CHAPTER 4

SITE SELECTION AND "SAWAH" SYSTEM DESIGN

Site selection for Sawah system development is very vital and plays a key role in effective Sawah establishment for effective and sustained rice production. Careful consideration of site selection is thoughtfully advised

Site Selection Skills

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Identifying suitable lowlands (valleys, flood plains etc.) for sawah system development is a key step. Several factors may be considered during site selected but these would vary depending on prevailing conditions and circumstances.

Most common factors to consider but not limited to include the following:

a. Water sources & quality: (>10 L/s, > 5 months/year) Stream/River, Spring, Seepage, Flood, Rain-fed

b. Topography and soil: Ongoing & potential rice area > 10ha, Slope < 1-2%, surface roughness, Soil texture, Soil fertility, surface roughness, Soil texture, Soil fertility

c. Socio-economics: Strong will, market access, road access in case of demonstration, land tenure, secured rent

NB:
(i) Collaboration between farmers, scientists, engineers, and extension staff is very essential at demonstration stage

(ii) Farmers know best, local and site specific hydrological conditions of any area in which they operate. This is very critical and very important for site selection

SKILLS FOR SITE SELECTION CON'T

1. Ongoing and potential lowland rice areas are larger than 10ha within walking distance of a core site. The core site can include various sub- sites with 0.5-10ha or more rice area.

2. Secured continuous water flow: > 5months, base water discharge: > 20l/sec, i.e., > 1500-2000m^3/day, potential irrigated *sawah* area: > 10-20 ha,

3. No strong flood attack: Flood depth will be < 50cm and continuation of the flood will be < 3-4days, Flood water discharge will be < 10 ton/sec

4. Flat and very gentle slope: < 2%, if slope is < 0-1%, levelling operation is easy.

5. Strong will of rice farmers to master *sawah* technology skills and *sawah* development by farmers' self support efforts

6. Intensive hearing from rice farmers on the local hydrological conditions for past 10-15 years is important.

SKILLS FOR 'SAWAH' SYSTEM DESIGN

1. *Sawah* layout and total potential area, shape and size of 'sawah', water intake and distribution are critical factors. Common examples of water sources and distribution methods include:
   (i) Spring and from 'sawah' to 'sawah',
   (ii) spring and diversion canal,
   (iii) Stream/seepage, (iv) Simple dyke and diversion canal,
   (v) Fish pond, dam, lake, Weir and Canal and (vi) Pump irrigation
2. Interceptor canal, Contour bund system
3. Flood control by drainage or dam
4. Drought control by pond/water-harvest
5. Soil movement and quality of leveling
6. Bund layout and quality

NB:

Successful examples of Sawah system design suitable for the various ecologies include:

(1) Type of oasis in floodplain (Sudan savanna zone)

(2) Pump irrigation system (all climatic zone)

(3) Irrigation with dyke on small river (Guinea savanna zone, forest/transition zone, forest zone)

