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DIRECT SEEDING MULCH-BASED CROPPING SYSTEMS (DMC): A TOOL FOR SUSTAINABLE MANAGEMENT OF CULTIVATED SOILS

What is DMC?

DMC (Direct seeding Mulch-based Cropping systems) is a new tillage-free agricultural approach that has short-to medium-term effects with respect to halting erosion, increasing soil fertility, stabilising or even increasing yields, even on infertile wastelands, while also reducing fuel consumption. This system is based on three principles: zero soil tillage, permanent soil (plant) cover, and relevant crop sequences or rotations associated with cover plants. These three principles combine to create a micro-environment for the crop, hence better expression of its potential to resist pests and diseases, and increased productivity.

What are The Aims of DMC?

To changing farming systems from conventional cropping systems based on soil tillage, massive use of industrial inputs (fertilizers, pesticides and energy), and a small number of cultivated species, into veritable cultivated ecosystems. In particular, it works to develop ways of protecting and restoring the soil by combining direct seeding with permanent plant covers.

Where were DMC Developed?

DMC was launched by CIRAD (French Agricultural Research Centre for International Development) in 1999 in reference to cropping systems that include no tillage and permanent plant cover on the soil. The expression 'plant cover' refers to dead mulch (crop residue, cover plants or dead weeds) or live mulch associated with the crop. CIRAD has been designed and developed DMC through fieldwork sites at a wide range of biophysical and socioeconomic situations representative of tropical environments. DMC was developed in Brazil by CIRAD teams, and now being used in Central Africa (Cameroon), North Africa (Tunisia), the Indian Ocean (Madagascar), Asia (Cambodia, Laos, Vietnam, Thailand and China) and the West Indies (Guadeloupe). Nowadays DMC systems was adopted in Amerika and Australia (Erenstein 2003, Lal 2007, Affholder et al. 2010).

Key Agricultural Principles Underlying DMC

DMCs are classified within the broad agroecological category. This system was contribute to farming system sustainability in an environment-friendly manner by simultaneously implementing several principles in the field (Table 1).

Modelling of Cropping Systems

Agro and socio-economic diagnosis provides a basis for modelling cropping systems and their components. In southern Xayabury (Laos), following the initial assessment, long-term experimental units representing the biophysical (integrating soil, slope and climate) and farming system diversities were set up in order to provide a large sample of cropping systems. Cropping systems comprise three major components (Figure 1):

- Soil management and land preparation through either conventional land preparation (slash-and-burn, ploughing) or through direct seeding (mulching, use of crop residues and cover crop).
- Crop management (rotation, association or crop sequence in the same season; sowing date and plant density). In DMC systems, efficient crop management can reduce weeds and pest pressure and maintain the main functions as close as possible to the natural ecosystem.
- Thematic adjustment (cultivar, manure, fertilizer, pesticides).

Table 1. Key Principles of DMC and Their Benefits

Principles	Functions/Benefits
No tillage	• Soil structure not upset • Erosion control • Rapid crop establishment • Reduced labour • More flexible cropping calendar • Little equipment required • Optimised use of available mineral and water resources: increased yields
Permanent Plant Cover	• Increased organic matter contents, water infi ltration and retention capacity of the soil • Fixation of atmospheric carbon and nitrogen (legumes) • Protection of the soil from erosion and enhancement of the soil structure • Increased quantity of nutrients via recycling of leached nutrients from deep horizons to the soil surface where they can be used by the main crops • Reduced evaporative loss of soil moisture • Weed control • Facilitated tapping of deep groundwater • Can be used as forage
Crop Rotation	• Diversification of agricultural production (food for humans and livestock) • Reduction in risks of disease outbreaks, pest attacks and weed infestation • Better distribution of water and nutrients in the different soil layers • Increased nitrogen fixation through the introduction of legumes • More efficient use of water resources and soil nutrients via sequences or associations with plants with different root systems • Better organic or mineral N/P/K balance • Increased humus synthesis

