

**Millennium Ecosystem Assessment (MEA):
Bridging Scales and Epistemologies: Linking Local Knowledge
with Global Science in Multi-Scale Assessments**

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**Knowledges and legal reform in the Sahel:
Linking traditional and modern natural resource
management legal regimes horizontally and
vertically through use of ICTs**

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Abstract

The paper describes a research-cum-action Initiative in Mauritania, Technology Fosters Tradition (TFT; www.cbnrm.net/webhosting/tft/), a radically new approach aimed at sustainable management of the Sahelian environment through empowering local people to transform the present exploitation of natural resources.

The Sahelian region can be characterized as follows: (i) rapid degradation of the flora and fauna, (ii) the public sector is unsympathetic to effective environmental protection, (iii) legal systems are dysfunctional, and (iv) there are increased levels of conflict between ethnic groups and between pastoralists and farmers.

The Initiative takes the following as points of departure: (i) the economic and cultural survival of people in the Sahel depends upon protecting the environment, (ii) local people know the traditionally recognized land-use patterns, (iii) some behavior needs to be changed in light of recent environmental degradation, (iv) traditional management has been corrupted by government intervention, and (v) changes in culturally embedded behavior will be achieved only voluntarily.

TFT's approach to addressing and resolving these problems lies in identifying and addressing the needs of the local people. The Initiative starts with assessing local practices, tracing and fixing them on maps, and screening for environmental effects. Required changes in use patterns will be negotiated until a consensus agreeable to all parties is reached.

These negotiated behavioral rules will be consolidated in regulations which are: (i) formulated by local people, (ii) written in local dialects, (iii) clear, short and succinct, stating purpose and policy; (iv) simultaneously drafted in the official languages of the country, revised and edited in an itinerant process with the input of experts, and (v) conform to the objectives of international environmental conventions. The texts will be archived in the Official Gazette and on the Internet and also affixed on GIS-centered geographic maps. The process constitutes a legal reform that gives priority to customary law over transplanted law, thus establishing the basis for a convergence between the actual behavior of the population and the laws and regulations intended to govern such behavior.

Several partly new approaches and tools will be used. They include: (i) specific biotopes will be governed by specific regulations, (ii) GIS and the Internet will be used to record laws and constitute the foundation for a modern land-registry with traditional use-right descriptions, and (iii) community-driven and co-management policies at the communal level.

Located at the intersection of several legal regimes, including French civil law, Islamic law and traditional customary rules, the Initiative aims to systematize and integrate these legal regimes on the local, national and international levels. This will be facilitated through extensive use of modern

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Information and Communication Technologies (ICTs). The epistemological aspects of aligning different bodies of legal knowledge, across a spectrum of cultures and ethnic groups as located on different societal levels, by means of traditional and modern ICTs is a case of trial and errors, that will provide useful insights and lessons for the future of similar progressive legal reform efforts elsewhere in the Sahel and beyond.

The partners are: GLIN - The Global Legal Information Network (www.loc.gov/law/glin/), GTZ (www.gtz.de/), NASA (www.nasa.gov/), and World Bank (www.worldbank.org/).

The Paper

Introductory Note

Dear colleagues! At the time of writing, the paper is unfortunately not in a state where it makes much sense to share it with you. Instead, below you will find an introduction to the Mauritania Technology Fosters Tradition (TFT) project, a joint World Bank & GTZ activity, which the paper will present and analyze. I am sorry that I won't be contributing to the communal approach and feeling of advance sharing, as the aim with this CD is, and I can only ask your forgiveness. By the time the conference begins, however, the paper will be available on the following two websites: (1) CBNRM Net - the Community-Based Natural Resource Management Network, at: <http://www.cbnrm.net/library/documents/>, and the TFT project website, at: <http://www.cbnrm.net/webhosting/tft/documents.html>).

Regards, Lars T. Soeftestad

OVERVIEW

The objective of this Initiative, Technology Fosters Tradition (TFT), is to document the totality of property- and use rights to natural resources in a given locality in eastern Mauritania, through the beneficiaries themselves. The Initiative would empower the beneficiaries to adopt their traditional resource use rights as the "law" governing their area, and observe over about three years whether the beneficiaries actually abide by these mutually agreed upon rules. The chosen locality would cover both sedentary and migratory land use.

