sensors, FullStop etc.

It is planned to evaluate irrigation scheduling with soil moisture devices/ sensors on pilot basis in LBDC command as well at WMRF. The plan includes their demonstration for creating awareness among the farming community about the impact of these soil moisture measurement devices/ sensors to proceed for introducing a model, whereby progressive farmers will be selected who would be willing to install these devices at their farms for upscaled demonstration and capacity building of these innovators for providing services to other fellows farmers as shown in **Figure-6**.



Figure-6: Implementation Concept

Three types of soil moisture measurement gadgets would be pilot tested in LBDC command and at WMRF i.e. ICT based soil moisture monitoring gadgets including GSM based/ digital Soil Moisture Sensor and digital Soil Moisture Meter (Locally made by LUMS and NUST). GSM based/ digital Soil Moisture Sensor (**Figure-7**) provide online data of soil moisture contents in the soil at different rooting depths. These gadgets will be installed permanently for entire crop season at the representative places in the field after soil survey. These gadgets send soil moisture contents condition to the computer based software which reflect that either the soil moisture is at wilting point or saturation or optimum condition. These gadgets also convey the daily water use by the crop. Soil moisture monitoring gadgets would be provided on all TTCs by the government for demonstration purpose.



Figure-7: Different Soil Moisture gadgets

The quantity and placement of moisture meters depend on rooting depth of the crop as only one moisture meter will be required for shallow rooted crops like vegetables and at least two for deep rooted crops/ orchards such as wheat, citrus etc. as shown in **Figure-8 & 9**.

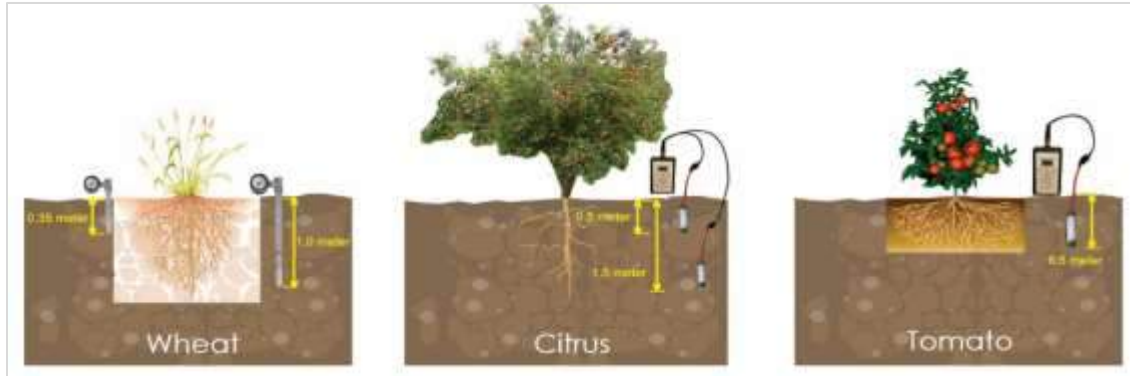


Figure-8: Placement of Moisture Meters for Different Crops



Figure-9: ICT based Soil Moisture Monitoring System

f) Application of Alternate Wetting & Drying (AWD) and Direct Seeding Rice (DSR)

Alternate Wetting and Drying (AWD) is a water-saving technology that can be promoted among the farmers to reduce their irrigation water consumption in rice fields without decreasing its yield. In AWD technique, irrigation water is applied a few days after disappearance of the ponded water. Hence, the field gets alternately flooded and dried. The number of days of non-flooded soil between irrigations can vary from 1 to more than 10 days depending on a number of factors such as soil type, weather, crop growth stage etc.

A practical way to implement AWD safely is by using a ‘field water tube’ (‘pani pipe’) to monitor the water depth in the field. On irrigation, the water depth will rise and then gradually decrease



Figure-10: AWD pipe tube

When the water level has dropped to about 15 cm below the surface of the soil, irrigation will be applied to re-flood the field to a depth of about 5 cm. From one week before to a week after flowering, the field will be kept flooded, topping upto a depth of 5 cm as needed. After flowering, during grain filling and ripening, the water level will be allowed to drop again to 15 cm below the soil surface before re-irrigation.

g) Implementation Arrangements

It is indicated that well understood and accepted approach, similar to introduced under previously completed scheme and replicated under the PIPIP for provision of LASER units to the farmers/ service providers, will be adopted for provision of equipment package to the farmers at the TTCs under the proposed project. This involves provision of equipment package to the farmers and their capacity building to carry out the envisaged task. The implementation modalities to be followed for the proposed project are described hereunder.

- i) The quota of TTCs for each district of LBDC command area will be approved by the Project Steering Committee (PSC) and the same will be conveyed to the districts by the DGA (WM).
- ii) Massive awareness and publicity campaign will be launched through print/ electronic media at districts and tehsil level in LBDC command area.
- iii) Agriculture Department will advertise for invitation of applications from the farmers interested to participate in the proposed project activities.
- iv) The DDAs (OFWM) concerned will be informed about the time bound action plan for provision of equipment package to the farmers.

- v) The applications will be received/ collected in the office of Deputy Director Agriculture (OFWM) that will be scrutinized vis-à-vis approved criteria by the designated committee headed by concerned DDA (OFWM) with concerned ADAs (OFWM) and representative of DA (OFWM) concerned as members.
- vi) The ineligible applicants will be informed about rejection of their applications who may submit appeal to the Director Agriculture (OFWM) concerned against the ineligibility within specified period and concerned authority will decide the eligibility/ ineligibility after hearing appeals within stipulated timeframe.
- vii) The DDA (OFWM) will convey the complete list of eligible applicants to the DGA (WM)/ Director, WMTI for confirmation of quota as the activity will be demand driven.
- viii) After completion of pre-requisites by the selected farmers including change of farm layout and LASER land leveling as per directions of OFWM staff, the allotment of equipment package to the eligible applicants will be made under intimation to DGA (WM) for supply of equipment to the beneficiary farmers.
- ix) The Director, WMTI will procure the equipment/ materials for the TTCs as per intimation of concerned DDAs (OFWM).
- x) The supplier firm will ensure delivery of procured equipment package to the Director, WMTI/ concerned farmer within stipulated period which will be inspected by designed Inspection Committee and defaulting firms will be dealt as per government Rules.
- xi) A committee comprising of concerned DDA (OFWM), Assistant Agriculture Engineer o/o Director Agriculture (OFWM) concerned, representative of Director, WMTI and recipient farmer will inspect the equipment jointly and record the make, model, serial number and other features of all components of equipment supplied to the beneficiary farmer.
- xii) The technical inspection report, duly signed by the inspection team, will be sent by DDA (OFWM) to DGA (WM)/ Director, WMTI for releasing payment.
- xiii) DGA (WM) will make payment to the firm through cheque.

