The "Agrfor System" (Agronomes et Forestiers sans Frontieres)".

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Abstract

The "Agrfor System" for soil and water conservation (a simplification/improvement of the "Vallerani System") is an easy, semi mechanised and multifunctional technology, integrated by human labour, to control rainwater and wind erosion and improve agricultural activities in the arid regions.

The System is based on a normal tractor (180-200 Hp) and a reversible plough, to excavate furrows (transversely to the soil slope), then adjusted and transformed by local communities in a series of water harvesting micro basins. Since the mechanical intervention is made once only, the participative approach is essential to secure the continuity of a sustainable eco-development. By replenishing water table and feeding vegetation, collected waters optimise food crops, pastures and agroforestry production, thus realising a true "green revolution".

The operation success is largely based on the local communities, which, being interested to its sustainability, secure its maintenance and improvement during the dry season. When largely implemented, this System (which is a "locomotive technology") could be an effective solution to the 3 UN Conventions (Biodiversity, Climatic changes and Desertification).

I. INTRODUCTION: SOIL AND WATER CONSERVATION (SWC) - SOIL PROTECTION AND RESTORATION (SPR) TECHNIQUES

The Sahel is a region where the population has always faced a high degree of climate variability, manifested both in terms of time (unexpected dry spells can occur during the rainy season) and in terms of space (rainfall can vary greatly from one area to another). Over the last two decades, the effects of climate change have exacerbated the already difficult conditions. According to projections made by climatologists, the Sahel will experience a rise in temperatures combined with highly variable rainfall and an increase in extreme weather events. The Sahel has always been a region with a high degree of climate variability over the same year, from year to year and from one area to another. These changes in the climate increases risks to crop, forest and rangeland systems in the Sahel, which are already severely affected by soil degradation, the loss of vegetation cover and growing population pressure (GIZ, 2012). Climate change makes it increasingly difficult for farmers to obtain and manage the water they need for their farming activities (Kunze, 2001).

Since the 1980s and 1990s, effort was made for the development of technical, environmental and agricultural strategies and approaches. Efforts to achieve the sustainable management of the environment and improve different types of landscape unit have focused on soil and water conservation (SWC) and soil protection and restoration (SPR) techniques (FAO.1991; GIZ, 2012). These SWC/SPR techniques have helped people in the Sahel to manage their ecosystems more effectively and improve their productive land. As a result, communities are better prepared to cope with environmental changes (changes in the climate, land degradation, etc.) and the impact of shocks, particularly droughts. SWC/SPR measures aim to achieve various goals: (i) improve water management, (ii) increase the productivity of cropland, forestland and rangeland and (iii) ensure sustainable management at the environmental, social and economic level. With regard to the beneficiaries, the goal is to improve food security by guaranteeing, increasing and diversifying production to enable them to cope better in the lean season. Their income increases and comes from more diversified sources, which contributes to reducing poverty. In social terms, the goal is to improve the organization and capacities of rural communities, promote the rational use of natural resources and prevent conflicts over them. These measures also contribute to raising the water table and making water more readily available to people and livestock. In environmental terms, they improve the ecology of the areas in question by protecting the land against erosion, increasing soil fertility and conserving biodiversity. SWC/SPR measures are an effective way of improving the management of water resources and reducing degradation of the soil, vegetation and biodiversity, which helps to increase and maintain crop, forest and forage yields. They therefore contribute to mitigating the effects of climate change and significantly improve food security and the resilience of the rural population to external shocks. Including the rational use of natural resources in territorial planning increases land tenure security, reduces the risk of conflicts and incorporates this component into commune and regional plans. Most of the SWC/SPR techniques were developed in the 1970s and 1980s in response to the humanitarian and environmental crises that brought severe famine and resulted in the loss of large areas of cropland, rangeland and forestland (source of wood and forage and habitat for biodiversity). These crises that afflicted the Sahel were due to a combination of human and natural factors and dynamics and to political changes (GIZ, 2012).

In-situ micro-catchment strategies aim at enhancing rainfall infiltration in the soil, improve soil water storage and limit top soil losses through wind and water erosion. They can be based on the construction of a physical barrier against run-off and/or on the improvement of soil water holding capacity through improved soil structure and soil fertility. Rock bunds or stone lines, zaï, half-moons and agroforestry are now widespread, sometimes extending across entire slope basins (Sawadogo, 2006; Sawadogo et al., 2008; Sawadogo, 2011).