The Initiative is called "Technology Fosters Tradition" because modern technological tools, such as computerized maps, GIS, combination of geographic data and text, and dissemination of data via the Internet, would help to: (1) elicit the specific traditional knowledge existing in a given location, (2) provide constant and visible feed-back of the map depicting the rights to the population [comment: don't understand this – feedback to whom, how, when?] and (3) monitor and track the actual observance of the traditional knowledge, transformed into rights, by the local beneficiaries. Availability of the data to everybody at all times is assumed to facilitate these developments. Changes in the environment, if any, would be detected by remote sensing and made public.

It is assumed that consensus among the beneficiaries will lead to a confirmation of all existing use rights, and that this represents the best option of land use through striking a balance between short-term economic return and long-term environmental sustainability. The Initiative would explore the existing situation in depth, providing a "best practice example" for the initial steps of any project under the World Bank's community-driven development (CDD) approach.

The Initiative would not provide investments. As the population expects tangible returns for its participation, such investments would be provided through a partnership with projects implemented by the World Bank and the *German Gesellschaft für Technische Zusammenarbeit* (GTZ) in the target area. Furthermore, the Global Legal Information Network (GLIN) and, through it, the US National Aeronautic and Space Administration (NASA) is also participating.

CONTEXT

Changes in land use, increase of incidents of conflict

Over the last 25 years the isohyet for 400-millimeter precipitation has moved approximately 40 kilometer southwards in the Sahel. This is partly responsible for the increase in desertification in the east of Mauritania. As a consequence rain fed agriculture is no longer possible in many places. New land for cultivation is marginally productive.³ However, local agricultural farmers, encouraged by the Government and donors, continue to plant north of this benchmark isohyet. At the same time, pastoral people, generally Moors, have descended South, following the rain, and are raising their animals in areas where they have not been seen in 30 years, creating a new ethnic mix.⁴ Pastoral grazing resource areas further south for use during the *transhumance* have been otherwise appropriated and shut off to itinerant herders. This creates conflicts between pastoralists and agriculturalists as well as amongst pastoralists.

Mauritania's traditional social organization has undergone drastic changes over the last 25 years. In sub-Saharan Africa, the rapid increase in population in many countries places too large a burden on traditional systems of land ownership.⁵ The population has doubled, pastoral areas are unable to absorb this increase in the strain on their already meager resources, and the increasing desertification is also an important factor. As a result, large numbers of the rural population have migrated to urban areas, notably Nouakchott.

The Government program in support of the rural population emphasizes irrigated agriculture, which accordingly receives most funding. Rain fed agriculture ranks a distant second. Livestock has received veterinarian services in the recent past, but, even though considered an important sector in the overall drive for poverty reduction, has not received much support. There are also problems caused by large pastoral herds owned by wealthy individuals with government influence. These herders ignore customary rules and do not consult local communities before using pastoral zones.⁶

The rural economy: livestock, an undervalued asset

The livestock sector is probably the largest employer in the country. Mauritania has about 4 million (UBT) of livestock. At least one herder is required for every 70 UBT.⁷ This implies at least 57,000 herders employed for 24 hours year-round.⁸ If you take into account peripheral industries such as construction of and maintenance of wells, drawing water and commercialization and transformation, the number of employed increases even more.⁹ At the same time, the nomadic practice of livestock raising represents core values of Mauritanian culture. Its demise would have a profound negative impact for society, beyond mere economic loss.

Yet the Mauritanian government neglects the sector. There are several possible explanations for this lack of governmental support: Ruling Mauritians come from a livestock background, believe they know the field and see no reason to change current methods; The last century has ingrained the idea of pastoralism as an outdated, inefficient system detrimental to the environment; Donor initiatives attempting to substitute ranching over the last 25 years have failed and no one is willing to invest in the sector; There is an enormous conceptual gap regarding what to do about pastoralism.¹⁰ After 50 years of misoriented and negligent assistance to the sector, there are few institutions with the capacity

³ Kevin Cleaver and Gotz Schreiber. 1995. *The downward spiral in Sub-Saharan Africa: Population growth, agricultural decline and destruction of the environment*.

⁴ Comment contributed by Thomas Sommerhalter.

⁵ Cleaver, supra note 1.

⁶ Sommerhalter, supra note 2.

⁷ Id.

⁸ Id.

⁹ Id.