Source: Seguy, 2007

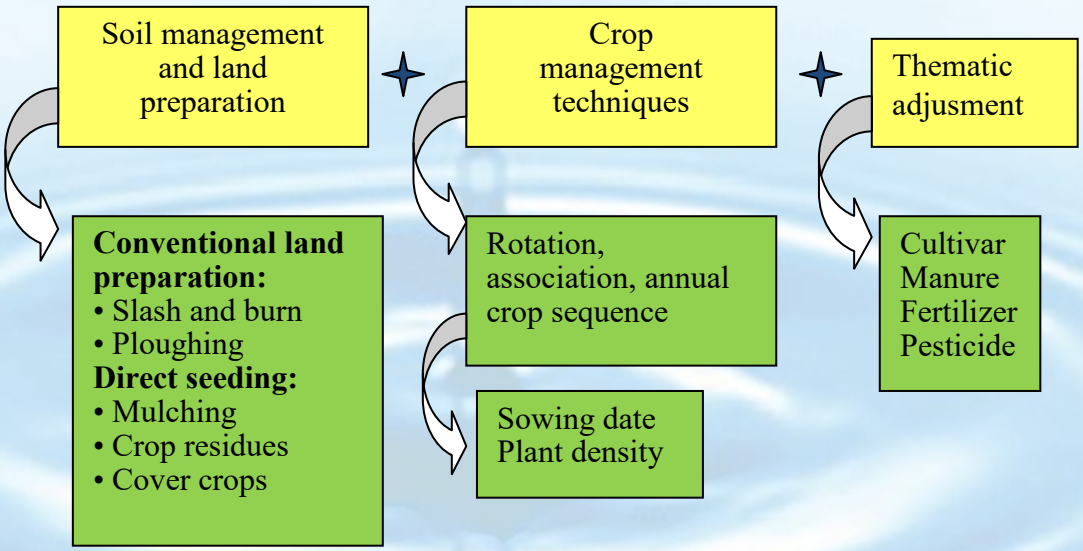

Figure 1. Components of cropping systems (Source: Tivet et al. 2004)

DMC Modification Action Research in Selopamioro Micro Catchment

An iterative generation of DMC system modification is followed in Selopamioro micro catchment. The first step is based on modification of land preparation with crop and weed residues management. Cash crops like chilli, maize, and peanut can be considered as key crops for implementing of DMC (Figure 2). Degradation of crop residues is relatively slow due to a high rate of lignin. This provides good soil protection, reducing evaporation, soil erosion and weed pressure. The second step integrates soil and crop management (rotation and/or intercropping sequence) in order to diversify the production (grain production, rational use of forages by grazing and/or cut and carry for livestock), and so reduce agronomic, economic and climatic risks.

(a) (b) (c)

Figure 2. (a): apllication of rice sraw mulch on chilli, (b): apllication of litter mulch on eggplant, (c): peanut harvest activity after chilli at Selopamioro micro catchment, Bantul District, Special Region of Yogyakarta, 2010/2011.

Moreover, DMC at dry season in Selopamioro micro catchment for crop residues are implemented for cash crops such as "kangkung". A few modifications to cropping systems are proposed to smallholders in order to set-up and adapt each step using current crops and cultivars. DMC systems for crop residues (Figure 3) can exhibit very good results in terms of net income, yield and labour productivity (Tivet et al. 2006). There is a same case in Selopamioro micro catchment. Water supply to irrigate the crops were come from the reservoir on the land.

(a) (b) (c)

Figure 3. (a): Left, direct-seeding of maize on former crop residues; right, maize after ploughing. Southern Xayabury Laos; (b): reservoir as a source of irrigation in dry season; and (c): harvest of "kangkung"after chilli at Selopamioro micro catchment, Bantul District, Special Region of Yogyakarta, 2010/2011.

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