Annex 3.4

# Methodological and institutional framework for an information system on agricultural water use

**Federal Democratic Republic of Ethiopia**

**Ministry of Water Resources**

**Food and Agricultural Organization of the United Nations**

**Project: Strengthening National Water Monitoring Capacity with Emphasis on Agricultural Water Management**
**GCP/GLO/207/ITA**

# METHODOLOGICAL AND INSTITUTIONAL FRAMEWORK FOR AN INFORMATION SYSTEM ON AGRICULTURAL WATER USE

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# 1. INTRODUCTION

Irrigation development in Ethiopia dates back centuries but the area developed under irrigation is very small compared with the potential and needs of the country and the irrigation practised is inefficient. Both the area developed under any form of irrigation and the water abstraction for agriculture is unknown. On the other hand, the Federal Democratic Republic of Ethiopia has given top priority for water resources development and improved water management in order to improve food security and promote economic growth. However, lack of information on water use particularly on agricultural water use poses difficulties in proper planning and development of water-based programmes and projects. It is therefore imperative to monitor irrigated area, agricultural water use and related environmental effects in order to enable informed decision making in development planning and improving irrigation management.

In this context, this methodological framework is prepared as part of the project: Strengthening the National Water Monitoring Capacity with Emphasis on Agricultural Water Management. The suggestion is made based on the existing institutional setup at federal and regional bureaus as well as the anticipated establishment and strengthening of basin level authorities.

The proposal is prepared to serve as a general methodological framework which can be applied by stakeholders involved in irrigated agriculture who are supposed to monitor and report to the relevant institution.

# 2. INDICATORS AND DATA FOR MONITORING

## 2.1 Indicators Related to Agricultural Water Management

The following four indicators are considered for monitoring.

Proportion of water use as percentage of renewable water resources (only agricultural water use is considered within this framework).
Irrigated area under "advanced practices" (sprinkler and localized) as percentage of total irrigated area
Area under irrigation and "improved rainwater agriculture"[1] per capita by type of system.
Area treated with soil and water conservation measures as a percentage of total treated area.

However, as population data is not or could not be available by hydrologic unit or river basin, calculation of the irrigated area per capita cannot be made. Hence, this indicator is modified to reflect the area under irrigation.

Therefore, the data to be monitored should at least enable the estimation of these indicators. Moreover, additional data that can be easily monitored are also included to enable monitoring other aspects of irrigation water management. The data to be collected or monitored are divided into three categories:

1. Data on Irrigation schemes of all types.
2. Improved agricultural water management - woreda aggregate for areas up to 2.5 hectares.
3. Soil and water conservation (woreda aggregate).

## 2.2 Types of Information and Data for Monitoring

The data to be collected is not limited to those required for estimating the indicators. Accordingly, the data to be collected under the above categories are given in Table 1. Details on these are provided in the Baseline Survey Report. Technical aspects of data collection and estimation of data at field level are provided in the Guideline for Agricultural Water Use Monitoring.

[1] "Improved rainwater agriculture" comprises non-conventional irrigation such as rainwater harvesting, spate irrigation and runoff farming.

**Table 1: Data to be collected**

| At Irrigation scheme level | Improved Rainwater Agriculture at woreda level | Soil and water conservation at woreda level |
|---|---|---|
| Location (administrative, hydrologic, geographic and agro-ecologic)<br>Area (equipped, actually irrigated and harvested)<br>Water Resources and method of abstraction<br>Irrigation system and scale<br>Environment and scale<br>Investment related information<br>Socio-economics (beneficiaries by gender, ownership)<br>Cropping pattern and production | Location (administrative, hydrologic, agro-ecologic)<br>Irrigated area (by type of system and water abstraction<br><br>Beneficiaries<br><br>Cropping pattern | Location (administrative, hydrologic)<br><br>Areas treated by type of measures:<br><br>– Physical<br>– Biological<br>– Area closure |

## 2.3 Calculation of Indicators

The four indicators can be calculated from the data collected above. The calculations of the four indicators are provided in Annex 1.