SURVEY AND MAPPING

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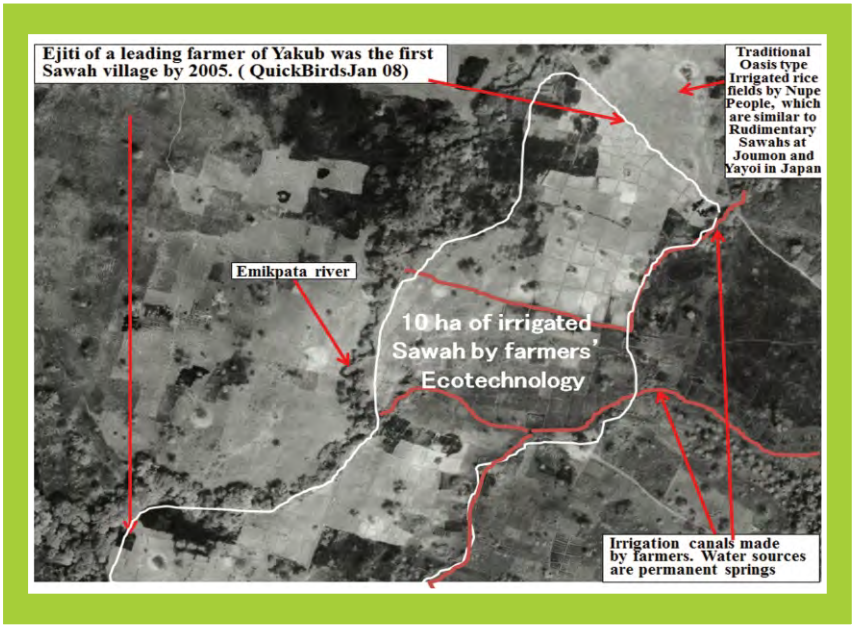
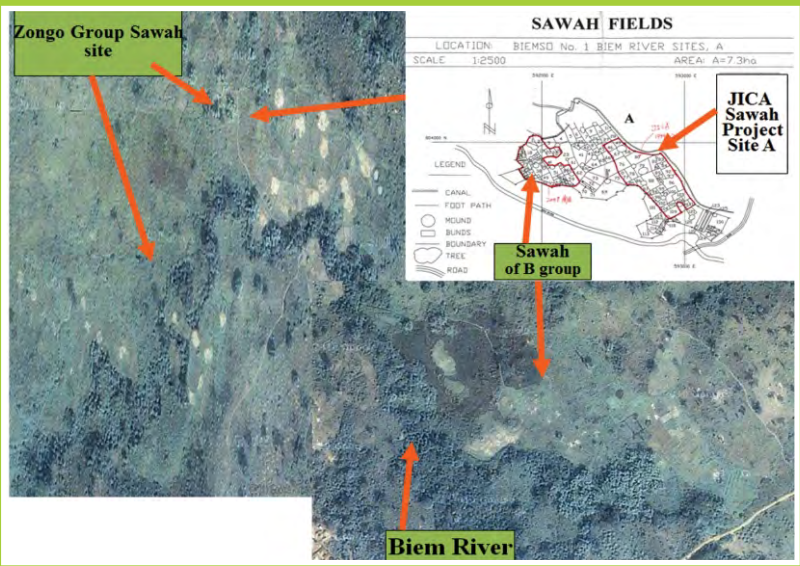
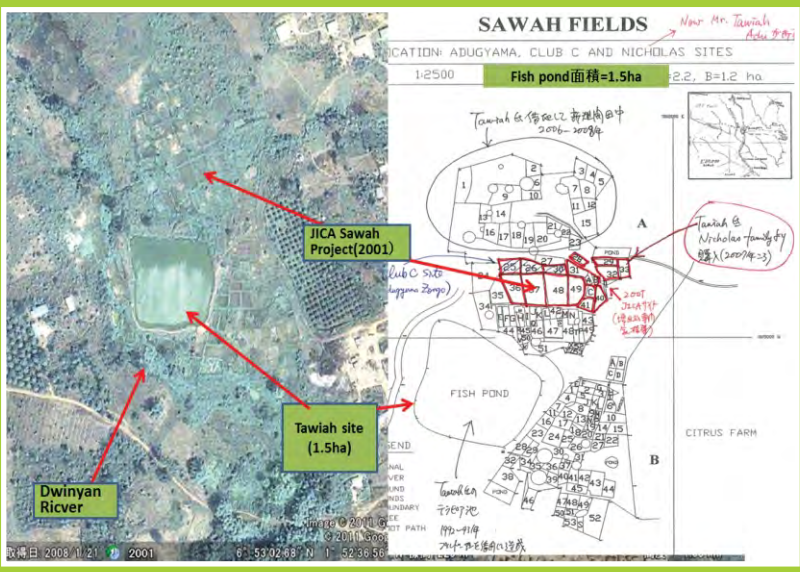
Existing satellite maps or surveys if available can helps to early identify or locate watershed water and water sources



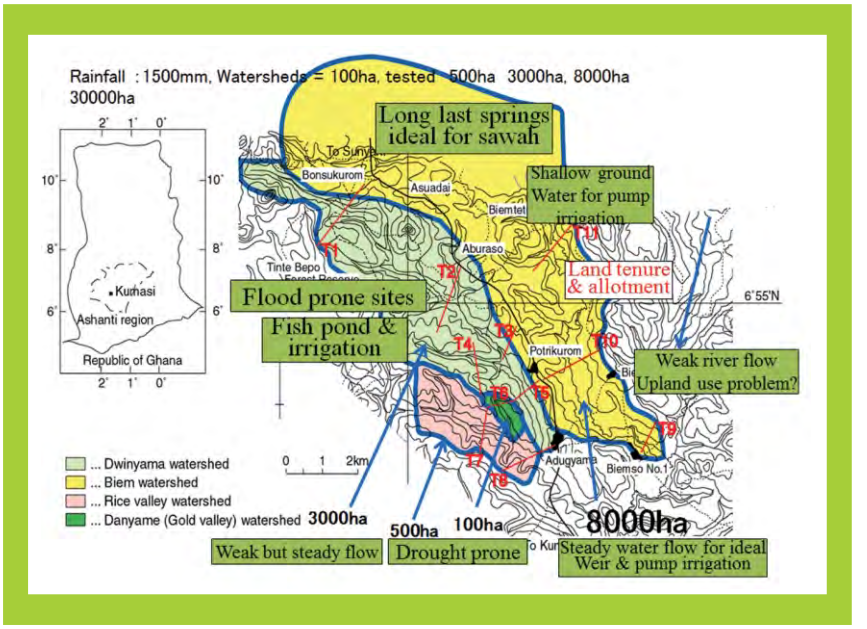
Quick Bird Image of the Ejiti Sawah Village, Bida, Nigeria. Permanent spring water sources identified along the Emikpata river



A satellite map of the Mankran watershed in Ashanti. Ghana showing suitable sites along the Biem river that have been developed into Sawah systems



A sitelite map of the Mankran watershed in Ashanti. Ghana showing suitable sites along the Dwinyam river that have been developed into Sawah system.



