KOMBOLCHA AGRICULTURE TECHNICAL, VOCATIONAL, EDUCATION AND TRAINING (ATVET) COLLEGE

SMALL SCALE IRRIGATION DEVELOPMENT

Level IV

Model TTLM

Learning Guide#04

Unit of Competence: Manage and Improve Irrigation Practices and Develop Value Chains

Module Title: Managing and Improving Irrigation Practices and Develop Value Chains

LG Code: AGR SSI4 M04 LO1-LO4

TTLM Code: AGR SSI4 TTLM04 1218V$_1$

Nominal Duration: 60 Hours

Instruction Sheet	Learning Guide 04

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics –

- Promote Innovative irrigation practices
- Monitor water distribution plan
- Outline irrigation patterns and future prices
- Build value addition producer groups’ entrepreneurial and business planning capacities

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to –

- ✓ Identify improved irrigation practices
- ✓ Set water distribution plan
- ✓ Outline Irrigation patterns and future price rise
- ✓ Build value addition producer groups’ entrepreneurial and business planning capacities

Learning Activities

1. Read the specific objectives of this Learning Guide.
2. Read the information written in the “Information Sheet”
3. Accomplish the “Self-check”.
4. If you earned a satisfactory evaluation proceed to the next “Information Sheet”. However, if your rating is unsatisfactory, see your facilitator for further instructions or go back to Learning Activity.
5. Submit your accomplished Self-check. This will form part of your training portfolio.
6. Read and Practice “Operation Sheets”.
7. If you think you are ready proceed to “Job Sheet”.
8. Request you facilitator to observe your demonstration of the exercises and give you feedback.

INFORMATION SHEET 1	Promote Innovative irrigation practices

Introduction

Irrigation systems have been under pressure to produce more with lower supplies of water. Various innovative practices can gain an economic advantage while also reducing environmental burdens such as water abstraction, energy use, pollutants, etc. Farmers can better use technological systems already installed, adopt extra technologies, enhance their skills in soil and water management, tailor cropping patterns to lower water demand and usage, reduce agrochemical inputs, etc. Water-efficient practices potentially enhance the economic viability and environmental sustainability of irrigated agriculture, without necessarily reducing water usage. To inform such practices, experts have developed various models of water efficiency, yet these are little used by farmers.
This learning out comes will address the following questions:

- ✓ When an irrigation area invests in innovative technology, how can its operation help farmers to achieve the full potential benefits together, e.g. an economic advantage, greater water-use efficiency and lower resource burdens?
- ✓ Why innovative technologies are often applied in ways which miss the full potential benefits?
- ✓ What tensions arise among various objectives and potential benefits?
- ✓ How can these difficulties be addressed?

Innovative irrigation technology is generally promoted as raising water-use efficiency along with multiple benefits, but these remain elusive in practice, as outlined in the first sub-section below.

1.1 Identifying practical limitations of water-efficient irrigation technology

EU policy frameworks place great expectations upon technologies to improve water efficiency. The European Commission emphasizes 'technological innovation in the field of water, given that water efficiency will be an increasingly important factor for competitiveness. According to the European Parliament, solutions should be found in 'clean technologies that facilitate the efficient use of water.

Such technological expectations arise in expert reports on agricultural water use: Water-efficient irrigation, irrigation on demand and irrigation using brackish water are technologies that will enable the better husbandry of more scarce freshwater resources. Technological developments in respect of irrigation will encompass sensors and communication, intelligent watering systems and high-efficiency delivery mechanisms for water and nutrients, as well as the means of incorporating all of these elements into irrigation packages.

Likewise water efficiency can be enhanced by better using current installations and/or by adopting new equipment. The main European farmers' organization has likewise advocated technological means to increase water efficiency. In particular this needs 'investments in more efficient irrigation systems, use of new technologies (e.g. soil moisture and canopy sensors) to better match irrigation with plant needs, and good agricultural practices', such as conservation tillage, management of soil fertility and water retention capacity, and scheduling of irrigation during night to reduce evaporation. The basis for improvement is described as follows:

Water efficiency measures that provide complementary benefits, such as reduced energy needs or other environmental benefits, will also deliver better results. In many Member States, efforts are being made to increase the water storage capacity of soil under agricultural land use. The modernization of irrigation systems has steadily progressed and water productivity has also improved considerably.

As indicated above, greater water-use efficiency depends on better agricultural practices alongside extra technology. Yet companies generally promote irrigation technology as if it inherently brings all the benefits. Improperly managed 'hi-tech' systems can be as wasteful and unproductive as poorly managed traditional systems. When incorrectly applied, irrigation technology 'can cause losses arising on investments made by farmers, thus decreasing the economic water productivity index and the overall sustainability. Beyond a problem-diagnosis of inefficiency, moreover, intensive farming practices can degrade soil and water resources, especially through more input-intensive farming in crops such as maize, vegetables, orchard and vine cultivation: Intensive arable production is partly responsible for poor soil structure, soil erosion, loss of soil OM [organic matter] and pollution from fertilizers and pesticides. . .. The expansion of maize cropping and the move to growing winter cereals in particular have contributed to soil erosion even further.

Such harmful practices have been driven and supported by EU policies. In past decades CAP subsidies have tended to favor crops with high water demands, such as maize, thus increasing the risk of water shortages under climate-uncertain conditions. Either as price-support or area-based, CAP subsidies likewise have ensured the profitability of some water intensive crops such as cotton which otherwise would be phased out under a market-orientated scenario; likewise water-price subsidies. In some cases, water-price increases have induced farmers to adopt technology and appropriate practices for conserving water. Yet water-pricing policies often have been ineffective means to reduce water demand. Farmers experience rising water prices as an extra penalty. Rather than higher water prices, administrative water allocation or re-allocation lowering the supply often has led farmers to adopt water-efficiency practices. If agricultural water demand is inelastic, then policies which encourage changes in cropping patterns can be more effective than higher prices. Inelastic water demand results from farmers' perspectives on water benefits. Water-use efficiency (WUE) and water productivity (WP) are often used interchangeably but have different meanings. WUE specifically means the ratio of biomass produced per unit of irrigation water used, i.e. the sum of transpiration by the crop and evaporation from the soil. By contrast, WP means the ratio of above-ground biomass per unit of water transpired by the crop. Both terms have relevance to farmers' economic goals. WUE interests mainly the water districts or management agencies, while WP interests more farmers and research community. WP better speaks to perspectives linking water usage with production levels and economic benefit. Yet even WP remains distant from farmers' perspectives. They generally perceive 'irrigation efficiency' as maximizing net revenue rather than saving water. Policies seek to lower water usage, and river basin managers try to allocate limited supplies, yet water-saving is not a priority for most farmers. They manage labor and other inputs to get better economic gains. Towards that economic aim, most growers make irrigation decisions by relying on subjective judgments, based only on their practical experience and observation. Consequently, there have been limited benefits from irrigation technology, as well documented in the technical literature; the following examples compare various techniques. Although micro irrigation systems are seen as 'efficient technologies', they were performing less well than traditional surface irrigation methods such as furrows and borders. To gain the extra benefits of such technology, most important is adequate system design, alongside proper installation, operation and maintenance, regardless of the irrigation method used and reported the attainable application efficiencies for different irrigation methods; assuming irrigations are applied to meet the crops' water needs. Micro irrigation has the potential to achieve the highest uniformity (90%) in water applied to each plant, yet poor uniformity and application efficiency can result from various causes, e.g., inadequate maintenance, low inlet pressure or pressure fluctuations, emitter clogging and inadequate system design. Consequently, micro irrigation technology has on-farm efficiencies varying from 0.7 to 0.95.

Reasons for those limitations and ways to overcome them

Given the above water-efficiency limitations in applying irrigation technology include:-

- Irrigation equipment is promoted as if the technology per se brings various benefits,
- Farmers seek to maximize net income rather than water productivity per se,
- Innovative technologies can achieve the full potential benefits only through appropriate technical advice, and
- Farmers lack a knowledge-system for anticipating effects of specific irrigation practices or for retrospectively evaluating their irrigation efficiency.

1.2 Setting improvements in irrigation practices

1.2.1. Improving irrigation practices and value chain

Improving irrigation efficiency aims at minimizing water use within the agricultural sector while continuing to maintain optimal crop productivity rates. Water (and energy) efficient irrigation also provides a number of environmental and socio-economic benefits. High irrigation efficiency is becoming increasingly important due to the current decrease in available water resources and growing populations that drive expansion of agricultural activities. Technological advances for improved irrigation include more efficient irrigation systems where water release can be controlled so that crops receive only the amount needed (e.g. pressurized irrigation systems such as drip irrigation).

To maximize crop water-use efficiency, it is necessary both to conserve water and to promote maximal growth. The former requires minimizing losses through runoff, seepage, evaporation and transpiration by weeds. The latter task includes planting high-yielding crops well adapted to the local soil and climate. It also includes optimizing growing conditions by proper timing and performance of planting and harvesting, tillage, fertilization and pest control. In short, raising water-use efficiency requires good farming practices from start to finish.

