DMC development in Cambodia
A tool for economic and territory development

Stéphane BOULAKIA (CIRAD / MAFF)
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A tool for economic and territory development

Plan

1/ Potential place of DMC in Agriculture Development

2/ Construction of DMC based cropping systems for upland rainfed agriculture

3/ Toward an ambitious plan for upland cultivation development?

4/ Conclusion
1/ Potential place of DMC in Agriculture Development
## 1/ Potential place of DMC in Agriculture Development

An agricultural sector of declining economic importance but which still underpins the Cambodian society

### A base of the Cambodian society…

- 80,5 % rural population (2,34 / 2,85 millions households – census 2008)
- > 2,0 millions households grow rice
- 90 % of the poor live in countryside
- 80 % of the poor people depend on rice cropping
- Agricultural sector provides [70% of the employment](#) (stable proportion)

### With declining economic importance

- **1998**, “Agriculture” produces 3,5 m.t rice and weights #45% national GDP
- **2008**, “” 7,0 m. t rice “” < 35% national GDP
- The Agricultural sector covers the needs for the [national self-subsistancy](#)
- but many regions often face a food crisis during “bad years”
- Growing but irregular surplus from year to year, a limited diversification of the products and a narrow national market …
  - constrain the emergence of an agro-industrial sector (added value)
  - favour informal trade exchanges across frontiers (Thailand / Vietnam)
1/ Potential place of DMC in Agriculture Development

Fundamental geographical reminders
4 major Agro-ecosystems … cropped or “crop-able”

Rainfed lowland rice on Sandy plains (strictly rain dependant)
Rice, associated to Cattle/Buff. livestock
Ann. / Perennial based upland cult. possible

Floating Rice or Water management on deeply flooded areas
Water management for counter-season cultivation (different types : prek, dam …)
1/ Potential place of DMC in Agriculture Development

Fundamental geographical reminders
Some constraints of the physical conditions: soils, climate and flood

<table>
<thead>
<tr>
<th>Soil</th>
<th>Flood</th>
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<tbody>
<tr>
<td>Plateau &amp; hill</td>
<td>Flood of tributaries / distributaries</td>
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<tr>
<td>Great soil potential</td>
<td>Flood of Mekong / Tonle Sap</td>
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<tr>
<td>(basaltic substratum)</td>
<td>variation in extent, speed &amp; date of flooding</td>
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<tr>
<td>Upland agriculture</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Sandy Plain</th>
<th>Hydromorphic Plain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor sandy Soil</td>
<td>Clay-silt Soil (greater soil x water potential)</td>
</tr>
<tr>
<td>&gt; 60 % of ricefield</td>
<td>Rice crop - hazardous, surplus in the West reg.</td>
</tr>
<tr>
<td>Main part of the national land reserve?</td>
<td>“Alluvial soils”</td>
</tr>
</tbody>
</table>

Flooded areas
Water management & counter season rice
The 4 main Agro-ecosystems

Upland cultivation on Red and Black soils
The 4 main Agro-ecosystems

Rainfed lowland rice on Sandy plains
The 4 main Agro-ecosystems

Rainfed lowland rice on hydromorphic plains
The 4 main Agro-ecosystems

Rice based on water management in deep flood area
1/ Potential place of DMC in Agriculture Development

Fundamental geographical reminders
An unevenly population distribution on the national territory

The populated part of Cambodia: < 40% territory
> 90 % population

1870 : < 1 million inhabitants
2008 : > 12 millions inhabitants
1/ Potential place of DMC in Agriculture Development

Fundamental geographical reminders

“Rice & central Cambodia” vs “Forest & peripheral Cambodia”

<table>
<thead>
<tr>
<th>Central and populated Cambodia</th>
<th>Peripheral and sparse Cambodia</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.1 millions inhabitants</td>
<td>1.3 millions inhabitants</td>
</tr>
<tr>
<td>&gt; 200 inhab./km²</td>
<td>&lt; 15 inhab./km²</td>
</tr>
<tr>
<td>agriculture &gt; 55% of the territory</td>
<td>agriculture &lt; 5% of the territory</td>
</tr>
</tbody>
</table>

Cropped area < 20% of the country surface

- 75% of the farms < 1.0 ha
- 80% of farms not connected to market

- 75% of strict rainfed lowland rice
- 2.4 t/ha/year in average

Subsistence farming in the populated area

Commercial farming and pressure on natural resources in the sparse area
1/ Potential place of DMC in Agriculture Development

Peripheral Cambodia … A large “public land reserve”

Where and how to plan for sustainable, equitable development?