Mankran watershed showing different valley types/forms. Farmer based Site Specific Sawah Development and Management through On-The-Job Training are key (Sawah project phase I) in Ghana

Expanded photo of numerous small Oasis type pump irrigated fields in Nigeria.

Sokoto-Birnin Kebbi flood plain in Nigeria, Google 2007

It may be good (but not a necessity) to have a topo-survey of a site

It may be necessary to physically walk through the area to acertain prevailing conditions on the ground

Where a proper survey has to be done, transect lines will be cut and citing poles used

Simple survey tools may be used to establish co-ordinates and proper geographical location of site

The type of system design for any particular valley is greatly influenced by ;

1. **The type of water source (spring, weir & canal, etc) and**

2. **The physical nature of the valley (wet, dry, wide, narrow, etc).**

Restoration measure to connect spring water and Sawah by irrigation canal and syphon pipes at Adugyama, Mr. Tawiah's site. August 2011. This site was destroyed by IVRDP through poor knowledge of Sawah system development.

Mr. Tawiah trained another farmer to develop 3ha of sawah using small spring water source at Adugyama in Ghana. Only local farmers know much about such water sources.

A strong spring source can irrigate large areas of land in a season as in Dwinyama, Ghana

Water source could be a small stream with several springs along both banks. Such combination can provide enough water for sawah rice cultivation in Ghana.

Rice growing in a narrow but long valley that relies on a small stream supported by several spring sources

Natural ponds that have a high recharging capacity can be useful sources of water

Al contained in spring water can, however, result in poor rice growth as experienced in Bida, Nigeria.

Photo. 3-25. Compaction to create impermeable layer on the front of dyke, March 2000

Photo. 3-23. Excavation of river bottom and jute bags

Photo. 3-26. Dyke was covered with sand bags after compaction of permeable layer

Photo. 3-17. Flooding over dyke

A dyke can be constructed over stream and water harvested for sawah rice cultivation. (e.g. JICA/CSIR Sawah project in Ghana)

Sand bag and Wooden Weir, construction through farmers' self-support management in Ghana (1999)

Sand bag weir by farmers and SRI Sawah team, Aug.2009, Asuodei, Ghana

Canal construction by participating farmers indicates the commitments of farmers towards Sawah System Development.

Bigger water sources such as rivers can be partially intercepted and water harvested for use as in Nigeria.

Fadama III Sawah Demonstration site, 40km south from Gwagwalada along Abuja Lokoja road, (Upper - 25 Feb 2011, Lower - 2 May 2010).

Flood plain and pump

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Flood plains are relatively flat areas where variable water harvesting methods needs to be adapted.

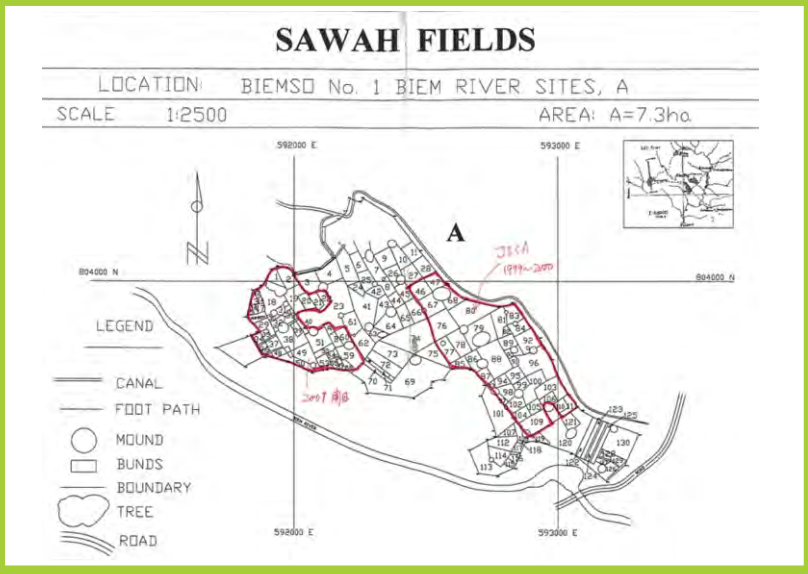
Small pond may be constructed by farmers, when necessary for water to irrigate (e. g. Kodadwen, Ghana)

