# 3.7 STRUCTURED OR SPONTANEOUS DISSEMINATION OF DMC TECHNIQUES IN SMALL-SCALE COTTON-BASED AGRICULTURE? THE NORTHERN CAMEROON CASE STUDY.

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## Abstract

The northern Cameroon cotton-based agricultural region, as well as the whole of the western and central African cotton belt is mainly characterised by a cotton based agriculture extension program implemented and monitored by the cotton companies. The companies' names or field approaches may differ from one country to another, but they all operate a strong extension team and program that follows the cotton crops from seedling through harvesting, offering relatively higher performances to cotton sectors. Such extension performances can be seen on the large areas covered, involving a large number of cotton farmers and relatively intensive production practices (with high level of fertilisers and other chemical inputs, high average yield, etc.).
Direct seedling-Mulch based-cropping systems (DMC) extension program in the northern Cameroon began in 2007 within the Soil Conservation Project (PCS) following the pilot experimental phase in the Water-Soil-Tree Project (ESA) from 2002 to 2006. Since the two soil conservation projects were monitored by SODECOTON (cotton development company), the newly emerging DMC extension program had to choose between two different extension approaches: a structured extension approach laying on Sodecoton performed and experienced extension team which implies well defined technical message to disseminate; and a spontaneous extension, laying on progressive construction of on-farm technical messages, permanent adaptive processes on cropping systems, and hence little need of a highly structured extension team but rather of an agricultural based progressive approach to change. This study examines the two approaches not by offering a final answer to the best suitable extension approach, but through investigations on the advantages and constraints of each approach and common determinants of DMC extension programs like seed supply and community based experimentations and up scaling. The study is based on seven years of experience on DMC experimentation and extension program in northern Cameroon including on-farm trials and spontaneous disseminations around the village-based cropping systems trials as well as three years of DMC pre-extension program.
According to the study, structured dissemination approach may be adapted to dissemination through an extension team performing its activities on simple but definitive cropping systems. Consequently, any additional amelioration within the system may need high input investment (skills and materials). This may be of interest in familiarising farmers with DMC techniques but may limit DMC appropriation by them since simple and rigid options may not fulfil their main constraints like less fertiliser use, and appropriate integrated weed control.
DMC spontaneous extension approach aims at permanent adaptation of DMC techniques to each given context. This means that various DMC options may be suited to different contexts, thus excluding or avoiding a single "able to disseminate" technical message. Therefore, for an extension team, the need of permanent on-farm construction of technical messages may imply new adaptive skills for taking into account the diverse socio-economic and ecological constraints of farmers which are always ignored in the structured extension approach. On the

other hand, this maximum farmer's engagement in decision-making implies minimum input from the structured extension agents' team. Thus, the farmers' uptake rate of techniques and know-how will be determined either by extension agent dissemination rate (area or farmers he/she is able to supervise) for the structured extension approach or by the ability of the DMC options to respond to farmers constraints for spontaneous extension.

*Key words: DMC, conservation Agriculture, structured extension, spontaneous extension, extension approach, cotton.*

## Introduction

The assessment of adoption of Direct-seeding mulch-based cropping systems (DMC) (synonymous with Conservation Agriculture, see below) based on "adoption school" as opposed to "evaluation school" in economic analysis focuses on explaining and predicting the divergences in soil conservation behaviour between economic agents. This analytical approach helps to explain the reasons behind differential adoption of an innovation. Different factors influence the adoption of agricultural innovations, and specifically DMC. These factors include farm resources, technology, institutions and farms preferences. Different extension approaches try to take these factors into account by providing an adapted framework to ensure wide dissemination. They can vary from little to full consideration of these factors in the field approach.

DMC in this paper refers to FAO (Food and Agriculture Organization) definition of Conservation Agricultural (CA) cropping systems comprising:

- Minimum soil disturbance
- Permanent soil cover
- Appropriate crops rotations and associations.

Based on these three main component practices of CA, it appears that DMC is not a single technology but a package of technologies and practices which can vary according to given specifications. It is not a ready-made standard innovation package. There is no single DMC option, but several DMC options that may be designed for each agro-climatic situation and according to specific socio-economic factors. Variability in DMC options may derive from several factors that will affect its agronomic performances:

- Choice of the main crop or crops combination
- Choice of cover crop or cove crops combination
- Crop/cover crop combination management (date of sowing, biomass management after harvesting, weed and crop control by herbicides).