Ways to improve water-use efficiency are:-

1. Conservation of water

- Reduce conveyance losses by lining channels or, preferably, by using closed conduits.
- Reduce direct evaporation during irrigation by avoiding midday sprinkling. Minimize foliar interception by under-canopy, rather than by overhead sprinkling.
- Reduce runoff and percolation losses due to over irrigation.
- Reduce evaporation from bare soil by mulching and by keeping the inter-row strips dry.
- Reduce transpiration by weeds, keeping the inter-row strips dry and applying weed control measures where needed.

2. Enhancement of crop growth

- Select most suitable and marketable crops for the region.
- Use optimal timing for planting and harvesting.
- Use optimal tillage (avoid excessive cultivation).
- Use appropriate insect, parasite and disease control.
- Apply manures and green manures where possible and fertilize effectively (preferably by injecting the necessary nutrients into the irrigation water).
- Practice soil conservation for long-term sustainability.
- Avoid progressive salinization by monitoring water-table elevation and early signs of salt accumulation, and by appropriate drainage.
- Irrigate at high frequency and in the exact amounts needed to prevent water deficits, taking account of weather conditions and crop growth stage.

1.2.2. Improving potential crop water use.

Improvements in irrigation practices depend on quantitative knowledge of farmers' current practices in relation to actual and potential crop water use:

Any effort to improve water use efficiency needs to start with the assessment of the actual and attainable efficiencies for the given situation, as quantitatively as possible. This information is fundamental for making rational improvements aiming at raising the overall efficiency to the attainable level. But such information is rarely available to farmers.

Such difficulties arise for water-management improvements through expert systems. Decision Support Systems (DSS) have aimed to improve crop water use efficiency at farm and water basin scale, but few are widely applied, given the necessary specialized skills. For a DSS to be successful, the key elements have been: giving farmers a simple, timely, user friendly, free-of-charge, informative system helpful to decide how much to irrigate in everyday practice; tailoring the tools for a large number of crops; calculating the irrigation profitability; and assessing the economic benefit, especially its relevance to the next irrigation. Thus more reliable information systems and expert capacity are necessary to guide farmers in using water more efficiently. This exemplifies the broader need for farmer training and education in order to improve modern irrigation management.

1.3. Designing service oriented irrigation scheme

Irrigation modernization is a process of change from supply-oriented to service-oriented irrigation. It involves institutional, organizational and technological changes and transforms a traditional irrigation scheme from protective to productive irrigation.

Therefore the System Design Criteria of oriented irrigation scheme objectives are:-

- You will learn that designing an irrigation system means satisfying three criteria - water availability, irrigation system capacity and distribution uniformity.
- You will understand that a design is limited by operating time and water supply.
- You will learn that application uniformity is subject to keeping pressure losses low.

When building, modifying, maintaining, or operating any part of an irrigation system, one must always consider the effect of that part on the entire system. The original design must be kept in mind and the balance of flows and pressures must be maintained.

Three overall design criteria of service oriented irrigation scheme should be kept in mind are:-

Adequate availability of water: - The water supply may be limited to some minimum flow rate for year round delivery. Wells may be fairly steady all year but surface water supplies may fluctuate. Determine the limits on the water supply and size primary and backup pumps to the available flow. Seasonal minimum flow rates will likely occur at time of maximum demand.

Irrigation system capacity: - An irrigation system frequently cannot everything at one time and must be divided into zones that do not exceed the water supply available in gallons per minute. An irrigation zone is the amount of the irrigation system that can be operated at one time without exceeding the water available. The total number of zones cannot exceed the daily water supply. An irrigation zone must be able to supply the water needed by a mature crop on a hot, summer day.

An irrigation system should not be required to operate 24 hours a day to meet crop needs; some maintenance downtime should be included in the daily schedule. This extra capacity may be needed for extreme weather conditions.

Distribution Uniformity: - Uniformity refers to the extent to which all plants in an irrigation zone receive the same amount of water. Although perfect uniformity is an ideal that cannot be achieved in practice, a high level of uniformity is desired so that the crop is fairly uniform.

Pressure losses in the piping system, emitter or sprinkler variability, and variability in plant water demand all contribute to the non-uniformity. Uniformity can be improved by investing in more expensive irrigation equipment, such as larger diameter pipes and more sprinklers to achieve better overlap of watering patterns. This investment may not be justified by the slightly better uniformity. However, the more uniform the irrigation system, the less over-irrigation is required.

1.4. Using eco-efficiency indicators to evaluate potential innovative practices

Eco-efficiency framework and indicators

If efficiency is simply the level of output per unit of input, "eco-efficiency" targets this simple notion toward the production of food and fiber products relative to the ecological resources used as inputs, mainly land, water, nutrients, energy, or biological diversity. Such focus should not be considered in isolation of the critical human and economic dimensions of labor and capital nor ignoring outputs such as environmental loads on wider ecosystems—nutrient, salt, acid, or sediment losses to terrestrial, aquatic, or marine ecosystems, greenhouse gas emissions to the atmosphere—or other ecosystem services that might be positively or negatively influenced by agricultural practice.

Any measure of eco-efficiency involves some measures of outputs (desired or undesired) related to some measure of inputs or alternative independent variable against which outputs are assessed. Figure 1 presents a set of output-input relationships, normally representing crop and environmental responses to increasing nitrogen supply. The shape of these response functions, their intercept, and scale will depend on the measure being used and the responses observed under the spatial and temporal drivers of variability (e.g. climate).

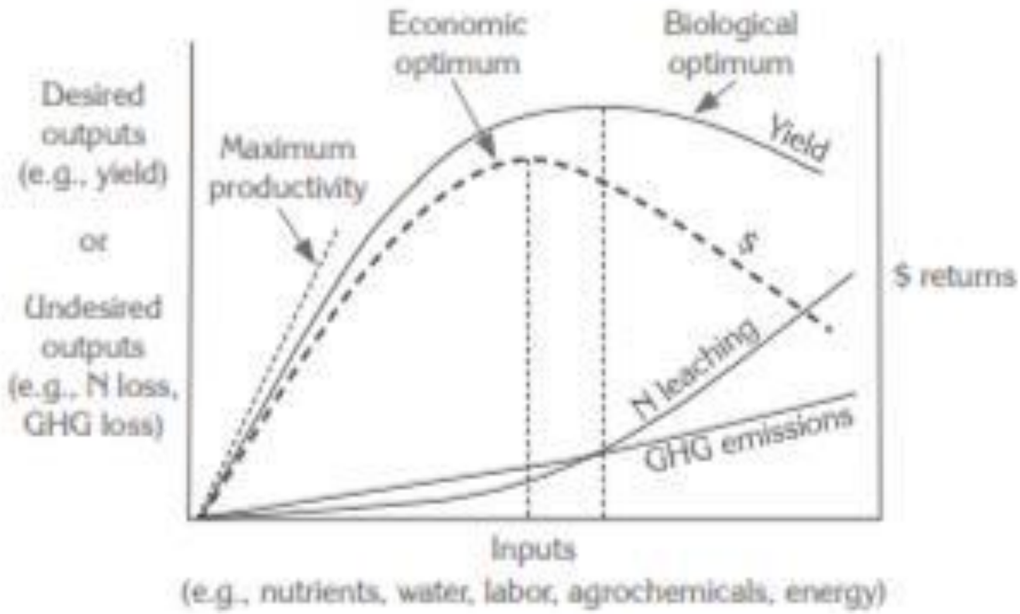


Figure 1 Example of output-input relationship relating desired and undesired agricultural outputs to the level of resource supply including water, nutrients, energy, agrochemicals, labor, etc.

Desired output measures might typically include some measure of harvested product, profit or return on investment, or of the security of a food system; measures could also extend to quality aspects or ecosystem services.

Input measures typically involve a unit of land, nutrients, and water, energy, labor or capital investments. In agriculture, alongside the desired outputs from production, some **undesired outputs** are possible such as biodiversity loss, GHG emissions, nutrient or soil loss, and other forms of land degradation, and these undesired outputs are often a function of relevant input levels.

Eco-efficiency indicators are manufacturing products without environment harm of the ability to manufacture goods efficiently and at competitive prices without harming the environment.

Eco-efficiency index (EEI) can be defined as the ratio of economic to environmental/ecological efficiency or impacts of a production system or process.

The EEI approach integrates measures of economic performance and the associated environmental or ecological performance of agricultural production systems into a single dimensionless (aggregate) index (Figure 2). The EEI approach has been widely used around the world to understand business decision issues, such as optimizing resource use efficiency while minimizing pollution production.