Small dams constructed for water storage in the dry regions can be used to irrigate rice and source of water for animals

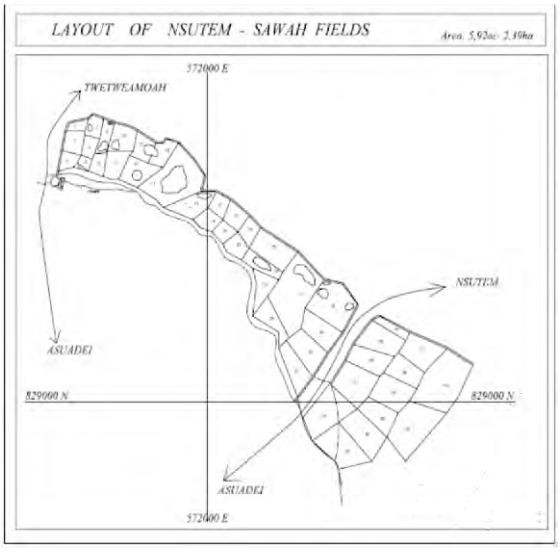
A pump lifting water from a pond onto a rice field at a site in Nigeria

Oasis type pump irrigated rice and vegetable fields under poor water use efficiency and weedy rice field before Sawah technology was introduced at Kebbi, Nigeria

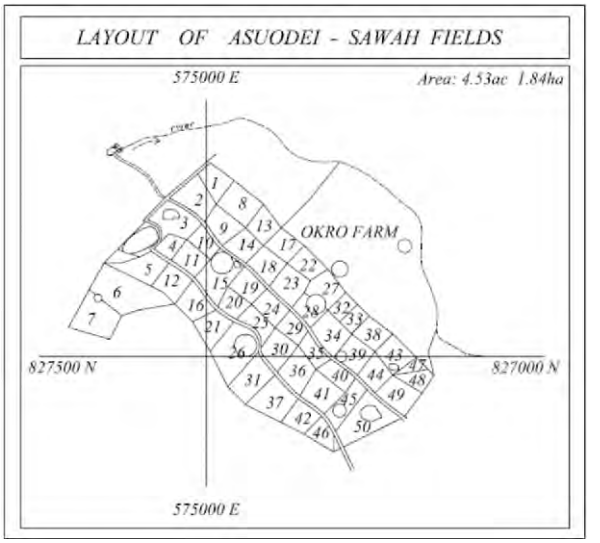
EXAMPLES OF SAWAH FIELD LAYOUTS AS INFLUENCED BY LOWLAND TYPE, WIDTH OF LOWLAND AND EXISTING PHYSICAL CONDITIONS



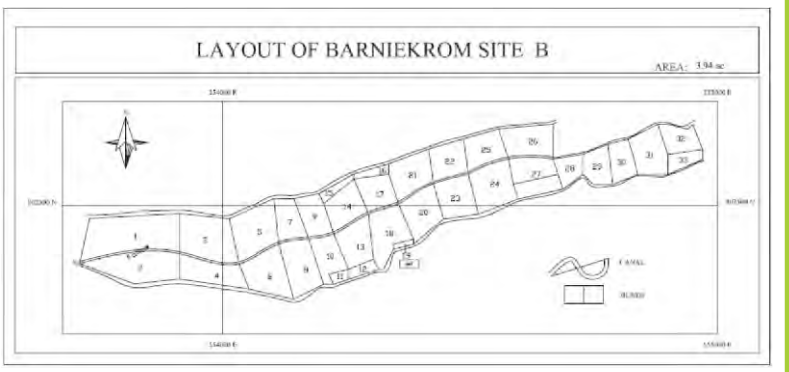
Layout of several fields along a meandering valley of the Biem river in Ghana



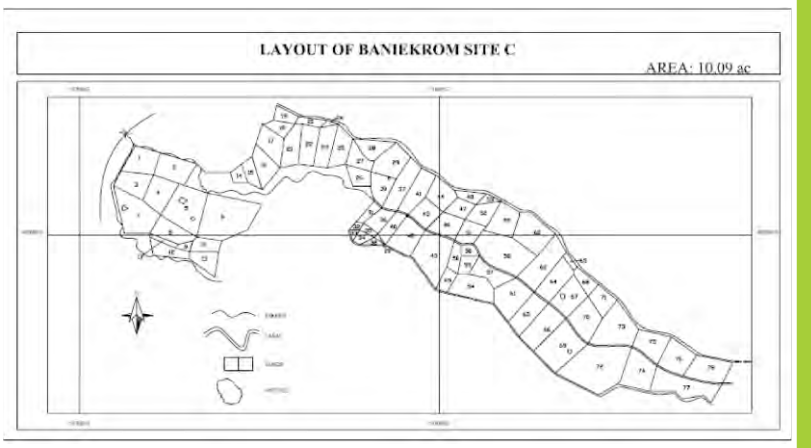
Field layout of a valley that harvest water from bridges on roads that cut across Several portions of the valley



