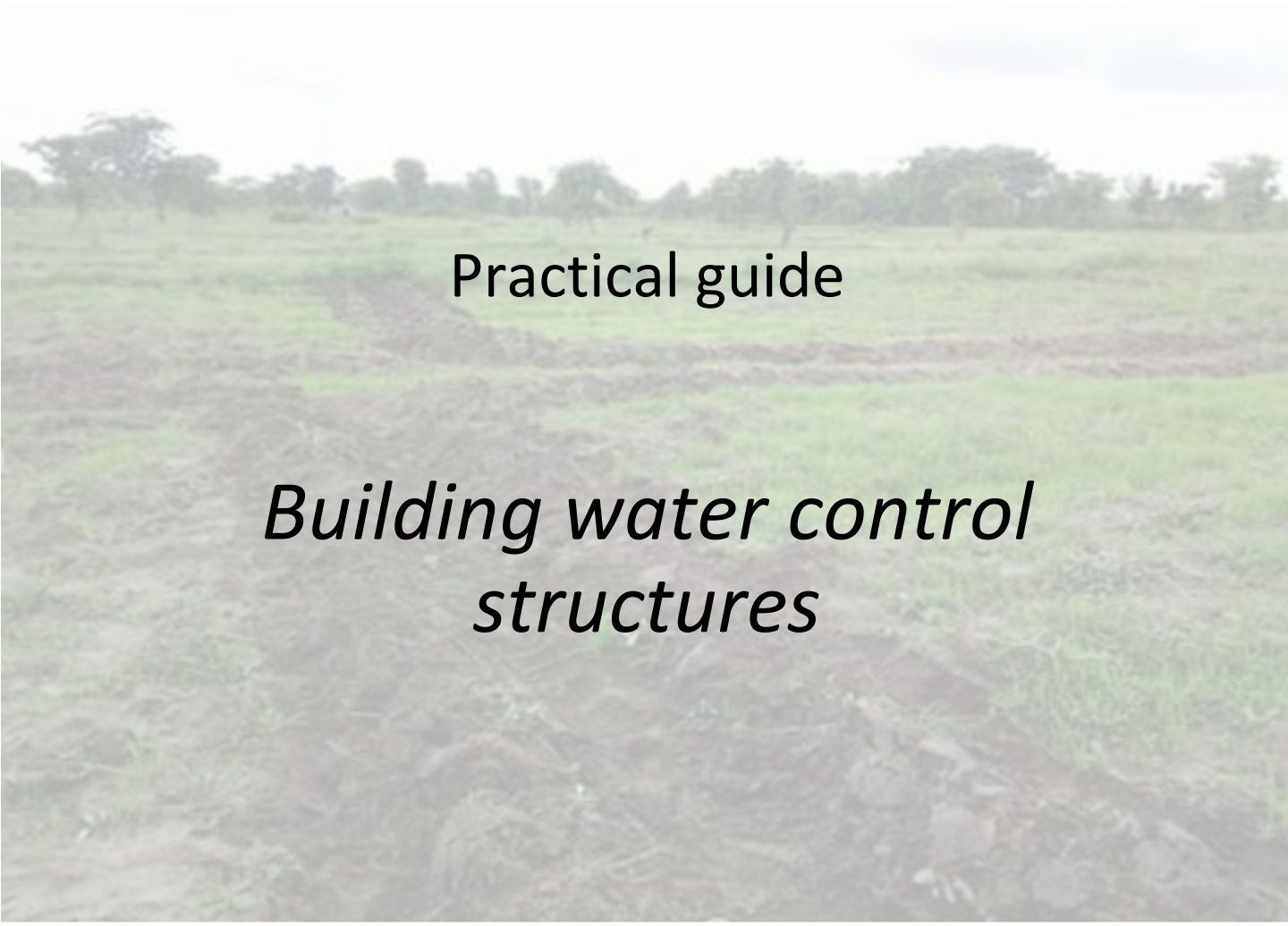
AfricaRice
Rice science at the service of Africa
La science rizicole au service de l'Afrique

AFRIQUe-learning



Practical guide

# *Building water control structures*

## *Summary*

## About AfricaRice and Afrique-learning

***AfricaRice:***

AfricaRice is a leading pan-African rice research organization committed to improving livelihoods in Africa through solid science and effective partnerships. AfricaRice is a research center of CGIAR, which is part of a global research partnership on future food security. It is also an intergovernmental association of African member countries. Today, it has 30 member countries. The mission of AfricaRice is to contribute to poverty reduction and food security in Africa through research, development and partnership activities, aimed at increasing the productivity and profitability of the rice sector so as to guarantee the sustainability of the agricultural environment.