Rock bunds or stone lines: small stone dykes known as rock bunds are a well-known anti-erosion measure used to decrease the flow of runoff water, improve water infiltration and reduce the removal of topsoil by wind and water (Maatman et al., 1998; Sawadogo et al., 2001).

Zaï or tassa planting pits: Zai or tassa planting pits are an old farming technique rediscovered after the great drought of 1973/74 and later perfected by development partners working with the farmers. It involves digging planting pits with a diameter of at least 30 to 40 cm and 10 to 15 cm deep. They are spaced 70 to 80 cm apart, resulting in around 10,000 pits per hectare. Staggered rows of holes are dug perpendicularly to the slope. Zai planting pits are used on marginal or degraded land that is no longer cultivated, such as low-gradient pediments and land with encrusted soil in areas with rainfall levels of less than 800 mm a year. Zaï is not suitable for all types of soil: it is very good for crusted soils, but not for shoals. It should be always associated with bunds (Kaboré and Reij,2004). A variation is the “zaï forestier” (Koutou et al. 2007) and the mechanized zaï using animal traction, a technique that can achieve self-sufficiency in food and, in most cases, increase revenues for farmers (Barro et al. 2005). The major disadvantages of planting pits are the labour requirements for construction as well as the maintenance -the farmer has to watch over the state of the holes, deepen them and refill them with manure before each wet season and check them after heavy rainfall- and water logging in very wet years.

Semi-circular bunds (Half-moon / Demi-lunes): this technique involves building low embankments with compacted earth or stones in the form of a semi-circle with the opening perpendicular to the flow of water and arranged in staggered rows. They are used to rehabilitate degraded, denuded and hardened land for crop growing, grazing or forestry. Semi-circular bunds are designed for use on crop, forest and rangeland. They are constructed on gently to moderately sloping pediments and plateau areas that are degraded, denuded and/or affected by soil crusting. Half-moon Coming from Niger in the 90s, this technique is similar to the zaï, except that the hole is less deep and in the form of a half-moon of about 4 m diameter, with the removed soil put on the downhill side (Barry et al. 2006). The technique is used on bare and crusted soils, as the zaï, and can be also used on gentle slopes (< 3%)(Zougmoré et al. 2003). Mechanization of half-moons through the use of a special type of tractor (“Delfino” plow or “Vallerani system”) is currently being developed in Northern Burkina (Conedera et al. 2010).

Nardi/Vallerani trenches: Nardi/Vallerani trenches are microcatchments 4 m long and 0.5 m wide. They are made using a tractor-pulled plough specifically designed for this purpose (Vallerani, 2009). The Nardi plough cuts a furrow perpendicular to the slope, throwing up a ridge on the downhill side and thereby creating a barrier on that side of the furrow (GIZ, 2012). The number of trenches varies according to the gradient of the terrain and the type of soil: the recommended number of microcatchments for flat or gently sloping terrain is between 250 and 400 per hectare, with the rows spaced 5 to 7 m apart; and for steeper slopes, the rows should be spaced 3 to 4 m apart, with a density of up to 600 microcatchments per hectare. In each Nardi/Vallerani microcatchment, two or three trees are planted or sown by direct seeding and then separated when they come up. Perennial grasses are sown a year later to allow the trees to become established first (GIZ, 2012). The choice of species largely depends on the use to which the improved land is to be put and the priorities of the beneficiaries. It is recommended that the improved site be protected from grazing animals for at least three years to give the trees time to grow and the grass time to reproduce naturally, although the exact amount of time required will depend on the type of trees planted and how degraded the site is.

Nardi/Vallerani trenches are generally combined with scarification, which is carried out using a tractor-pulled scarifier. The strips between the trenches are scarified a year after they have been dug (GIZ, 2012). These scarified strips are sown with perennial grasses at the same time as the trenches. The trees planted the year before are a year old, and the risk of the saplings being choked by the grass is minimal. The technique is designed to restore degraded and encrusted forests and rangelands: hardened land on the plateaux, low-gradient slopes in highland areas and lateritic pediments (GIZ, 2012).

II. THE “AGRFOR SYSTEM”

II.1. Context

The "Agrfor System" for Soil and Water Conservation (SWC) and to fight against Desertification is an integrated approach to the management of human and natural resources in arid and semi-arid regions. Land degradation is often mentioned as a threat to the basis of many farming communities and their livelihoods (Bationo et al., 1998). Others have postulated that land degradation, especially due to declining soil fertility, is the fundamental biophysical cause of declining per capita food production in sub-Saharan Africa (Sanchez et al., 1997).