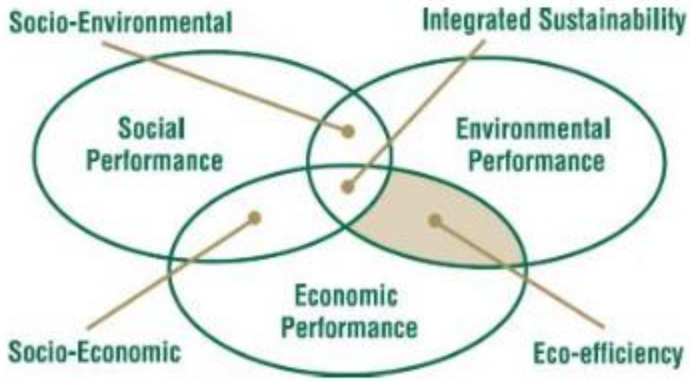


Figure 2 Sustainable development dimensions and inter-relationships among social, environmental and economic performances (Source: *International Council on Metals and the Environment, 2001).*

Eco-efficiency of agricultural systems can be enhanced by choice of crops and farming practices (such as rotation sequence) which reduce negative environmental impacts while at the same time maintaining or increasing farm returns. Thus, agricultural production systems with higher EEIs are considered more economically and environmentally sustainable. The EEI framework has been used to assess trade-offs between agricultural production and various environmental impacts.

1.4.1 Using indigenous interpersonal skills and knowledge

Indigenous irrigation systems have been a central feature of agriculture since prehistoric times, and reflect technical skill and knowledge with a proven record of sustainability. Modern agricultural development efforts often ignore this indigenous knowledge, replacing traditional infrastructure with new construction, and replacing indigenous management arrangements. For reasons of environmental conservation as well as institutional stability, indigenous irrigation systems should be intelligently assisted, rather than mindlessly replaced.

1.4.2 Manufacturing products\goods without environmental harm

Manufacturing products\good has a negative impact on the environment in different ways. Manufacturing has a negative impact on the environment in different ways. Directly, gaseous, liquid and solid waste is generated as a by-product of production that may lead to the pollution of our natural resources. Therefore the Promoted Innovative irrigation practices will be free from the pollution of the environment.

1.4.3 Evaluating potential innovative practices including technology adoption

An important step introducing more efficient water use innovative practices is the evaluation of actual farmer's irrigation practices. Based on simple climatic, crop and soil data and basic information compiled on the frequency of irrigation and the average irrigation application depth an assessment can be made on the efficiency of water application and the effect of possible stress.

Generally, the strategies to improve water productivity can be referred to both agronomic and engineering technologies and practices, and aiming to:

i) increasing the harvest index (*HI*) through crop breeding or management;

ii) reducing the transpiration ratio (*T/B*) by improved species selection, variety selection, or crop breeding;

iii) maximizing the dry matter yield through enhanced fertility, disease and pest control, and optimum planting (precision agriculture research to enhance yields relative to needed inputs at the correct time and location in the field);

iv) Increasing the transpiration (*T*) component relative to the other water balance components (almost all current water conservation technologies to enhance rainfall capture and to improve irrigation technologies to avoid or minimize application losses).

The latter strategy can be obtained by:

a) reducing evaporation (*E*) by increasing residues, shallow mulch tillage, alternate furrow irrigation, or narrow row planting;
b) reducing deep percolation (*D*) by avoiding overfilling the root zone and minimizing leaching to the absolute minimum for salinity control;
c) increasing effective rainfall (*P*) and reducing surface runoff (*R*) by using furrow diking, dammer diking, crop residues, or avoiding soil compaction and hardpan problems;
d) Increasing soil water depletion from the profile by gradually imposing soil water deficits, deeper soil wetting, or using deeper rooted varieties.

Technologies and practices under evaluation

For the specific purposes of this learning outcome is a selection of advanced water and energy technologies and farm management practices for eco-efficiency improvement and their potential impact in terms of eco-efficiency improvement.

A. Advanced technologies for water supply management

a. Remote and automated control of irrigation water supply;
   - ✓ Sensors for monitoring weather variables and soil moisture content
   - ✓ Variable Rate Irrigation (VRI)
b. Efficient irrigation methods
   - ✓ Sprinkler irrigation
   - ✓ Micro-irrigation (drip and subsurface)
c. Deficit irrigation strategy
   - ✓ Supplemental irrigation (SI)
   - ✓ Regulated Deficit irrigation (RDI)
d. Use of treated wastewater

B. Energy saving technologies

a. Variable speed pumps for irrigation

b. Network sectoring and dynamic pressure regulation

C. Eco-friendly agronomic practices

a. Cropping pattern changes
- ✓ Crop and variety selection
- ✓ Early sowing and crop rationing
- ✓ Super high density plantations (for olive farming)

b. Conservation agriculture and soil management techniques
- ✓ Conservation tillage and surface residue management
- ✓ Use of biodegradable mulches

c. Organic farming and agro-ecological practices

d. Sustainable land management practices

The importance of water supply management strategies in Promote Innovative irrigation practices including:

i) increased storage capacities (including those to favor supplemental irrigation);

ii) improved irrigation conveyance and distribution systems that provide increased flexibility of deliveries and reduce system water wastages;

iii) enhanced operation and maintenance; and

iv) Development of new sources of water supplies, including treated wastewater, saline groundwater and drainage water (the use of which requires improved irrigation practices and management, mainly to avoid impacts on health and environment).

1.5 Assessing and avoiding adverse environmental impact

Impact assessment refers to the detailed evaluation of the environmental and social impacts of the promote innovative irrigation practices and identified alternatives, compared to the baseline conditions. This includes qualitative descriptions such as measuring high, medium and low impacts, and quantitative descriptions, such as indicating the cubic meters of water withdrawn, sewage produced, and pollutants released. This is done for the promote innovative irrigation practices as well as the identified alternatives, allowing for comparisons. Once the detailed assessment is complete, mitigation measures to reduce or avoid impacts are identified.

Mitigation refers to minimizing or avoiding the described impacts. Overall, mitigation measures are a response to the findings of impact assessment; they need to cover all the areas identified.

The key focus of mitigation actions should be on:

- Preventive measures that avoid the occurrence of impacts and thus avoid harm or even produce positive outcomes.
- Measures that focus on limiting the severity and the duration of the impacts.
- Compensation mechanisms for those impacts that are unavoidable and cannot be reduced further.

Key impacts and potential mitigation actions often relate to land. Almost all development proposals involve disturbance of the land surface. This is usually extensive for major linear projects (roads, pipelines), dams and reservoirs, and large-scale mining, agriculture, forestry and housing schemes. Environmental impacts of particular concern can include drainage of wetlands, conversion of natural areas, or expansion into areas that are vulnerable to natural hazards.

Promote innovative irrigation practices can have variety negative impacts on ecology and socioeconomic, which may be mitigated in a number of ways. These include silting the innovative irrigation practices in a location which minimizes negative impacts. The efficiency of existing innovative irrigation practices can be improved and existing degraded croplands can be improved rather than establishing innovative irrigation practices. Developing small-scale, individually owned irrigation practices as an alternative to large-scale publicly owned and managed schemes. The use of sprinkler irrigation and micro-irrigation systems decreases the risk of water logging and erosion. Where practicable, using treated wastewater makes more water available to other user. Maintaining flood flows downstream of the dams can ensure that an adequate area is flooded each year, supporting, amongst other objectives, fishery activities.

Self-Check 1	**Written Test**

Directions: **Answer all the questions listed below. Illustrations may be necessary to aid some explanations/answers.**

1. Describe the limitation of water use efficiency in promote innovative irrigation practice?(5pts)
2. Explain the ways to improve irrigation practice and value chain of water use efficiency? (5pts)
3. Write the objective of service oriented irrigation scheme design?(5pts)
4. Write the advantage to know the eco-efficiency indicator to evaluate potential innovative irrigation practice?(5pts)
5. Write positive and negative environmental impacts of improved irrigation practices and value chains?(5pts)

Note: **Satisfactory rating - 20 points and above Unsatisfactory - below 20 points**

You can ask your teacher for the copy of the correct answers.

INFORMATION SHEET 2	Monitor water distribution plan

Introduction:

Water supply and delivery schedules are keys to proper irrigation water management. When water users pump from a well or an adjacent stream or maintain a diversion or storage reservoir, they control their own delivery.

In some areas delivery is controlled by an irrigation district or company. Delivery by an irrigation district may be controlled by its own institutional constraints (management) or by canal supply and structure capacity limitations. Flexibility in delivery generally is controlled by institutional restraints or capacity limitations on the downstream ends of irrigation laterals. Capacity limitations are primarily because required storage is not within or very close to farm delivery locations.

2.1 Agreeing monitoring system and performance evaluation of working team

The overall aim of monitoring is to improve the performance of an organization as measured against its mission and objectives. Most of the time **monitoring system and performance evaluation uses a** benchmarking.

Benchmarking implies comparison - either internally with previous performance and desired future targets, or externally against similar organizations performing similar functions. Monitoring system and performance evaluation of irrigation water users working team must be agreed in the following steps of encompassing.