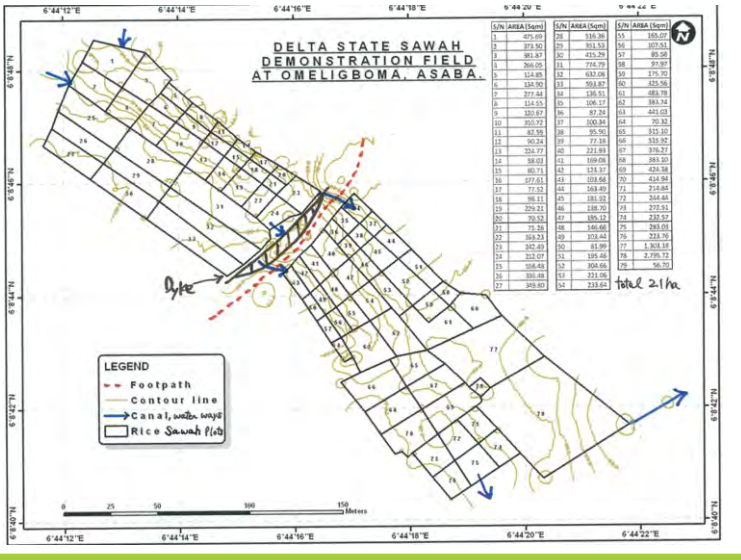
Field layout of a short but relatively wide valley that lies off the main water Source (river/stream) at Asuodei in Ghana



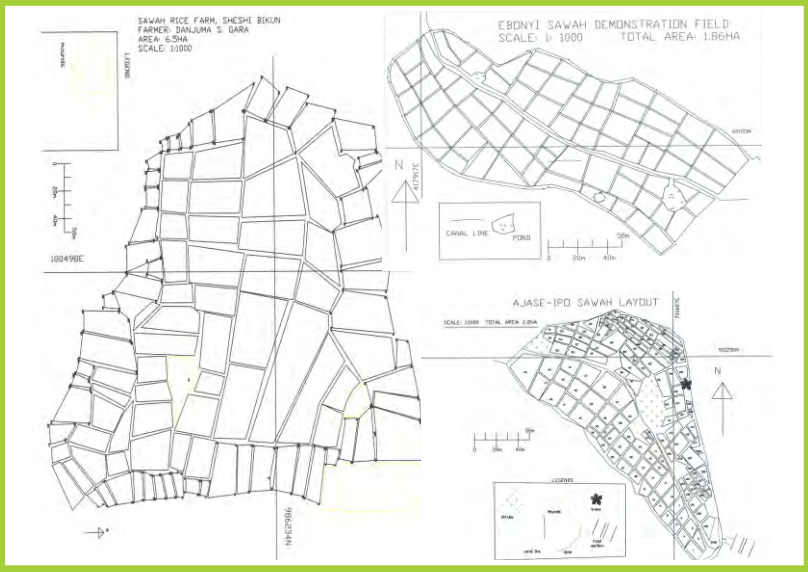
Upper portion of field layout of a long and narrow valley in Baniekrom In the Ashanti region of Ghana



Field layout for the lower portion of a long but narrow valley at Baniekrom in Ashanti region of Ghana



Sawah demonstration field (flood plain) at Asaba in the Delta State of Nigeria



Ebonyi state sawah demontration field (a wide flood plain) in Nigeria

Rehabilitation of degraded irrigation system

Sawah technology can renovate abandoned pump irrigation fields (eg. Lagos State in Nigeria)

Other but costly conventional irrigated development system involving expensive materials are not cost effective and difficult to manage by farmers

A large and abundant dam that is not beneficial to the farmer. Such development project are not sustainable and have no direct benefit to farmers.

Large irrigation sites where farmer water management and water use-efficiency are very poor

CHAPTER 5

‘SAWAH’ SYSTEM DEVELOPMENT

In developing a Sawah system, several stages and processes need to be followed or adopted. However, depending upon prevailing conditions, several of such steps may be merged while others may be skipped. The guiding principle is what exist on the ground at the time of development. Common processes or steps include:

1. Brushing
2. De-stumping
3. Construction of water harvesting structures (Weir, Dykes, Canals)
4. Bond Construction
5. Puddling
6. Levelling (Micro and Macro)

Development cost should be minimal and materials used should be easily available and affordable.