***Afrique-Learning:***

Afrique-learning is a Beninese cooperative which creates and manages vocational e-learning courses specially designed for African youth. Courses are tailor-made in collaboration with experts in the field with the aim of producing interactive, illustrated, interesting and easy-to-study courses that provide the student with important information in simple and appropriate language. Learning is done independently at the student's own pace, it is assessed and a course certificate is attained following a final test. Courses are available on computer, smartphone or android tablet. They only require a very modest bandwidth and are therefore within the reach of students. Registration and classes are free.

## Acknowledgements

Development of the toolkit was supported by AfricaRice project: "Fostering the Impact of Rice Technologies for Better Livelihoods in Sub Saharan Africa (FIRITEL)" funded by the Belgian Development Cooperation.

# I. Description of the structures

*The construction stages of bunds, water inflow and outflow canals which controls and manages water movement for rice cultivation. It is a component of the Smart-Valleys development approach.*

## *Bunds*

- Bund belts, protection bunds or main bunds (all have the same size)
  - the bund belts frame the entire inland valley development
  - the protection bunds protect both sides of the main drainage canal
- Secondary bunds
  - they demarcate and frame the plots
  - they protect the secondary drainage canals

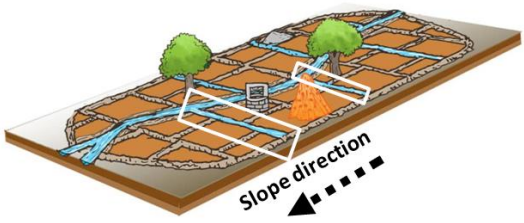
Bund belt [3]

The white frame shows the secondary bunds framing the plots [3]

# *Drainage canals (natural and artificial)*

- They ensure appropriate water distribution
- They drain and supply water to the field if necessary
- The canals are protected with bunds to reduce water pressure
- Main drainage canals
  - they are protected by protection bunds
- Secondary or transversal drain canals are perpendicular to the slope
  - they are protected by secondary bunds
  - they are positioned every two plots
  - they are less wide and less deep than the main drainage canals

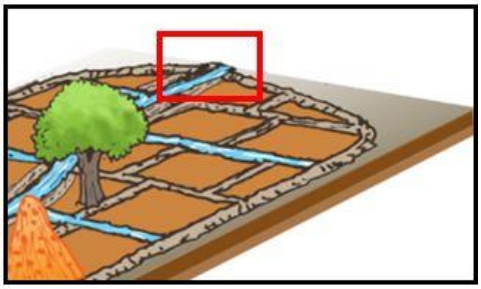
Construction of drainage canals [3]




The white frames shows the transversal drainage canal perpendicular to the slope [2]

# *Water supply structures and points of singularity*

- Water supply structures
  - the structure through which water enters the field
- Points of singularity:
  - these are obstacles in the field
  - they normally do not require additional work
  - examples: trees, wells, termite mound, hills



The red box shows water supply to the field [2]

Image of a point of singularity [3]

# *Plots*

- Area where rice plants are cultivated
- Framed by secondary or secondary bunds
- They must be properly levelled for better water distribution
- Plot size is determined based on field slope
    - the steeper the field slope, the smaller the plots will be for proper levelling

Framed plots - farmers undertaking the structures [3]

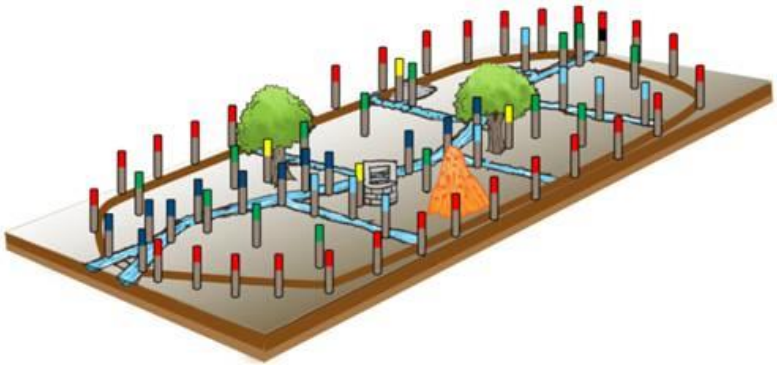
Cultivated rice plots marked on the photo with white lines [1]

# II. Activities, tools used and Procedure

*The construction of water control structures (bunds, drainage axes, water supply structures) and its success, require the actors, the working tools and the procedure of the building structures.*