- Regularly comparing aspects of performance (functions or processes) with best practices, past track record or a recognized target or norm.
- Identifying gaps in irrigation performance such as; water use efficiency and scheduling
- Identifying the causes of under-performance and proposing measures to address them
- Following through with the implementing of improvements
- Following up by monitoring progress and reviewing the benefits from irrigation scheme

2.2 Considering environmental and community factors affecting water distribution

Generally, Irrigation has significant contribution to poverty alleviation, food security, and improving the quality of life for rural populations. However, the sustainability of irrigated agriculture is being questioned, both economically and environmentally. The increased dependence on irrigation has not been without its negative environmental effects.

Decisions to embark on these costly projects have often been made in the absence of sound objective assessments of their environmental and social implications. Major capital intensive water engineering schemes have been proposed without a proper evaluation of their environmental impact and without realistic assessments of the true costs and benefits that are likely to result.

The sustainability of irrigation projects depends on the taking into consideration of environmental effects as well as on the availability of funds for the maintenance of the implemented schemes. Negative environmental impacts could have a serious effect on the investments in the irrigation sector. Adequate maintenance funds should be provided to the implementing organizations to carry out both regular and emergency maintenance.

It is essential that irrigation projects and distribution system be planned and managed in the context of overall organizational protocols, river basin and regional development plans, including both the upland catchment areas and the catchment areas downstream by participating and considering community.

Potential environmental impacts of irrigation water distribution systems

Water distribution systems have the potential to cause major environmental disturbances, resulting from changes in these lose and use of land. Some of the impacts may include:

- Water logging and salinization of soils from leakage of the distribution system
- Increased incidence of water-borne and water-related diseases,
- Possible negative impacts of larger distribution canals may cause problems of resettlement or changes in the lifestyle of local populations.

2.3 Determining and agreeing feedback mechanism

Feedback is concerned with the control of a mechanism on the basis of its past performance and consists of procedures to determine deviations from plans to indicate and execute corrective action regarding these deviations. In irrigation monitoring and planning processes feedback mechanism would be determined and agreed upon the distribution and use of water among parties of the water users.

2.4 Preparing water distribution plan

Planning is the process of thinking ahead to achieve desired future outcomes and to avoid undesired future pitfalls. It is something we all do at many levels every day of our lives. There are benefits to be gained and risks to be avoided by water distribution planning.

The planning process is helpful to:

- Outline a systematic but flexible planning process
- Help you identify water management issues and set appropriate goals
- Help you evaluate potential ways to achieve goals and resolve issues
- Help you decide what water management improvements or activities should become part of your action plan

Every-day plan is an ongoing process of identifying issues, setting goals, and completing tasks to accomplish a desired outcome. The planning process is just a logical sequence of decision-making steps or activities that can be followed to achieve some desired outcome.

Steps in the process include:

1. Gathering information
2. Identifying and prioritizing issues
3. Setting goals and objectives
4. Identifying candidate measures capable of achieving the goals
5. Evaluating the candidate measures
6. Defining a plan of action
7. Implementing the plan of action
8. Monitoring implementation progress
9. Evaluating progress and updating the plan

There is nothing magical or complicated about this sequence of activities. If you think about it a little bit, you will realize that you use this thought process for almost every decision you make. In the context of water management, it is simply used as a framework to ensure a systematic and thorough decision making process.

Water distribution planning should be viewed as an ongoing activity and not as a one-time effort. Situations change, new technologies arise, and issues may be seen in a new light. As a result, plans become outdated. Water management planning must become a routine part of district management to be effective in the long run.

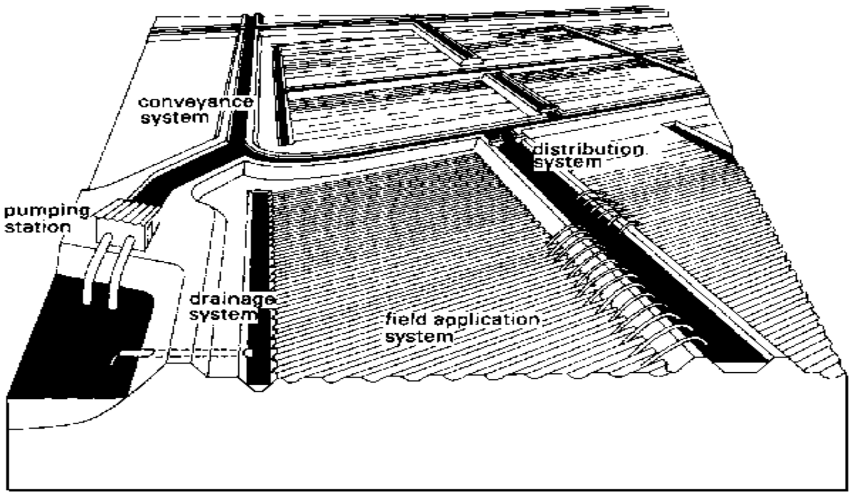
2.4.1 Irrigation distribution systems and farm layouts

Distribution systems and farm layouts

The type of the irrigation conveyance and distribution system depends on the topography of the area:

- Undulating, irregularly sloping land require buried pipeline systems;
- Flat and gently sloping land is irrigated by trapezoidal shaped open channel systems.

The locations of the farm and crop lands and farm layouts will be determined after more consultation with the resettles and further topographic survey and investigations on soil types. The crop lands must be in the flatter areas with different types of soils. There are some existing shifting cultivation areas and they will be more suitable for agriculture. Farm and village access roads are required within the areas, the cost of which has not been included in the irrigation development estimates.



Materials of distribution network system

Based on economic, topography, availability and suitability considerations distribution network can be composed of:

- Canal Systems
- Buried Pipelines Systems
- Farm Inlets and Terracing

Canal Systems

A typical canal distribution system has main, secondary, tertiary and quaternary canals. However for the small resettlement schemes, not all this order of canals may be required. A system also has canal structures to control the discharges and water levels within the system including turnouts, checks, and check/drops. Conveyance structures such as culverts and siphons will be required to convey water under roads or drains.

Buried Pipelines Systems

A typical buried pipeline system will use uPVC and smaller-diameter high density polyethylene (PE) pipes and has valves for flushing accumulated debris from pipe low spots and trapped air from high spots. Other fittings will include gate valves, clamps, junctions, tees, elbows and reducers. In the undulating areas, the farm layouts will be irregular, the Area 16 Pilot Village Scheme being a good example. There, no two farm plots are of the same shape and long pipeline lengths are required to convey and distribute the water throughout the area. The pipes will be laid on sand bedding. Concrete anchor blocks, also known as thrust blocks, are necessary to transfer any forces in the system to the surrounding soil and prevent any pipe movement leading to disruption of the joints and subsequent leakage.

Farm Inlets, Siphons and Terracing

Each farm plot will have its own farm inlet structure. At the Pilot Village Irrigation Scheme the farm plots are of various shapes and slopes. Consequently a unique type of farm inlet has been installed so that various farm plot irrigation techniques can be practiced and tested.

2.4.2 Planning Irrigation scheduling methods

Irrigations can be scheduled using methods varying from simple soil water monitoring using the feel and appearance method to sophisticated computer assisted programs that predict plant growth. Scheduling involves continual updating of field information and forecasting future irrigation dates and amounts. Crop yield and quality can be improved with most plants by maintaining lower soil-water tensions (higher moisture levels). Thus, it is wise to irrigate when the soil profile can hold a full irrigation. Waiting until a predetermined percent of soil AWC is used can cause unnecessary stress.

1. **Soil and crop monitoring methods**

Some scheduling practices are based solely on monitoring soil-water content or crop water use. Irrigations are needed when the soil-water content or crop water use reaches predetermined critical levels.

Accurate monitoring should provide the irrigation decision maker information at or soon after the time of measurement. The data must be available to ensure that the field can be irrigated before moisture stress occurs. Monitored data must be displayed so that the information is easy to understand and use to predict an irrigation date.

2.5 Presenting water distribution plan for approval

Water distribution plan would present for approval according to the organizational protocols and guide lines to the donation board or administration unit.

The water distribution plan may present focused on the following points:

- Ways of managing land and water resources, so that their long-term productivity is optimised and sustained
- Support implementation ways of water allocation reform through water use monitoring and curb illegal water use.
- The economic and social well-being of all within the shared water resource environment
- Safeguard the livelihood s and well-being of farmers, farm workers and their families
- Ensure efficient water resource management & maintain healthy, functioning agricultural ecosystems
- Facilitate implementation of an Integrated support from various departments plans
- Supportive conditions of the plan to mitigate and adapt to climate change at a local level.

2.6 Identifying, evaluating changes and modifying and finalizing water distribution plan

These are written documents that describe how you will monitor and evaluate your program, as well as how you intend to use evaluation results for program improvement and decision making.

Water distribution plan encompasses the following processes:

- Identified the primary users of the evaluation,
- created the evaluation stakeholder workgroup,
- defined the purposes of the evaluation,
- described the program, including context,
- created a shared understanding of the plan,
- Identified the stage of development of the plan, and
- Prioritized evaluation questions and discussed feasibility, changing and modifying budget, and resource issues.