# 3. INSTITUTIONAL RESPONSIBILITIES

## 3.1 Data Collection from Community Schemes

As per the existing instructional setup and responsibilities, the Ministry of Water Resources (MoWR) is vested with the mandate of the overall water resources development and management. It is also responsible for medium and large-scale irrigation schemes while the Ministry of Agriculture and Rural Development (MoARD) is responsible for small-scale irrigation development. These federal ministries do not have branches at the regional level. Basin authorities which will be responsible for managing and administering water resources in the basins are also being established. So far, only the Awash River Basin Authority is in place but it is not in a position to exercise its mandate due to limitations of capacity.

The regional water bureaus are involved in the implementation of small-scale irrigation projects and water supply schemes. The structural set-up of the bureaus differ from region to region. The Amhara Regional Bureau of Water Resources has three core processes: Water supply and sanitation; Irrigation and Drainage; and Water Resources Management with branches down to woreda level. The Water Resources Management Process is mandated to deal with information related to water resources, irrigation management and water supply and sanitation, The Oromia Regional Water Bureau has two technical processes on Water supply and Sanitation, and Irrigation and Drainage. The Irrigation and Drainage Core Process deals with irrigation development and management but does not handle agronomic aspects of the irrigated agriculture. It is expected that other regions have similar institutional set-ups.

On the other hand, the Agriculture and Rural Development Bureaus of all regions have well-established structures down to kebele levels and hence irrigation scheme levels. The woreda and development agents of the bureau are responsible for the day-to-day management of irrigation schemes and water harvesting systems as well as catchment treatment.

Although the presence of the agriculture and rural development bureau at grassroots level makes the bureau suitable for collecting agricultural water management related data through its Development Agents (DAs) supported by their woreda supervisors, responsibility should be shared between Water and Agriculture bureaus as explained below.

As explained above, the monitoring format consists of three distinct items (irrigation scheme, water harvesting and soil and water conservation). The irrigation scheme format is further divided into location, area and water related data, socio-economics and cropping pattern.

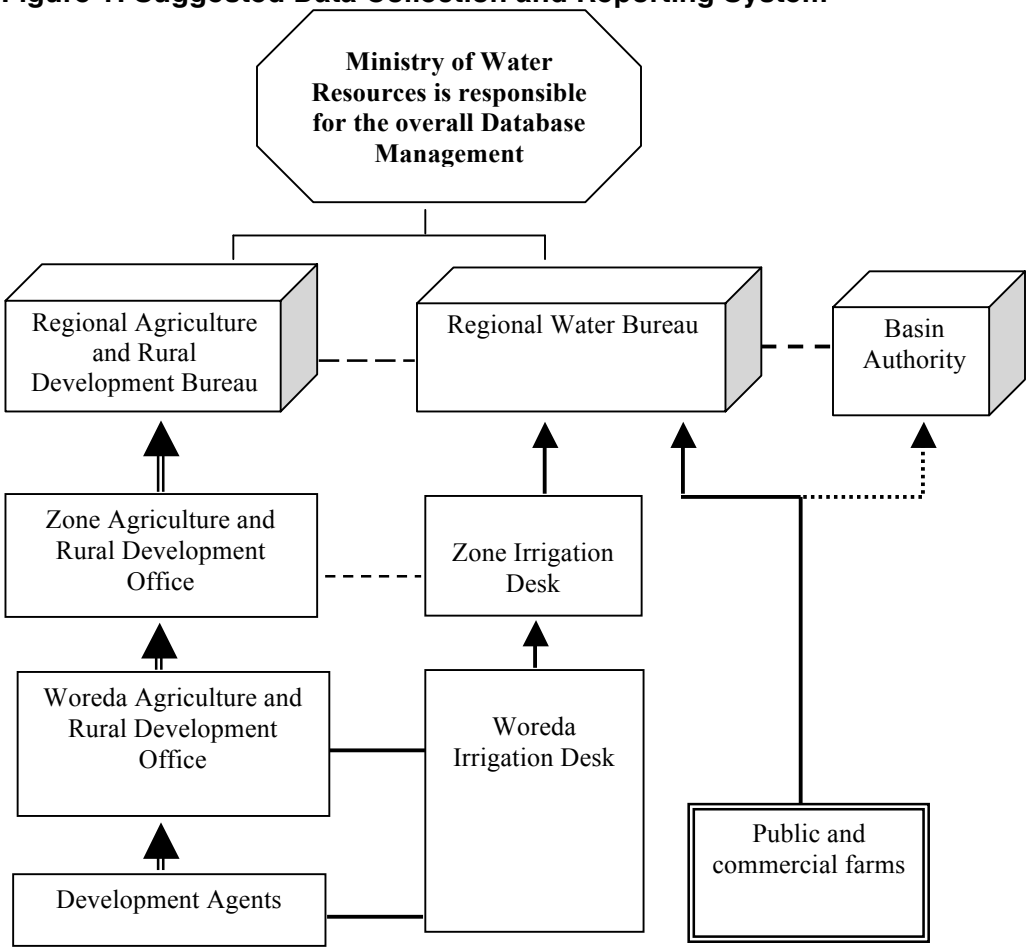
Although both bureaus work together at woreda level, it is suggested that the two bureaus collect categories of data as indicated below.