¹⁰ Id.

to safeguard, develop and modernize pastoralism.¹¹ There is not a single educational institution in the Sahel that trains people on pastoralism.¹²

Despite little or no government support, pastoralism remains Mauritania's only viable sector in the rural areas. Whereas the statistical evidence for agricultural production in irrigated agriculture is precise, it becomes less reliable in the case of rain fed agriculture, and involves pure estimate for pastoralism. There is also nearly nothing known about livestock repartition.¹³ Therefore, comparisons are difficult to make. Anecdotal evidence, however, seems to indicate that the overall value invested in livestock is about double the value of all crops. The economic assessment of the value of nomadic livestock is rendered more difficult by two characteristics of this sub-sector: (1) the extent of the trade in camels, cows, sheep and goats across the international borders is unknown, and (2) herds are sometimes kept for purposes of status only, and not for economic reasons.

Traditional knowledge: under-appreciated in modern legislation

The Mauritania legal system is the result of three distinct sources of law which overlap and are not always coherent: (1) the traditional customary rules and regulations, (2) the Sharia Islamic law system (*rite Malekite*, which is one of the four schools in Islamic law), and (3) the French civil law system. All three sources of law coexist, but neither is professionally implemented. This legal pluralism creates uncertainty as to how property rights will be determined which can result in decreased tenure security.¹⁴ This leads to a general disrespect of legal rules, the Kadi and the judiciary, and it fosters corruption (judgment shopping).

Since 1968, Mauritania has tried to harmonize the civil law with the Islamic legal rules. In the last decade, this work was assisted by World Bank funding. Despite considerable efforts, it has not yet led to any tangible results in practice.

A credible and effective legal system, which guarantees social peace, and is the foundation of any society, depends on the voluntary adherence of the citizens. The citizens will only respect a legal system that reflects their values.¹⁵ A legal reform, which is needed in Mauritania in view of the fast-changing society from a tribal context towards the modern state, would have to build on the traditional values that are shared by the majority of society.

The TFT does not assume that rules and rights have not or will not change. While tradition is an evolving concept, often changing with the needs of the people abiding by the tradition, in order to assess the current situation in the area where the TFT will operate, the initiative will confirm present-day customs. During the monitoring process, the initiative will note changes that occur in the traditions.

In order to facilitate the legal reform necessary in Mauritania, these local values first have to be recognized, defined and evaluated. This work has, so far, not been done. It can only be done with active participation of the population, through articulation of their traditional governance system.

An example of such work is the "*Code Pastoral*", enacted in Mauritania in 2001. The Code was initiated by the pastoral organization GNAP. GTZ staff working on GIRNEM, the GTZ project that the TFT will collaborate with (see below), supported the initiative and facilitated interaction of Mauritanian and GTZ expertise in a consultation and decision-making process¹⁶. It was discussed at length with the local population and Islamic scholars. It

¹¹ Id.

¹² Id.

¹³ Id.

¹⁴ Ruth S. Meizen-Dick and Rajendra Pradham. 2002. *Legal pluralism and dynamic property rights* (adding also that legal pluralism provides a flexibility that a single structure lacks and is more adaptable to changing times or environments).

¹⁵ See Jeffery D. Brewer, R. Sakthivadivel and K.V. Raju. 1997. *Water distribution rules and water distribution performance: A case study in the Tambraparani Irrigation System*. (Concluding that if rules did not match the needs of the local users, those users would subvert the rules. The solution to this problem is the establishment of a system that involves the users in the reformation of the rules in order to ensure that the users will accept those rules).

¹⁶ Sommerhalter, *Supra* note 2.

is a good example for lawmaking in several ways: (1) its language follows a natural flow, and is immediately understood, and (2) the objectives pursued and the values protected are spelt out in the first paragraphs. The entire law is short and explicitly embodies both traditional and Sharia regulations. A conflict resolution mechanism built into the law provides for the official judiciary only as the third and last resort (the first level is the parties supported by their respective elders, and the second is local administrative mediation). This law was greeted by Parliament with approval. It may be considered a model to be used for reforming the older laws pertaining to the environment (for example land use, forests and water). The application decree of the Code Pastoral is in the process of adoption.

The TFT will facilitate implementation of the Code in its target area, and emulate the drafting methodology for its own work.

