Mountainous Agrarian Systems

Traditional slash-and-burn cultivation of upland rice in Bac Kan Province, Northern Vietnam. An agronomic diagnosis

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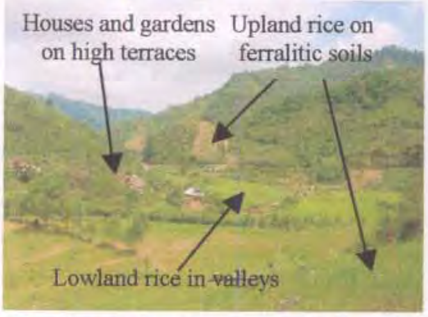
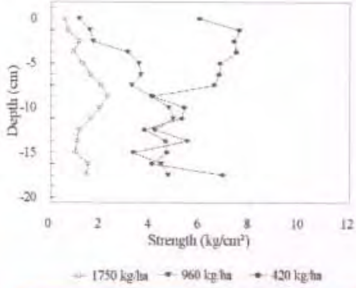
In the mountains of Northern Vietnam, traditional systems are based on upland-rice or maize cultivation, after slashing and burning the forest or shrubs. However, this practice leads to low and extremely variable yields. A rapid but sound and clear agronomic diagnosis was conducted in 1998/1999 to identify the main factors limiting rice growth and yield, and to understand the source of the high variability and unstability of upland-rice yield.

Cropping situations and land use

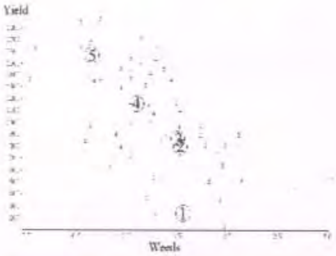


Upland-rice yield variability

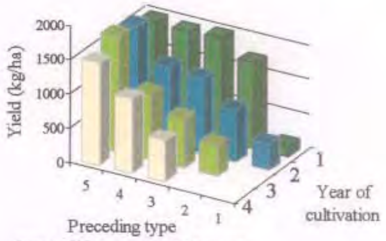
Between fields, upland rice yield mainly is explained by preceding vegetation type and number of years of cultivation after slashing the forest. Within field, major factors limiting rice yield are soil physical and chemical characteristics, in relation to poor biological activity. These factors reflect, the level of soil regeneration (during fallow periods, but limited by grazing and extraction) or degradation (erosion during cultivation periods). Yield also is limited by weed pressure.



Rice yield as a function of soil compaction



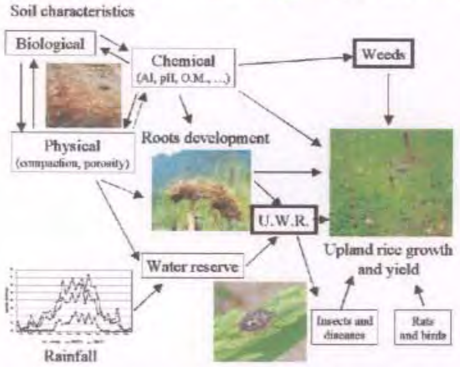
Rice yield as a function of weed pressure and preceding vegetation type



Type 1: Old pasture (over 20 years)
Type 2: Less than 10 years-old or 10-20 y.o. heavily grazed forest
Type 3: 10-20 y.o. moderately grazed or over 20 y.o. heavily grazed forest
Type 4: 10-20 y.o. not grazed or over 20 y.o. moderately grazed forest
Type 5: Over 20 years-old, not grazed forest

Rice yield as a function of preceding vegetation type and number of cultivation

Factors limiting upland rice yield



Rainfall and soil physical characteristics determine water reserve. Soil physical and chemical characteristics, in relation to biological activity, limit roots development. As a consequence, useful water reserve (UWR) is very limited. Together with high weed pressure, this leads to poor plant development. Weak plants also have low resistance to pests and diseases. As a consequence, yields are low (1 t/ha on average) and unstable.

With the rapid population growth, the high pressure of cattle and changes in land tenure, the traditional systems of slash-and-burn are no longer sustainable.

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Cropping systems on vegetal cover

Fundamental principles

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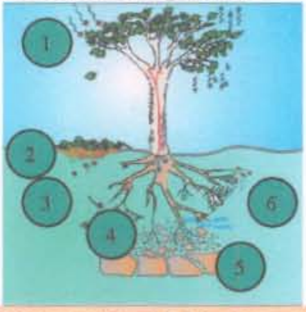
Techniques of direct seeding on vegetal cover have been developed for tropical conditions in Brazil during the past decade. These techniques propose a change in paradigm and open new perspectives for agriculture. They are nowadays used on millions hectares all over the world. Since 1999, they are being adapted for the conditions of Northern and Central Vietnam, for hilly and mountainous areas. They are based on a few fundamental principles:

Copy a forest ecosystem

A forest ecosystem ensures a certain number of functions, which are fundamental in the processes of soil genesis :

1. Transformation of solar energy and creation of organic matter through photosynthesis
2. Supply of fresh organic matter on soil surface (leaves, branches) and under the surface (roots)
3. Mineralisation and humification of organic matter, recycling of nutrients
4. Soil aeration by roots
5. Breaking up of parent material by roots and alteration of this parent material. Production of clay.
6. Regulation of underground water flows



Main functions insured by a forest ecosystem

Direct seeding techniques try to copy this forest ecosystem while speeding-up the processes.

Replace mechanical plowing by biological improvement of soil structure

Improvement and stabilisation of the soil structure is made by cultivation of plants with strong root systems (as *Brachiaria sp.*), able to develop in adverse conditions, and by development of biological activity.