<table>
<thead>
<tr>
<th>Total area of Cambodia</th>
<th>Agricultural area</th>
<th>Great Lake</th>
<th>Protected area</th>
</tr>
</thead>
<tbody>
<tr>
<td>18,0</td>
<td>3,0</td>
<td>1,5</td>
<td>3,5</td>
</tr>
</tbody>
</table>

10,0 millions hectares

How this area can support smallholders agriculture and contribute to poverty reduction?
2/ Construction of DMC based cropping systems for upland rainfed agriculture

... too short time to present DMC development for rainfed lowland rice agro-ecosystems!
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

Stop plowing … the horror pictures show
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

Stop plowing … and NT on crops residues insufficient

Impact of conventional tillage associate with monoculture in C losses in temperate, sub-tropical and tropical areas

Canada & USA
48 a 58 % (Wheat)
Campbell & Souster, 1982; Mann, 1985
Latitude 42° N

Pergamino/Sarmiento-ARG
24-60 % (Wheat)
Michelena, 1989; Casas, 1998
Latitude 32° S

Ponta Grossa - PR
35 % (Soybean)
Sá et al., 2001
Latitude 25° S

Cerrado – GO & MT
35 a 69 % (Soybean)
Resck, 1998
Seguy & Bouzinac, 2002
Latitude 13 a 16° S

1,0 to 1,2% /y
1,2 to 3,0% /y
3,5% /y
7,0 to 13,8 % /y
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

The tropical forest: a model to be reproduced at field scale

Most of the nutrients are
- kept in the soil-plant system
- recycled between dead & alive O.M.
… with little exchanges with soil mineral compartments

A stable ecosystem with high biomass productivity, even on poor soil

from L. Seguy & S. Bouzinac, CIRAD, 1996
The 3 principles of DMC

1/ No soil's tillage
2/ Soil's permanent plants' cover
3/ Succession / Rotation of species

Biological parameters
- carbon & Soil organic matter,
- weeds, pests, ...

Chemical parameters
- pH, ECC, bases, ...

Physical parameters
- erosion, porosity, water, ...

a continuous flux of CARBON
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

The “notion” of biological pump

## 2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

The “Multi-functionality” of biological pump

<table>
<thead>
<tr>
<th><strong>FUNCTION</strong></th>
<th><strong>EFFECT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food</strong></td>
<td>Nutrient for crops, Fodder for cattle</td>
</tr>
<tr>
<td></td>
<td>Biomass for soil’s fauna/µflora chains</td>
</tr>
<tr>
<td><strong>Protection</strong></td>
<td>Erosion / run-off, Evaporation, T (°C)</td>
</tr>
<tr>
<td></td>
<td>Xenobiotiques bio-degradation ®</td>
</tr>
<tr>
<td><strong>“Pest-buster”</strong></td>
<td>Weed control (shade, <em>allelopathy</em>)</td>
</tr>
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<td></td>
<td>Disease (splash effect, blast on rice…®)</td>
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<tr>
<td></td>
<td>Insect (…via biodiv. … ®)</td>
</tr>
<tr>
<td><strong>C Loader</strong></td>
<td>C storage - ECC increase, pH buffer …</td>
</tr>
<tr>
<td></td>
<td>Bio activity / diversity increase ® publi.)</td>
</tr>
<tr>
<td></td>
<td>Bio-degradation / detoxification (?) ®</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Roots system matrix, decompaction</td>
</tr>
<tr>
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<td>Porosity, Water reserve</td>
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<tr>
<td></td>
<td>Aggregation &amp; O.M.% ®</td>
</tr>
<tr>
<td><strong>Recycling pump</strong></td>
<td>Connection to deep water <em>i.e.</em></td>
</tr>
<tr>
<td></td>
<td>maximization of the water potential</td>
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<tr>
<td></td>
<td>Recycling of lixiviated ions NO₃⁻, bases ®</td>
</tr>
</tbody>
</table>
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