Natural resource management, conflicts, and governance

The broader context for natural resource management and conflict management lies with the rule of the state and the quality of governance. The resolution of conflicts is closely linked to development strategies and management of natural resources, and peace and stability are understood to be necessary preconditions for development.

The World Bank's 2000 study "Can Africa claim the 21st Century" establishes four broad pillars of support to Africa's development, one of which is reducing conflict and improving governance. Reduction of conflicts is especially targeted in the TFT. Whether on the local or the regional level, conflicts in Africa represent a serious problem (about 2 percent of per capita GDP are lost annually due to conflicts, according to World Bank data). The other pillars, which also are being targeted to one extent or another, are: investing in people, increasing economic competitiveness and diversification, and improving aid effectiveness while reducing aid dependencies.

Due to the declining attention to traditional values in Mauritania, together with the diminishing authority of the tribal hierarchic structure, destructive environmental behavior increases. The modern administration cannot curtail such misuse, because of competing interests and lack of oversight. As indicated, the existing conflict-avoidance or conflict solving institutions is discredited. Rural communities elected to administrate the property have no legal power to deal with natural resource management issues.¹⁷ A new approach is required.

The technological challenge

New technology will have to be utilized to make a program of documenting traditional land use knowledge effective and transparent for the beneficiaries. Towards this end, information on existing land use rights will be made graphically available both on paper and in digital form, the latter to be based on GIS. Graphical representation is intended to support the adherence of the local population to the identified land use patterns, which will be established based on information they themselves provide. Aerial photographs of the area will be taken by a plane equipped with GPS.¹⁸ From the distance of a plane, villagers would be able to distinguish the limits of their territory.

Using new technology may be difficult. Rights cannot be mapped; only plots or spaces where a group or an individual holds rights that have yet to be described. GIS is not always useful to show flows and movement because the movement does not always follow the same pattern – it depends on the rain and the availability of grass. There is also a danger that use of high technology or information technology will further marginalize already-marginalized populations. A registry that can be used, accessed and understood by most people is critical.

¹⁷ Id.

¹⁸ Andrew Stancioff, *Fwd: TFT-Technical question: Aerial-satellite remote sensing*, Personal communication. (Suggesting that photographs taken by plane would be less expensive and provide more detail than satellite images). See also Eric Tielkes. 1992. *L'Utilisation de la Photographie Aérienne par Cerf-Volant Comme Outil d'Analyse et de Suivi des Etats de Surface*.

Mastering the modern technology necessary for continuous follow-up will need focused and special training of selected members of the communities. The easy acceptance of Information and Communication Technologies (ICTs) in the local communities where the TFT will operate, as witnessed by the boom of expansion of cellular telephones and Internet services in Mauritania, is expected to assist in achieving results.

Land management and poverty reduction

Documentation of land ownership and land use will aid in the alleviation of poverty. Secure tenure encourages land users to manage the land properly.¹⁹ Secure property rights will also promote efficient management of common property resources. People often fail to adopt technologies for natural resource management because of a lack of secure property rights and a lack of collective action.²⁰ Additionally, the creation of registries allows the poor to formalize their ownership rights and interests. Formalized ownership rights and interests will reduce social and economic inequalities among those with and those without use and access rights.²¹

The documentation of local land use practices and patterns, and its graphical representation, is aimed at reinforcing the adherence to land use rights. They will be recorded in the local languages and translated into French and Arabic. The respect of these rights by the local and the central administration will be observed by the TFT and the projects with which it collaborates (see below). The transparency of the governing land use rights in the identified area, and the adherence of the local population and the administration to these rules, is expected to contribute to limiting the amount of conflicts, and to increased success in mediating conflicts.

Transparency of the land-use rights will also clarify access to land use and therewith provide a data source for further exploration of other issues that the Bank might deal with, such as gender studies. While TFT does not focus on women's resource use rights *per se*, the results of the initiative will provide material for further socio-legal work in this area as well as others. Transparency of land use rights as a data source can be used to study equity disparities among different social groups also, such as old-young, rich-poor, or access availability by former servants or slaves. The ownership, or lack of ownership, of livestock that would be documented by the initiative could also provide a useful source of data for studying inequalities as well.²²

Relevant past and present interventions

The World Bank has been involved in the pastoral sector in Mauritania since the late 1980s. The projects supported by the World Bank include the First and the Second Livestock Projects (Cr. 0273 and Cr. 1658), and the Rainfed Natural Resource Management Project (RNRMP/PGRMP, Cr. 2965). The RNRMP/PGRMP will close [comment: update date] in March 2003, and a follow-on project, the Community-Based Rural Development Project (CBRDP/PDRC), is under preparation [comments: update date].