In cotton areas of developing countries, the extension approach on cotton related innovations is strongly based on a top-down field approach and strong incentives to adopt through supplying the needed input to reduce farmers' constraints related to level of available resources (Erenstein, 1999). Little consideration is directly accorded to other adoption factors like institutional factors, technology and preferences of the farm household. The extension framework focuses on improvement of resources level of each household, with a strong assumption that this can influence other factors by generating a new set of resources and technology within the farm household. Because of its ability to provide logistical support facilities production inputs, technology and credit, and for wide dissemination of a technical message through various geographical areas, this approach is said to be "structured" dissemination. During the last decades in northern Cameroon, structured extension approach ensured the necessary or required results on cotton figures, with more than 330,000 cotton farmers; 215,000 ha of cotton total cultivated area; and 300,000 tons of seed cotton produced in 2003/2004.

However, recent figures reveal relatively lower performance due to limited availability of financial resources by the cotton company, thereby leading to less intervention on production inputs and credit supply and greater reliance on farmers organisation and farmer households in the decision making process. Specific interest has thus been accorded to household resources and preferences, in addition to institutional factors which now appear to be taken as given and less subject to modification by external intervention strategies. On the other hand, the new dissemination approach, focusing on innovation adaptation to farm household, and on farmer's preferences and participation through out the innovation adaptation process, is called "spontaneous" dissemination. This extension approach, designed by many research teams and formerly implemented by the non-public (or NGO) extension institutions is progressively being adopted by the NGO's especially for the extension of complex agricultural innovations like DMC.

In this paper, we discuss the advantages and constraints of both structured and spontaneous dissemination approaches, before proposing strategic perspectives for efficient DMC dissemination in cotton areas in developing countries in general and in northern Cameroon in particular. Since access to production resources is important, the study also focuses on the importance of incentives on input availability for DMC dissemination in developing countries, and finally the paper discusses the appropriate size of extension team over time.

Information on field experiences about DMC dissemination approach was gathered especially in northern Cameroon for structure dissemination, while for spontaneous diffusion experiences from Madagascar have also been cited. DMC dissemination in the Madagascar context is marked by little input access to farmers in addition to DMC dissemination dedicated approach and team.

## Overview of different extension approaches in northern Cameroon

### Structured dissemination approach

Extension approaches to disseminate innovations in northern Cameroon widely include the use of the structured approach by public institutions and Cotton development Company and more recently the spontaneous approach, especially by specific development project, and on dedicated innovations.

Structured approach refers to a well organised extension team, covering permanently a given geographical area and number of farmers, and extending simple and clear technical message on a top-down approach basis. Additional services are provided to ensure both farmers ability to respect the technical sheet (input and credit supply) and adapted tool for monitoring and evaluation (cotton production and commercialisation data and other climatic and agronomic figures on the agricultural campaign). The three main features of structured extension approach are:

- input and credit supply,
- specific monitoring and survey organisation-based and
- Simple message extended by a structured field team.

In fact little attention is given to farmers specific needs and constraints since farmers' circumstances and features are taken to be similar. Basically, structured extension approach focuses partly on institutional factors, mainly correcting market imperfections related to farm household resources to influence adoption of an innovation. Institutional factors are not taken to be only related to external conditions but also influence resources availability within the farm household (Reardon and Vosti, 1997). In fact, structured extension generates new institutions by providing unavailable agricultural services. Structured extension, by relying on a diffusion

model, also tends to see diffusion as strongly influenced by information and past experiences. Therefore, a strong assumption made here is that a well organised extension team ensures technical information on the innovation and helps the farmer to build good skills and experiences on it.

**Spontaneous dissemination approach**
In response mainly to the inability of the structured extension approach to tackle specific constraints arising from the variability among farmers, the spontaneous extension approach lays emphasises on:

- adapting innovation to its beneficiaries,
- Facilitating self replication of the technology and spontaneous dissemination.