The identification and evaluation plan clarifies how you will describe the "What," the "How'' and the "Why It Matters" for your program. The "What" reflects the description of your program and how its activities are linked with the intended effects.

It serves to clarify the program's purpose and anticipated outcomes. The "How" addresses the process for implementing a program and provides information about whether the program is operating with fidelity to the program's design. Additionally, the "How" (or process evaluation), along with output and/or short-term outcome information, helps clarify if changes should be made during implementation.

The “Why It Matters” provides the rationale for your program and the impact it has on public health. This is also sometimes referred to as the “so what” question. Being able to demonstrate that your program has made a difference is critical to program sustainability.

Why evaluation plan is required?

Just as using a roadmap facilitates progress on a long journey, an evaluation plan can clarify what direction your evaluation should take based on priorities, resources, time, and skills needed to accomplish the evaluation. The process of developing an evaluation plan in cooperation with an evaluation workgroup of stakeholders will foster collaboration and a sense of shared purpose.

Having a written evaluation plan will foster transparency and ensure that stakeholders are on the same page with regards to the purpose, use, and users of the evaluation results.

Written evaluation plans can:

- create a shared understanding of the purpose(s), use, and users of the evaluation results,
- foster program transparency to stakeholders and decision makers,
- increase buy-in and acceptance of methods,
- connect multiple evaluation activities—this is especially useful when a program employs different contractors or contracts,
- serve as an advocacy tool for evaluation resources based on negotiated priorities and established stakeholder and decision maker information needs,
- help to identify whether there are sufficient program resources and time to accomplish desired evaluation activities and answer prioritized evaluation questions,
- assist in facilitating a smoother transition when there is staff turnover,
- facilitate evaluation capacity building among partners and stakeholders,
- provide a multi-year comprehensive document that makes explicit everything from stakeholders to dissemination to use of results, and *f*
- Facilitate good evaluation practice.

Approval of irrigation water distribution plan

After approval of the irrigation water distribution plan by the Approving Authority, and concurrently with submittal of plans for building permit, an irrigation system implementation plan complying shall be submitted for staff review and approval.

- A completed Irrigation shift / Run Time Schedule spreadsheet shall be included with the irrigation plan submittal.

- Irrigation plans shall be included with the building construction plan set documents submitted to the managing department
- No permit for additional building, paving, utilities, or other on-site construction improvement, other than grading, shall be issued until irrigation plans for the water distribution is also to be approved.

Self check # 2	**Knowledge questions**

Name: _________________________ Date: _______________

Directions: Answer the following questions in the space provided

1. Why need an approval on water distribution plan *(4 points)* _ _ _ _ _ — _ _ _ _ _ _ — _ _ _ _ _ _ — _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ _ _ — _ _ _ _ _ _ _ _ _ — _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ — _ _ _ _ _ —
2. Describe the environmental impact of irrigation water distribution on irrigation users blocks *(4 points)* _ — _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ — _ _ _ _ _ _ — _ _ _ _ _ _ — _ _ _ _ _ _
3. List the importance of preparing water distribution plan*(7 points)*

Note: satisfactory Rating-5 and above pts.   Unsatisfactory Rating-below 5 pts.

You can ask your teacher for the copy of the correct answers

Information Sheet 3	Outline irrigation patterns and future price rise

The value chain mapping of both systems has been completed through the definition of system boundaries, its main components (water source, hydraulic infrastructures and cropped lands) and stages (e.g. water abstraction, accumulation, conveyance, storage, distribution and use). The processes (e.g. pumping and energy consumption, water losses in conveyance and distribution network, on-farm water losses, distribution uniformity, evapo-transpiration, deep percolation and drainage, cropping pattern setup, nutrient supply, etc.) included in specific stages of the system are described considering the actual uptake of technologies and depicting eventual problems. The resource inputs and environmental impacts relevant to each stage (or process) of the system are explained considering the costs and benefits for the system.

3.1. Assessing and monitoring sustainable use of shared water resources

The assessment of water resources is becoming increasingly important in the context of rapidly changing conditions related to human-induced changes including population, standards of living, industrialization, agriculture, land use changes and water use demand and patterns. Adding to this complexity is the experience of a changing climate resulting in generally higher variability of available freshwater resources.

Global demand for food production increases progressively at very high rates. Currently, in most countries, continents and regions, agriculture consumes nearly 70% of the total available. There is an enormous need for reduction of this use through the introduction of appropriate technologies, the elimination of waste and introduction of reuse and recycling. The uses of water include excessive utilization for irrigation from underground waters.

3.2. Differentiating water prices

There are various methods for collecting irrigation water delivery fees:

- By the size of the irrigated area;
- By a share of the harvested crop
- By the irrigation volume;

In some countries, the state recovers irrigation costs through taxes:

- By a tax on irrigated land;
- By a sales tax on crops that are usually produced with irrigation;
- By personal income tax.

The type of system to collect the fee

1) Area Based System

a) A fixed rate per hectare of farm, where the charge is not related to the crop grown or the volume of water received. It is usually part of a "two-part" tariff designed to cover the fixed costs the service different tariffs may be used for gravity and pumped supplies "A fixed rate per total irrigation farm size"

Pricing Methods Total irrigation farm size assessments were made per each cropping season & payments were restricted or payments were devised for the users.

b) A fixed rate per hectare irrigated farm. The charge is not related to type of crop grown or actual volume of water received (except that a large irrigated area implies a greater volume of irrigation water) ‘‘A fixed rate per net irrigated farm size"

Pricing Methods Net irrigated farm size assessments were made per each cropping season & payments were restricted or payments were devised for the users.

2) Crop-Based System

a) A variable rate per irrigated hectare of crop, i.e. different charges for different crops, where the charges is not related to the actual volume of water received, although the type of crops and area irrigated serve as a proxies for the volume of water received.

Pricing Methods Crop-type assessments were made per each cropping season & payments were restricted or payments were devised for the users.

3) Volumetric System

a) A fixed rate per unit of water received, where the charge is related directly to, and proportional to, the volume of water received

b) A variable rate per unit of water received, where the service charge is related directly to the quantity of water received, but not proportionately (e.g. a certain amount of water per hectare may be provided at a lower unit cost, a further defined quantity at a higher unit cost, and additional water above this further quantity at a very high unit cost). This method is referred to as "a rising block tariff"

4) Tradable Water Rights System

The entitlements of users in an irrigation project, or more widely, other users, are specified in accordance with the available water supply. Rights holders are allowed to buy or sell rights in accordance with specified rules designed primarily to protect the rights of third parties. Sales require authorization by a licensing authority or may require court approval with reference to any specified authority.

Summery Table Bases for Irrigation Water Fee

No	Type	Detail	Pricing methods
1	Area based	1a) A fixed rate per hectare of farm, where the charge is not related to the crop grown or the volume of water received. It is usually part of a "two-part" tariff designed to cover the fixed costs the service different tariffs may be used for gravity and pumped supplies "A fixed rate per total irrigation farm size"	Total irrigation farm size assessments were made per each cropping season & payment were restricted or payments were devised for the users.
		1b) A fixed rate per hectare irrigated. The charge is not related to type of crop grown or actual volume of water received (except that a large irrigated area implies a greater volume of irrigation water) "A fixed rate per net irrigated farm size"	Net irrigated farm size assessments were made per each cropping season & payments were restricted or payments were devised for the users.
2	Crop-based	2) A variable rate per irrigated hectare of crop, i.e. different charges for different crops, where the charges is not related to the actual volume of water received, although the type of crops and area irrigated serve as a proxies for the volume of water received.	Crop-type assessments were made per each cropping season & payment were restricted or payments were devised for the users.
3	Volumetric	3a) A fixed rate per unit of water received, where the charge is related directly to, and proportional to, the volume of water received.	
		3b) A variable rate per unit of water received, where the service charge is related directly to the quantity of water received, but not proportionately (e.g. a certain amount of water per hectare may be provided at a lower unit cost, a further defined quantity at a higher unit cost, and additional water above this further quantity at a very high unit cost). This method is referred to as "a rising block tariff"	
4	Tradable water rights	The entitlements of users in an irrigation project, or more widely, other users, are specified in accordance with the available water supply. Rights holders are allowed to buy or sell rights in accordance with specified rules designed primarily to protect the rights of third parties. Sales require authorization by a licensing authority or may require court approval with reference to any specified authority.	

3.3. Improving scientific knowledge of crops' water needs

Innovative irrigation practices can enhance water efficiency, gaining an economic advantage while also reducing environmental burdens. In some cases the necessary knowledge has been provided by extension services, helping farmers to adapt and implement viable solutions, thus gaining more benefits from irrigation technology. Often investment in technological improvements has incurred higher water prices, however, without gaining the full potential benefits through water efficiency. Farmers generally lack adequate means and incentives to know crops' water use, actual irrigation applications, crops' yield response to different water management practices, and thus current on-farm water-efficiency levels.