| **Water Bureau** | **Development Agents/BoARD** |
|---|---|
| Location of irrigation scheme | Cropping pattern |
| Area related information | Soil and water conservation |
| Socioeconomics | |
| Water harvesting | |

This division is based on data entry structure of the database. Water harvesting is the responsibility of the water bureau in the Oromia region while it rests with the agriculture and rural development bureau in others. Moreover, the water bureaus do not have water desks in all woredas and those already in place do not have the capacity to handle the issues. In all cases, therefore, the two bureaus have to discuss and decide on the issue. Moreover, they need to co-review the information at different levels as depicted by the dotted lines in Figure 1 below.

Community irrigation schemes are not necessarily small scale. Therefore, all modern and traditional community schemes should be handled by the water and agriculture Rural Development Bureaus, regardless of scale.

**Figure 1: Suggested Data Collection and Reporting System**




**Key for information flow**

Data to be handled by MoARD
Cropping pattern
Soil and water conservation

Data to be collected by Water Bureau
Irrigation and water harvesting
– Area related data
– Location
– Socio-economics

Closely working together

Review/consultations by both bureaus

Future reporting to basin authorities

Collection and calculations

Data checking, calculations and entry

## 3.2 Data Collection from Public and Commercial Irrigation Schemes

Public irrigation schemes are medium and large-scale farms while private commercial farms could range from small to large scale. The cropping patterns on these farms are limited to a single crop or very few cash crops and hence no complex multiple cropping pattern is expected.

Collection of monitoring information and data on these farms could be handled either by the river basin authorities of the farms themselves. The latter is preferred as the farms should also take part in the monitoring activities. The farms should complete the monitoring format and report to the river basin authorities which check the validity of the information. Until the river basin authorities are established or strengthened, the farms should report to the regional water bureaus.

## 3.3 Data Quality Check, Analysis and Entry

As the monitoring information is a pre-requisite for making appropriate decisions, the data to be collected should be of good quality. Collection of good quality data depends on the capacity of the woredas/development agents in terms of skill and facilities. Therefore, the first and most important measure to be taken is improving the capacity of the woreda administrations in water management. This will not, however, avoid the need for data quality checking. While data are checked at all levels, the final check will be made by the respective regional bureaus and river basin authorities.

With regard to data analysis, the only analysis or calculation required is the estimation of irrigation water requirement if measured values of agricultural water withdrawal are not available. This could be handled at region, zone or woreda level. It is preferred to make the estimations at woreda level because it is easier to handle a few irrigation schemes than many schemes at region or zone level. The prerequisite of this option is capacity development at woredas in terms of skill and provision of necessary meteorological data. The second alternative is the zones but currently in the same situation of the woredas in terms of capacity. Moreover, some regions do not have water or agriculture offices at zone level. Therefore, until the capacity of the woredas/zones calculations of agricultural water withdrawal should be made by region.