## *Activities and tools used*

- Activities :
  - once pegging has been completed in accordance with the land development plan, experienced farmers are able to carry out the structures unaided
  - farmers who don't have such field experience needs to be guided by the technician-trainer
- Tools: cutlass, hoe, small plank for levelling



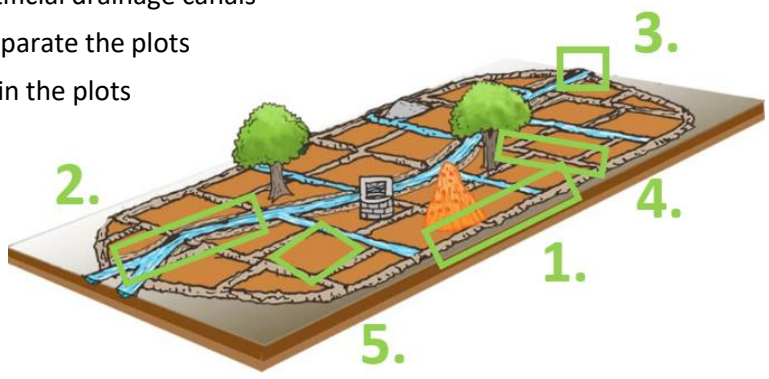
Pegged field [2]

Using a hoe [1]

# Procedure - Building the structures

You must always follow this sequence:

1. build the bund belts
2. build the protection bunds for the natural drainage canals
3. then build the water supply structures
4. once the natural elements have been built, the following structures are built:
   - secondary bunds for the artificial drainage canals
   - then secondary bunds to separate the plots
5. plough or till lightly and level soil in the plots




Water control structures [2]

# *Dimensions of the structures*

The work dimensions depending on soil type [I]

| Types of structure | Type of soil | Thickness/ width in cm | Height/ depth in cm |
|---|---|---|---|
| **Belts / protection bunds** | Sandy soil | 60 - 80 | 60 - 80 |
| | Clay soil | 50 - 60 | 50 - 60 |
| **Secondary bunds** | Sandy soil | 40 - 50 | 40 - 50 |
| | Clay soil | 30 - 40 | 30 - 40 |
| **Secondary drainage canals** | Sandy soil | 30 - 40 | 15 - 20 |
| | Clay soil | 25 - 30 | 20 - 25 |

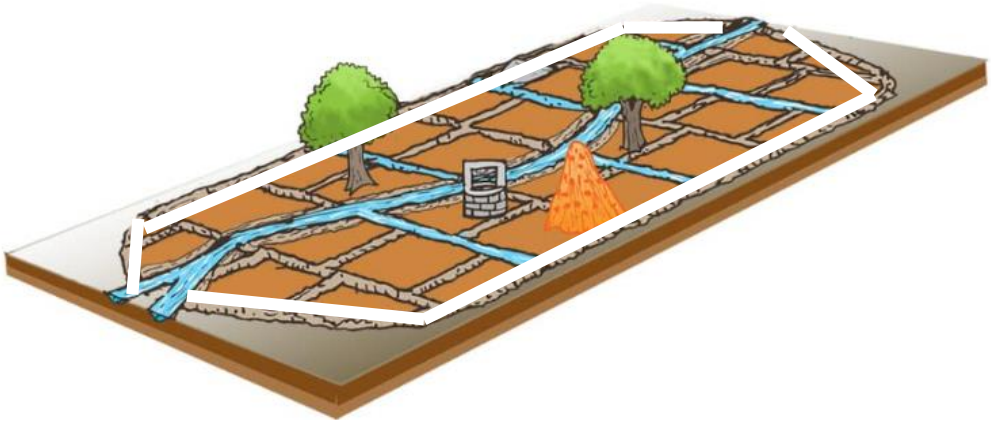
Silt clay soil [1]

Sandy soil [3]

# III. Detailed steps for building the structures

## *1. Belt bunds*

- They are built on the borders of the development site (except in places where the drainage canals pass)
- You should modify the bunds dimension according to the usual water pressure on site
- Reinforce bunds with stones or sandbags if necessary

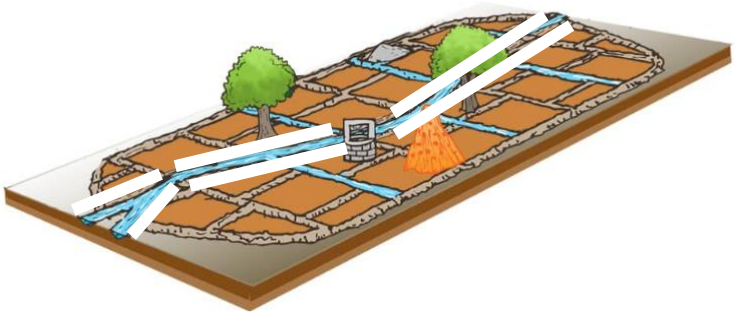


Belt bunds (here in white) surround the development site [2]

# 2. Main drainage canal

The construction of protection bunds (to protect the main drainage canals) is carried out by digging soil and compacting it.