BRUSHING/LAND CLEARING

Site has to be first brushed of any thick vegetation

Too much trash or cut down vegetation should be partially gathered

Dried thrush should be partially but not totally burnt to allow for quick or rapid organic matter buildup

Tree stumps and roots should be thoroughly removed (de-stumping) for smooth operations of machinery, safety of operators and creating more space for rice

Water harvesting can be done from several sources. For streams that flow, a location should be identified upstream and cleared for construction of a water harvesting structure for diversion onto rice fields

Select a point which is narrow across river/stream but at a good slope to allow free and easy water flow

Wooden poles, harvested on or around the fields should be firmly fixed on the ground across the water sources (eg. Stream)

Empty polyethelene sacks may be filled with soil from adjacent high land/hill, preferably closed to source

Sand bags are then lined infront of wooden poles that have been firmly put into he ground

Water harvesting structure (weir) using local materials is ready and water impounded for diversion to rice fields

Small ponds may be constructed by farmers to harvest water where no reliable spring/stream flow is available (e.g. Kodadwene, Ghana)

Canal Construction: Participating farmers should be thought how and where to construct canals for free flow of water after weirs/dyks/pond are in place

Canal construction by participating farmers to direct water into rice fields in Ghana

A farmer opening up a canal to direct water onto his field in Ghana

Water freely flowing from a constructed weir to rice fields in Ghana after being constructed by farmers with technical guidance from Sawah experts

A properly constructed canal by farmers to feed several hectares of rice fields can easily be done at minimum cost but with active farmer participation.

Bund construction starts after the field is cleared and debris removed. Bunds can be constructed individually or by groups of people.

Bund construction is easier and faster when the soil is moist but not covered by water. However, bund construction is not advisable under very dry conditions

Bunds should always be strong and should be directed across the direction of water flow

The interval between bunds is greatly influenced by the topography of the land. Intervals are wider and bunds longer when land is relatively flat (< 2% slope).

Initial land levelling follows after bund construction when field is flooded with water to identify high/raised portions.

Training young Scientists under a United Nations University Program in using water levels for macro field levelling

To create more space (flat land) for rice and for easy machinery work for increased efficiency, some trees should be roved from the field

For effective Sawah development, animal traction or small machinery (power tiller) is necessary, Kou valley, Burkina Faso

Office du Niger, 50,000ha irrigated sawah project (In addition to animal traction, farmers assist in manual land development of Sawah)

Ploughing using a Power Tiller can be done under wet or moist conditions. Avoid ploughing under dry conditions

Power tiller ploughing is best when there is sufficient water on soil surface. Machinery movement is easier and efficiency is higher

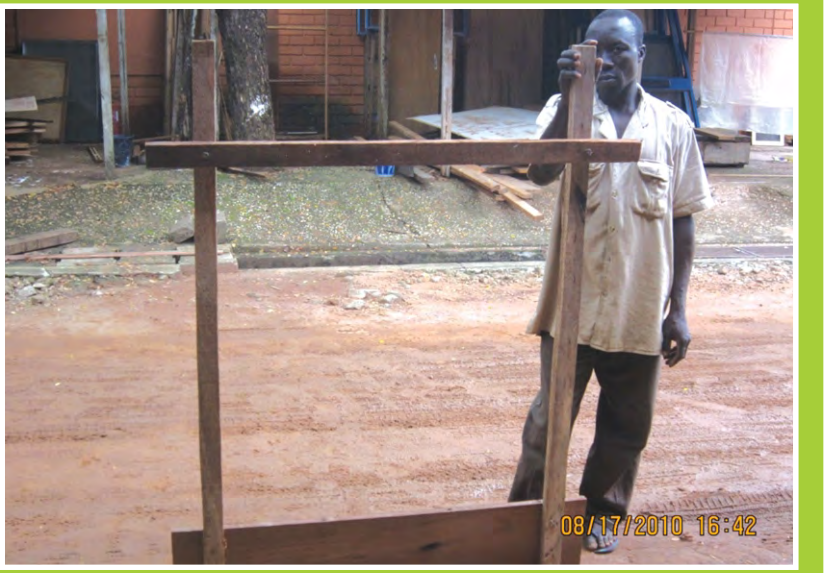
For good quality land preparation and to maintain power tiller life, operators must be properly trained on power tiller handling. Training staff of Togo and Benin under the SMART-IV of AfricaRice.

Experience operators can combine ploughing and puddling in a single operation depending on water availability and field conditions.

For effective crop establishment, the soil should be pulverised through puddling

Farmers should be thought the art of properly pulverishing the fields using the power tiller through field training and practice

Training both farmers and technical staff is a key component of on-the-job training under "Sawah" system development. Training of technical staff from Togo and Benin on power tiler handling and puddling



Simple tools (eg. wooden plank) can be designed to assist famers carry out field levelling (micro) before transplanting.