Brachiaria brizantha roots

Brachiaria brizantha roots in ferralitic soil

Improvement of soil structure in termites gallery

Always keep the soil covered with a dead or living mulch

As in a forest, the soil is permanently covered with a mulch, and thus protected against erosion.

Upland rice on a dead mulch of grasses

Maize on a living mulch of Arachis pintoi

Direct seeding on vegetal cover

A change in paradigm
for a more efficient agriculture

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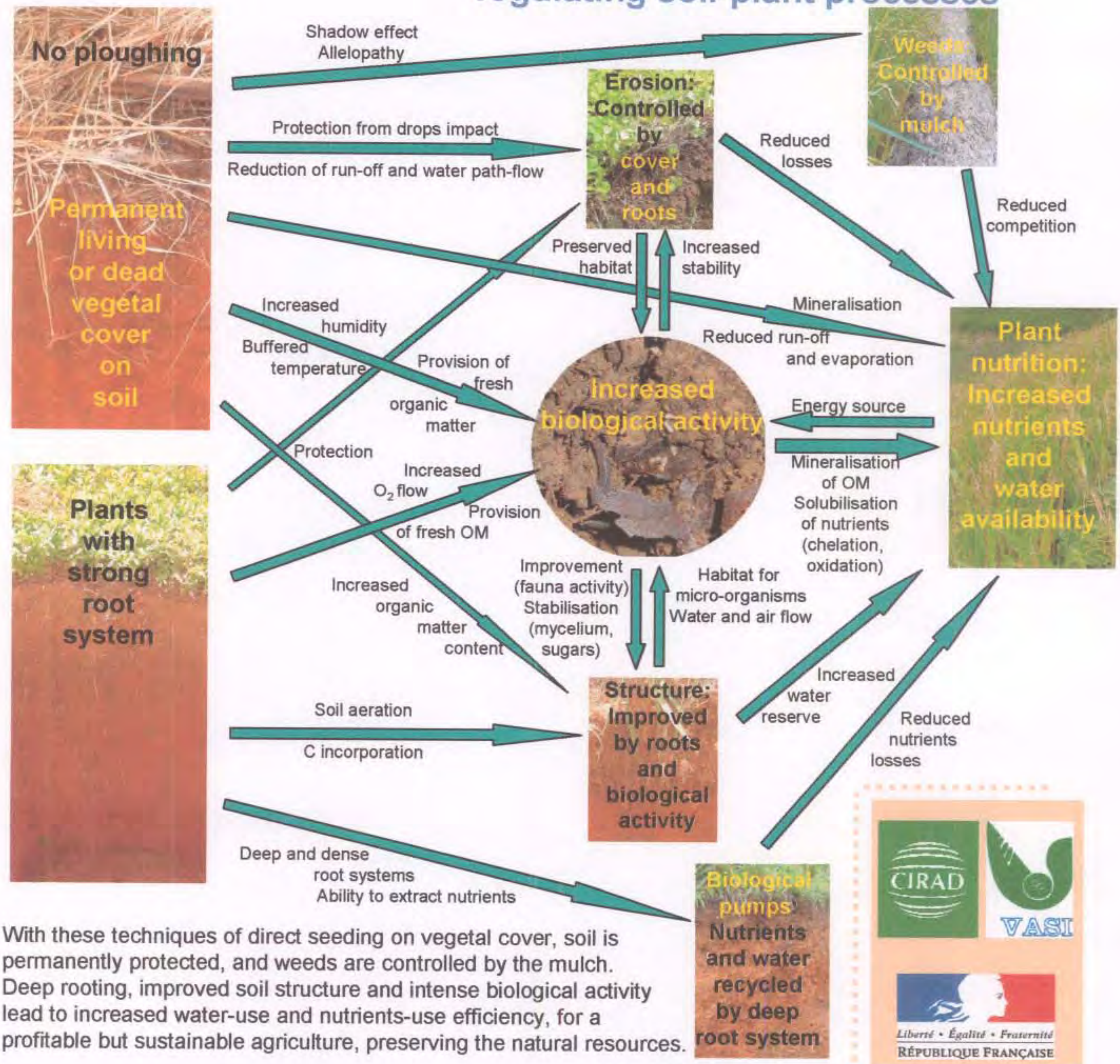
Techniques of direct seeding on vegetal cover have been developed for tropical conditions in Brazil during the past decade. These techniques propose a change in paradigm and open new perspectives for agriculture. The soil is no longer disturbed by mechanical action (no tillage), and always kept covered by a dead or living mulch. Soil structure is improved by plants with strong rooting systems and development of biological activity. This leads to an environment-friendly, technically and economically efficient agriculture.

Two principles

Six fundamental functions regulating soil-plant processes



No ploughing

Permanent living or dead vegetal cover on soil

Plants with strong root system

Shadow effect
Allelopathy

Weeds: Controlled by mulch

Protection from drops impact
Reduction of run-off and water path-flow

Erosion: Controlled by cover and roots

Reduced losses

Reduced competition

Preserved habitat

Increased stability

Mineralisation

Increased humidity

Buffered temperature

Provision of fresh organic matter

Reduced run-off and evaporation

Increased biological activity

Energy source

Mineralisation of OM
Solubilisation of nutrients (chelation, oxidation)

Plant nutrition: Increased nutrients and water availability

Protection

Increased O_2 flow

Provision of fresh OM

Increased organic matter content

Improvement (fauna activity)
Stabilisation (mycelium, sugars)

Habitat for micro-organisms
Water and air flow

Increased water reserve

Reduced nutrients losses

Soil aeration
C incorporation

Structure: Improved by roots and biological activity

Deep and dense root systems
Ability to extract nutrients

Biological pumps Nutrients and water recycled by deep root system

With these techniques of direct seeding on vegetal cover, soil is permanently protected, and weeds are controlled by the mulch. Deep rooting, improved soil structure and intense biological activity lead to increased water-use and nutrients-use efficiency, for a profitable but sustainable agriculture, preserving the natural resources.