3.3.1. Improving scientific knowledge of crops' yield-response to water

Improving the efficiency and effectiveness of water use can result from better managing a number of factors, including water availability, fertility, pests and diseases, crop or pasture variety, planting date, soil water conditions at planting, plant density and row spacing. This means that improving water use efficiency requires an understanding of the whole system and should not focus solely on the application of water. However, the scope of this publication is confined to the capture, conveyance and application of water for irrigation.

Evaluating Irrigation System Performance

Irrigation system performance describes the effectiveness of the physical system and operating decisions to deliver irrigation water from a water source to the crop. Several efficiency terms are used to evaluate irrigation system performance. These include water conveyance efficiency, water application efficiency, soil water storage efficiency, irrigation efficiency, overall irrigation efficiency, and effective irrigation efficiency.

Evaluating the Response of the Crop to Irrigation

Irrigation system performance and irrigation uniformity parameters mentioned above evaluate the engineering and operational aspects of the irrigation system. Different parameters are used to evaluate the response of the crop to irrigation water. The three most commonly used parameters for evaluating the response of the crop to water are crop water use efficiency, irrigation water use efficiency, and water use efficiency.

Crop Water Use Efficiency (CWU_E)

Crop water use efficiency (CWU_E) is mostly used to describe irrigation effectiveness in terms of crop yield (crop productivity). It is defined as the ratio of the mass of economic yield or biomass produced per unit of irrigation water used in ET. It is expressed as:

$$\mathbf{CWU_E = (Y_i - Y_d) / (ET_i - ET_d)}$$

CWU_E = crop water use efficiency (bushel/acre-inch)

Y_i = yield of the irrigated crop (bushel /acre)

Y_d = yield for an equivalent rainfed crop (bushel /acre)

ET_i = ET for irrigated crop (inch)

ET_d = ET for rainfed crop (inch)

From the above definition, crop water use efficiency has units of production per unit of water used in ET. Units typically used are ton per acre-inch, pound per acre-inch, or bushels per acre-inch.

Irrigation Water Use Efficiency (IWU_E)

Irrigation water use efficiency (IWUE) is used to characterize crop yield in relation to total depth of water applied for irrigation. It is expressed as follows:

$$IWU_E = (Y_i - Y_d)/IR_i$$

IWU_E = irrigation water use efficiency (bushel /acre-inch)

Y_i = economic yield of the irrigation level crop (bushel / acre)

Y_d = economic yield for an equivalent rainfed crop (bushel /acre)

IR_i = depth of irrigation water applied for irrigation (inch)

Water use efficiency is a term commonly used to describe the relationship between water (input) and agriculture product (output). When used in this way the term is, strictly speaking, a water use index. Water use efficiency is also often used to express the effectiveness of irrigation water delivery and use.

The CWU_E is a better indicator when quantifying the efficiency of a crop production system because it directly reflects the amount of grain yield produced per amount of water used rather than per depth of water applied, which is the case with the IWU_E. This is because not all irrigation water applied to the field is used for crop ET. Thus, IWU_E does not account for the irrigation application losses and actual water used by the crop.

Crop Water Use Efficiency

Benchmark water use efficiency looks at the total amount of water used to produce the yield and is expressed as:

$$WUE_b = Y_i / (P_e + IR + \Delta SW)$$

WUE_b = benchmark water use efficiency

Y_i = yield of irrigated crop (bushel /acre)

P_e = effective rainfall (inch)

IR = irrigation applied (inch)

ΔSW = change in soil water content in the root zone during the growing season (inch)

The denominator of equation in the above equation is a surrogate estimate for the water used to produce yield. It neglects deep percolation losses, groundwater use, and surface runoff. Experienced irrigation practitioners use WUE_b for a specific region and to identify differences between irrigation methods, irrigation management, or both.

Summary

Irrigation efficiency is described by several terms used to measure how efficiently irrigation water is applied to the field and/or used by the crop. High irrigation efficiency translates into lower operating costs; improved production per unit of water delivered, and improved environmental benefit and management. Incorrect use of efficiency terms can lead to misrepresentation of how well an irrigation system is performing. Therefore, it is important for both producers and irrigation management professionals to select the appropriate efficiency and uniformity parameters when evaluating irrigation systems. Several adjustments can be made to the volume of water delivered to the field to increase irrigation efficiency or uniformity. However, efficiencies of 100 percent are not always desirable or practical. The efficiency and uniformity indices can provide the measure to achieve more efficient irrigation management that will lead to conserving water and protecting environmental quality in irrigated agriculture.

3.3.2. Improving scientific knowledge of crops' water needs, their yield response to water and actual on-farm versus attainable efficiency

Irrigation efficiency is a critical measure of irrigation performance in terms of the water required to irrigate a field, farm, basin, irrigation district, or an entire watershed. The value of irrigation efficiency and its definition are important to the societal views of irrigated agriculture and its benefit in supplying the high quality, abundant food supply required to meet our growing world's population. "Irrigation efficiency" is a basic engineering term used in irrigation science to characterize irrigation performance, evaluate irrigation water use, and to promote better or improved use of water resources, particularly those used in agriculture and turf/landscape management. Irrigation efficiency is defined in terms of: 1) the irrigation system performance, 2) the uniformity of the water application, and 3) the response of the crop to irrigation. Each of these irrigation efficiency measures is interrelated and will vary with scale and time. The spatial scale can vary from a single irrigation application device (a siphon tube, a gated pipe gate, a sprinkler, a microirrigation emitter) to an irrigation set (basin plot, a furrow set, a single sprinkler lateral, or a microirrigation lateral) to broader land scales (field, farm, an irrigation canal lateral, a whole irrigation district, a basin or watershed, a river system, or an aquifer). The timescale can vary from a single application (or irrigation set), a part of the crop season (pre-planting, emergence to bloom or pollination, or reproduction to maturity), the irrigation season, to a crop season, or a year, partial year (pre-monsoon season, summer, etc.), or a water year (typically from the beginning of spring snow melt through the end of irrigation diversion, or a rainy or monsoon season), or a period of years (a drought or a "wet" cycle). Irrigation efficiency affects the economics of irrigation, the amount of water needed to irrigate a specific land area, the spatial uniformity of the crop and its yield, the amount of water that might percolate beneath the crop root zone, the amount of water that can return to surface sources for downstream uses or to groundwater aquifers that might supply other water uses, and the amount of water lost to unrecoverable sources (salt sink, saline aquifer, ocean, or unsaturated vadose zone). The volumes of the water for the various irrigation components are typically given in units of depth (volume per unit area) or simply the volume for the area being evaluated. Irrigation water application volume is difficult to measure, so it is usually computed as the product of water flow rate and time. This places emphasis on accurately measuring the flow rate. It remains difficult to accurately measure water percolation volumes groundwater flow volumes, and water uptake from shallow groundwater.

A. It must be fully recognized and appreciated that beyond water management, non-water related agronomic practices also play important roles in increasing crop water productivity.

1. While the particular practices required to close the gap between attainable and actual yield per unit water use are specific to a given crop and cropping system, some are common to most cases. These are timely sowing, on-farm water management including operation and maintenance of water delivery systems for irrigated agriculture, effective control of weeds, arthropod pests and diseases and adequate fertilization.

2. Trade-offs between water productivity and nutrient requirements need to be considered carefully: maximizing water productivity in some farming systems may require nitrogen rates that are too costly, too risky, or environmentally unsound. This is particularly important with high fertilizer-to-grain price ratio, in environments prone to nitrogen leaching, or where biophysical, social, economic or infrastructure factors constrain the use of fertilizer. Likewise, trade-offs between yield and water productivity that are mediated by amount and method of water supply are common. These, and all other trade-offs need to be considered, as the aim of improving water productivity on its own is not necessarily the best pathway to sustainability as this involves specific production, environment and social targets.

B. Beyond physical crop–water productivity, there is much scope for increasing the 'value' per unit of water used in agriculture by designing and managing agricultural water for multiple uses.

3. Strategies for increasing the net value of water consumed in agriculture include: increasing yield,

reallocating water from low to higher valued uses, lowering the costs of inputs, increasing health benefits and the value of ecological services of agriculture, decreasing social, health and environ-mental costs.

C. The scope for improving crop–water productivity varies between regions, along the value chain from producer to consumer, and has a nexus with trades.

4. There are areas of the world that already exhibit high physical crop water productivity, with limited prospects for improvements using current technology. This is the case in many of the most productive areas of the world, such as the Lower Yellow River Basin, or in most of Europe, North America and Australia. The areas with the highest potential gains are sub-Saharan Africa and parts of South-, Southeast- and Central Asia.

5. There is significant'waste' along the value chain from producer to consumer. The post-harvesting losses (from transport, to conservation, to processing, to packaging, to distribution, etc.) can be relevant insofar as reducing them would already allow a significant increase in water productivity when measured on the basis of production actually reaching consumers. In developing countries, produce waste is close to the beginning of the producer-consumer path, while in developed countries produce waste is close to the end.