Studies at supranational scales indicate that land degradation unabated in sub-Saharan Africa (Muchena et al., 2005). Global assessment of Soil Degradation estimates that 65% of Afrivan agricultural land, 31% of permanent pasture land, and 19% of forest and woodland is degraded (Muchena et al., 2005). The report further mentions that water and wind erosion, respectively, account for 46% and 38% of total soil degradation in Africa (Sivakumar and Wills, 1995). Chemican degradation accounts for 12% and physical degradation, 4% of total degradation. Causes of soil degradation in Africa were reported as overgrazing (49%), agricultural mismanagement (28%), deforestation (14%) and overexploitation of vegetation for domestic and industrial use (13%). Poverty and economic pressure, high rate of population growth, insecure land tenure, agricultural mismanagement of soil and water resources, lack of agricultural intensification, deforestation, overgrazing and shifting cultivation are widely claimed as responsible for land degradation (Bationo et al, 1998; FAO, 2001). Thus, land degradation is largely a consequence of socio-economic constraints, dynamics of natural resource systems and policy distorsion (Muchena et al., 2005).

The "Agrfor System" is essentially based on a "Technical Mechanized Unit/UTM”, represented by a tractor (of 150-200 hp) with wheels and a reversible heavy plow. The action of the UTM, integrated by manual intervention by populations and farmers directly interested, introduces in the agro-sylvo-pastoral production systems (ASP) a strong improvement of soil fertility and agricultural yields in dry cultivation. Its application therefore has considerable advantages of a technical, socio-economic, cultural and environmental nature.

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The soil treatment, realized with a Technical Mechanized Unit/UTM (essentially consists of a wheeled tractor and a heavy plow) and perfected by manual intervention, introduced into agro-silvo-pastoral production systems significantly enhanced crop production. His applying therefore involves considerable technical, socio-economic and environmental advantages.

From a technical point of view, the "System" allows harvesting / concentration of scarce resources (meteoric waters, surface layer of soil and organic matter) into a series of transverse furrows at the slope of the soil, partitioned manually by the communities concerned to prevent the harvested waters from sinking in the furrow in case it had a minimum slope (AGRFOR, unpublished data). These partitions thus transform the furrows into a series of micro-basins. As far as environmental restoration and the fight against desertification are concerned, this technology is, to our knowledge, the most advanced, simple, economical and efficient today. It is thus possible to intervene on large areas (1000-1500 ha / year for each UTM) and to quickly realize, at a reduced cost (+50 US $ / ha), the SWC//SPR and the promotion of sustainable development. Based on the big advantage represented by the mechanization towards manual labor (one machine performs the work of about 1,500 men), this new technology, properly used, becomes an indispensable development tool for the arid regions (AGRFOR, unpublished data).

Besides increasing production on land cultivated and the recovery of those abandoned or undervalued, the application of the system allows the direct sowing of forest species, effective practice from a technical point of view and particularly good at educational and participatory plan. The introduction of the system, however simple it may be, requires accompanying action and technical assistance until its advantages and its maintenance, necessary from year to year, have not been included and insured by the concerned population.

At the socio-economic level, the development of available energy and resources makes it possible to effectively combat food insecurity and desertification in arid regions and to achieve a real "agricultural revolution" capable of ensuring at the same time better resource management, increased agricultural products and environmental restoration. Recovery of degraded and marginal land, which is a potential resource but difficult to value with traditional techniques, is also an effective means of promoting sustainable development and opposing rural exodus and emigration (AGRFOR, unpublished data).

The economic benefits of the System, which improves agricultural productivity and the well-being of the communities concerned from the first year on, are positive and often exceptional. The reduced cost of farming corresponds to good agricultural product growth and a very favorable cost / benefit ratio, enabling the producers and the communities concerned to cover a significant part of the costs of agricultural and rural development. The introduction and dissemination of the System is thus able to boost the economy, create a relationship of trust in institutions and improve living conditions in arid regions of developing countries (AGRFOR, unpublished data).

At the cultural and environmental level, this technology is making it possible to solve most of the problems related to the three United Nations Conventions (Biodiversity, Climate Change and Desertification), the gravity of which is becoming increasingly more urgent. It should be noted that contrary to what can be believed so far - desertification is - along with environmental degradation - the main cause of biodiversity loss and ongoing climate change, phenomena to be considered, In large part, as the effects of a single cause (AGRFOR, unpublished data).