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Cropping systems on vegetal cover

A range of systems based on different technical levels

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The diversity of the cropping systems based on vegetal cover developed makes it possible to propose a wide range of systems, requiring different technical levels (from the simplest to the more demanding) and having different efficiency levels on the functions of regulation of the soil-plant functioning. This diversity can be broadly sorted in four main kinds of systems.

SYSTEM I : Mulching

SYSTEM II : On location biomass production

Regulation functions

	I	II	III	IV
Erosion control	◧	◧	🟩	🟩
Nutrition function	◧	◧	🟩	🟩
Mineral nutrients recycling	🟥	◧	🟩	◧
Weeds control	◧	◧	🟩	🟩
Biological activity	◧	◧	🟩	🟩
Soil structure improvement	□	◧	🟩	◧

Technical level required

	I	II	III	IV
Establishment of the cover	🟩	◧	□	◧
Biomass production	🟩	◧	▢	◧
Biomass control	🟩	◧	□	◧
Working time	◧	◧	◧	◧
Respect of cropping calendar	🟩	◧	🟥	◧
Choice of active ingredients	🟩	◧	🟥	◧
Flexibility on chemical doses	🟩	◧	🟥	◧

Cropping adaptability

	I	II	III	IV
Cropping adaptability	▢	◧	🟥	◧

🟥	No effect or delicate implementation
□	Insufficient
◧	Satisfactory, but under certain conditions
▢	Satisfactory
🟩	Excellent or simple

SYSTEM III : Permanent living vegetal cover

SYSTEM IV : Mixed systems

Technical sheet

A range of systems for red and yellow ferralitic soils

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On ferralitic soils, main problems are linked to the low soil fertility due to their origin, to erosion and to loss or biological activity. On the most degraded ones, soil compaction is a strong limiting factor. The range of systems proposed can answer to these various constraints while combining soil protection against erosion, re-activation of biological activity, soil chemical fertility restoration (soil smouldering and use of legumes) and soil structure improvement by plants having strong root systems.

SITUATION 1

Fields cultivated with rice
for 2 to 3 years
Soil not compacted
Presence of *Crassocephalum*

Slope > 25°

- *Soil smouldering*
- 🟡 *Bracharia Ruzi.* (3 months)/Rice
- 🟡 *Mucuna* (3 months)/Rice
- 🟡 *Mucuna* (3 months)/Maize
- 🟡 *Bracharia Ruzi.* (3 months)/Maize

Slope < 25°

- Same systems as >25°
- 🟡 Rice with mulch (7 t/ha)
- 🟡 Maize with mulch (7 t/ha)

SITUATION 2

Fields cultivated with rice
for 4 to 5 years and abandoned
Soil compacted
Presence of *Urena, Sida,*
Cassia tora, Melastoma

Slope > 35°

- 🔴 Forest
- 🔴 Industrial plants
- 🟠 Mini-terraces

Slobe < 35°

- Soil smouldering
- 🟠 Cassava + *Stylosanthes*
- 🟢 Forages production
- 🟡 *Bracharia Ruzi.* (3 months)/Rice
- 🟡 *Bracharia Ruzi.* (3 months)/Rice
- 🔴 Orchards

SITUATION 3

Old pasture land
Very compacted soils
Presence of *Crysopogon,*
Paspalum conjugatum

With irrigation

- 🟡 Riz irrigué

Without irrigation

- 🟢 Forages
- 🔴 Orchards

Rotation of the temporary cover plants

Legumes (N)

Grasses
(Strong root systems)

Technical sheet

A range of systems for brown soils developed on limestone

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On brown soils developed on limestone, main problems are linked to steep slopes favouring erosion, poor soil structure, poor biological activity, low chemical fertility (N) for maize cultivation, and weeds. Cropping systems based on vegetal cover make it possible to face these various constraints.

If slope > 35°

Mini-terraces
🟠
- Maze+ *Arachis p.*
- Maize + *B. ruziz.*

If slope < 35°

	SITUATION 1	SITUATION 2	SITUATION 3
	Preceding vegetation: *Chromolaena* Good, well structured soils	Preceding veg.: *Andropogon* Rather well structured but poor soils	Preceding vegetation:*Imperata* Degraded soils, compacted in the deep horizons
ESTABLISHMENT	Slashing	Slashing	
	Regrowth (3 weeks)	Regrowth (3 weeks)	
	1,5 l/ha 2,4-D	3– 4 l/ha Glyphosate (Water pH = 4)	3 – 4 l/ha Glyphosate (Water pH =4)
	🟡 Maize + *Mucuna* (delayed 30-45 days)	🟡 *Mucuna* (3 months) Then maize	🟡 *Mucuna* (3 months) (+ mulch) then Maize
	🔴 Or orchards + *Arachis pintoï*	🔴 Or orchards + *Arachis pintoï*	🔴 Or orchards + *Arachis pintoï*