Soil movement, puddling and levelling at Biemso No.1, Zongo site in Ghana in 2002

Training field technical staff and farmers on how to mount and direct the leveller when attached to the power tiller is essential

Manual Leveling needs hard-works for Sawah system construction and this drudgery can be eliminated with mechanisation (eg. Use of of power tiller)

A training session for both farmers and field technical staff

Where levelling using the power tiller leaves micro-spots such as wells, sinks, etc, such location can be manually levelled with simple tools like a hoe. Such areas are too soft or deep and can make tiller sink or get damaged.

A well levelled plot at Biemso in Ghana ready to be transplanted

Common field problems when using the power tiller include sinking into too soft lands or old sunk wells. As much as possible such situations should be avoided as they tend to damage machinery

Power tiller operations need good skills. When it does sink, more hand, more energy and experience is required to move it out without causing any damage to the machine.

CHAPTER 6

‘SAWAH’ BASED RICE FARMING

This Chapter outlines the necessary processes or procedures in order to establish a good and viable ‘Sawah’ rice field that will provide the expected results (good growth, disease/insect free, weed free and higher yields)

CHOOSING A RICE VARIETY

a Good quality seed is a prelude to attaining maximum productivity.

b Planting stock should be from a known source and use a pure variety.

c Do not use seed from fields that were previously sown to a different variety.

d Carry out viability test before planting to know the amount of seed required to plant a given area of land.

e Good seed should give ≥ 80% germination, free from weed seed and other physical impurities

Good and viable seed should give over 80% germination

ESTABLISHING A NURSERY

1. **Select good seed (fully filled seeds) – gives healthier seedlings and results in uniform germination.**

2. **Seed bed should be prepared away from trees and building shades.**

3. **Nursery is done on good soil so fertilizers are not normally applied.**

4. **Water nursery bed evenly and sufficiently insufficient water results in slow seedling growth.**

Rice seed can be pre-germinated before nursing

SIMPLE METHOD OF CALCULATING THE AMOUNT OF SEED REQUIRED TO NURSE

- Assuming a spacing of 20cm x 20cm is to be adopted.
- This gives a total stand of (100cm x 100cm)/ (20cm x 20cm) = 25 stands per square meter.
- To transplant at 2 seedlings per hill gives 50 seeds per square (calculated per ha = 500 000 seeds).
- Assuming average weight of 1000 seeds = 28g
- Then quantity of seed required per ha = (500000/1000) x 28 = 14 kg
- At 80% seed viability, total quantity of seed to nurse is (100/80) x 14 = 17.5 kg

NB:

- For any losses and inefficiencies, this amount could be increased by 10-20%
- When transplanting is to be done at more than two seedlings per stand, seed rate should be adjusted accordingly.

Setting up a nursery bed and nursing.

Nurseries should not be too thick to allow for healthier, vigorous and stronger seedlings growth

Farmers or farmer-groups should be thought the right processes and procedure for establishing a necessary on the field

TRANSPLANTING

- Transplanting is preferred to direct seeding under “Sawah” systems.
- Transplant good seedlings (free from insects, diseases, weeds).
- Seedlings that have vigour and are uniform in height provide good growth.
- Weak seedlings take a longer time to recover.
- Based on the tiller production ability of the rice variety to use, transplanting may be done at 2- 4 seedlings per stand.

Seedlings should be removed only under very moist or wet conditions

Seedlings should be carefully washed off soil material and root volume reduced if necessary for fast crop establishment

Transplanting in rows is best and it is easier and goes faster when done by farmer-groups / family members together

For smaller groups, transplanting in rows should be done by a minimum of 2 persons.

Good and healthy seedlings should stand erect soon after transplanting.

Both farmers and field technical staff should be trained in the art of transplanting. Technical staff from Togo and Benin being trained on transplanting in Ghana.

Micro-surface leveling and smoothing at Sokwae in Ghana during transplanting

Fields that have been prepared (ploughed, puddled and levelled) should be left flooded until ready for transplanting. Removal of water earlier from such field results in soil caking and very difficult to transplant even when water is re-introduced later.

Under advance conditions (in Japan), transplanting is mechanically done using machines which saves labour and time and ensures efficiency. Sub Saharan Africa can get there one day.

WATER MANAGEMENT AFTER TRANSPLANTING

- Water level should be minimum on field during transplanting.
- After transplanting minimum water level should be maintained to allow for faster root establishment until after basic fertilizer application.
- As crop grows, field water level may be raised to help suppress any weed growth.
- However, fields should be periodically drained for short periods to allow for aerobic processes to proceed.
- Fields should be completely drained at least 7 days before harvest.