The GTZ has also been active in the rural sector in eastern Mauritania (the two Hodhs, where the TFT will operate) for many years. The relevant GTZ project is *Projet Gestion Intégrée des Ressources Naturelles de l'Est Mauritanien* (GIRNEM).

The accumulated experience of these projects constitutes an essential knowledge base for the TFT. This is particularly true because both donors designed their projects specifically to be holistic and community-driven, in order to take the cultural, social, and economic realities of the selected area into consideration before selecting specific interventions. It is possible,

¹⁹ Abhijit v. Bannerjee, Paul Gertler and Maitreesh Ghatak, *Empowerment and efficiency: Tenancy reform in West Bengal*, (concluding that the effect of enforced agricultural tenancy laws in West Bengal which gave tenant farmers more security encouraged them to invest more in the land).

²⁰ Anna Knox and Ruth Meizen-Dick. 1999. *CAPRI: Property rights, collective action and technologies for natural resource management*.

²¹ Cecilia Siac, *Registries: A tool for empowerment of the poor and facilitator of economic integration*.

²² John Bruce. Personal communication.

however, that in the process of operationalizing this approach the focus has shifted to individual investments, and that the holistic aspect of natural resource management has been pushed in the background. This is likely because the national partners claiming to represent the target population are mainly interested in hard investment. The delay of the adoption of the application decree of the Code Pastoral prevents the main activity of the GTZ project, thereby pushing the micro-investment activities of the project to the forefront. The TFT will take up the initial project concepts of both these donors in its chosen area of operation in order to complement their findings.

ISSUES

The key issues faced by Mauritanian agricultural and rural economic systems are the following:

- (1) The rural-to-urban migration,
- (2) Pastoralism provides high returns and is the only feasible form of land use in large areas of the country, yet receives a low priority from the government compared with rain fed and irrigated agriculture,
- (3) Desertification (man-induced and through the southward movement of the 400 millimeter isohyet) and deterioration of wet lands and marginal areas,
- (4) Demographic pressure leads to unsustainable land-use activities and in- and out-migration,
- (5) Traditional communal property rights' systems are in flux,
- (6) Traditional institutions for mediating conflicts over natural resources within and across ethnic groups, and between traditional institutions and the administration have been weakened to the point where they are no longer effective,
- (7) Legislation is ill adapted to local particularities (exception: *Code Pastoral* and new legislation pertaining to oases),
- (8) A lack of genuine representation of marginalized groups,
- (9) An increasing concentration of wealth in the hands of a few, and
- (10) A lack of decentralized power in natural resource management.

OBJECTIVES OF THE TFT

The primary objectives of the TFT are to facilitate the clarification and formalization of traditional property use and access rights determined by the local population. The initiative will then monitor the area to determine if, in fact, the target population will respect their own rules. If the population does subscribe to the rules they formalized, the value of the initiative will increase for both the beneficiaries, the Mauritanian government and for the Bank.

Overall objectives

- (1) Ecologically and economically sustainable natural resource management, and
- (2) Reduction in the level of conflict among the target population over property access and use.

Value added for beneficiaries

- (1) Clarification of existing property- and use-rights,
- (2) Graphical representation of property – and use rights – for all, including beneficiaries, administration, and outsiders,
- (3) Empowerment to safeguard and enforce property- and use-rights, and
- (4) The obtainment of tangible investment support from participating donor projects due to clarification of rights, and
- (5) Outside recognition of property-and use-rights.

Value added for the government

- (1) Potentially higher income from livestock taxes,
- (2) Higher and more sustainable return on marginal lands, and optimal utilization of the various agro-ecological zones,
- (3) Reduction of conflicts, and
- (4) Protection of natural resources, the environment (incl. biodiversity protection), and nomadic culture.

Value added for the World Bank and GTZ

The project will provide more clarity regarding:

- (1) The importance of pastoralism in the rural economy of a Sahelian country,
- (2) The importance of traditional knowledge in traditional/local natural resource management, and
- (3) The relevance of embedding traditional values in the content of regulations and laws, of respecting tradition in form and concept when writing regulations and laws in order to assure adherence.