FOLLOWING YEARS

- 🟡 • *Mucuna* (3 months)/Maize
- 🟡 • Maize + *Mucuna* (30-45days)
- 🟡 • Maize + *Vigna* (30-45 days)
- 🟠 • Maize + *Arachis pintoï.*
- 🟠 • Maize + *B. ruziz*
- 🟢 • Forages

Or orchards
+ *Arachis pintoï*

🟡	Systems based on annual crops
🟠	Mixed systems: crops and forages
🟢	Systems based on forages production
🔴	Systems based on trees and orchards

+ : Crops in association
/ : Crops in succession

SCV *Sustainable technical alternatives*

Technical sheet

A technically simple solution: soil mulching

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The technically simplest system consists in direct seeding in a mulch made out of weeds, crops residues and/or imported straws. Bringing a moderate regulation of the soil-plant functioning, it makes it possible to easily discover the direct seeding technique while appraising the interest of a vegetal cover to control erosion, reduce evaporation, restore biological activity and control weeds.

Preparation

- Traditional weeding with a hoe or chemical spraying on the natural vegetation (3 l/ha glyphosate + 1.5 l/ha 2,4-D)
- Weeds are not burned nor removed from the field, but kept as standing mulch
- Supplementation with straws up to 7 t/ha d.m. (6 – 10 cm thick mulch)

Hill-drops are not covered by the mulch

Seeding

Opening hill-drops with a bamboo stick

Hill seeding, directly in the mulch

Maize emergence in the mulch

<u>Precautions</u>

- Seeds are treated (fungicide + insecticide)
- For cereals or grasses, N fertilisation (20 to 30 kg/ha Urea) is recommended at sowing.

Making-up a vegetal cover for the next crop

Relay cropping of a legume, as a cover between rice rows

Growth of the legume after rice harvest

Advantages

- Low technical level required
- Simple system to discover direct seeding (erosion, weeds, evaporation, biological activity)

Drawbacks

- Straw, mulch availability,
- Poor improvement of the soil structure
- Requires hill seeding

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Technical sheet

A solution for degraded and compacted soils:
Brachiaria ruziziensis *followed by upland rice*

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Brachiaria ruziziensis *is a leafy, stoloniferous perennial grass (over 3 years). It rapidly produces an important biomass (up to 15 t/ha in three months). Its strong root system is capable of mobilising mineral nutrients in difficult conditions (compacted, acid soils with high aluminium content) and makes* B. ruziziensis *perfectly adapted to cropping systems with direct seeding on vegetal cover. Notably, its capacity to improve soil structure makes it an excellent preceding crop for upland rice cultivation.*

A strong root system

A high and fast biomass production

Seeds production is easy

Possible on steep slope

Establishment of *Brachiaria ruziziensis*

At the beginning of the rainy season (mid-March to early April)

- Traditionnal hoeing on very compacted soils, then B. ruziziensis broadcasting (10-12 kg/ha). Seeds are superficially covered with soil, using the hoe.
- On softer soils, local vegetation is sprayed 7 days before sowing with herbicide (3 l/ha glyphosate + 1,5 l/ha 2,4-D, Water pH =4)

In case of weeds regrowth, spraying of 1 l/ha Paraquat + 1 l/ha petrol and hill seeding of *B. Ruziziensis* with 4 to 6 grains per hill-drop and a spacing of 40x40 cm to 50x50 cm (8-10 kg/ha). Hill seeding is made with a hoe or a simple bamboo stick.

- Biomass production is high and fast. According to rice varieties cycle duration (grouping flowering periods to reduce pest pressure), *B. ruziziensis* will be killed between end of May and beginning of July.
- 7 to 10 days before rice sowing *B.ruziziensis* is killed by Glyphosate spraying (3l/ha, water pH = 4). If need be (*B. ruziziensis* not entirely killed) 1 l/ha Paraquat mixed with 1 l/ha of petrol is sprayed before rice hill seeding.

The mulch 7 days after spraying.

Upland rice cultivation

Upland rice growth on B. ruzi. mulch

- Hill seeding of rice is made with 5-6 grains per hill-drop
- Spacing between hill-drops: 20 cm x 20 cm
- Hill seeding is made with a hoe or a simple bamboo stick.

Precautions

- Hill-drops should not be covered with mulch, to allow good emergence of young plants
- Seeds are treated (fungicide + insecticide)
- N fertilisation (20 to 30 kg/ha Urea) is recommended at sowing.

Hill seeding

Advantages	Drawbacks
Can be used in a large range of situations	Hardly possible to control *Brachiaria* with simple cutting (requires herbicide)
Weeds control (dramatic reduction in weeding time)	Requires hill seeding
Improvement of soil structure	When *Brachiaria* has produced grains, controlling its seedling in the rice field will be difficult
Fast production of an important biomass	
Seeds production is easy	

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Technical sheet

A solution for the less degraded and compacted soils:
Mucuna pruriens *followed by maize cultivation*

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Mucuna pruriens *is a climbing and voluble legume, necessitating soils with a medium fertility level, which are well drained and not compacted. Its seeds are traditionally used as fodder for animals. It is aggressive against weeds (shadow and allelopathic effects) and its seed production is easy. It is easily controlled by simple cutting and disappears in winter. Its ability to fixate atmospheric Nitrogen makes it an excellent preceding crop before maize cultivation.*

Establishment of *Mucuna*

At the beginning of the rainy season (mid-March to early April)

- On soft soils, local vegetation is sprayed 7 days before sowing with herbicide (3 l/ha glyphosate + 1,5 l/ha 2,4-D, Water pH =4)
  In case of weeds regrowth, spraying of 1 l/ha Paraquat + 1 l/ha petrol and
- Hill seeding of *Mucuna pruriens* with 1 or 2 grains per hill-drop and a spacing of 40x40 cm to 50x50 cm, 2 to 4 cm deep. 180 to 190 kg/ha of seeds are needed
- Hill seeding is made with a hoe or a simple bamboo stick. Hill-drops should not be covered with mulch.