iv) Training and Capacity Building

The well informed and knowledgeable farmers contribute significantly in enhancing productivity of all factors of production i.e. water, nutrients, energy, labor, capital etc. It is, accordingly, planned to impart training to the farmers for adoption of climate smart interventions and capacity building of professional/ technical staff for providing technical support to the farmers for successful adoption of interventions. The farmers will be made aware of efficient irrigation

methods, farm layout planning and improvement, water saving agronomic practices, soil moisture measuring/ monitoring tools and techniques etc. Technical information will be provided to the farmers for enhancing conveyance, application, and water use efficiencies at the farm level for improving crop as well as water productivity. It is, therefore, planned that two technical courses on soil moisture measurement techniques with different gadgets for enhancing water use efficiency will be conducted for technical staff including Deputy Directors Agriculture (OFWM), Assistant Directors Agriculture (OFWM) and Water Management Officers (WMO) at WMTI/ WMRF while training courses and field days will be conducted to build the capacity of the farmers.

v) Anticipated Impact of the Project

The quantifiable anticipated impact of the proposed project climate smart interventions to enhance water use efficiency is given below.

- i) Saves water upto 30 percent
- ii) Increases yield by 8 percent
- iii) Reduces energy use upto 35 percent
- iv) Reduction in surface water consumption 69 percent
- v) Reduction in groundwater mining 28 percent
- vi) Improves produce quality
- vii) Curtails nutrient costs

III) Project Implementation, Supervision, Monitoring and Coordination Mechanism

The proposed project will be implemented with the existing infrastructure and human resource of Water Management wing. Director General Agriculture (Water Management), Punjab would act as Project Director who will supervise, manage, and monitor the proposed project from provincial headquarters through Director, Water Management Training Institute (WMTI). Director, WMTI and concerned Directors Agriculture (OFWM) will carry out internal monitoring and provide necessary technical support to the Deputy Director Agriculture (OFWM) and Deputy Director Farms, WMRF for execution of the proposed project activities. The Deputy Director Agriculture (OFWM) and Assistant Director Agriculture (OFWM) would be responsible for supervision, coordination and internal monitoring at district & tehsil levels while Deputy Director Farms will supervise research & development activities at Water Management Research Farm (WMRF). The Project Steering Committee (PSC) for the proposed project will oversee the project

implementation and will arrange necessary financial resources timely for execution of project activities.

IV) Project Management

The project management arrangements similar to those approved under the PIPIP will be adopted for successful execution of envisaged activities under the proposed project. The coordination, administration, and monitoring will, however, be achieved through following committees under the PIPIP as given below.

- a) Project Steering Committee (PSC)
- b) Project Implementation Committee (PIC)
- c) District Implementation Committee (DIC)

a) Project Steering Committee (PSC)

The Project Steering Committee (PSC) will be constituted comprising of following officers.

- | | |
|---|-------------------|
| ▪ Secretary Agriculture | Chairman |
| ▪ Representative of Finance Department | Member |
| ▪ Representative of Agri. Section of P&DD | Member |
| ▪ DGA (Ext. & AR) Punjab | Member |
| ▪ Director General Agriculture (Water Management) Punjab/
Project Director | Member/ Secretary |

The PSC would meet annually/ biannually to review the physical and financial progress as well as to suggest means to overcome the constraints/ bottlenecks faced in the field for execution of project activities. The major functions of PSC would be as follows.

- i. Approve annual work plan and streamline flow of funds.
- ii. Monitor physical and financial progress.
- iii. Approve/ amend/ change the criteria for selection of beneficiaries, if required.
- iv. Identify the constraints in achieving targets and devise strategies for their redressal.
- v. Review provincial/district monitoring reports and take appropriate actions.
- vi. Devise mechanism for transparent monitoring of project activities.
- vii. Make necessary modifications/ improvements in project implementation modalities including cost sharing, execution arrangements, flow of funds, inter-component physical & financial adjustments etc. for smooth execution of project activities.

b) Project Implementation Committee (PIC)

The Project Implementation Committee would be chaired by the Director General Agriculture (Water Management) with Director, WMTI and concerned Directors Agriculture (OFWM) and Deputy Directors Agriculture (OFWM) as its members. Director, WMTI would act as Secretary of the committee. The PIC would meet every month or as and when required to review the physical

and financial progress as well as to suggest means/ measures to overcome the constraints faced during execution of project activities. The major functions of PIC would, interalia, be as follows.

- i) Prepare annual work plan
- ii) Review physical and financial progress
- iii) Coordinate and supervise the project activities
- iv) Ensure implementation of decisions of Project Steering Committee
- v) Formulate mechanism for transparent external monitoring of project activities
- vi) Review the monitoring reports and rectification of the shortfalls
- vii) Devise/ recommend mechanism for change in project implementation modalities if needed.

c) District Implementation Committee (DIC)

A District Implementation Committee (DIC) comprising the following would be constituted to implement the program at district level as per plan.

- | | |
|--|------------------|
| ▪ Director Agriculture (OFWM) concerned | Chairman |
| ▪ Deputy Director Agriculture (Ext. AR) | Member |
| ▪ Assistant Directors Agriculture (OFWM) | Member |
| ▪ Deputy Director Agriculture (OFWM) concerned | Member/Secretary |

The DIC is proposed to meet on monthly basis. The major functions of DIC are as follows.

- i. Review physical and financial progress.
- ii. Ensure effective implementation of project.
- iii. Arrange transparent internal monitoring.
- iv. Make recommendation to PIC for improving pace of implementation.
- v. Resolve field dispute/ issues locally to ensure smooth implementation of project activities.

V) MATERIALS, SUPPLIES AND EQUIPMENT REQUIREMENT

It is envisaged to utilize existing facilities and infrastructure for implementation of the scheme. However, necessary equipment will be procured under the proposed project for provision to the farmers at TTCs and carrying out research activities at the WMRF.