The need for adapting innovation arises from the assumption that adopting farm households may be different from those for whom the original innovation was dedicated, and also that within the adopting farms, there may be specific differentiation that could influence the level of adoption (Napier et al, 1994, and Nowak, 1987). Variability among farmers includes differences in term of resources, technology, institutions and preferences (Erenstein, 1999). Farm household may differ based on resources they can afford.
In spontaneous diffusion, inputs may not necessarily be provided by the extension service, or may be provided insufficiently and, therefore, resources availability still influences the level of the adoption within and between the farm households. Innovation screening and adaptation is therefore crucial in order to make it suitable or match to the farm household. In spontaneous dissemination of innovation a strong assumption is made on farm resources: typically land, labour and capital resources are the main bottle necks in dissemination of innovations, because they imply assessing the opportunity cost of using their scarce resources in implementing the innovation. Technology influences adoption for innovation in term of available technology among the farm household and complementarities of available technology and the innovation implications. Farm household preferences are influenced by its objectives and attitudes. Both objectives and attitudes are specific to each farm household, and therefore, the household will seek to choose innovations that ensure maximum utility given the constraints imposed by available resources, technology and institutions.

**DMC extension in northern Cameroon: a two approach framework**
An experimental pilot phase of designing and monitoring DMC was conducted from 2002 to 2006 by ESA project through on-station trials and on-farm trials distributed within the cotton belt. Results from this work provided information on agronomic performances of several DMC options in cotton-based cropping systems.
As from 2007, Soil Conservation Project (PCS/ESA 2), a new DMC extension program replaced ESA project. This project emphasised DMC extension on two different intervention scales:

- A wide dissemination of DMC based on structured extension approach relying on the SODECOTON operated experienced extension team with a well defined technical message to disseminate, and
- A spontaneous dissemination, relying on progressive on-farm technical messages construction, permanent adaptive processes on cropping systems, and based on adaptive research program in specific villages.

Within PCS project, DMC wide dissemination by Sodecoton team was organised at the same time as adaptive research was being organised on designing DMC options and collective action for an appropriate adoption of DMC within the village. This deliberate (and contradictory) alternate choice made during the feasibility study clearly assumed that:

- a structured extension team may be sufficient in disseminating rapidly DMC techniques, and
- an adaptive phase is needed to design technology packages that are suitable to farm household preferences and resources, and also institutional factors.

While spontaneous dissemination based on DMC adaptation and farmer participation as organised in other fields like Madagascar seems to be also suitable in northern Cameroon, several reasons leading to structured dissemination by the cotton Company are listed as:

- Efficient pre-existing extension program relying on wide field coverage (both area and farmers' coverage) by extension team
- Sustainability of DMC adoption by farmers at the end of project funding by the extension team
- Agricultural credit and inputs supply organization
- Availability of reliable statistics on dissemination rate

Therefore, designing the field intervention approach of DMC dissemination in northern Cameroon provides a theoretical framework to assess the determinants of adoption mainly according to extension approach and input incentives.
In practice, planned quantitative objectives have been assigned to structured dissemination (Table 1) while evaluation of spontaneous dissemination relies on percentage of farmers adoption within specific village ("terroir" in French) selected on agro-ecological and collective rules on resource access. Other evaluation tools of spontaneous dissemination relay on qualitative aspects of DMC desig, according to farm household and collective action constraints within the specific village.
According to figures in Table 1: DMC dissemination within structured approach depends on number of field extensionists involved and the average area of DMC the field extensionists can supervise. The low dissemination rate at the beginning only reflects the time needed for a field extensionist to master the technical message to transfer (Evangelista and Charpentier, 2006). After sufficient training of field extensionists, number of villages and area per village can rapidly increase.

**Table SEQ Tableau * ARABIC 1:** planned figures of structured dissemination of DMC in Northern Cameroon

| Parameters/Year | 2007 | 2008 | 2009 |
|---|---|---|---|
| DMC area per village (hectare) | 2,5 | 5 | 10 |
| Number of villages involved | 3 | 3 | 3 |
| Number of field extensionists | 100 | 100 | 100 |
| New total area under DMC (hectare) | 750 | 1 500 | 3 000 |
| DMC area per village (hectare) | | 2,5 | 5 |
| Number of villages involved | | 10 | 10 |
| Number of field extensionists | | 150 | 150 |
| New total area under DMC (hectare) | | 3 750 | 7 500 |
| DMC area per village (hectare) | | | 2,5 |
| Number of villages | | | 3 |
| Number of field extensionists | | | 100 |
| New total area under DMC (Hectare) | | | 750 |
| Total area under DMC (hectare) | 750 | 5 250 | 15 500 |

