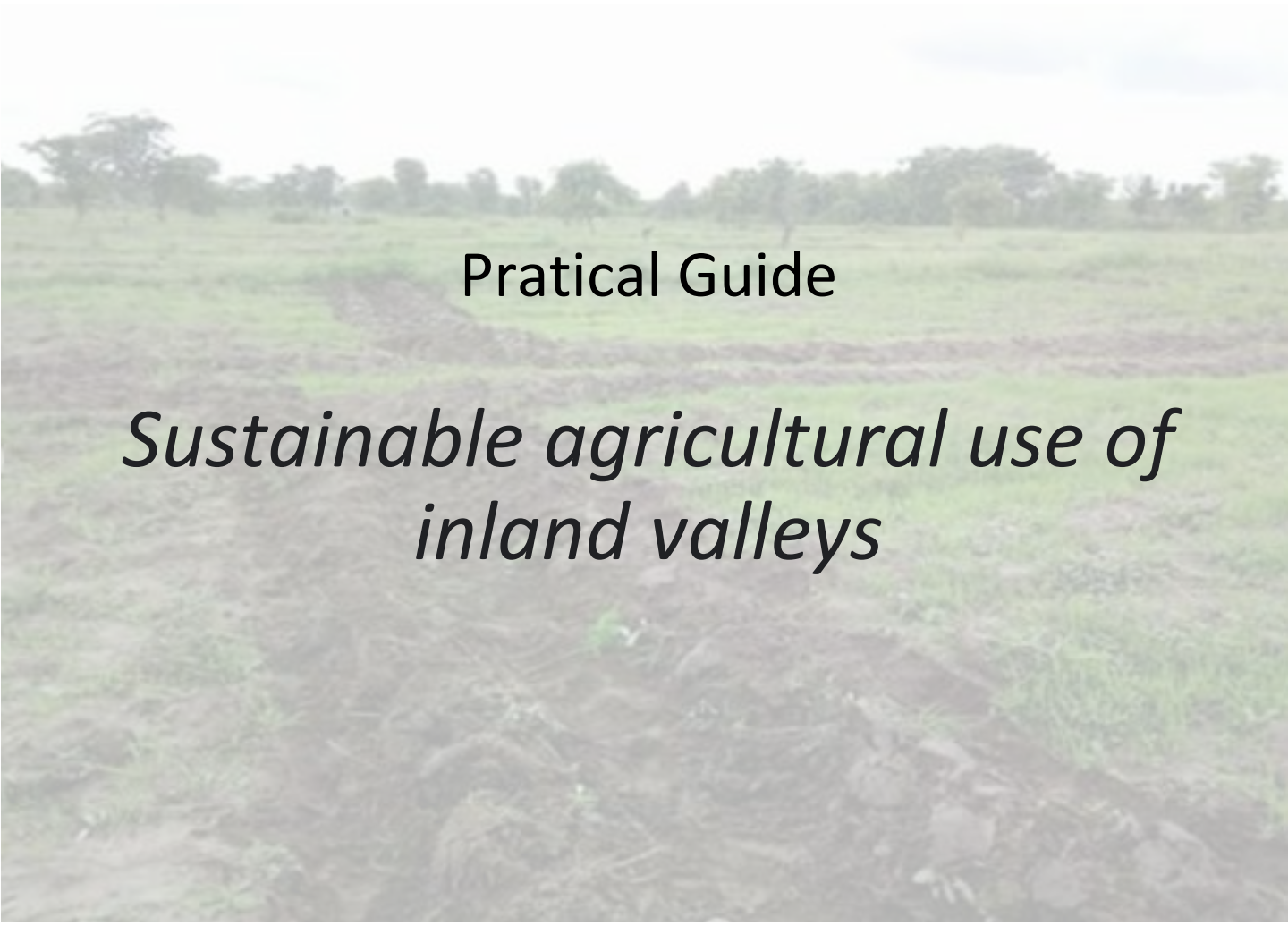

Pratical Guide

Sustainable agricultural use of inland valleys

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

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Sources of images and tables