VI) CAPITAL COST ESTIMATES

a) Indicate date of estimation of project cost estimates

The cost estimates of the project have been prepared during May 2019.

b) Basis of determining the capital cost (market survey, schedule rates, estimation on the basis of previous work done etc.)

Capital cost of the project is based on the prevailing average market rates of various items available in the open market during May 2019.

c) Year-wise/ Component-wise Phasing of Physical Activities

The year-wise/component-wise phasing of physical targets/activities of the project is appended (**Annexure-C**).

d) Year-wise/Component-wise Financial Requirements

The year-wise/component-wise phasing of financial requirements are provided at **Annexure-D** and project management & non-recurring cost estimates for procurement of additional equipment for research activities at WMRF is provided as **Annexure-E & Annexure-F**.

VII) ANNUAL OPERATING AND MAINTENANCE COST AFTER COMPLETION OF PROJECT

It is envisaged that the farmers would be responsible for the operation and maintenance of the soil moisture monitoring gadgets and other equipment provided under the project at TTCs. As such, there would be no recurring expenditure for activities to be carried out after completion of the proposed project.

VIII) DEMAND AND SUPPLY ANALYSIS

It is well established fact that irrigation water is the most critical factor in crop production and its regular supply as per crop requirement can ensure enhanced productivities of other non-water inputs for higher crop yields. The Punjab is facing acute shortage of irrigation water particularly in its southern parts for last few years on one hand and there are food security threats for exponentially growing population on the other. Accordingly, it is needed to improve efficiency of agricultural inputs, particularly the irrigation water through efficient utilization of available resources for enhancing crop yields and lowering the cost of production. The gravity of the situation gains further significance under WTO regime of open markets that would allow free international trade, which will make survival of inefficient agriculture highly difficult. Irrigation scheduling and improvement of water use efficiency at farm/ field level offer a great opportunity in meeting these challenges through minimizing water application losses and improving water productivity for efficient utilization of other inputs under irrigated agriculture.

IX) FINANCIAL PLAN (FINANCING SOURCES)

a) Equity

NA

b) Debt

NA

c) Grants alongwith Sources

(Rs. in million)

Sources		Amount for Capital Cost	Amount for Recurring Cost
(a)	Foreign Assistance		
	i- Loan	-	-
	ii- Grant	-	-
	iii- Technical Assistance	-	-
(b)	Federal Government	-	-
	i- Grant	-	-
	ii- Loan	-	-
	iii- Investment	-	-
	iv- Direct Expenditure	-	-
(c)	Provincial Government	50.88	-
	i- Grant	-	-
	ii- Loan	-	-
	iii- Investment	-	-
	iv- Direct Expenditure	-	-
(d)	Sponsoring Agency's own fund	-	-
(e)	Private Investment (SSCs)	-	-
(f)	Local Body Resources, if any	-	-
(g)	Non-Government borrowing	-	-
(h)	Beneficiaries Contribution	-	-
(i)	Other sources (e.g. Recoveries)	-	-

d) Weighted Cost of Capital

NA

e) Flow of Funds

An Assignment Account/ Special Drawing Account (SDA) will be opened in the name of DGA(WM), after authorization of the Finance Department and fulfilling prescribed codal formalities, in National Bank of Pakistan, Main Branch, Lahore. The DGA (WM) would be allowed to maintain and operate the said account for channeling the funds released by the provincial government. Accordingly, the funds from provincial government will be transferred directly into specified Assignment Account for disbursement by DGA (WM). The allocations will be approved by the Project Steering Committee (PSC) for various project activities. The PSC would be authorized to make necessary adjustments in financial and implementation modalities, if needed, while keeping the overall scope and cost of the project intact.

X) PROJECT BENEFIT AND ANALYSIS

a) Financial Benefits

The project will have both tangible and intangible benefits but there will be no direct income from the scheme to the government. The implementation of the project activities would result in

assessment of interventions for promoting/ upscaling among the farming community for substantial increase in farm incomes. Application of soil moisture gadgets results in water saving, yield increase, cultivated area enhancement and labour saving. As such, irrigation scheduling would result in benefits to the tune of about Rs. 14,000 /acre per annum owing to water saving, yield increase and better input utilization. Detail of financial benefits/ analysis is attached as **Annexure-G**.

b) Economic Benefits

The interventions proposed under the project are reported to be technically viable and economically feasible with EIRR of 40.0 percent (**Annexure-H**). However, their efficacy will be confirmed under the proposed project.

c) Social Benefits

The proposed project interventions will be evaluated in LBDC command area as well as WMRF. Afterwards, these interventions will be promoted at farmers' field which would have substantial impact on social lives of the rural people. The increased crop and water productivities through irrigation scheduling by using soil moisture monitoring devices would enhance income level of the farmers using the technology. Improved water productivity would help in growing more crops with less water and less competition to get more water eliminating conflicts among the farmers which often results in loss of lives and litigations with heavy financial losses.

d) Environmental Benefits

The project builds on existing infrastructure to assess efficacy of intervention for bringing operational improvements in water management system at farm level. It would, therefore, not cause any adverse environmental affects normally associated with new developments, e.g. resettlement, depletion of land and water resources, loss of wildlife habitat etc. The project interventions will indirectly result in reduction of unwanted dikes and ditches leading to decreasing the cultivable wasteland and increase in area available for crop production. Moreover, reduction in unnecessary dikes/ ditches would result in less weed infestation and destruction of insects' shelter leading to less use of herbicides and pesticides for crop management.

e) Impact of Delays on Project Cost/Viability

The escalating surface water shortages, depleting groundwater aquifers, and mining of subsurface water resources due to over exploitation necessitate immediate adoption of water

conservation technologies for efficient utilization of limited water resources. Any delay in evaluation of proposed interventions and their demonstration among farming community for their adoption to enhance water use efficiency at farm level may result in irreversible losses besides increase in project costs due to price escalation of materials.