6. While trade is driven by economic and political reasons at the global level, gains in water productivity can be achieved by growing crops in places with high water availability and trading them to places with lower water availability.

D. There is a crucial need to create order in the terminology and definitions associated with 'efficiency' and 'productivity' of water use. As scope, diagnosis and objectives of water 'accounting' and expected 'saving' may be largely misleading.

7. The term efficiency is widely used by irrigation specialists to express the ratio between water available at different points in the system. Thus 'conveyance efficiency' relates water delivered from a channel or system of channels to the water diverted into the channel (the excess going to spills, leakage and evaporation from the water surface). Similarly, 'field application efficiency' relates water delivered to the plant root zone to the total water delivered to the field (the excess typically going to runoff, percolation below the root zone, or evaporation from the wetted soil surface). Efficiency is a

dimensionless ratio and its theoretical limits are between 0 and 1, or between 0 and 100 if expressed as a percentage.

8. Agronomically, efficiency is usually defined as a ratio of output-to-input. This definition does not scale in the 0 -1 range. When evaluating agricultural production systems from the viewpoint of water use, the term water use efficiency refers to production per unit of water used, with units such as kg grain/ha per mm or kg/m^3 or Birr/m^3.

9. Recently, various analysts have proposed revised terminology that entirely avoids the word 'efficiency', thus using (i) hydrologically-based terminology (consumed and unconsumed fraction, recoverable and non-recoverable return flows) for the analysis of resource use, and (ii) productivity terms to describe the effectiveness of the system in using water to produce crops.

10. The proposed revisions in terminology are based on three separate considerations:

-First, the engineering concept of efficiency is entirely appropriate and valid when designing irrigation systems, estimating potentially irrigable areas for a given cropping pattern, and planning releases to meet field-level demands, but is misleading when water competition and scarcity beyond the boundaries of a project are under consideration (and this is increasingly the case as demand for water increases). The engineering concept of efficiency does not distinguish between water that is consumed through transpiration and evaporation and water that simply passes, unconsumed, through the system and may (or may not) be recoverable elsewhere for reuse.

-Second, when water is scarce and interventions are proposed to improve availability, it is critically important to have terminology that is consistent across sectors; so that interventions are evaluated on a common basis. For example, most interventions to improve catchment status will involve increases in consumptive use and reductions in runoff volume (albeit that the rate of runoff may be reduced and spread more usefully over time). Investments in low-flow showers and the like reduce the water used in these activities, but since consumption is close to zero the actual savings in water are minimal. Most observers, when told that irrigation efficiency can be improved from 40 to 80 percent would expect consumption to fall, and more water to be available for other uses, just as would happen if the thermal efficiency of a boiler was dramatically improved. This is not the case for irrigation and terminology based on consumption avoids this confusion. Of course there are situations when improvements in 'efficiency' are highly beneficial – when in-stream flows between offtake and drainage return points are improved; where underlying aquifers are saline, reductions in percolation are real water savings that allow increased consumptive use elsewhere.

-**Third**, by distinguishing clearly between hydrology and production aspects of water systems, far more clarity is possible in describing the impacts of proposed interventions.

11. Water productivity, in its broader sense, defines the ratio of the net benefits from crop, forestry, fishery, livestock and mixed agricultural systems to the amount of water consumed to produce those benefits. We can distinguish physical water productivity, defined as the ratio of mass of product to the amount of water consumed ('more crops per drop'), and economic water productivity, defined as the 'value' derived per unit of water used. In this case the 'value' can refer to economic return or to nutrition, or more broadly to any other economic and social benefit (e.g. jobs, welfare, environment, etc.).

E. The impact of saving measures must be carefully assessed through the application of proven scientific principles of hydrology, irrigation technology, energy balances and crop physiology that define and constrain the options available.

12. The objectives of any water conservation programme need to be rigorously specified owing to the several implications and trades-off (e.g. water vs energy or vs cost savings).

F. While society may have the incentive to increase water productivity, agricultural producers may not. The adoption of measures to improve water productivity, either operational, technological or infrastructural, will therefore require an enabling policy and an institutional environment that aligns the incentives of producers, resource managers and society.

3.4. Analyzing links between farmers' perspectives, innovative practices and their income benefits

A wide array of "on- farm" agricultural management technologies and practices are available or development that could increase yields and decrease pollution and water use; for example reducing yield gaps (not as high in Asia as in Africa), reducing subsidies, change land use and crop types, improving irrigation efficiency, diversified and intense cropping systems, limiting food waste, water harvesting, supplemental irrigation and precision farming and nutrient management. Innovative technologies and investments are required for education and training in the management of water for both irrigated and rainfed settings so as to achieve more productive use of water in agriculture. Decision- support (DSS) tools that inform farmers will be particularly important to smallholders. How much groundwater, pond water and rainwater will be available in different months

1. How water balance will look like in different months (present and future)
2. Whether available water is suitable for different uses
3. How much additional water storage is desired; and at what locations
4. How we as a community, can allocate the available water for different uses
5. Suitability of available land and water for various crops
6. Crop combinations that maximize income and risk involved)
7. Amount of water needed (& at what stages) for particular crop combinations.
8. How soil fertility will change and which fertilizers should be used.
9. What crop/PH processing will add value to products and enhance income
10. Besides agriculture, what other livelihood options will be viable given location, land- holding, income group, etc.
11. What market avenues are available?
12. Which gov't. schemes are available and for what purpose and when
13. Which gov't./local institutions can offer assistance and for what and when
14. Which TK/products can enhance income
15. What infrastructure facilities will be required (seed bank, storage, implements, fertilizers, insecticides, market, insurance, technologies).

3.5. Considering funds and earnings to lower resource burdens from inputs and pollutants

Decision- support tools would enhance agricultural risk management, particularly for smallholders, and would be critical in enabling farm households to adopt new technologies, diversify their activities, and sustain food security during periods of high input prices, low crop yields and major weather events. A more systematic use of climatic index- based insurance products and investments in infrastructure that enhance the availability and transport of farm inputs, crop and livestock products, and reduce the transaction costs of marketing farm produce would also provide support; they would increase the value generated by farmers using limited water resources while improving household food and nutritional security.

Self check # 3	Knowledge questions

Name: _________________________ Date: _______________

Directions: Answer the following questions in the space provided

1. What is the purpose of improving scientific knowledge of crops' water needs what is crop *(2 points)* ____
2. Describe irrigation system performance *(4 points)* ____
3. Describe the parameters used to evaluate the response of the crop to irrigation *(4 points)*

Note: satisfactory Rating-5 and above pts. Unsatisfactory Rating-below 5 pts.

You can ask your teacher for the copy of the correct answers

Information sheet 4	Build value addition producer groups' entrepreneurial and business planning capacities

4.1. Engaging training in the communication and delivery of entrepreneurial skills

4.1.1 Introducing entrepreneurship training

Entrepreneurship, value chains and market linkages are terms that are being used more and more when talking about agricultural irrigation and farming. Many small-scale farmers and extension organizations understand that there is little future for farmers unless they become more entrepreneurial in the way they run their farms. They must increasingly produce for markets and for profits. Becoming more entrepreneurial can be a challenge for small-scale farmers. They will need help from extension workers and other institutions.

What is an entrepreneur?
An entrepreneur is someone who produces for the market. An entrepreneur is a determined and creative leader, always looking for opportunities to improve and expand his business. An entrepreneur likes to take calculated risks, and assumes responsibility for both profits and losses. An entrepreneur is passionate about growing his business and is constantly looking for new opportunities.

Cultivators as entrepreneurs
Can small-scale farmers become entrepreneurs? Yes, particularly if they get engage of training in the communication and delivery of entrepreneurial skills that is geared to cultivating the entrepreneurial spirit of business-oriented processors.
Small-scale farmers all over the world have shown a remarkable ability to adapt. They look for better ways to organize their farms. They try new crops and cultivars, better animals, and alternative technologies to increase productivity, diversify production, and reduce risk and to increase profits. They have become more market oriented and have learned to take calculated risks to open or create new markets for their products. Many small-scale farmers have many of the qualities of an entrepreneur.

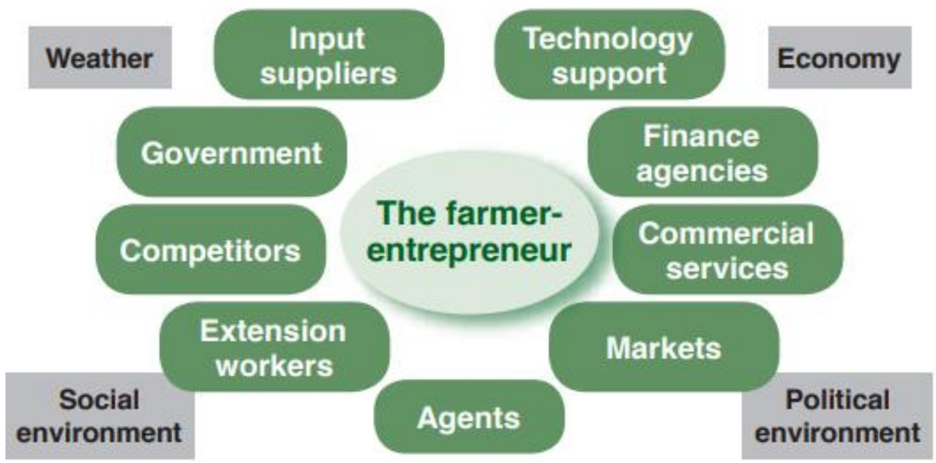
For small-scale farmers to become entrepreneurs they need all of these qualities and more. They need to be innovative and forward-looking. They need to manage their businesses as long-term ventures with a view to making them sustainable. They need to be able to identify opportunities and seize them. Some small-scale farmers do have these qualities, but they still focus on maintaining their traditional way of life. Their production decisions are based on what they need not on what is possible.