[1] Photo provided by AfricaRice
[2] https://fr.wikipedia.org/wiki/%C3%89rosion#/media/Fichier:Erosion.jpg
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[7] Photos: PLAR–IRM Curriculum: Technical Manual (Wopereis et al., 2009)
[8] https://fr.wikipedia.org/wiki/Pyriculariose#/media/Fichier:Rice_blast_symptoms.jpg
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[21] Photo provided by Hendrik Pöhl

I. Using an inland valley while protecting its biodiversity

Harmful actions to avoid

To protect an inland valley, you must avoid:

- destroying all the vegetation
- the unwise use of insecticides, chemical fertilizers and other chemicals
  - they destroy animals and soil microbiology
  - they contaminate the soil and pollute water
- heavy water control structures (flood spreading bund without an outlet channel, for example)
- monoculture

Rice monoculture [1]

Favorable actions

Here is a list of practices that respect the inland valley environment:

- use the topography and the natural water flow canals to control water
- conserve a representative area of biodiversity
- create corridors between the protected areas
- plant trees at the fringes
  - they will produce organic matter
  - they will limit soil erosion
- practice agricultural rotation and diversification
- use natural biocides against pests

Agricultural diversification on a field [4]

Examples of natural biocides

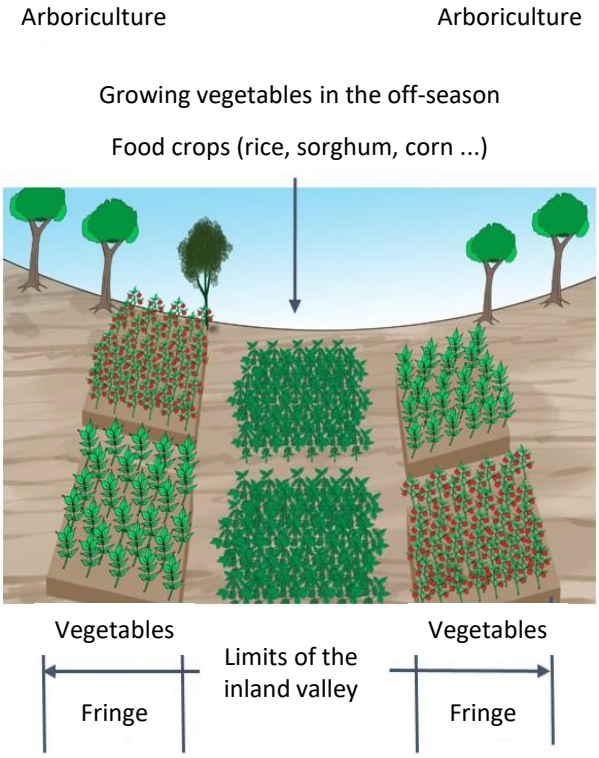
- Neem oil against the powdery mildew of curcurbitaceae (plant family: squash, zucchini, cucumbers, melons, watermelons, etc.) and the septoria (a fungal disease) of tomatoes
- Neem against crop insects (caterpillars, leaf beetles, aphids and leafhoppers)
- Sulfur against the white on vegetables
- *Gliocladium catenulatum* (a fungus) against the diseases caused by *Botrytis cinerea* (a fungus responsible for gray rot) on peppers, tomatoes, lettuce

Neem seed oil with soap [5]

Neem seed oil [5]

Inland valley development

- The figure opposite shows an inland valley development strategy:
  - the fringe area is favorable for market gardening because it benefits from the humidity of the inland valley during flooding
  - arboriculture ensures food security
  - dead matter from the fringes enrich the inland valleys with nutrients



Technical itinerary of inland valleys development [3]

Cultivation of legumes

- Legumes
  - enrich the soil with nitrogen
  - prevent soil erosion when used as cover crops
- Examples of legumes: peas, mucuna, soybeans, cowpeas, peanuts, beans, pigeon peas

Soybeans [9]

Peanuts [10]