Seeds production is easy

- Biomass production is fast and important. Only 3 months are necessary to produce a sufficient biomass.
- 7 to 10 days before sowing maize, *Mucuna* is either cut or killed by spraying 1 l/ha of 2,4 D-amine.

Young Mucuna plants after hill seeding on crop residues

An important and fast production

Mucuna is climbing and voluble

Maize cultivation

Maize growth on a mulch of Mucuna

- Maize is sown with 2 to 3 grains per hill-drop.
- Spacing between hill-drops is 80x40 cm
- Hill-pods are made with a hoe or a simple bamboo stick
- Traditional local or improved varieties can be planted
- Mucuna can be intercropped between maize rows, sown 45 days after sowing maize.

Precautions

- Hill-drops should not be covered with mulch, to allow good emergence of young plants
- Seeds are treated (fungicide + insecticide)
- Usual fertilisation is made. An extra N fertilisation (20 to 30 kg/ha Urea) is recommended at sowing.

Maize seedling emerging in a mulch of Mucuna

Advantages	Drawbacks
• Can be used in a large range of situations • Very competitive: good weeds control during *Mucuna* growth • Fast biomass production • Seeds production is easy • Mucuna can be easily controled by cutting or with herbicide (1 l/ha 2,4-D)	• Mulch made out of *Mucuna* is rapidly decomposed • As a consequence, weeds control in the main crop is limited to a few weeks. • Its root system is not strong (limited soil structure improvement) and *Mucuna* can not be used on compacted soil.

Technical sheet

Mini-terraces on steep slopes

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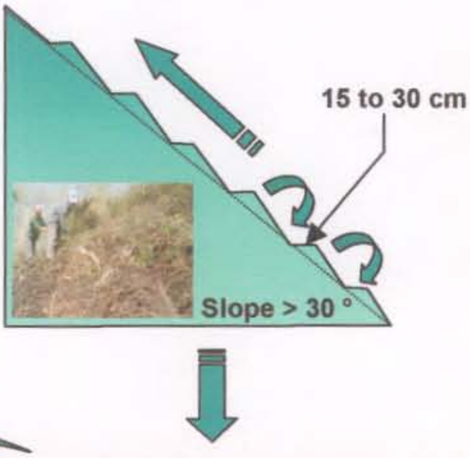
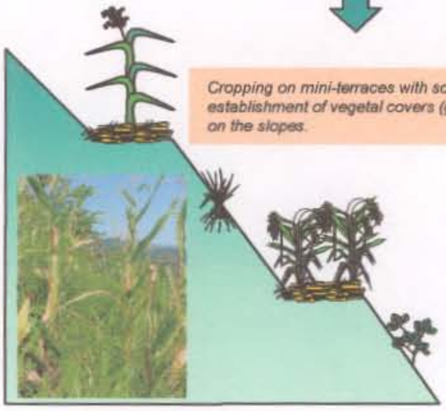
On very steep slopes (>30°), cropping conditions are extremely difficult and erosion is intense. Development of mini-terraces makes it possible to face these constraints. Combined to cropping systems on vegetal cover, it is a sustainable alternative to traditional cropping systems.

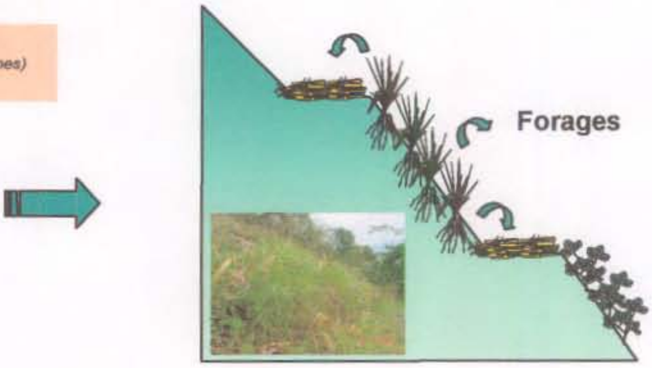


Development of mini-terraces with a hoe, before the rainy season



Cropping on mini-terraces with soil mulching and establishment of vegetal covers (grasses or legumes) on the slopes.

Development of vegetal cover after crop harvest



Advantages

- Adapted and recommended for steep slopes
- Sustainable systems
- Erosion control
- Forages production
- Access to, and work in fields eased