XI) IMPLEMENTATION SCHEDULE (INCLUDING STARTING AND COMPLETION DATES)

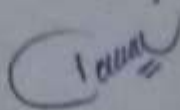
Indicate starting and completion date of the project:-

Starting Date	Completion Date
July 2019	June 2022

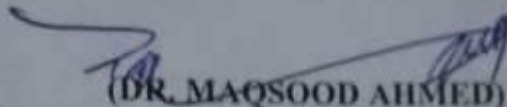
XII) CERTIFICATE

Certified that the project proposal has been prepared in the light of instructions provided by the Planning Commission for the preparation of PC-1 for production sector projects.

Prepared by:

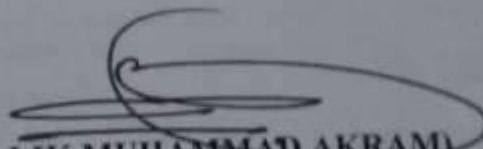


(TAHIR MEHMOOD)
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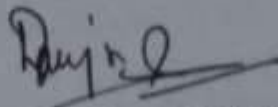
(DR. MAQSOOD AHMED)
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Checked by:



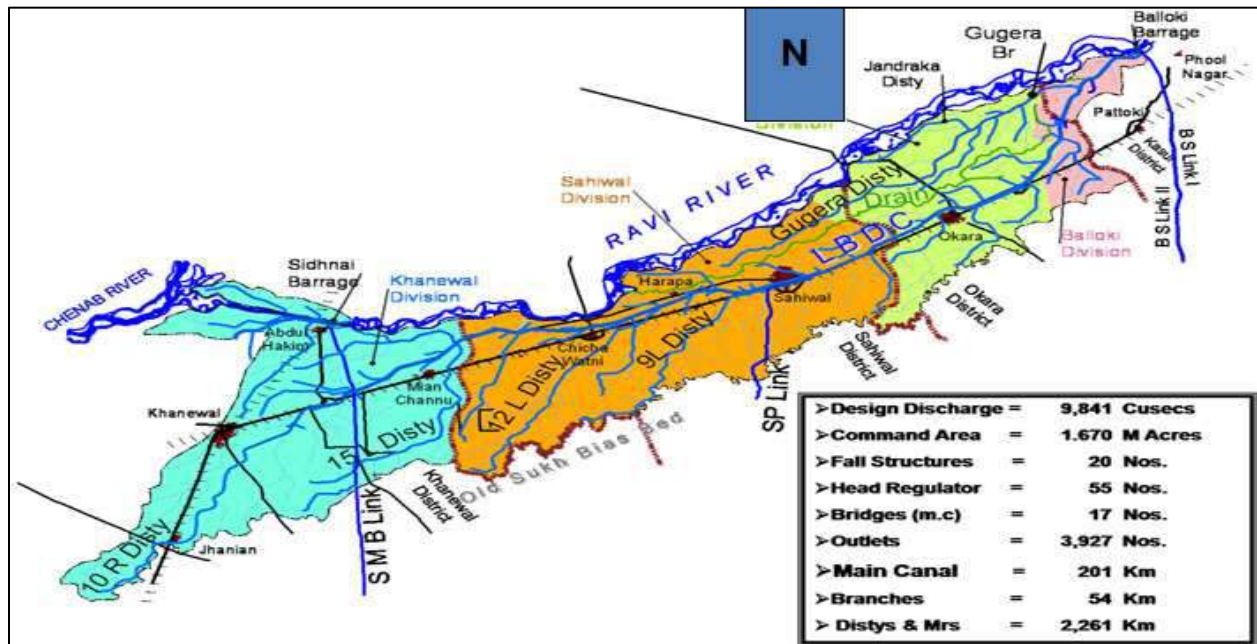
(MALIK MUHAMMAD AKRAM)
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Ph. # 042-99200703

Approved by:

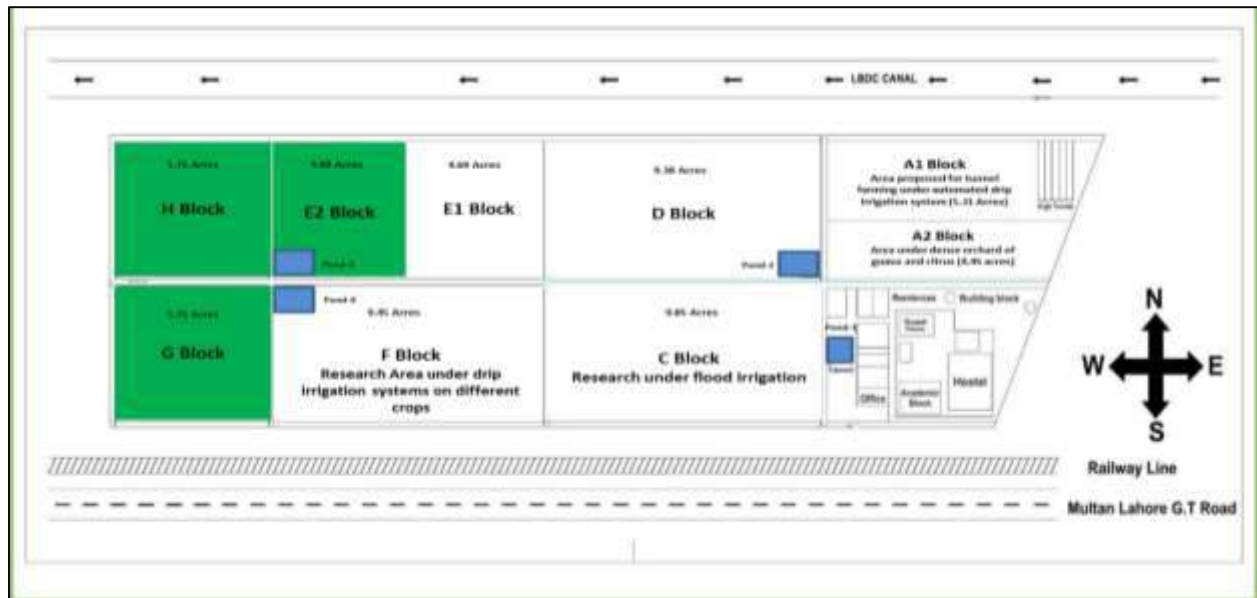


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Pilot Testing of Innovative Technologies to Improve Water Use Efficiency Location Map of Lower Bari Doab Canal (LBDC) Command



Location Map of Water Management Research Farm, Renala Khurd



Pilot Testing of Innovative Technologies to Improve Water Use Efficiency
Cost of Package of one TTC