Pigeon pea [11]

Agricultural diversification

Crop rotation:

- Is about cultivating rice in the rainy season and market gardening in the dry season
- the farmer can create water collection canals or bunds in the rainy season
    - to ensure crops watering in the dry season
- it is preferable to cultivate crops with very low water requirements such as cucumber, nightshade or chilli

Mixed crops:

- it is a combination of different crops
- it helps to control diseases and harmful insects
- example: Tomato + carrot + onion + cabbage

Mixed crops [4]

II. Integrated Management of Rice Pests

Integrated insect control in a rainfed rice field

- Integrated pest management through a combination of seed choice and farming practices can reduce pest damage:
    - choose resistant or tolerant seeds
    - apply good farming practices such as:
        - sowing early-ripening varieties of rice on time
        - plowing wet soil after the first rains
        - broadcasting or sowing in furrows rather than in clumps:
            - plants are better protected against insects
        - intercropping with a crop that does not have the same pests as rice

View of a broadcast sowed rice field [12]

III. Insect control methods

Control against pests

- It is recommended that you favor natural methods by:
  - choosing good quality seeds and resistant or tolerant varieties
  - good farming practices
  - promoting plants that harbor beneficial insects such as:
    - *Paspalum scrobiculatum* or sword grass
    - colorful flowering plants that attract beneficial insects, especially parasitoids, predators and pollinators

Paspalum scrobiculatum, a formidable rice weed but recognized as harboring two parasitoids of rice midge

Farming practices: plowing, intercropping, fertilizing

- Plow the land after the first rains:
  - this brings buried insects to the surface
    - which will be destroyed by birds, poultry etc.
  - plowing immediately after harvest produces the best results
- Intercropping can reduce the damage caused by rice pests that feed on the part of the plant above ground such as:
  - aphids, some beetles, stem miners and grasshoppers
- Other farming practices, such as the application of fertilizers and mulching, have a beneficial effect on the populations of certain insect species

Intermediate crop [4]

Good farming practices: sowing

- Sowing early-ripening varieties of rice on time:
  - protects plants from minor diptera, white grubs, etc.
  - helps prevent the proliferation of pests.
- Broadcasting or sowing in furrows rather than in clumps:
  - protects seeds which are easily damaged by insects, rodents and birds in dibble sowing
  - protects plants against soil insects
- All of these must be considered if the insect pest population is to be kept as low as possible

White worms in the larval stage [13]

Chemical insect control

- Insecticides are rarely used on upland rice, as they are too expensive compared to the productivity of this crop
- Seed treatment is inexpensive:
  - it is effective against minor diptera, ants, termites, etc.
  - it is ineffective against white grubs
  - it is necessary to soak the seeds and remove the floating seeds
  - dry in the shade for 2 to 3 hours
  - do the germination test
  - choose an approved treatment product
  - treat the seed 1 to 3 days before sowing

Chemical control in a rice field [3]

- Baits are used against ants, lesser diptera, mole crickets and field crickets
  - these baits, impregnated with insecticides, can be easily prepared with local equipment
- Insecticides in spray form can also be used in rainfed crops to control leaf pests
- Chemical insecticides are very dangerous and should be used by trained professionals protected by personal protective equipment

Example of chemical insecticides

- For example, the following insecticides were recommended by FAO in 1997 against certain types of pests
- The authorized products for sale vary by country, and change over time: it is therefore essential that you check the list of products authorized at this time, in your country
- You can either consult this list with the Ministry of Agriculture or ask your extension services who will be able to provide you with information
- In all cases, it is essential to strictly follow the recommendations of the ministry and the manufacturer, and to wear personal protective equipment when using these products

Insects	Means of control
Ants, termites, grubs, black mealybugs	Seed treatment with carbosulfan, chlorpyrifos 0.5-1 kg / 100 kg of seeds
Rice hesperids, leaf moths, gall gall midge, green horn caterpillars, stem borers, locusts, mealybugs, thrips, moths	Foliar spraying with chlorpyriphos, dichlorvos, phosphamidon, monocrotophos 0.3-0.4 kg a.i./ha
Leafhoppers, delphacids	Foliar carbaryl spray 0.3-0.4 kg a.i./ha directed at the feeding point