Intervention on degraded and desertified land not only enables them to be valued for productive purposes, but also the recovery of a greater vegetation cover, with herbaceous and tree species, minimization of the planting of trees (fruit, windbreaks or shade), soil preparation and nurseries, seedling transport, transplanting and watering), and at the same time creates the conditions necessary for optimal management of available resources (AGRFOR, unpublished data). In addition, it allows rural communities to devote a significant part of their energies, especially during the dry season, to light and complementary maintenance, management and environmental restoration work, ranging from harvesting of forest seeds to creating hedges, windbreak lines and village woods, upgrading pastures, etc.

Rationally, these actions can rapidly lead the communities concerned to take ownership of good management practices and to develop land that has never been cultivated before, but which is still productive and hitherto used as pasture or timber reserve land. burn. This simple and effective approach responds perfectly to the expectations of rural populations as well as those of development agencies and donor countries.

Major benefits include strong growth in plant biomass, groundwater recharge and the conservation of natural ecosystems, especially forest ecosystems, ie the reversal of environmental degradation processes and, in the medium term, the control of environmental factors. This technology, which is easy to introduce into the rural world, makes it possible in particular to cope with and correct the obstacles to the development of arid regions, especially in Africa (AGRFOR, unpublished data)., which are:

- the weakness of manual energy and lack of water,
- insufficient control of soil erosion and fertility,
- the poverty of pastures and water points for livestock,
- the difficulty of reforestation and the increasing scarcity of firewood,
- the lack of environmental education on the part of the populations concerned.

Without it, it is virtually impossible to fight effectively against environmental degradation and its consequences (desertification, continued reduction in agricultural productivity, food insecurity, rural exodus, emigration, etc.) in space and time. The first of these obstacles - lack of energy and water scarcity - are also the most important ones, because they are the answer to all other problems. In addition to environmental and productive restoration, the introduction of the "System" makes it possible to integrate and modernize agro-sylvo-pastoral production systems (ASP).

By adopting this technology, the Government of Burkina Faso has formulated, with the CAP (Polyvalent Agricultural Center) of Matourkou and its Italian partners, Agrfor (Agronomists and Foresters without Borders) and Fidaf (Italian Federation of Agricultural and Forestry Engineers), a pilot project "Combating desertification and participatory eco-development in the North region of the country, to be extended subsequently - on the basis of the results - to the whole country (AGRFOR, unpublished data)..

II.2. The traditional practice of "water harvesting" and "Agrfor System"

The manual technical and traditional "water harvesting"- or collection of rainwater and runoff - are able to realize a significant improvement in the soils productivity in arid and semi-arid regions. The effectiveness of these techniques has been recognized by all cooperation agencies, bilateral and international, who are encouraged to apply and spread, especially in the Sahelian belt. Being based exclusively on manual labor, their impact on the production, however, is weak and insufficient on environment.

Aware of the potential of these techniques, Agrfor experts have argued from the outset the need for their mechanization, which allows to take action over a much larger surface, in the most varied soil conditions and morphology of the land; that, in order to control environmental issues, preservation or restoration of the primary resources (water / soil / biomass) and revive the prospects for development in arid regions.

II.3. Technical Mechanized Unit (UTM)

The Technical Mechanized Unit/UTM, the basic units of the proposed technology, it also serves to define the intervention operational module . An UTM should have the equipment and the "know-how" the following (AGRFOR, unpublished data):

a) *Equipment*

- 1 wheeled tractor from about 180-200 Hp
- 1 plow heavy voltorecchio or burglary for hydraulic-agrarian arrangement of cultivated land intended in particular for agro-food crops and / or agro-forestry (or agro-forestry), but also for the treatment of plane alluvial, characterized by heavy soils and difficult to work with hand tools which, although the most fertile, often remain uncultivated. This plow, which lends itself to work not stony soils, flat or gently sloping (15-20% maximum), it is also suitable for the actions of reforestation, improvement of natural pastures and development of forage crops.
- 1 special ripper to 3-4 teeth, suitable to treat compacted soils, stony or sandy little, for the improvement of pastures and sowing / planting of arboreal forage species or shrub.
- 1 off road vehicle for the transport of persons;
- 1 off road vehicle for the transport of the necessary materials;
- a range of hand tools (shovels, hoes, rakes, hand drills, etc.), which simplify the manual operations and complementary following the mechanical intervention and increase productivity greatly.

b) *Personnel*

- 1 expert in Soil and Water Conservation, the primary resource management and agro-forestry and pastoral production systems, preferably agronomist, with a good socio-cultural approach and able to ensure the UTM best use in the different types of intervention.
- 1 expert in agricultural mechanization, knowing equipment proposals, their maintenance and responsible for the training of tractor drivers;
- 2 tractor drivers, of which one at least of general mechanics notions;
- animators and / or advisers, to ensure a constant ratio between UTM and the rural communities concerned.