## Advantages and constraints of different approaches in extension of DMC

### Advantages and constraints of structured dissemination of DMC

Advantages

Rapid dissemination rate, due to efficient monitoring approach. Frequently in cotton crop monitoring, the survey is made through step-by-step operations monitoring, and relevant statistics enabling anticipated technical constraints to be tackled. Also, quantitative-based vision of monitoring in cotton companies make it easy for the extension team to evaluate quantitative goals to be achieved, based on annual bottom-up quantitative objective planning. Global objective is achieved through a wide geographic coverage by field extensionists.

Relevant technical sheet adaptation for the use of extension team providing simple and clear technical message to disseminate. When starting DMC dissemination, the need of simple extension and communication tool for farmers is always necessary to understand the simple agronomic principles of innovations before adopting them. Complexity of DMC may therefore alter this comprehension and influence farmers' adoption. During transitory phase of adoption, simple DMC options to disseminate help in building farmers' comprehension and appropriation of the innovation. Annual adaptation of various technical sheets is necessary to move from the complex message provided from on-station trials to operational extension sheets.

Strong link between annual planning, input supply and implementation. Since input supply is the key factor of structured extension, agricultural campaign planning in term of inputs needed by household is important. Implementation of DMC is then monitored by the technical assistance team to make sure of the final utilization of the provided input. This finally makes it easy to attain rapid planned extension objectives.

Constraints

Limited self replication of DMC, due to poor farmers' incentives to provide needed input for replication, since input supply (agrochemical inputs and seeds) is provided by the technical team. In addition, simple DMC options and technical message used make it clear for the farmers that self adaptation may not be useful in the process. Access to cover crop seeds may be of great concern in self replication of DMC, especially in cotton areas where because of crop protection reasons, cotton seeds have always been provided to the farmers who are charged for them. Most of cover crops seeds are not common and thus farmers always feel that providing seeds by SODECOTON is an informal go-ahead from the extension team in DMC extension process.

Limited DMC options to disseminate, thus altering farmers individual interest and incentive to adopt, given their own internal farm household preferences and resources. Limited options mean little technical alternatives for the farmer. Given that a particular DMC option is not equally attractive for all farmers within a given area, the diversity of farm environment thereby tends to undermine generalizations. Even if few options are necessary to train farmers on DMC principles at the beginning, the basket of DMC options must then be provisioned by the extension team, to help the farmer adapting and selecting among different options.

Strong need for technical team training, and sometimes on different ranges of DMC alternatives. Historically, to provide strong technical skills to field extensionists, technical message has therefore been simplified to a maximum for it to become rigid. Specific skills is now required with more flexibility and therefore, extensionists feel unsatisfied with this new flexible training approach. Limited diversified technical skills of extensionists are of great concern since intervention is based on reporting to hierarchy, with little individual initiative. Inappropriate approach to tackle territorial resources management. In fact, structured dissemination is designed to determine new institutional arrangements by the emergence of new rules on resource

management with no or little stakeholders' participation. This works with cotton since the emerging rules do reinforce traditional rules on land and residues, but may not be suitable for DMC dissemination given the importance of traditional rules and attitudes to changes.
Poor qualitative monitoring of farmers, which by not emphasizing on qualitative success on DMC plots, thus alters the demonstration of agronomic and economic performances of DMC. In Cameroon, this occurs mainly in the intercropping year of cereal with cover crop, where poorly monitored plots provide insufficient biomass to ensure soil coverage the next year.