A freshly transplanted rice field should look like this

Water should be drained sometime after transplanting to allow for aerobic processes

Maintain optimum water levels to suppress weed growth after transplanting

Water management before, during and after transplanting can be done through several means based on field existing conditions

SRI practice needs good leveling and water control based on Sawah system, West Sumatra, Indonesia, August 2010. Farmers in Sub Saharan Africa can get there soon with experience and necessary support.

Nutrient requirements of rice

Nitrogen (N), phosphorus (P) and potassium (K) are well known limiting nutrients (macro-nutrients) to rice production.

Both Sulfur (S) and Zinc (Zn) have become limiting factors to proper rice growth and yield within the West Africa sub-region.

- N enhances growth, development, yield and grain quality.
- P stimulates recovery after stress, root development, tillering, pollination and reduces the period to maturity.
- K plays an important role in the resistance to stress and in the synthesis, ransformation and transport of carbohydrates to the grain
- S plays an important role in plant height, tiller number, panicle number and size, and spikelet number.
- Zn plays an important role in bio-chemical processes such as chlorophyll production.
- Other nutrients (Ca, Mg, Mn, Cu, Fe, B, etc.) are required in very small quantities.

Nutrient Management

- Varying levels of nutrients account for variation in rice growth and final yield of rice.
- Nutrients can be supplied to rice from several sources (organic/mineral fertilizers).
- Required nutrients should be applied in the correct quantities, at the right times and in the correct forms.
- Under transplanted and flooded conditions, mineral fertilizer should be uniformly broad cast on the field during both basal and topdressing.
- Organic matter/fertilizers , however, should be worked into the soil at least 2-3weeks before transplanting.
- Basal mineral fertilizer application should be done about a week after transplanting.
- Top-dressing should be done at panicle initiation stage

Basal fertilizer application using mineral fertilizer (NPK) should be done by uniformly broadcasting onto the field a week after transplanting

After fertilizer application, minimum water levels should be maintained on the field. Field should neither be flooded nor completely drained.

Top dressing (mainly using N based fertilizer eg. Urea and Ammonium Sulphate) should be done at panicle initiation stage.

Weed management and control techniques

Like the human body, all plants including rice need proper protection from pests (insects, diseases and weeds) to attain maximum growth and yield.

Weed management involves the deliberate selection, integration and implementation of effective weed management measures (both preventive and control)

Over-use of one management strategy may allow other major species to become adaptive in the ecological vacuum created by the effective control of the weed species now present.

Weeds commonly found in the lowlands are grasses, sedges and a few broad-leaf plants

There are several methods of clearing weeds.
In order to promote rapid growth, the rice crop should be free of any weeds during 30-40 days after transplanting

- **Hand weeding**:
  Hand pulling or hand hoeing where necessary
- **Mechanical weeding**:
  Use rotary a weeder where appropriate.
- **Herbicide application:**
  Could result in the rapid evolution of new weed populations.
- **Water management**:
  Effective field water management to control weeds is the most economical

Cultural weed control methods are more economical when done at the correct times

When using chemicals to control weeds, seek technical advise, use appropriate equipment, use recommended chemicals in the right quantities and spray at the right times for efficiency and effectiveness

Signs of herbicide injury (too much herbicide / higher rates)

- ❖ Spreading tillers
- ❖ Distinct round brown spots
- ❖ Tube shaped new leaves emerge from plant
- ❖ Dwarfing of the rice plant

Spraying using recommended chemicals can also help to reduce or minimize the destructive effect of some insect pests.

Field discussion with farmers on the importance of maintaining good farm sanitation

Using pure varieties and good seed leads to crop uniformity at heading and ripening stages. Harvesting can be done uniformly

Good farm sanitation is necessary for proper crop growth, disease / pest control and obtaining higher paddy yields

Harvesting should be done at physiological maturity when all grains turn yellowish

Cutting is mostly done a few centimetres from the soil surface using a knife or sickle under small scale farmer conditions.

Harvested rice should be heaped on a tarpaulin or threshing floor to prevent any contamination with any foreign materials (stones, weeds, soil etc) in order to maintain high quality rice.

Manual threshing can be done using sticks, empty barrels or wooden boxes depending on availability and prevailing conditions.

Under manual threshing, use tarpaulin or threshing floors to get quality grain

Winnowing should be done on cemented floors/ tarpaulins to minimize contaminations.

Threshed and winnowed rice should be put in clean bags/containers before being transported to drying or processing centres

Par-boiling paddy rice before milling is a common practice in most parts of Nigeria and northern Ghana and therefore requires the introduction of improved methods to maintain quality of grains.

Some rice cultivation and processing equipment commonly in use across some sites in West Africa particularly Nigeria and Ghana