The training for cultivator's entrepreneurs should create and develop the learning processes that stimulate and encourage the farmers actively to look for knowledge.
This can be achieved by:

- Putting the farmers own development in focus and asking the right questions.
- Emphasizing the development of dialogue between the farmers and, encouraging the farmers to discuss solutions and ask questions among each other.
- Developing the team spirit so the farmers feel secure.
- Strengthening the farmers' self-confidence.
- Applying a common view on the process of knowledge which allows the farmers to apply what they have learnt in everyday situations.
- Making different options clear.
- Encouraging co-operation among the farmers and prevent competition.
- Gearing to cultivating the entrepreneurial spirit of business-oriented processors.

4.1.2 Understanding the entrepreneurial environment

While farmer-entrepreneurs are free and independent, they do not work alone. They operate in a complex and dynamic environment. They are part of a larger collection of people including other farmers, suppliers, traders, transporters and processors, each of whom has a role to play in the value chain.



Uncertainty in the entrepreneurial environment

For farmers to cope with the risks they will face in the complex world in which they compete, they need to develop an entrepreneurial spirit. A farmer with an entrepreneurial spirit energetically, enthusiastically and carefully makes many different decisions about his farm in the context of the value chain that influences the profits of the farm business. This is all happening in a dynamic, ever-changing and uncertain setting.

4.2. Continuing capacities building in business planning, administration, accounting, work organization, and human resource management.

4.2.1 Continuing capacities building

Business is any form of commercial organization involving either services or goods for the sole purpose of making profit. Business development in agribusiness refers to process that are essential in the initiation, development and growth of an irrigated agricultural business.

In order to improve up the capability of enterprisers must take a continuous training and discussion focused on the following points.

a. What is a business?
b. What types of businesses exist in the agricultural value chain?
c. Why should farming be practiced as a business?
d. What is required for a business to grow over time?

Business plan

A business plan allows the entrepreneur to write down the business operation on paper. This will help to evaluate how the business is likely to perform before investing money and time.

The farmers should discuss what is required to effectively plan for a new enterprise by asking the following questions:

a) Where will the product come from?
b) How much does it cost to produce it?
c) Where will the product be sold?
d) How will the product be delivered to the market?
e) How much profit will be made from the product?
f) Are there sufficient resources to produce and sell the product at a profit?

Administrating organization and coordination

Organization involves the coordination of all aspect of the business that is essential for it to succeed. This will include organization of production and marketing through good leadership. Ensure that all the responsible staffs are available and are doing their work well.

Success through collaboration

Key success factors to collective entrepreneurship

There are some factors that are critical for collective marketing to be successful. These factors include:

- Group leadership: the group must have dedicated and committed leadership with a clear vision to steer the group to achieve its objectives.
- Members' participation: members must actively participate in group activities e.g. attending meetings, production etc.

- Trust among members: members should trust each other and their leaders with emphasis on integrity and ethics.
- Information: the members must be well informed about the marketing activities of the group to enable theme participate in decision making.
- Laws to govern group activities: the group must have clear and enforceable law to manage the members and the leadership.
- Division of labor: member or leader must have clearly defined roles in the management, promotion and marketing of the group products.
- Record keeping: there must be clear records to ensure the payment are made based on the supplied done by each member and to help the group grow through access to credit and other technical services.
- Market information: information on prevailing market trends are essential in decision making and planning purposes. This can also be achieved through market research.
- Uniformity and high quality of group products (variety, size, color etc.).
- Benefit sharing: there must be transparent and equitable distribution of benefits.

Financial planning and accounting

The cultivator organization (as well as individual farmers) should work out a budget for all the operations to be undertaken and explain how the activities are to be financed.

- A budget should be done for all operations for the farmer group.
- The business plan should as well consider how the finances will be managed to by the group members.
- A basic understanding of finance enables a farmer to make strategic decisions to ensure efficient operations.
- Important financial records that farmers need to generate and understand for their business are balance sheet and profit and loss account.

The financial plan is a key component of your business plan because the process of creating financial projections for your business revenues and expenses, cash flow, and financial.

Acquiring and applying credit management skills

- Loans need to be well managed to ensure that it is used for the purpose for which it was obtained and that repayments are promptly made.
- The group has to appraise itself on the technical ability of her members to pay.
- An accountant may also be required to help the group manage the funds where the technical expertise cannot be internally obtained.

4.3 Assisting implementation of business plans

Implementation of business plan is the process that turns strategies and plans into actions in order to accomplish strategic objectives and goals. Implementing your strategic plan is as important, or even more important, than your strategy.

- The business plan is the image of your business idea, your goals and how they can be achieved. The structure of a business plan will vary depending on the nature of the business.
- The business plan is a written document that provides an overview of the company, its future and financial position.
- The business plan of the company explaining the situation, plan the future, action plan, how much it will cost and who will be the associated revenues.
- A business plan contains a description of your company (products/services), target market, marketing plan and sales strategy, a review of financial documents and the management team.
- The business plan is a working tool used to start and run a business that requires material resources, human and financial.
- It is a guidance and shape direction of activities of firm/firms.
- Business plans must help investors understand and gain confidence on how you will meet your customers' needs.
- Eight common parts of a good Business Plan are:
    - ✓ Executive Summary
    - ✓ Business Concept/description
    - ✓ Products and Services description
    - ✓ Market Analysis(Market research)
    - ✓ Management Team
    - ✓ Marketing Plan (4P's)
    - ✓ Financial Plan
    - ✓ Operations and Management Plan

Based on the above eight common parts of a good business plan we can assist the implementation of our innovated irrigation practice with their business plans throughout the project to include regular coaching sessions and mentoring activities. That means a mentor or coach is an 'accountability partner' who works in their protégé's best interests. He or she will bring a new approach to either a specific skill or an entire career. Neither mentoring nor coaching is about teaching, instruction or telling somebody what to do for innovated irrigation practices.

4.4. Linking target value adding producer groups to existing finance schemes

Advances in value chain knowledge and experience have taken place in parallel with the evolution of financial services, although the two have often developed as separate processes. In particular, an agricultural value chain is no longer viewed as a single channel that tracks a product from a farmer to a market, but as a complex chain that is impacted by relationships within the chain, enabling environments, availability of appropriate services and inputs from technology to raw materials, and most importantly, changing market demand.

Important value chain innovations in the irrigation schemes that support the financing of the chain are:

- The development of models for market access such as contract farming, lead firm buyers, vertically integrated chains, networks of producers and buyers, and various niche markets, including organics and fair-trade.
- Assessing relationships through a range of analysis techniques: for example, value chain drivers, linkages, power relationships, and value chain control and governance.
- Development of commodity management companies with end-to-end service support options for ensuring compliance, security and quality, as well as facilitating finance.
- Commodity exchange development with rapid and accessible prices and trade opportunities for facilitating trade, risk management and opportunities for use of new financial instruments.
- The promotion of industry competitiveness through the formation of member-led industry associations, market assessment and development strategies, promotional tools, branding, product life cycle and product differentiation.

With the growth of micro finance, social investment, and other forms of non-conventional funding, creative forms of financing are being developed, and existing financial institutions have become more flexible and resourceful. These efforts are supported by donors who frequently offer loans or grants, guarantees, capacity building and other forms of assistance that can aid financial institutions in high risk, low collateral lending.

Why should entrepreneurs or innovators use the value chain approach?

The four major drivers of change that trigger and promote value chain development in agribusiness are;

1. Supplying the market in a timely manner and at the lowest cost: ensures that products are availed to the consumer when they want them, at the place they can access the product, at the right quality and at the best price.
2. The product delivered to the consumer must satisfy the consumer quality needs. The quality of the product enables the product to compete with similar products for other producer and provide the market edge required to develop sustainable businesses for farmer groups.

3. Identifying the product required by the market and supplying it to the consumers. Before making a decision to invest in a new or differentiated product there must be sufficient demand or market for the product.
4. Understanding the rules and regulation that govern production and marketing of the product. The relationship between different value chains actors also determine the environment is which a business operates. These relationships are often influenced by social, economic, political and cultural environment, which determines the nature and success of business transactions within the chain products and services.