**Advantages and constraints of spontaneous dissemination of DMC**

Advantages
Various DMC adapted options, hence improving farmer's adapted alternatives seeking. Despite adapting DMC to farm specific features was of great concern in on-station DMC designing, dissemination must also provide a large basket of alternatives to each farm household. Spontaneous dissemination provides this by conducting within the same village all possible agronomic alternatives to make it easy for the farmers to compare and select the ones that are more suitable to their specific preferences.
Strong implication of farmers in DMC options differentiation. Spontaneous dissemination relies on farmers' visits and self assessment on demonstration plots or during on-farms visits. Different scales in DMC options differentiation exist.
On a pure agronomic base, different options may be compared.
Then the comparison will progressively take into account specific farm household constraints to screen among them.
The final differentiation step consists of taking into account external factors to the farm household to assess the feasibility of selected options.
For example, high biomass providing options may not be feasible according to fertilizer availability of the farmer, or given livestock keeping practices within the village.
Strong and progressive replication among farmers. Despite it taking time before real appropriation, farmer to farmer technology transfer deriving from spontaneous dissemination approach (demonstration plots) is more sustainable than in structured dissemination. Even input and seeds availability is organized by the farmers on their own. For the selected cover crops, seeds multiplication or harvesting is organized individually or collectively and is no more a limitation for larger scale dissemination.
Proper arrangements on territorial resources management issued from farmers strong belief and conviction on the need to disseminate DMC. In conflictual context like in northern Cameroon, strong conviction of farmers generate interesting lobbying actions with other stakeholders (livestock owners and traditional rulers) to make it possible to modify traditional practices and collective rules on land and crop residues management. Spontaneous dissemination also include different stakeholder consultations and validation framework to define:
General rules on crop residues access within the village
Specific distribution on related differentiated access within the village (pasture lands, systematic non exportation fields, crop residues exportation subject to individual negotiation)
Penalties in case of non-compliance of validated rules
Additional measures to accompany livestock activities and avoid externalities on this activity.

Constraints
Limited extension rate at the beginning due to preeminence of diversifying DMC options with few farmers, rather than covering a large number of farmers with limited options. But from the time when general principles are understood by farmers (2 to 4 years) and replication begins, this rapidly changes.

Weak initial mastering of annual planning, input supply and implementation. Flexibility when planning excludes quantitative-dedicated approach. Therefore permanent adjustments can make it difficult to provide specific input in a large quantity. This also makes it difficult to respond to project evaluation framework, relaying on strong planning over time and quantitative objectives assignment. Planning limits also disappear with time, as self-replication is initiated among the farmers. Therefore, to assess input needs, where as seed provisioning is supposed to be handled by farmers, others such as credits may be assessed during individual area planning by farm household.

Tendency to provide less economic incentives to farmers. Wrong assumptions based on no need for project team to provide input to farmers but rather to enhance farmer's replication is responsible for this. On a theoretical point of view, weak response of farmers on conservation techniques derives from low marginal returns of conservation investment and market imperfections in developing countries. Providing input and credit supply by extension team responds to these specific constraints, and make it easy for the farmers to tackle transitory cost of soil conservation, to facilitate rapid marginal returns on the investment on soil conservation. Especially in northern Cameroon, input supply (credit not necessarily included in subsidies) determines the most adoption rate of each innovation. This effect is more emphasized within the actual context of financial limitation on input supply by SODECOTON. Even if adoption of DMC seems to be related to input access differentiation, this only ensures a greater access of farm household to this limited capital resource.

Specific needs in term of extensionist's skills imply a wide variability in mastering the technical aspects. Considering DMC as alternative of crop diversification, such skills are not common, since technical skills are specific to each major crop. For the present, extensionists in spontaneous dissemination previously worked on standard on-station trials and therefore accumulated wide skills on related technical aspects. Specific actions are to be taken to ensure training of a great number of field technicians with such similar technical profiles.

### Strategic perspectives of efficient DMC dissemination in northern Cameroon.

According to the assessment of both structured and spontaneous dissemination on DMC, a three point framework is proposed to ensure rapid and sustainable dissemination of DMC within small-scale, cotton-based cropping systems. This framework relies on options to be disseminated, extension approach, and input strategy.

In term of extension approach, both structured (but bottom-up) and spontaneous (participatory) approach must be used. When initiating DMC dissemination, because of the complexity of the innovation package and constraints inherent to quantitative project-based objectives, structured approach is always necessary in training farmers on fundamental principles of DMC. This is done properly with a near-rigid extension approach, which is more able to avoid counter-demonstrations on DMC performances. With time, the near-rigid extension must shift to a more flexible supervision, to facilitate farmers' adaptation through participatory learning.

In terms of variability of options, extension message must move progressively from simple message to more complex technical options. Learning about DMC principles required simple DMC options at the beginning, with little variation from conventional practices, to facilitate farmer's perception on single change effects on their cropping systems. With time, variability in DMC options designing will effectively be made by both farmer and the extensionists, according to individual farm characteristics. In the context of tropical agriculture, there is a strong assumption that given the climatic constraint, the best performances of DMC options are related to more complex options, ensuring greater biomass production.