- As much as possible, existing drainage canals are not deepened
- Leaving grass on the water (over a width of 2 to 3 m, even more if there is a lot of water) is the best way to avoid erosion
- Avoid disrupting what is already in place as much as possible
- Rectify or correct water flow if necessary
- Fill the deeper parts of the drainage canals with stones
- Widen them if necessary to facilitate water flow and reduce erosion or run-off

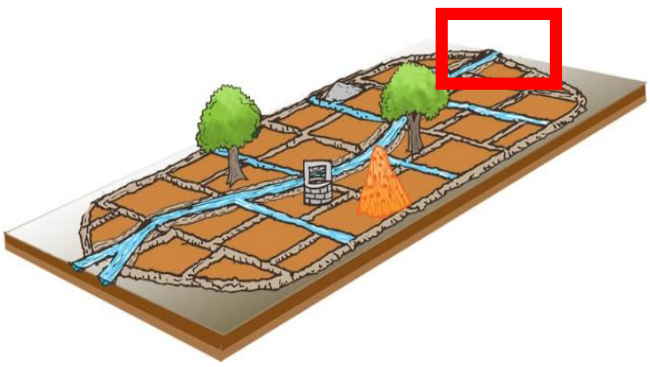


Visualization of the protection bunds of the main drainage canal [2]

Completed drainage canal [3]

# 3. Water supply structures

- Special attention must be paid to the water inflow points into the inland valley site
- The structures required must extend beyond the width of the drainage canal in order to avoid overflow, which can cause serious damage
- For water control use solid materials like stones if possible
- Finally, check that the whole system is working properly after a heavy rainfall



water supply structures marked in red [2]

Water control with stones [4]

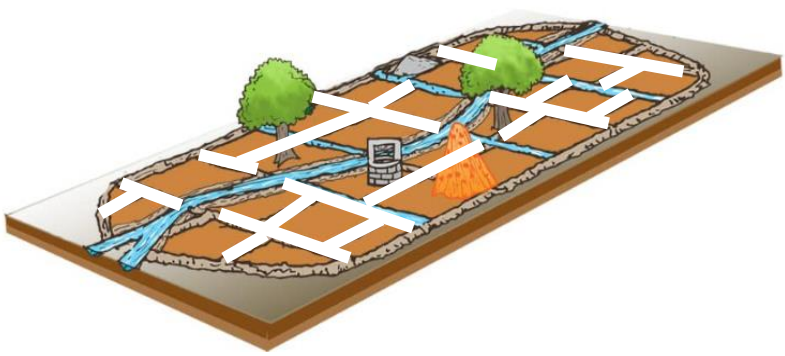
# *4.1 Secondary drainage canals and transversal drainage canals*

- Secondary drainage canals are generally perpendicular to the slope
- They should be dug - to create an artificial passage to channel water
    - the secondary bunds (which protect these canals) are built by raising the soil and are constructed first on both sides of the secondary canals
- The direction of the secondary natural drainage canals can be changed depending on the field
- They are repeated every two plots
- They must not be linear

In white are additional water canals dug in accordance to the field [2]

# *4.2 Secondary bund*

- They are raised to separate individual plots (adapt the dimension of these bunds to the usual volume of water)
- In principle the inland valley development plan should be followed, but it is possible that additional bunds need to be constructed
- It is important to ensure that each plot has at least one border a secondary or main canal (in order to ensure that water can be brought in or drained out without passing through other plots)
- To finish demarcate or isolate the points of singularity (with small bunds or small canals- depending on the land configuration around a termite mound, for example)



Secondary bunds marked in white [2]

# 5. Developing the plots

- Basic principles:
  - properly level the plots to ensure good water distribution
  - the objective is to obtain a layer of water with consistent depth at the time of flooding and drying at a homogeneous rate during the dry period
- One of the borders of a plot should correspond to a secondary bund
- Levelling within the plots will be perfected using sensible cultivation techniques:
  - tilling should be done in a direction roughly perpendicular to the slope of the plot
  - depending on the case, it will be done in a manner that:
    - will move the soil up the slope (to compensate for natural erosion
    - or on the contrary move it down (thus contributing to creating terraces, but only if the lower bund is high and solid enough to hold the soil)

Developing the plots within the bunds [3]