The fact that Water Bureaus are currently involved in studies and designs which include estimation of irrigation water requirements makes the bureau fit to estimate agricultural water withdrawal. Therefore, the suggestion is that the regional water bureaus do the calculations based on the actual cropping patterns to be provided by Agriculture and Rural Development Bureau. The same suggestion holds true for zone or woreda water desks when their capacities are improved.

For public and private commercial farms, both farm enterprises should make the calculations and report to the basin authorities which check the correctness of the estimations.

Data entry into the database system goes with the reporting mechanism outlined above. Therefore, regional water and agriculture and rural development bureaus and river basin authorities will enter the respective data they will collect. However, before encoding the collected and estimated data, these organizations need to establish a forum at regional level to discuss the important indicators such as the irrigated areas, agricultural water withdrawal and crop yields which are critical for decision making.

## 3.4 Database Management

Database systems cannot operate without human intervention. They need dedicated human resources for their successful operation, administration and maintenance. Without thorough understanding of how the system functions, no one can use the database system. Most importantly, a clear statement of who owns and is responsible for the maintenance of the database is crucial for the successful operation of the database system. As the Ministry of Water Resources owns the database system, the overall responsibility of operation and maintenance of the database rests with the MoWR. The database system will be hosted within the Information and GIS Center of the Ministry.

The MoWR will manage user accounts and access privileges for data entry and updating. As this database will be linked to the MoWR web site, the existing practice of web site maintenance will continue.

Through time, modification in the business rules of the organization will require resetting parameter values and modifying the application source code itself. User error may also cause data corruption and require the intervention of professionals. All these and performing backup and recoveries will be handled by the MoWR.

## 3.5 Capacity Building

As indicated above, awareness raising and capacity building at all levels is the pre-requisite for effective and efficient monitoring of irrigated agriculture. The regional bureaus in Amhara and Oromia will be trained by the FAO as part of familiarizing the database system. Hence, following the familiarization of the databases system by the project, the regions should organize tailored training to the development agents and database system operators. It is expected that the bureaus and river basin authorities will train the zones/woredas and public and commercial farms respectively with their own resources and expertise or with external assistance if required and available.

## Annex 1: Methodological Sheet for Indicator Computation

| **Indicator Name** | **Agricultural Water Withdrawal as a Percentage of Total Renewable Fresh Water Resources and Total Water Use** |
|---|---|
| Prepared by | MoWR/FAO |
| Challenge area | Determination of water use |
| Rationale/aspect of the challenge area | The agricultural water use will indicate the status of irrigated agriculture development and proportion of freshwater use as the knowledge of remaining potential or overexploitation of freshwater resources is essential for decision making. |
| Position in DPSIR chain | Pressure |
| Definition of indicator | Proportion of the total water use for agricultural production as compared with water use by other sectors and as a proportion of available water resources. As pressure on surface and groundwater bodies is determined by abstractions, water withdrawal rather than actual consumption is determined to calculate the indicator. |
| Underlying definitions | Agricultural water use comprises water use for crop production and livestock watering. The Gross Irrigation Water Requirement is defined as crop water requirement divided by Irrigation Efficiency. |
| Specifications for determinants needed | Total actual irrigated area covered by each crop<br>Irrigation water requirement of each irrigated crop/amount of water abstraction |
| Computation | $AWWP = 100\frac{AWW}{TRWR}$ $AWWC = 100\frac{AWW}{TWW}$<br>TRWR=SWR +GWR TWW=AWW + DWC + IWU<br>LWC=ΣLWCi<br>AWW= IWR + LWC<br><br>Where,<br>AWW= Agricultural water withdrawal (This is considered to be equivalent to IWR<br>AWWP= AWW as a percentage of TRWR<br>AWWC= AWW as percentage of TWW or use<br>SWR= Surface water resources<br>GWR=Groundwater resources<br>LWC= Livestock water use<br>IWR=Gross Irrigation water requirement<br>LWCi=Water consumption by type of livestock<br>TWW= Total water withdrawal<br>DWC= Domestic water consumption<br>IWU=Industrial water use<br>DWC and IWU are not considered in this exercise |
| Unit of measurements | Indicator measured both as amount in volumetric units and percentage<br>Determinants measured are area and volumetric units |
| Data sources, availability and quality | Water resources data from river master plans and water balance studies<br>Other data will be collected and reported by local levels using a format prepared for the purpose and passed to the highest level for analysis |
| Scale of application | At basin and national level |
| Geographical coverage | Global |
| Interpretation | The increasing trend of irrigation development and hence water use in agriculture shows government's priority to improving food security and promoting agriculture-led industrial development. The level of water use vis-à-vis irrigated area the need for developing strategies to improve water use efficiency and water productivity through integrated water management. |
| Linkage with other indicators | This indicator is linked with other indicators: total area developed under irrigation, area developed with different irrigation practices and income differential between farmers using irrigation and rainfed production systems. It is also linked with area treated with soil and water conservation measures which contribute to replenishing both groundwater and surface water resources |