Other non-chemical insecticides

Targeted pest	Type of method tested
Termites, stem borers	Jatropha oil, neem oil or powder, neem cake
Termites	Tobacco powder (moistened), Bamboo cuttings, dried corn stalks, *M. anisopliae* (fungus)
Rod drillers	Strip crops (maize-cassava)
Sitophilus oryzae (grain pest)	Seed treatment with P. guineense black pepper powder 0.50 to 2.5 g of powder per 100 g of seeds

[II]

Use of neem oil

- 2 liters of neem oil + 1 liter of water + 10 g of soap type "OMO" or other
- 10 liters of water are added to 1 liter of the concentrated solution before application to the field
- The diluted mixture is applied (15 l / ha) between the pockets 25 days after sowing and then every 20 days until maturity

Neem seed oil with soap [5]

Neem seed oil [5]

IV. Rice disease control methods

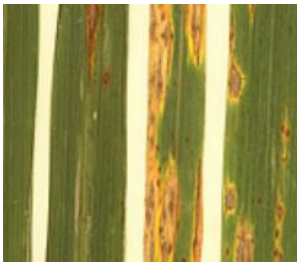
Blast control: farming practices

- Rice blast is caused by the Pyricularia oryzae fungus
- It mainly affects these aerial organs:
  - leaves, stems and panicles
- It is favored by:
  - the use of nitrogen in high doses
  - a high air humidity for 7 to 9 hours

Control:

- Use healthy and unscathed seeds
- Remove and burn contaminated plant debris
- Remove host plants and wild rice
- Practice crop rotation
- Plan the rice sowing so that vulnerable stages of plant growth coincide with periods of low air humidity

Symptoms of blast on knots of rice stems [14]



Lesions on rice leaves affected by blast [15]

Helminthosporiosis control: farming practices

Symptoms:

- Brown pits with oval lesions are found on all leaves
- This disease is mainly due to:
  - unfavorable soil conditions
  - the use of infested seeds

Control:

- Use healthy and unscathed seeds
- Optimize soil fertility
- Remove and burn infected plants or parts of plants
- Remove any wild hosts, such as Setaria sp., Leersia sp., and Echinochloa sp

Setaria italica [16]

Echinochloa crus-galli [17]

Bacterial leaf wilt

Symptoms:

- Bacterial wilt on rice leaves is caused by *Xanthomonas oryzae pv. Oryzae*
- Wilting first appears as a small wet spot on the periphery of the lower leaves
- As the spots spread, the leaves turn yellow, dry and wither
- Lesions appear on the edges of the limbus from the tip:
  - and grow larger with a wavy outline
  - then turn yellow and dry
- Areas adjacent to the healthy parts are water-soaked.
- Grains can also be affected
  - it manifests itself on the glumes as patches of changed color, surrounded by a wet margin

Control of bacterial leaf wilt: cultural practices

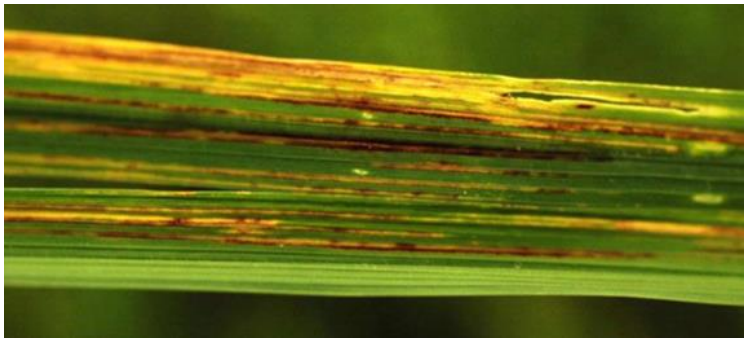
- Use healthy, unscathed seeds
- Suppress host weeds like *Leersia sayanuka, L. japonica, L. panacea, Zizania latifolia*, etc.
- Remove and burn contaminated plant debris
- Practice crop rotation
- Apply only the optimum level of fertilizer:
  - higher doses of nitrogen predispose the plant to contamination