Localization of the main PADAC’s R&D areas

1/ Kampong Cham Province - Dambe / Ponhea Krek Districts
   Cassava production area with (very) smallholders

2/ Kampong Cham Province – Chamcar Loeu District
   Divers. crop. Σ (Soy., Corn, Cass.) with various farms types

3/ Battambang Province – Rattanak Mondul District
   Corn (+ Cass.) production area with small /medium farms

1 & 2 = PADAC - 2008-2012:
   400 to 500 ha pilot extension

3 = PADAC \ SANREM - 2009-2014:
   200 ha pilot extension
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

Main Plow based cropping systems (Farmers’ references)

|------|-------|-----|------|---------|------|-------|--------|------|------|

1/ **Sesame** disc  **Soybean**

2/ **Cassava Monoculture**

3/ **Maize** disc  **Maize**

High technical and economical randomization + soil’s degradation

- irregular and decreasing profit margins
- progressive shifting to perennial … when capital available!
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

First DMC based, using short term biomass production

Bio-pump sc *Eleusine c.*

or *Eleusine + Cajanus*, Sorghum, Millet ...

Maize + Stylo, Brach. …
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

The “second” generation, using long term biomass production

Step 1: association of Bio-pump lc with Maize

Year 1

Bio-pump sc

Maize + Bio-pump lc

Year 2

...Bio-pump lc

Maize + Bio-pump lc

Bio-pump lc
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

The “second” generation, using long term biomass production

Step 2: association of Bio-pump Ic with Rice and Soybean

- Year n: Rice + Stylosanthes
- Stylosanthes is oversown by no till planter at # 40 DAS
- Year n + 1: Rice + Stylosanthes
- Year n + 1: Maize + …

- Year n: Soybean + Brachiaria
- Stylosanthes or Brachiaria is broadcast sown at first
- Year n: Soybean + Stylosanthes
- Year n + 1: Soybean + …
- Year n + 1: Rice + Stylosanthes
- Year n + 1: Maize + …

Soybean’s yellow leaves appearance
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

First DMC – Economic analysis and cropping systems’ “tuning”

1/ secondary crop  
2/ livestock  
3/ input reduction

Year 1


"scattered" rains  heavy rains

Year 2


"scattered" rains  heavy rains


Sorgho + Stylo  Maize  Mil + C. juncea  Maize

Stylo.  Rice bean  

2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

First DMC – Economic analysis and cropping systems’ “tuning”

1/ secondary crop  2/ livestock  3/ input reduction

Gross Profit Margins (USD/ha)

**DMC:** Brach. / Soybean + Brach. vs Plow reference: Sesame / Soybean

![Diagram showing Gross Profit Margins (USD/ha) vs yield (kg/ha) for different DMC systems.](image-url)
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

First DMC – Economic analysis and cropping systems’ “tuning”
Construction of DMC based cropping systems for upland rainfed agro-ecosystems

The case of Cassava

Evolution of the farm gate cassava's price (USD / t of dry tuber) in Dambe / Ponhea Krek districts
2/ Construction of DMC based cropping systems for upland rainfed agro-ecosystems

The case of Cassava

Year 1

"scattered" rains

heavy rains


Reduced growth of the Stylo.
due to shade, dry soil’s conditions at Cassava’s harvest and early replanting in Year 2

Active growth of the Bio-pump lc

Year 2

"scattered" rains

heavy rains


3/ Toward an ambitious plan for upland cultivation development?
3/ Toward an ambitious plan for upland cultivation development?

For what kind of family based agriculture / farming?