| **Indicator Name** | **Area of land under irrigated agriculture or under improved rainwater agriculture (per capita) by type of system** |
|---|---|
| Prepared by | FAO |
| Challenge area | Determination of actual irrigated area |
| Rationale/aspect of the challenge area | The area developed under irrigation per capita will indicate the level of irrigated agriculture development vis-à-vis the population of a country and food security situation |
| Position in DPSIR chain | Driver/Pressure |
| Definition of indicator | The total irrigated area will indicate the status of irrigated agriculture as compared with the total cropped area in the country |
| Underlying definitions | Irrigated area comprises areas under different irrigation systems/technologies including conventional (modern and traditional schemes, and equipped spate and wetland systems) and non-conventional (improved rainwater agriculture) |
| Specifications for determinants needed | Actual irrigated area by type of irrigation system<br>Areas under different irrigation systems<br>Irrigation beneficiaries using different irrigation systems and total population |
| Computation | $Ap = \frac{AT}{Pop}$ $Asfc = \frac{Asf}{Pop}$<br>$Adc = \frac{Ad}{Pop}$ $Aspc = \frac{Asp}{Pop}$<br>**AT=Asf + Ad + Asp**<br>Where,<br>Ap=Irrigated area per capita<br>Asfc= Irrigated area by surface irrigation system per capita<br>Adp= Irrigated area by drip irrigation system per capita<br>Aspc= Irrigated area by sprinkler irrigation system per capita<br>AT= Total irrigated area<br>Asf =Irrigated area under surface irrigation systems<br>Ad = Irrigated area under drip irrigation systems<br>Asp=Irrigated area under sprinkler irrigation systems<br>Pop=Total population |
| Unit of measurements | Indicator measured in unit of area per person |
| Data sources, availability and quality | Data will be collected and reported by local levels using a format prepared for the purpose and passed to the highest level for analysis |
| Scale of application | At basin and national level as well as regional level |
| Geographical coverage | Global |
| Interpretation | The increasing trend of irrigated area shows government's priority to improve food security and promote agriculture-led industrial development and the area-population ratio indicates the level of irrigated agriculture development compared with significance of the investment |
| Linkage with other indicators | This indicator is linked with other indicators such as agricultural water use and the proportion of area developed under advanced irrigation practices |