In term of input supply, progressive actions must ensure seed production transfer to the farmers, and fertilizer, and pesticides provision by the extension team to accompany DMC adoption, until farmers' organization can handle this. Providing input and credit supply by extension team responds to market imperfection and low marginal returns on soil conservation, and make it easy for the farmers to tackle transitory cost of soil conservation. Relevant quantitative statistics are necessary to ensure input supply and logistics at the right time, while close monitoring will ensure high involvement for credit payment.

## Conclusion

Wide DMC dissemination within the cotton belt of northern Cameroon has been tackled through a strong involvement of SODECOTON extension team and logistics, and therefore involved more a top-down approach. At the same time, a spontaneous dissemination is being organised through an adaptive research program emphasizing on farm household features and institutional factors to design not only adapted DMC packages to be disseminated, but also extension features to be taken into account.

Since DMC is not a simple technology but rather a complex package of technologies and pratices, two points are important in disseminating it. First, a strong involvement of farmers in the process of adaptation is necessary. Secondly, designing DMC must imply flexibility of the resulting package, for the farmers to adapt them with little self-modification or to select between alternative options according to their preferences, resources and technology. Instead of disseminating ready-made solutions as proposed by structured extension approach, there is a real need to provide options that are assessed locally through participatory adaptive research. Final adaptation of DMC techniques after a certain period (2 to 3 years according to the level of complexity) will certainly serve in spreading autonomously these techniques from farmer to farmer, with little intervention from extension team. Technical adaptation of DMC may involve local cover crop selection, and technical adjustment on specific operations for example. Typically, when well understood, DMC adaptation by farmers never abandon the three principle components of DMC systems.
Results obtained from cotton extension make it clear that structured extension may be efficient in spreading simple DMC options to a large number of farms within a short period of time. This step seems to be of crucial importance in controlling the impact of transitional cost of DMC, hence it is appropriate for farmers' early training on DMC principles and practical options. Proper technical assistance and monitoring service will help in reducing counter-demonstration effects in the field, hence properly revealing on-site and farm household performances of DMC and facilitate its appropriation by farmers. By the time, early mastering of DMC package is well understood by the farmers, constructive adaptive process may take over. Flexibility and farmer participation is then needed to ensure self adaptation of DMC and autonomous replication from farmer to farmer.

On the other hand, technical DMC options to be disseminated must be adapted to resources constraints on the farm household. Not only techniques must be adapted to farm specific features, but also productive resources access must be improved through policy intervention. In this situation, logistic support by Cotton Company based on input and credit supply are crucial, since it is addressing market imperfections. Input and credit supply must be part of the extension package of DMC. Specific input need when starting adoption (especially of seeds and fertiliser) has to be ensured to guarantee a rapid increase of DMC marginal returns. Especially in western and central Africa disseminating innovation on cotton strongly relies on this, and DMC dissemination also may benefit from it.

Adapting complex innovations like DMC may not only take into account farm household scale of analysis but also include external factors, mainly territorial and collective resource management. Structured extension approach fails in addressing these important issues, especially in sub-Saharan Africa which in many parts is subject to free access to crop residues and poorly defined property rights on land. To create conditions for spontaneous dissemination, collective action must be organised at the overall community level to ensure specific arrangements that will ensure both private maximum utility for different groups of actors and overall social utility for the whole community. This collective adaptive research level may be more important than farm household level constraints since they will create an enabling environment for DMC's wide dissemination.

Spontaneous dissemination of DMC or CA practices are mainly the result of a process beginning from innovation adaptation, input supply, efficient farmers training and experiencing. It therefore needs structured extension tools and other methods and necessary time for training and learning to completely mastering the technology package. A three point framework is proposed to ensure rapid and sustainable dissemination of DMC within small-sacle, cotton-based cropping systems. This framework relies on options to be disseminated, extension approach, and input strategy. Finally, the way forward in DMC dissemination by SODECOTON consist in bringing together both spontaneous and structured extension approaches. In practice, this will imply maintaining logistics and organizational framework in extension facilities, while changing field intervention framework and tools.

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