Sr. No.	TTC Package	Unit Cost	Quantity/ TTC	Total Cost
1	Rapid Soil Testing Kits	0.025	1	0.025
2	Nakkas (9"=45 & 20"=10)			0.000
	-Nakka 9"	0.002	45	0.090
	-Nakka 20"	0.004	10	0.040
3	Digital Flow meter	0.275	1	0.275
4	Cut Throt flume	0.060	3	0.180
5	EnviroScan	0.600	1	0.600
6	Digital Moisture Meter	0.050	2	0.100
Total				1.310

Pilot Testing of Innovative Technologies to Improve Water Use Efficiency

Phasing of Physical Targets

Sr. No.	Particulars	Unit	2019-20	2020-21	2021-22	Total
I. Physical Targets						
A Research & Development Activities						
	a) Research & Development Activities for evaluation of CSI		1	10	9	20
B Awareness Creation & Social Mobilization						
	a) Farmer's Field Day for Awareness Creation	Nos.	1	10	9	20
C Establishemnt of Technology Trasfer Centres (TTCs)						
i) Farm Layout Planning & Designing and LASER land leveling						
	a) LASER Land Leveling with layout palnning & designing	Acres	-	135	135	270
ii) Provision of Soil Testing Kits						
	a) Provision of Rapid Soil Testing Kits to the Farmers	Nos.	-	9	9	18
iii) Installation of Flow Measuring Devices						
	a) Cut Throat Flume	Nos.	-	27	27	54
	b) Digital Flow Meter	Nos.	-	18	18	36
iv) Provision of Nakkas						
	a) 9" Pipe Nakka	Nos.	-	405	405	810
	b) 20" Check Nakka	Nos.	-	90	90	180
v) Installation of Soil Moisture Monitoring Gadgets						
	a) GSM Based Soil Moisture Meter	Nos.	-	9	9	18
	b) Digital Soil Moisture Meter	Nos.	-	18	18	36
D Training & Capacity Building						
	a) Technical Training Courses	Nos.	1	1	1	3
	b) Farmer Training Courses	Nos.	-	1	1	2

Pilot Testing of Innovative Technologies to Improve Water Use Efficiency

Phasing of Financial Implication

Object Code	Sr. No.	Particulars	Unit Cost	2019-20	2020-21	2021-22	Total
PC22036-Development							
A Research & Development Activities							(Rs. Million)
a) Research & Development Activities for evaluation of CSI				Research activity	Data collection	Report Compilation	Report Presentation
B Awareness Creation & Social Mobilization							
A06470		a) Farmer's Field Day for Awareness Creation	0.150	0.150	1.500	1.350	3.000
C Establishment of Technology Transfer Centers (TTCs)							
i) Farm Layout Planning & Designing and LASER land leveling							
a) LASER Land Leveling with layout planning & designing				In Kind	In Kind	In Kind	In Kind
ii) Provision of Soil Testing Kits							
A05120		a) Provision of Rapid Soil Testing Kits to the Farmers	0.025	-	0.225	0.225	0.450
iii) Installation of Flow Measuring Devices							
A05120		a) Cut Throat Flume	0.060	-	1.620	1.620	3.240
A05120		b) Digital Flow Meter	0.275	-	4.950	4.950	9.900
Sub-total				-	6.570	6.570	13.140
iv) Provision of Nakkas							
A05120		a) 9" Pipe Nakka	0.002	-	0.810	0.810	1.620
A05120		b) 20" Check Nakka	0.004	-	0.360	0.360	0.720
Sub-total				-	1.170	1.170	2.340
v) Installation of Soil Moisture Monitoring Gadgets							
A05120		a) GSM Based Soil Moisture Meter	0.600	-	5.400	5.400	10.800
A05120		b) Digital Soil Moisture Meter	0.050	-	0.900	0.900	1.800
Sub-total				-	6.300	6.300	12.600
A06470		D Training & Capacity Building	0.160	0.160	0.160	0.160	0.480
E Project Management Cost							
i) Non-recurring (Research Equipment)				8.890	2.200	-	11.090
ii) Project Supervision and Administration Cost				1.020	3.380	3.380	7.780
Sub-total				9.910	5.580	3.380	18.870
Total PC22036-Development				10.220	21.505	19.155	50.880
Total Project Cost (B+C+D+E)				10.220	21.505	19.155	50.880
Total Government Share				10.220	21.505	19.155	50.880

Pilot Testing of Innovative Technologies to Improve Water Use Efficiency
Supervision & Administration Cost

Sr. No.	Object Code	Post	2019-20	2020-21	2021-22	Total
	A03	Operating Expenses				
	A03805	Travelling Allowance	360,000	1,053,000	1,350,000	2,763,000
	A03807	P.O.L. Charges	360,000	963,000	1,080,000	2,403,000
	A03901	Office Stationery	50,000	135,000	90,000	275,000
	A03907	Advertising & Publicity	-	149,000	-	149,000
	A03970	Others	50,000	450,000	270,000	770,000
		Total Operating Cost	820,000	2,750,000	2,790,000	6,360,000
	A13	Repair & Maintenance				-
	A13001	Transport	200,000	630,000	590,000	1,420,000
		Total R&M Cost	200,000	630,000	590,000	1,420,000
		G-Total	1,020,000	3,380,000	3,380,000	7,780,000