Open & Transparent Markets **

Contract Agriculture

- Farmers Organizations
- Agro-industries processing in Cambodia
- Bank – MFI

** Services and Research

Input supply

** With supervision: e.g. Public auction sale system (cf Thai rubber sector), Δ local - international price monitoring
3/ **Toward an ambitious plan for upland cultivation development?**

**For what kind of production systems?**

<table>
<thead>
<tr>
<th>Scale of Farms</th>
<th>Upland cultivation</th>
</tr>
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<tbody>
<tr>
<td>Small (5-10 ha) / medium (10-20 ha)</td>
<td><strong>Upland cultivation</strong></td>
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<tr>
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<td>(sine qua non condition for sustainability: based on DMC)</td>
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</tbody>
</table>

**High degree of diversification**
- primary based on annual crops (grain, tubers …)
- and livestock productions
- with progressive integration of tree crops production

**High quality products, targeting in first priority national / regional markets**
- Post harvest, storage
- Sector organization, R & D
3/ Toward an ambitious plan for upland cultivation development?

Insertion in the Cambodian geography
Upland cultivation and Natural resource conservation
Creation of “biodiversity corridors” in a region of intense agriculture (Parana / Brazil)
At national scale

Creation of “biodiversity corridors” in between protected areas in Cambodia

... from patches to network
At regional/local scale

Keep “continuum” of “natural” area within developed zones and creation of “buffer” corridors along rivers
At regional/local scale

Keep “continuum” of “natural” area within developed zones and creation of “buffer” corridors along rivers
Major national/regional infrastructures (transport, energy) already planned

A need for comprehensive planning for agricultural, rural development and NR protection
How to combine efficient and pro-poor agriculture with country planning

Today
2008: 13,4 mill. inhab.

Tomorrow
2020: 16,0 mill. inhab.
2030: 18,0 mill. inhab.

Strategic policy
- Planning (Land access)
- Legal framework
- Public investment

Implementation
- Public-private partnership
- Research & extension

Where to from here?
3/ Toward an ambitious plan for upland cultivation development?

5 millions ha of DMC based upland cultivation in 2030? … Let’s see!

<table>
<thead>
<tr>
<th>Year</th>
<th>Camb. Pop.</th>
<th>ha DMC</th>
<th>Nb families</th>
<th>&quot;Pop. DMC&quot;</th>
<th>Technicians</th>
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</thead>
<tbody>
<tr>
<td>2004</td>
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<td>2030</td>
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Evolution based on Census 2008

Evolution based on 75% progress/year

Number family based on 6 ha/household

Population based on 4,5 people/household

Evolution based on 75% progress/year
<table>
<thead>
<tr>
<th>Year</th>
<th>ha DMC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>4</td>
</tr>
<tr>
<td>2005</td>
<td>7</td>
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<tr>
<td>2006</td>
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<td>2010</td>
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<td>2011</td>
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<td>2012</td>
<td>412</td>
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<td>2014</td>
<td>1,334</td>
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<tr>
<td>2015</td>
<td>2,401</td>
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<tr>
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<td>4,322</td>
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<td>7,780</td>
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<td>14,004</td>
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<tr>
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<td>25,207</td>
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<tr>
<td>2020</td>
<td>45,372</td>
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<tr>
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<td>81,670</td>
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<td>2022</td>
<td>147,006</td>
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<tr>
<td>2023</td>
<td>264,611</td>
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<tr>
<td>2024</td>
<td>476,299</td>
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<tr>
<td>2025</td>
<td>857,339</td>
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<tr>
<td>2026</td>
<td>1,543,210</td>
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<tr>
<td>2027</td>
<td>2,777,778</td>
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<td>2028</td>
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<td>2029</td>
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<tr>
<td>2030</td>
<td>5,000,000</td>
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</tbody>
</table>
4/ Conclusions

The “rediscover” of rural and agricultural development by DPs

WB report in 2008 …

Agricultural and rural development is difficult and take time:

- multi-scale approach based on detailed knowledge of farms economy
  - micro-macro economic factors
    (access to production factors: Land agrarian reform-, Input-capital-credit, Labor- mechanization, …)
  - adapted innovations (technical and organizational)
  - Training-information …
Thank you for your kind attention

visit website “agroecologie.cirad.fr”

Pailin & West Battambang

First large “social land concession” or
First “Special Agricultural development Zone” in Cambodia?