ACTIVITIES

The work would, in the proposed pilot phase, address the following:

- (1) An area assessment to: (1) assess and evaluate various ecological, ethnic and livelihood/subsistence practice zones in the country and their relationships to each other, and (2) identify suitable localities in the southeast of the country to test the design of the Initiative in a limited number of villages and areas (Pilot areas),
- (2) Identification of suitable partners (preferably local) to work with the local population,
- (3) Identification, clarification and formalization of the decision-making process of local land use patterns based on traditional property and use rights, through interviews with the local population,
- (4) Securing administrative support (*hakim* and *wali*) to enable local communities to practice these traditional land use patterns (even if formally in contradiction to the present national law),
- (5) Codification of these traditional property- and use rights in the local languages, explaining the respective notions in all applicable languages (including a dictionary of terms),
- (6) Translation of the data into Arabic and French,
- (7) Establishment of a legal rural registry based on the land-use pattern identified under (c) above,²³
- (8) Supporting existing relevant traditional institutions, and establishing new co-management institutions among representatives of right holders and the public sector, based on said regulations ((c) above), and
- (9) Registration of said regulations ((c) above) on a central digitized GIS centered map and the Internet (GLIN).

MONITORING AND EVALUATION

In order to assess the performance of the Initiative, criteria or indicators need to be established and monitored on a regular basis. These indicators will measure formal and substantive issues. The formal indicators will pertain to methodology (tools), while the

²³ The registry will be computerized and electronically available. Rules regarding the maintenance of the database will be drafted and enforced. The registry would confirm the existence and status of assets in the pilot area. It will reflect who owns or has access to what property and under what conditions; See Cecilia Siac, *Registries: A tool for empowerment of the poor and facilitator of economic integration*.

substantive indicators will pertain to the results achieved in changing and reinforcing behavior. The indicators can also be classified in terms of their focus on measuring change in the short-term and the long-term.

A preliminary set of indicators would include the following:

- (1) Reproduction of land use patterns on maps,
- (2) Consensus among the local population regarding the land use patterns described,
- (3) Recording of rights in the local languages,
- (4) Establishment of a classification of rights, from “strong” (meaning ownership of the land) to “weak” (such as leasing the land),
- (5) Establishment of a lexicon providing equivalent terms of the various traditional rights in all relevant languages,
- (6) Monitoring environmental change by means of remote sensing,
- (7) Observing the degree to which the established rules are being followed by the local population,
- (8) Extent to which the administration honors the agreement to uphold the local rules,
- (9) Number of conflicts being adjudicated following the traditional rules,
- (10) Extent to which the local population defends these rules against intruders (that is, local people not included in the initial assessment of land use patterns),
- (11) Compilation of assessed land rights into a rural registry, and
- (12) Extent to which the local population emulates and implements the approach in other localities.

OUTPUT

The output will be a body of traditional knowledge pertaining to local management of natural resources, in particular rangelands. This body of knowledge will be available in print form (in Arabic, French, and all relevant local languages), as well as via the Internet.

The TFT website, at <http://www.cbnrm.net/webhosting/tft/>, itself an outcome of the project, will carry updated and detailed information about the process of implementing the Initiative.

RELEVANCE

The TFT Initiative aims to prove that traditional land use rights still exist, serve to regulate access to scarce resources, contribute to avoid conflict once the local population is empowered and permitted to do so. It will give an overview of access to resources by gender. Furthermore, it will gather data to measure whether such traditional land regulations are well adapted to the environment and yield an optimal result in terms of productivity and sustainable management. In the affirmative, TFT should reform law making in Mauritania in the environment sector, by: (1) drawing the population into the process, (2) encouraging the development of differential legislation for different biomes/ecosystems, and (3) modernizing the drafting language in order that it becomes comprehensible for all beneficiaries.

If the TFT proves successful, its underlying assumptions, approach and methodology should be adopted by all donors involved in the rural sector in Mauritania, with the participating World Bank and GTZ projects acting as sponsors and catalysts. The TFT would strengthen the community-driven development (CDD) approach that the World Bank now mainstreams. These projects will, in turn, become more effective through increased participation, generating higher economic return, thereby reducing poverty among the rural population.