Pilot Testing of Innovative Technologies to Improve Water Use Efficiency

Cost Estimates of Additional/ Supporting Equipment for WMRF

(Rupees)													
Object Code	S.No.	Particulars	Unit	Requirement	Unit Cost (Rs.)	2019-20		2020-21		2021-22		Total	
						Qty.	Cost	Qty.	Cost	Qty.	Cost	Qty.	Cost
A09601	1	Velocity Probe	No.	1	600,000	1	600,000	-	-	-	-	1	600,000
A09601	2	Smart Flume	No.	4	250,000	4	1,000,000	-	-	-	-	4	1,000,000
A09601	3	Double Infiltration Meter	No.	3	450,000	2	900,000	-	-	-	-	2	900,000
A09601	4	Radiation Meter	No.	1	85,000	1	85,000	-	-	-	-	1	85,000
A09601	5	EnvironScan	No.	2	600,000	2	1,200,000	-	-	-	-	2	1,200,000
A09601	6	Digital Tensionmeter	No.	4	80,000	4	320,000	-	-	-	-	4	320,000
A09601	7	Digital Flow Meter	No.	14	275,000	14	3,050,000	-	-	-	-	14	3,050,000
A09601	8	Weather Station	No.	1	1,500,000	1	1,500,000	-	-	-	-	1	1,500,000
A09601	9	Application of AWD technique	No.	10	800	10	8,000	-	-	-	-	10	8,000
A09601	10	Provision of 9" Pipe Nakkas	No.	40	2,000	40	80,000	-	-	-	-	40	80,000
A09601	11	Provision of 20" Check Nakkas	No.	10	4,000	10	40,000	-	-	-	-	10	40,000
A09601	12	Oven for sample drying	No.	1	30,000	1	30,000	-	-	-	-	1	30,000
A09601	13	Weight balance	No.	1	15,000	1	15,000	-	-	-	-	1	15,000
A09601	14	Beakers for analysis	No.	10	5,000	10	50,000	-	-	-	-	10	50,000
A09601	15	Augur for soil sampling	No.	1	12,000	1	12,000	-	-	-	-	1	12,000
A06470	16	Construction of Water Storage Pond (Concret)	No.	1	2,200,000	-	-	1	2,200,000	-	-	1	2,200,000
Total						-	8,890,000	1	2,200,000	-	-	103	11,090,000

**Pilot Testing of Innovative Technologies to Improve Water Use Efficiency
Calculation of Financial Internal Rate of Return (FIRR)**

(Rs. Million)						
Year	Project Economic Costs			Project Benefits	Financial Benefits	Net Benefits
	Investment	O&M	Total			
1	10.22	-	10.22	2.23	2.23	(8)
2	21.51	2.86	24.36	7.25	7.25	(17)
3	19.16	4.58	23.73	12.27	12.27	(11)
4	-	4.58	4.58	21.75	21.75	17
5	-	4.58	4.58	21.75	21.75	17
6	-	4.58	4.58	21.75	21.75	17
7	-	4.58	4.58	21.75	21.75	17
8	-	4.58	4.58	21.75	21.75	17
9	-	4.58	4.58	21.75	21.75	17
10	-	4.58	4.58	21.75	21.75	17
11	-	4.58	4.58	21.75	21.75	17
12	-	4.58	4.58	21.75	21.75	17
13	-	4.58	4.58	21.75	21.75	17
14	-	4.58	4.58	21.75	21.75	17
15	-	4.58	4.58	21.75	21.75	17
NPV of Costs		70.7				
NPV of Benefits		128.6				
B/C ratio		1.8				
FIRR		34.2%				

**Pilot Testing of Innovative Technologies to Improve Water Use Efficiency
Calculation of Economic Internal Rate of Return (EIRR)**

(Rs. Million)						
Year	Project Economic Costs			Project Benefits	Economic Benefits	Net Benefits
	Investment	O&M	Total			
1	9.20	-	9.20	2.23	2.23	(7)
2	19.35	2.57	21.92	7.25	7.25	(15)
3	17.24	4.12	21.36	12.27	12.27	(9)
4	-	4.12	4.12	21.75	21.75	18
5	-	4.12	4.12	21.75	21.75	18
6	-	4.12	4.12	21.75	21.75	18
7	-	4.12	4.12	21.75	21.75	18
8	-	4.12	4.12	21.75	21.75	18
9	-	4.12	4.12	21.75	21.75	18
10	-	4.12	4.12	21.75	21.75	18
11	-	4.12	4.12	21.75	21.75	18
12	-	4.12	4.12	21.75	21.75	18
13	-	4.12	4.12	21.75	21.75	18
14	-	4.12	4.12	21.75	21.75	18
15	-	4.12	4.12	21.75	21.75	18
NPV of Costs			63.6			
NPV of Benefits			128.6			
B/C ratio			2.0			
EIRR			40.0%			

Project Title: Pilot Testing of Innovative Technologies to Improve Water Use Efficiency

Project Cost: Rs.50.88 Million

Gestation Period: 2019-20 to 2021-22 (3 Years)

Annotated reply of P&DD observations are given as under.

Sr. No	P&DD Observations	AD Reply
1	Basis of the quantifiable anticipated impact of the proposed project is not provided in PC-I. Administrative Department may provide the basis.	It is indicated that anticipated impact of the proposed project is based on various research studies carried out by different international organizations for same interventions in various countries. The details have been provided at page-28 in the PC-I.
2	Administrative Department may mention in the PC-I the use and effectiveness of soil moisture monitoring gadgets in the other neighboring countries.	It is pointed that various studies have been conducted in Oklahoma, USA and India regarding use and effectiveness/ performance assessment of different soil moisture sensors/ meters under irrigated field conditions. The results regarding effectiveness of soil moisture monitoring gadgets in these countries have already been mentioned in the PC-I (Page-28).
3	Project is proposed to be implemented on pilot basis and after successful result, it would be replicated in second phase. Administrative Department may justify why awareness campaign is required in pilot testing phase.	Soil moisture monitoring is an innovative technology for improving water use efficiency and farmers are unaware of this intervention. Accordingly, various soil moisture meters will be pilot tested at Water Management Research Farm (WMRF) during 1 st year of the project and farmers will be made aware about various allied interventions like efficient irrigation methods, farm layout improvement & LASER land leveling, water saving agronomic practices, Direct Seeding Rice (DSR), soil moisture measuring/ monitoring tools etc. at WMRF where the results will be more visible/ tangible in control conditions under crop environment. Relevant information will also be shared to the farmers for enhancing conveyance, application, and water use efficiencies at the farm level for improving crop as well as water productivity. It is, therefore, planned