The voltorecchio plow track at regular intervals (to be determined by specific tests based on the rainfall, the slope and the soil structure to be treated) of the grooves of about 60 x 60 cm (width and depth), that rural communities undertake to tune with manual tools (realizing in the furrows of the partitions that turn them into micro-basins) and to maintain thereafter, from year to year, to ensure the efficiency of the treated system (AGRFOR, unpublished data). Given the working conditions, wear of materials and the low incidence of purchase costs on operating costs, it is useful to provide the UTM equipment as complete as possible.

II.3.1. The possibilities for application of the "System"

The proposed technology is applicable to a wide range of agro-ecological situations and soil, characterized by a rainfall between 150 and 450 mm / year (AGRFOR, unpublished data). As a first approximation, the benefits arising from the system, and the sectors and types of intervention are:

- a sharp increase in yield agro-food and forestry and pastoral, the recovery of marginal, degraded or abandoned lands, and the improvement of soil fertility in arid regions (by combat erosion, creating multi-functional tree bands and shrubs - windbreaks, reforestation village, green belts, hedges and plant fences, etc ..);
- conservative management of resources and the 'integration of agro-production systems and breeding in regions characterized by practices that are incompatible with a sustainable development (through: agro-forestry systems, improvement and management of pastures; redevelopment of "classified forests" surface water protection, points and rivers by windbreaks or greenbelts bands);
- the redevelopment of the territory in the framework of integrated rural development programs and sustainable (with the revegetation, the protection of eco-systems natural, environmental reforestation and / or production);
- the fight against desertification, protection of bio-diversity and agro-bio-biodiversity and the balance of the eco-bio-climatic systems in degraded regions by one overfishing - the Sahel, the Mediterranean Basin, the Middle East, other arid regions (multiplication of seeds of herbaceous plants, shrubs and trees of special interest in environmental restoration, improvement and Improvocation of parks and nature reserves).

II.4. Technical and economic aspects

II.4.1. Technical aspects

a) Comparison of mechanical and manual labor:

A single UTM, equiped with a tractor and a plow, allows to treat a dozen of hectares per day, which correspond to the working possibilities of more than 1 000 men valid (AGRFOR, unpublished data). The excavated by the plow furrows are then provided with partitions (work to be done during the dry season) by the concerned communities. In terms of water harvesting / concentration and other available resources (fine earth and organic matter), the ratio is even more favorable, since the capacity of the "System" is by far superior to that of hand-dug micro-basins .

b) The increase of water availability and increased productivity

The average coefficient of water and multiplication of production made possible by the half-moons carved by hand was evaluated in Niger, the region of Tahoua, in about 2-3 times (Marceau Rochette, 1989) that of untreated soils. This coefficient is taken as a reference for our micro-basins, which actually gather far greater quantities of water and at greater depth, what sensibilize mind reduces losses for evapotranspiration and allows crops to escape in large part climatic irregularities - frequent in arid areas - allowing production even in case of severe drought.

The UTM intervention not only affects the cultivated lands, but also those abandoned and marginal or never cultivated, because it was too hard and difficult to cultivate by hand. The conventional practice of "water harvesting" sacrifice an important part of the living area to cultivate another and necessary to have water to increase agricultural yields. With the technology in question, it is instead the whole surface to benefit from rainwater, which allows to optimize the management of land and resources. The mechanical treatment causes - because of the speed of the tractor feed (4-7 km / h) - a deep rupture of sod in the most compacted soils and therefore greater capacity to collect rainwater, improving agricultural yields and development of tree species (AGRFOR, unpublished data). This treatment also has a positive effect on the ground water recharging.

c) The direct seeding of forest plants, a simple reforestation technique, fast and effective, based on farmer's participation.

Although known for some time on a theoretical level, the direct planting of forest species has never established itself in arid regions because of the technical difficulty of achieving full field agro-ecological conditions (such as a good seed bed, and a readiness adequate water, for a sufficiently long period) for seeds germinating and development of seedlings, up to their complete vegetative autonomy. The harvesting and concentration of rainwater instead makes possible this practice that mimics and thereby improve the natural plant propagation mechanism. As well as making much more rapid reforestation activities, economic and effective, this approach escapes the strict criteria of the conventional practices of reforestation (forest nurseries costs and jobs, transplant to a limited period of 15-20 days - at the beginning of the rainy season - competition with agricultural works, low participation of rural communities, bad root development, poor resistance to drought during the dry season and plant cropping during the rainy season, for at least 2 years) and therefore presents as the only real chance to carry out reforestation actions not marginal, effectively oppose the desertification and reverse environmental degradation of vast territories.