| **Indicator Name** | **Irrigated area using advanced practices (% of total irrigated area) by type of technology** |
|---|---|
| Prepared by | FAO |
| Challenge area | Determination of actual irrigated area |
| Rationale/aspect of the challenge area | The area developed by advanced irrigation practices will indicate the level of skill and improved productivity and irrigation efficiency |
| Position in DPSIR chain | Driver |
| Definition of indicator | The area developed by advanced irrigation practices will indicate the level of skill and improved productivity and irrigation efficiency |
| Underlying definitions | Irrigated area comprises areas under different irrigation systems/technologies including surface, drip and sprinkler irrigation systems |
| Specifications for determinants needed | Actual irrigated area by type of irrigation system<br>Area under surface system<br>Area under drip system<br>Area under sprinkler system |
| Computation | At=Asf + Ad + Asp  Adv=Ad+Asp<br>$Asfp = 100\frac{Asf}{At}$  $Advp = 100\frac{Adv}{At}$<br>$Adp = 100\frac{Asd}{At}$<br>$Aspp = 100\frac{Asp}{At}$<br>Where,<br>Asfp=Area irrigated under surface irrigation system as a percentage of total irrigated area<br>Adp=Area irrigated under drip irrigation system as a percentage of total irrigated area<br>Aspp=Area irrigated under sprinkler irrigation system as a percentage of total irrigated area<br>Advp= Area irrigated under advanced irrigation practices as a percentage of total irrigated area<br>At= Total irrigated area<br>Adv= Area irrigated under advanced irrigation practices<br>Asf =Irrigated area under surface irrigation systems<br>Ad = Irrigated area under drip irrigation systems<br>Asp =Irrigated area under sprinkler irrigation systems |
| Unit of measurements | Indicator measured in percentage of total irrigated area |
| Data sources, availability and quality | Data will be collected and reported by local levels using a format prepared for the purpose and passed to the highest level for analysis. |
| Scale of application | At basin and national level |
| Geographical coverage | Global |
| Interpretation | The increasing trend of advanced irrigation practices shows the commitment and extension services in improving agricultural water management and water productivity |
| Linkage with other indicators | This indicator is linked with other indicators such as agricultural water use and the total irrigated area |

| **Indicator Name** | **Area of the watershed developed under soil and water conservation practices / measures (%) by type of measure** |
|---|---|
| Prepared by | FAO |
| Challenge area | Determination of actual treated areas by different measures |
| Rationale/aspect of the challenge area | Treatment of catchments with different types of soil and water conservation (SWC) measures will indicate the restoration of sustainable water resources |
| Position in DPSIR chain | Response |
| Definition of indicator | The area treated with different types of soil and water conservation SWC measures indirectly indicates restoration of sustainable water resources. |
| Underlying definitions | Catchment areas and land use types can be treated with different SWC which include physical measures (soil and stone bunds, hillside terracing, check dams, cutoff drains), biological measures (grass strips, agro-forestry) and area closure. |
| Specifications for determinants needed | Area treated with physical measures<br>Area treated with biological measures<br>Closed area for natural regeneration |
| Computation | $Atp = 100\frac{Asc}{Acat}$<br>$Abp = 100\frac{Aph}{Acat}$ $Aphp = 100\frac{Aph}{Acat}$<br>$Acp = 100\frac{Ac}{Acat}$ $Abtp = 100\frac{Abt}{Acat}$<br>Asc=Ab + Aph +Ac +Abt<br><br>Where,<br>Abp = Area treated with different biological measures as a percentage of total catchment area<br>Aphp = Area treated with physical measures as a percentage of total catchment area<br>Acp = Area treated with area closure as a percentage of total catchment area<br>Abtp = Area treated with biological and physical measures as percentage of total catchment area<br>Asc = Total treated area<br>Ab = Area treated with biological measures<br>Aph = Area treated with physical measures<br>Ac = Area treated with area closure<br>Abt = Area treated with biological and physical measures<br>Acat = Total catchment area |
| Unit of measurements | Indicator measured in percentage of total catchment or treated area |
| Data sources, availability and quality | Data will be collected and reported by local levels using a format prepared for the purpose and passed to the highest level for analysis. |
| Scale of application | At basin and national level |
| Geographical coverage | Global |
| Interpretation | The increased treatment of catchment areas with different SWC measures shows the level of awareness in natural degradation and prevention and restoration as well as commitment and preparedness in extension services in protection of natural environment and restoration of sustainable water resources |
| Linkage with other indicators | This indicator is not directly linked with other indicators but with renewable freshwater resources |