		to conduct awareness campaign and field days for capacity building of the farmers during pilot testing at WMRF and subsequently on the TTCs.
4	Administrative Department has not mentioned whether the calibration of soil moisture monitoring devices would be carried out at AMRI or through private service providers. The same may be provided in PC-I.	It is indicated that the calibration of soil moisture monitoring meters will be carried out at Water Management Research Farm (WMRF) where the soil moisture meters will be installed for the purpose. The supplier firm/ service provider will collaborate with the OFWM staff for calibration/ standardization of equipment in this respect. The details have already been provided in the PC-I under R&D component (Page-17).
5	PC-I does not provide safety mechanism of gadgets to be installed at farmer's field. A stringent mechanism may be provided in the PC-I for the safety of the costly gadgets.	It is indicated that soil moisture meters/ nodes will be buried in the soil and display device will be at home safe. Furthermore, soil moisture meters will be provided to the farmers at technology transfer centers (TTCs) who will be responsible for safe custody and operation & maintenance of soil moisture meters under an agreement for the purpose as mentioned in the PC-I (Page-21). In addition, soil moisture meters will be well protected in the iron cages to safeguard them from tractor operation and vandalism.
6	Nos. of beneficiaries / farmers per technology transfer center may be mentioned in the PC-I.	It is indicated that originally there will be one beneficiary at each technology transfer center (TTC) as mentioned in the PC-I under implementation procedure at page-20. As evident from the nomenclature, TTC will act as demonstration site for other neighboring farmers. The TTC will be at village level and would cover commands of 2-3 watercourses having water users ranging from 150-200. As such, one TTC will act as demonstration center for 150-200 farmers.
7	The source of unit cost of gadgets to be purchased under the project is not given, the same may be indicated in the PC-I.	The estimated unit cost is based upon the prevailing market rates of July 2019 (Page-30 of PC-I). The same rates will be re-examined and rationalized at the time of procurement.

No. SOA (P) 9-9/2006
GOVERNMENT OF THE PUNJAB
AGRICULTURE DEPARTMENT
Dated Lahore the, 13 .09.2019

Subject: MEETING OF DEPARTMENTAL DEVELOPMENT SUB-COMMITTEE (DDSC), AGRICULTURE DEPARTMENT HELD ON 08.08.2019

The DDSC meeting of Agriculture Department was held on 08.08.2019 at 12:00 Noon under the chairmanship of Secretary Agriculture in the committee room of Agriculture Department, Lahore. List of participants attached **(Annex-A)**.

Following four projects were discussed during the meeting:

1. Establishment of Tissue Culture Lab at HRS & Provision of Missing Facilities at RARI, Bahawalpur
2. Development of Hybrids & OPVs in Vegetables Resilient to Climate Change
3. Provision of Fresh Irrigation Water & Other Basic Infrastructure at Jalalpur Pirwala Research Farm of MNSUA, Multan
4. Pilot Testing of Innovative Technologies to improve Water Use Efficiency

The meeting started with the recitation of few verses from Holy Quran. The Chair welcomed the participants and asked Deputy Secretary (Planning) to start the proceedings of the meeting. Project wise discussion held and decisions made during the meeting are as under:

1. ESTABLISHMENT OF TISSUE CULTURE LAB AT HRS & PROVISION OF MISSING FACILITIES AT RARI, BAHAWALPUR.

The Deputy Secretary (Planning) briefed the house about the project components and also pointed out the need of establishment of tissue culture lab for date-palm. The Chair invited the Chief (Agriculture), P&D Board and Deputy Secretary (F&A), Finance Department for their comments.

The Chief (Agri.) informed the house that P&D Board had already conveyed observations on the project. The observations and their annotated reply were discussed and found satisfactory. He further suggested that some additions may be made in the draft PC-I like pictorial evidence of poor sewerage system, additional information about value-chain of date palm, assumption based 3-5 year future plan etc. He further pointed out that demand of the staff should be rationalized and justified and suggested that demand of post of Assistant Research Officer (ARO) should be managed through existing system of Ayub

Agriculture Research Institute (AARI), Faisalabad to ensure sustainability of the project and need of lab attendant may be met from Daily Paid Labour (DPL). He further raised query on the demand of funds under head "Repair and Maintenance" of Building. The DGA (Research), AARI, Faisalabad commented that it is not Repair & Maintenance of building, actually funds are required for establishment of tissue culture lab in existing building of Horticulture Research Station, Bahawalpur which would be upgraded / rehabilitated according to requirement of tissue culture lab.

The Deputy Secretary (F&A) commented that Finance Department discourages the demand of posts under the development projects. She endorsed the viewpoint of Chief (Agri.) that the post of ARO should be managed through existing setup of AARI, Faisalabad.

Decisions:

After detailed deliberations, the project was approved with following conditions:

- i. The demand of post of Assistant Research Officer (ARO) will be managed through existing setup of AARI, Faisalabad.
- ii. The requirement of Lab Attendant will be met from Daily Paid Labour (DPL).
- iii. Observations of P&D Board will be addressed and incorporated in the amended PC-I.
- iv. The feasibility study already conducted and whose salient features shared during DDSC will be made part of the PC-I.
- v. After incorporating the above observations, amended PC-I will be submitted for final clearance of the project.



2. DEVELOPMENT OF HYBRIDS & OPVS IN VEGETABLES RESILIENT TO CLIMATE CHANGE

The Deputy Secretary (Planning) briefed the house regarding project activities and submitted that through this project, two stations of Vegetable Research Institute, Faisalabad are proposed to be established at Sahiwal and Layyah. The rationale of these stations is the development of zone specific varieties of vegetable to mitigate the challenges of climate change.

The Chair invited comments of P&D Board and Finance Department. Chief (Agri.), P&D Board endorsed the overall concept of the project and suggested that a report regarding effects of climate change during last 05 years may be made part of PC-I. Moreover, a future plan of research activities

after completion of project may also be included in PC-I. He also proposed to incorporate baseline data of all targeted crops in the PC-I, along with the rationale/basis of zoning of these crops. He also emphasized to mention references from Punjab Growth strategy 2023. Chair endorsed the viewpoints of Chief (Agri.)P&D Board. Deputy Secretary (F&A) commented that requirement of staff may be rationalized as it creates burden on current side after completion of project. She also endorsed the suggestions of P&D Board. DGA (Research) submitted that as two new stations are being established, therefore, new staff is essentially required to fulfill the staff requirements.

DGA (Res) also pointed out that there is no provision of buildings for the new stations in the PC-I which will create a lot of problems for the working staff. Deputy Secretary (F&A) endorsed the viewpoint of DGA (Res.) and commented that bare minimum requirement of civil works for staff may be added within total indicative cost of the project. After due deliberation, it was agreed that Civil Works may be added within the total indicative cost of the project i.e. Rs.250 million wherein an office hall with work stations shall be constructed for the staff to avoid expenditure on rental building.