Plot levelling with a plank [1]

# IV. Practical advice

## *Long lasting structures*

- How long lasting and solid the structures will be depends on the soil type, their dimensions (height, thickness, width and /or depth) the season and the care taken during construction
- Construction built with clay soil are more long lasting then those built with sandy soil
- structures undertaken during the rainy season do not last well on sandy soil they collapse while being constructed
- Generally, hastily undertaken structures when helping others are less long lasting than those carefully built by the inland valley farmers themselves

Construction with clay soil [1]

Construction with sandy soil [3]

# *Measures to protect the structures*

- To avoid erosion, lateral drainage canals should not discharge directly into the natural canal(s)
- To avoid a « cascade » effect from the speed of the water flow, specific constructions should be built that should avoid or limit erosion (using stones)
- It is also useful to build anti-erosion structures (using vegetation or stones) at the head of secondary drainage canals in order to avoid a rise of this part of the canals and especially to reduce the speed of water flow in the canals, thereby reducing the erosive force of the water

Erosion prevention measure: use of stones [4]

# *Recommandations*

- Carry out the development structures at the right period: the beginning of the rainy season or end, after the drainage of excess soil water
- inland valley development always begins from the head of the inland valley or its highest part for better water management
- Monitor the hydrodynamic regime of inland valleys with predominantly clay soils on a regular basis in order to determine the right period to carry out the development
- Avoid using mutual aid or community work groups to carry out development, as this approach does not guarantee the quality of work
- Take advantage of the rains during the development work to make corrections and adjustments in order to ensure the proper functioning of the structures

Corrections to be made after rainfall [1]

# *Glossary*

**Inland valley development :** Transformation of an agricultural area through the building of water control structures such as bunds and drains [a]

**Upstream** : The side where a stream comes from, the direction of its source [b]

**Water inflow :** Water inlet into the field (for example a steam) [a]

**Downstream :** Situated or moving in the direction where water flows, in the direction of the wtercourse current. [b]

**Drainage canal :** Natural or artificial canals that control the movement of water, especially to drain excess water (in a developed inland valley field, they are reinforced by bunds ). [a]

**inland valleys :** A generally humid agricultural area with characteristics of soil moisture and fertility, making it better than agricultural lands of the plateau. [a]

**Plots :** The space between the dividing bunds where rice is actually grown. [a]

**Bunds:** Small walls that secondary the plots, so that the water level is managed for rice production [a]

**Points of singularity:** A natural obstacle in the inland valley ground which the development will need to take place. For example termite mound, a tree or rocky outcrop. [a]

**Draft:** In the context of Smart-Valleys development, this is an illustration of the field, a sketch made during the site visit to locate all the elements of the field. This draft is the basis for creating the land development plan. [a]

**Hydrodynamics:** The dynamics in space and time of ground and surface water movement (in the inland valley) [a]

**Pegging:** In this context, it is the transfer of information from the land development plan to the actual field, through the marking and planting of stakes. The actual development of the inland valley will then follow these markings. [a]

**Levelling:** is the action of creating a flat or even-ground surface, in this context, it is to level the plot for better water distribution. [a]

**Work:** in this context, the work is an element of the inland valleys development that is built with earth, on the ground, for example bunds or drainage canals. It is also referred to as structure. [a]

**Structure :** In this context, the structure is an element of the inland valleys development that is built with earth; on the ground, for example bunds or drainage canals. It is also referred to as a work. [a]

**Slope:** inclination of a surface with respect to the horizon. [c]

**Site:** This is the inland valley to be developed or under development. [a]

# *Sources of image / illustrations*

[1] Photos provided by AfricaRice

[2] Illustrations produced by Eudox Béatitudes for AfricaRice

[3] Photos taken by Dr Soklou Kodjo WOROU

[4] Photos taken by Justin Djagba, AfricaRice

[5] *Smart Valleys* : Manual of trainer-facilitator (Defoer et al, 2017), AfricaRice

[6] https://fr.wikipedia.org/wiki/Machette#/media/File:Machete.png

# *Sources of glossary definitions*

[a] Justin Djagba, AfricaRice

[b] https://cartebateau.com/fr/amont-aval-definition

[c] https://www.larousse.fr/dictionnaires/francais/pente/59310?q=pente#58949

[d] https://fr.wikipedia.org/wiki/Piquetage_(g%C3%A9om%C3%A8tre) / Justin Djagba

[i] https://fr.wikipedia.org/wiki/Tari%C3%A8re

[j] https://fr.wikipedia.org/wiki/Implantation

# *Sources des tableaux*

[I] Soklou Kodjo WOROU