Leersia oryzoides [18]

Bacteriosis of translucent streaks

Symptoms:

- In the early stages of the disease, the striae are 0.5-1mm wide and 3-5mm long
- They are longitudinal, dark green in color and have a moist translucent appearance
- The disease is usually confined to the space between the large veins
  - but can cross these
- Bacterial ooze appears on the surface of the lesions in humid conditions
  - and dries up after forming small yellow drops.
- High temperatures are conducive to the spread of this disease



Streak leaf symptoms [19]

Disease control: farming practices

- Use healthy and unscathed seeds
- Remove and burn contaminated plant debris
- Remove other host plants and wild rice
- Practice crop rotation
- Plan the rice sowing so that vulnerable stages of plant growth coincide with periods of low temperature

Crop rotation with soybeans [21]

Burn contaminated plant debris [3]

V. Weed control methods

Preventive weed control

Cropping techniques for preventive control include the following steps, which must be carried out carefully, and as recommended:

- soil preparation
- transplanting
- management of irrigation water (cover weeds with a 2-10 cm of water depth)
- population density
- crop rotations
- use of clean seeds

Carrying out transplanting in the field [3]

Curative weed control

- Curative weed control is mainly weeding
- This can be done:
  - manually, but it is slow and painful
  - by mowing, but it is slow
  - mechanically, which is possible if the sowing or transplanting is in line and the soil is drained.
  - Chemically, using herbicides which are classified into three types:
    - pre-emergence herbicides (for example: Simazine, Atrazine, Diuron)
    - contact herbicides (for example: nitro dyes, Diquat, Paraquat)
    - systemic herbicides (for example: 2,4 D, Dalapon, Aminotriazole, Round up)
- Plowing at the end of the cycle also helps control weeds

Mechanical weeding with a weeder [3]

Chemical control in a rice field [3]

Examples of chemical herbicides

- Farming practices allow good control of several weeds, in the case of weak attacks.
- The most commonly used herbicides are:
  - Penoxsulam 25G / L (selective post-emergence herbicide)
  - Garil Power EC (selective post-emergence herbicide)
  - Top Star 400 SC (selective herbicide)
  - DEKAT-D720 SL (herbicide against dicotyledonous weeds of rice)

Always check with your country's Ministry of Agriculture which products are registered, as these products change depending on the country and the year!

VI. Protection against water and wind erosion

Reduce the detachment of soil particles

- Protect the ground from the direct impact of raindrops:
  - apply mulch and use crop residues and tree leaves
  - 2 to 6 t / ha of straw are needed to control erosion
- Reduce the strength of raindrops:
  - the plants leaves reduce the force of the raindrops impact on the soil surface
  - it is therefore necessary to maintain a continuous plant cover above the ground

Reduce soil transportation: water speed

- Shorten the length of the slope. The longer the slope is, the faster water moves
- Use physical barriers by covering the ground with a mulch of living or dead biomass (such as grass strips, crop residues, tree stumps, logs, etc), stone lines and edges of terraces
- Reduce the steepness of the slope with terraces made up of stone retaining walls, grassy barriers and contour walls

Reduce soil transportation: Increase water infiltration

To reduce the loss of soil washed away by water flow, we must increase the amount of water that infiltrates and reduce the amount of water flowing on the slope

- Form a rough surface that reduces water speed
  - by carrying out light plowing
  - by applying crop residues
- Improve organic matter content in the soil, thereby improving the structure of the soil and its water holding capacity:
  - by mixing crop residues with soil
  - by applying animal manure to improve soil structure.
- Solve the problem of surface crusting:
  - by increasing water infiltration into the soil using the "Zaï" technique: dig small holes in the ground and add small amounts of mineral and / or organic fertilizers