Decisions:

After detailed deliberation, the project was approved with following observations:

- i. A report regarding "Effects of climate change during last 05 years" shall be made part of PC-I.
- ii. Future research Plan (3-5 years) shall be made part of PC-I.
- iii. Baseline data of concerned crops along with rationale of zoning of these crops shall be incorporated in PC-I.
- iv. BCR shall be got vetted from P&D and incorporated in PC-I.
- v. Office halls along with work stations shall be added in the PC-I within the indicative total cost of PC-I i.e. Rs. 250 million.
- vi. The proposed vehicles for both stations shall be single cabin vehicles with customization.
- vii. Annual operating expenses after completion of the project shall be rationalized.
- viii. The feasibility study already conducted and whose salient features shared during DDSC will be made part of the PC-I.
- ix. Observations of P&DD will be addressed in the PC-I.
- x. Amended PC-I shall be submitted for Final Clearance of PC-I after addressing the above mentioned observations.



3. PROVISION OF FRESH IRRIGATION WATER & BASIC INFRASTRUCTURE AT JALALPUR PIRWALA RESEARCH FARM OF MNSUA, MULTAN

The Deputy Secretary (Planning) briefed the house about the project components and highlighted the need of fresh irrigation water availability at the said site. The Chair invited Chief (Agri.) P&D Board & Deputy Secretary (F&A) for their comments.

The Chief (Agri.) apprised that P&D Board had already conveyed observations on the project. The observations and their annotated reply were discussed and found satisfactory. The Chief (Agri.) was of the view that the cost of the project may be curtailed to Rs.170 million instead of 189.170 million. The Deputy Secretary (F&A) also endorsed the viewpoint of Chief (Agri.) P&D Board. After discussion, the Chair agreed that the cost of the project would be curtailed to Rs.170 million by reducing scope of work in Civil Works other than the works related to water resource development.

Decision:

After detailed deliberations, the project was approved with following observations:

- i. The cost of the project will be curtailed to Rs.170 million by reducing scope of non-water related civil works.
- ii. Observations of P&DD will be properly addressed in the amended PC-I.
- iii. After incorporating the above observations, the PC-I will be submitted for final clearance of the project.



4. PILOT TESTING OF INNOVATIVE TECHNOLOGIES TO IMPROVE WATER USE EFFICIENCY

The Director General Agriculture (WM) briefed the concept of the project to the participants of the meeting and highlighted the importance of climate smart gadgets for enhancing water use efficiency. The Chair invited the Chief (Agri.) & Deputy Secretary (F&A) for their comments.

The Chief (Agri.) informed the house that P&D Board had already conveyed observations on the project. The observations and their annotated reply were discussed and found satisfactory. The Chief (Agri.) was of the view that water losses could be reduced through these gadgets at farm level. The Deputy Secretary (F&A) also commented that these gadgets would be helpful for water saving and this project will also promote their adoption at farm level after

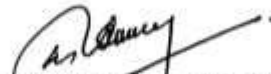
pilot testing their results. The Chair agreed with the comments of Chief (Agri.) and Deputy Secretary (F&A).

Decisions:

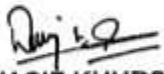
After brief discussion, the project was approved with following observations:

- i. Observations of P&DD will be properly addressed and made part of the PC-I.
- ii. DGA (WM) will submit the amended PC-I in the light of observations of P&D Board for final clearance.

Meeting ended with a vote of thanks to and from the Chair.


(Dr. Muhammad Ashraf)
Chief (Agriculture)
Government of the Punjab
P&D Board

(Ms. Fareeha Tahseen)
Deputy Secretary (F&A.)
Government of the Punjab
Finance Department


(WASIF KHURSHID)
Secretary Agriculture
Government of the Punjab

NO. AND DATE EVEN:

A copy of minutes is forwarded to the following for information and further necessary action:

1. Vice Chancellor, Muhammad Nawaz Sharif University of Agriculture, Multan.
2. The Chief (Agri.) P&D Board, Punjab Lahore.
3. The Deputy Secretary (F&A), Finance Department, Punjab, Lahore.
4. The Director General Agriculture (Research) AARI, Faisalabad.
5. The Director General Agriculture (WM) Punjab, Lahore.
6. The Chief Engineer (South Zone), C&W Department Punjab, Lahore.


SECTION OFFICER (PLANNING)

ANNEX-A

LIST OF PARTICIPANTS OF MEETING OF DEPARTMENTAL DEVELOPMENT SUB-COMMITTEE (DDSC) AGRICULTURE DEPARTMENT HELD ON 08.08.2019 AT 12:00 NOON UNDER THE CHAIRMANSHIP OF SECRETARY AGRICULTURE IN THE COMMITTEE ROOM OF AGRICULTURE DEPARTMENT, LAHORE.

#	Name of Officer	Department / Designation
1.	Mr. Wasif Khurshid	Secretary Agriculture, Agriculture Department
2.	Ms. Fareeha Tahseen	Deputy Secretary (F&A), Finance Department
3.	Dr. Muhammad Ashraf	Chief (Agri.), Planning & Development Board
4.	Dr. Abid Mahmood	Director General Agriculture (Res.), AARI, Faisalabad
5.	Malik Muhammad Akram	Director General Agriculture (WM)
6.	Mr. Muhammad Najeebullah	Director, Vegetable Research Institute, AARI, Faisalabad
7.	Mr. Naeem Khalid	Deputy Secretary (Planning) Agri. Deptt.
8.	Dr. Ahmad Bilal	Deputy Secretary (Technical) Agri. Deptt.
9.	Muhammad Ikhlq	Horticulturist, Research Station Bahawalpur
10.	Dr. Muhammad Rafiq ur Rehman	Subject Expert, MNSUA, Multan
11.	Malik Muhammad Iqbal	Executive Engineer MNSUAM
12.	Mr. Tahir Mahmood	Assistant Director HQ. (WM)
13.	Dr. Kashif Bashir	Section Officer (Planning) Agri. Deptt.
14.	Mr. Abdul Manan Saeed	Research Officer (Planning) Agri. Deptt.
15.	Mr. Nisar Farooq	Sub-Engineer, C&W Department, Building Division No.1, Bahawalpur