Drawback

- High labour demand the first year

Maize and Brachiaria ruziziensis on mini-terraces

Maize, Arachis pintoï and mulch made of B. ruziziensis

Maize, mulch and Brachiaria ruziziensis regrowth

Technical sheet

Soil smouldering for a low-cost restoration of fertility

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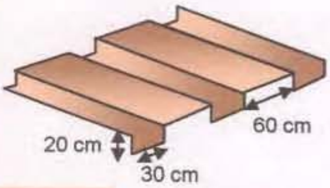
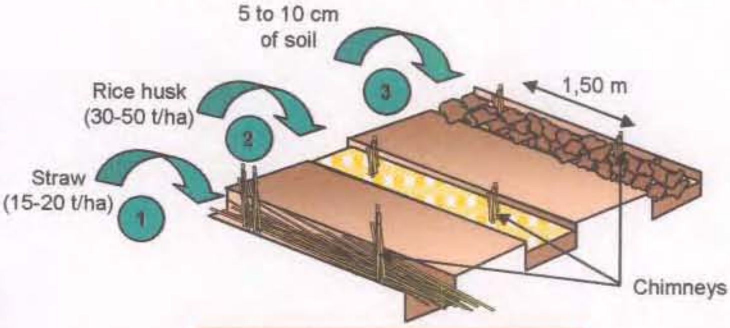
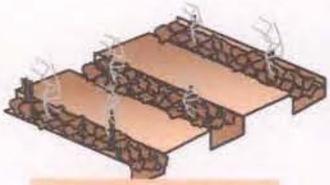
In Vietnam Northern mountainous areas, traditional management practices lead to low chemical fertility and soil restoration is needed to achieve satisfactory yields. However, the very low capital availability makes it impossible for rural population to invest in massive chemical or organic fertilisation, or liming. Soil smouldering, consisting in a slow and partial burning of the soil organic matter makes it possible to restore favourable conditions at minimum cost. It has to be associated with vegetal covers.



Digging trenches



Filling in the trenches with fuel (straws and rice husk) and covering with 5 to 10 cm of soil



Slow burning for 24 to 48 h

Details of the chimneys

Soil improvement

- Raise in pH of 1 unit
- Phosphorus release
- Mineralisation of organic matter without volatilisation
- Soil de-compacting

Soil after smouldering

Caution

- Decrease in O.M. content (0,5 – 1 %) (do not perform to consecutive years)
- Temporary soil structure destruction
- Temporary soil biological activity decrease

Implement soil smouldering locally, and associate imperatively with vegetal covers

Rice emergence: it is planted in twin rows, on the smouldered part and soil is covered with a mulch of straws

Raising of a legume planted between rice rows, 3 weeks after rice

Rice yield of 1,7 t/ha

Without fertilisation and without weeding

After rice harvest, the legume (for example Canavalia) can develop and constitute a new vegetal cover

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Technical sheet

Direct seeding of upland rice on oats vegetal cover for paddy fields with poor water control

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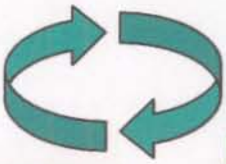
For paddy fields with poor water control (e.g. new terraces with poor access to water, etc.), direct seeding of upland rice or mix (upland x irrigated) varieties on oats vegetal cover can be proposed. Oats also can be used as forage during the winter period (when forage availability is low).

Winter: Oats

Oats in paddy field in January (front: oats regrowth after cutting for animal feeding)

Oats as forage for cattle: 4 t/ha d.m. available in January-February

Oats directly sown in paddy field after rice harvest (from October to December)



From March-April to June: rice can be directly sown in oats mulch, either after herbicide spraying (glyphosate, 3l/ha) or after simple cutting (after oats booting, cutting will be sufficient to prevent its regrowth)

Spring-summer-autumn: Rice and other crops

Rice yield over 2 t/ha, without irrigation

Upland rice at flowering in a paddy field without irrigation. No weeding.

Thanks to strong allelopathic effects, oats mulch controls most weeds and weeding is not necessary

Introduction of Brazilian rice varieties adapted to both irrigated and upland conditions

By crossing upland and irrigated varieties (*O. japonica x O. sativa*), Brazilian breeders (Agronorte) in cooperation with Cirad (L. Séguy) selected high-quality rice varieties having a high potential of productivity in both irrigated (over 10 t/ha under intensive cultivation practices on rich soils in Brazil) and upland conditions (over 7 t/ha with direct seeding techniques at high technological level). These varieties are being tested in Vietnam since 2001. Yield over 2 t/ha has been achieved for several varieties, with direct seeding on *Brachiaria ruziziensis* mulch on degraded ferralitic soil.

They are now tested with direct seeding on oats mulch in paddy field with poor water control.
Their mix characteristics give high expectation for further improvement of this system.

Brazilian rice collection on degraded ferralitic soils in Bac Kan (CIRAD 141: 2 t/ha)

Brazilian rice in irrigated conditions near Plei Ku (3 to 4 t/ha)

CIRAD

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Technical sheet

Cassava with a *Stylosanthes guyanensis* living cover

Husson Olivier (CIRAD)
Ha Dinh Tuan (VASI)
Chabanne André (CIRAD)
Lienhard Pascal (CIRAD)
Séguy Lucien (CIRAD)

In the traditional systems in Northern mountainous areas of Vietnam, upland rice is cultivated for 2 to 5 years after slashing the forest, and is followed by cassava cultivation for one to two years. Land is then abandoned and left as fallow for 10 to 20 years before rice cultivation is possible again. Establishment of a Stylosanthes guyanensis *cover under cassava improves the soil and makes it possible to cultivate rice again immediately after cassava.*

Young Stylosanthes guyanensis

Stylosanthes guyanensis establishment

- At the first weeding, weeds are not burned nor removed but kept in the field for mulching
- *Stylosanthes guyanensis (CIAT 184* is recommended as resistant to major diseases*)* can be established from seeds (6-8 kg/ha) or rooted cuttings (40 cm x 40 cm spacing, 2 to 3 cuttings per hole after dipping in mixture of clay, cattle dung and water).

Advantages

- The soil is protected by a dense vegetal cover
- *Stylosanthes guyanensis* is a perfect plant to improve soil as it combines nitrogen fixation and soil structure improvement by a strong root system
- It is a perennial legume, and doesn't need to be sown every year
- It is an excellent forage, rich in proteins and remains green and grows during the dry and cold season
- It requires low input and technical knowledge

Soil profile under Cassava + Stylosanthes guyanensis

Limitations

- *Stylosanthes guyanensis* is rather slow to establish
- Seeds production may be difficult in the conditions of Northern Vietnam

Stylosanthes guyanensis *flowers*

The soil is permanently covered and protected by S. Guyanensis

S. guyanensis *remains green during the dry season*

Vigna sp. cultivated on S. guyanensis mulch

Other possible legume covers

Other legumes, especially *Cassia rotundifolia* (also called *Chamaecrista rotundifolia*) can be used as cover crops under cassava (but soil structure improvement is not as good as with *Stylosanthes guyanensis*)

Nitrogen-fixing nodules on Cassia rotundifolia *roots*

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Technical sheet

Arachis pintoï as *living vegetal cover in orchards*

Husson Olivier (CIRAD)
Ha Dinh Tuan (VASI)
Chabanne André (CIRAD)
Lienhard Pascal (CIRAD)
Séguy Lucien (CIRAD)

In orchards, especially on sloping land, weeds and erosion are two major problems. Arachis pintoï, *a legume (thus fixing nitrogen) with a strong root system, competitive to weeds but not climbing on trees proved to be particularly well adapted to conditions met in mountainous areas of northern Vietnam. It is an excellent forage, rich in proteins, and can be used for cattle feeding.*

Arachis pintoï establishment

- Traditional shallow hoeing or herbicide spraying to kill the natural vegetation (3 l/ha glyphosate + 1.5 l/ha 2,4-D)
- Weeds are not burned nor removed but kept in the field for mulching

Young Arachis pintoï *on mulch*

- *Arachis pintoï* can be established from seeds (expensive), or simply by rooted cuttings, with a 40 cm x 40 cm spacing
- Cuttings can be dipped in a mixture of clay (1/3), cattle dung (1/3) and water (1/3) before planting, to ease the regrowth.
- Two or three cuttings are planted per hole
- Two eyes from the cutting are pushed in the ground after opening the soil with a hoe. One or two eyes are kept above the soil surface

Dipping the cuttings in a mixture of clay, water and cattle dung

Arachis pintoï *: Regrowth one month after planting the cuttings*

Advantages

- Soil protected against erosion
- Improvement of soil structure
- Increase in biological activity (earth worms, etc.)
- Nitrogen fixation
- Weeds control
- Production of high quality forage
- Withstands heavy cutting or grazing
- Creeping (no competition with trees)

Arachis pintoï *cover in a young orchard (1 year)*

Arachis pintoï *cover in an orchard on sloping land*

Other possible legumes cover for plantations

Other legumes, especially *Stylosanthes guyanensis* can be used as cover crops in tree plantations. It can be controlled by simple cutting

Cutting Stylosanthes guyanensis *in a coffee and rubber tree plantation (Pleiku)*

Technical sheet

Direct seeding of upland rice on oats vegetal cover for paddy fields with poor water control

Husson Olivier (CIRAD)
Chabanne André (CIRAD)
Ha Dinh Tuan (VASI)
Martin Cédric (CIRAD)
Séguy Lucien (CIRAD)

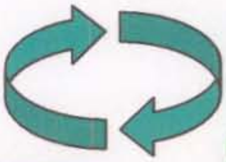
For paddy fields with poor water control (e.g. new terraces with poor access to water, etc.), direct seeding of upland rice or mix (upland x irrigated) varieties on oats vegetal cover can be proposed. Oats also can be used as forage during the winter period (when forage availability is low).

Winter: Oats

Oats in paddy field in January (front: oats regrowth after cutting for animal feeding)

Oats as forage for cattle: 4 t/ha d.m. available in January-February

Oats directly sown in paddy field after rice harvest (from October to December)



From March-April to June, rice can be directly sown in oats mulch, either after herbicide spraying (glyphosate, 3l/ha) or after simple cutting (after oats booting, cutting will be sufficient to prevent its regrowth)

Spring-summer-autumn: Rice and other crops

Rice yield over 2 t/ha, without irrigation

Upland rice at flowering in a paddy field without irrigation. No weeding.

Thanks to strong allelopathic effects, oats mulch controls most weeds and weeding is not necessary

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Mauvaises Herbes et Riz pluvial, Quelles contraintes ?

Village de Ban Cuon, District de Cho Don, Province de Bac Kan

Stevoux Véronique (CIRAD- ENSAM)
Le Bourgeois Thomas (CIRAD)
Husson Olivier (CIRAD)

Image

L' enherbement de la culture de riz pluvial sur pente au Nord Vietnam représente une des contraintes majeures pour la durabilité des systèmes de production. Aujourd'hui, les méthodes de gestion traditionnelles (défriche- brûlis) de l'enherbement ne sont plus adaptées aux nouvelles conditions socio-économiques. Dans ce contexte il apparaît important de caractériser la flore adventice et son fonctionnement afin de proposer par la suite des méthodes de gestion adaptées.

Le constat:

L'augmentation importante de l'enherbement des parcelles de riz pluvial est une des causes d'abandon des parcelles après 3 à 4 ans de culture. Le plus souvent un désherbage à la main est réalisé en cours de culture (100 jours/homme/ha) et souvent trop tardivement, 2 mois après le semis, faute de main d'œuvre et de temps. De plus la lutte contre cet enherbement représente 56 % du temps consacré à la culture. Aujourd'hui, la diminution de la durée de jachère corrélée à l'interdiction de défricher de vieilles forêts conduisent à un salissement très important des parcelles dès la première année de culture. De plus, faute de moyen financier et de connaissances techniques, les agriculteurs n'utilisent pas d'herbicide.

Ageratum conyzoides

Relations espèces - milieu:

Photos V.Stevoux, O. Husson

Afin de comprendre les relations entre la présence des espèces adventices (abondance- fréquence) et certains facteurs de milieux (nombre d'années de culture, place dans la pente, type de sol, précédent cultural, ...) une étude phyto-écologique a été réalisée dans le village de Ban Cuon pendant la campagne 1999. Les relevés floristiques et mésologiques, réalisés sur 21 parcelles à différents moments du cycle cultural, montrent l'importance des Asteracées, des Poacées et des espèces issues du milieu forestier (recru ligneux, fougères). La saisonnalité ainsi que le type de forêt précédent la défriche, apparaissent comme des facteurs influant sur la composition floristique. La place dans la toposéquence semble influencer la répartition des espèces, les bas de pente ayant de forts enherbements.

Lygodium flexuosum

Imperata cylindrica

Crassocephalum crepidioides

Borreria alata

Melastoma sp.

Paspalum conjugatum

Eleusine indica

Trema angustifolia

Caractéristiques écologiques :

La majorité des mauvaises herbes du riz pluvial se caractérisent par la possibilité de faire plusieurs cycles en une saison de culture (*Ageratum conyzoides*), par une forte production de graines (*Borreria alata*), par une adaptation aux méthodes de lutte traditionnelles: feu, sarclage, désherbage manuel (*Imperata cylindrica*).

Espace Logos

Bandeau thématique

Mauvaises Herbes et Riz pluvial, Les systèmes à base de couverture végétale: une solution ?

Stevoux Véronique (CIRAD- ENSAM)
Le Bourgeois Thomas (CIRAD)
Husson Olivier (CIRAD)

Image

Dans l'écosystème montagnard fragile du nord Vietnam, la gestion de l'enherbement, la gestion de la fertilité, la conservation des sols et de leur humidité, ainsi que la disponibilité en fourrages sont fortement interdépendants. C'est dans ce contexte que le projet SAM étudie de nouvelles opportunités de gestion des adventices à travers la mise en place de systèmes de culture à base de plante de couverture et de paillis.

Principales étapes: *Photos V.Stevoux, O. Husson*

Brachiaria ruziziensis

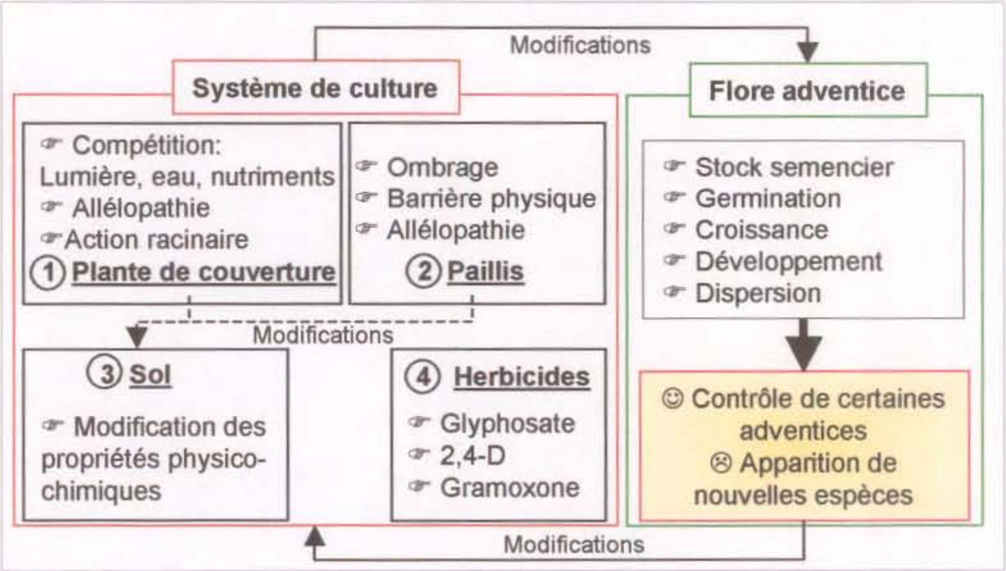
Passage d'herbicide

Germination du riz dans
le mulch de *Brachiaria ruziziensis*

Riz pluvial et
mulch de *B. ruziziensis*

Gestion des adventices, le principe :

<u>Légende</u>:
○ Eléments du système de culture
☞ Conséquences



Modifications

Système de culture

☞ Compétition:
Lumière, eau, nutriments
☞ Allélopathie
☞ Action racinaire
① **Plante de couverture**

☞ Ombrage
☞ Barrière physique
☞ Allélopathie
② **Paillis**

Modifications

③ **Sol**
☞ Modification des propriétés physico-chimiques

④ **Herbicides**
☞ Glyphosate
☞ 2,4-D
☞ Gramoxone

Flore adventice

☞ Stock semencier
☞ Germination
☞ Croissance
☞ Développement
☞ Dispersion

☺ Contrôle de certaines adventices
☹ Apparition de nouvelles espèces

Modifications

Temps de travaux:

Les systèmes en semis direct avec plante de couverture testés par le projet SAM peuvent apporter des solutions intéressantes en supprimant la majorité des sarclages (nettoyage avant semis, désherbage à la main) tout en augmentant les rendements. La productivité du travail est alors considérablement améliorée par l'augmentation des rendements et la diminution des temps de travaux. La préparation du sol et les sarclages étant remplacés par l'installation d'une plante de couverture et des passages d'herbicides .