These constraints, which limit and often condemn all unsuccessful reforestation programs in arid regions, are outweighed by the new approach, which also provides the following benefits (AGRFOR, unpublished data):

- the possible best exploitation of the labor force available during the dry season for the redevelopment of the territory and a rapid environmental education;
- increased technical success of tree and forest plantations (elimination of stress graft, optimum radical and vegetative system development, better resistance of plants to drought and disease, power, life, etc ..);
- a substantial reduction in costs, due to elimination of forest nurseries, transportation of seedlings;
- the simplification of cultural practices, which are limited to a light weeding and thinning of seedlings;

II.4.2. The economic aspects

The economic aspects of the proposed technology are:

- the cost has to, lower than that of any other technology of "water harvesting", not exceeding US $ 50 / ha (AGRFOR, unpublished data)., which depends on several factors (degree of utilization of UTM, distance between lines, soils nature, capacity of the tractor drivers, maintenance, etc.).
- the possibility - for the populations of arid areas - to deal directly with the challenges environmental faced by (the fight against desertification, redevelopment environment, protection of natural ecosystems, sustainable development, etc ..).

II.5. Socio-cultural and environmental aspects

Being particularly effective and applicable to variously extensive territories, the technology in question should be the focus of special attention from the national and international cooperation agencies. It is therefore important to examine the socio-cultural and environmental aspects of its introduction and dissemination, and evaluate them in terms of socio-cultural compatibility, education / training and empowerment for the purpose of eco-participatory and sustainable development.

II.5.1. Socio-economic and cultural compatibility

This technology is easily integrated into traditional production systems, within which introduces the most dynamic factors of renewal and development (AGRFOR, unpublished data). With a participatory approach, so it exercises - without any external pressure - an accelerated and profound transformation of these systems, leaving rural communities control of the desired changes. Just consider the relationship between the costs and benefits made possible by its application to understand the importance of the benefits that it is able to ensure in the different fields of intervention.

II.5.2. Participation / Empowerment

The objectives of and the possible types of intervention (increase in crop yields, agro-forestry, reforestation and productive village, windbreaks and hedges, anti-erosive rooms of various types, improved pastures, etc ..) must be examined and defined with the populations concerned, which remain free to apply them and adopt them, assuming the related costs, which are never too heavy. And it is possible to promote a large and spontaneous participation of people who really understand the benefits of its application (AGRFOR, unpublished data).

In this respect a project document (Projet d'appui à la sécurité alimentaire par la récupération des terres dégradées au Nord du Burkina Faso, March 2001, page 18 of the project document), developed within the framework of the food security program from a mission FAO / BOAD in northern Burkina Faso, he says: "*following the phase-experimental pilot, there is a very important question in the region and a real enthusiasm from the population and technical services (engaged for more than 10 years in the work of SWC / RPR - cords of stones, deep tillage, grazing reserves, reforestation actions - which have proved disappointing after all) to pursue and strengthen the spectacular results obtained from the first year with the plows Vallerani* ". Plows which “Agrfor technology” is an improvement and evolution (AGRFOR, unpublished data).

The interest of the population to be naturally more immediate benefits (increase in agro-food production) than to those of medium-long term (shrub and tree plantations) but, given the difficult environmental situation, one can observe a growing sensitivity for reforestation, also deriving from the demands of women's work, which has the increasingly difficult task of water approvisionnement- and firewood for family needs (food cooking, etc ..). The commitment required for the population to carry out agricultural work and the environmental restoration are still lower than those charged by the only traditional agricultural work (soil preparation, weeding, re-seedling, etc ..) and the "forced labor" of women.

The proposed system becomes so naturally a "locomotive technology" which affects the processes of agricultural and rural development. Soil treatment, to be progressively extended to all cultivated areas, however, must be done only "one-off", can and should farmers easily restore, from year to year, the efficiency of hydraulic-agrarian accommodation (AGRFOR, unpublished).

II.5.3 Socio-cultural appropriation and educational development

The full integration of this technology in the agricultural and rural world, both modern and traditional, is related to its use and distribution, as well as the costs and benefits that it delivers. In fact farmers, although they can not directly manage it, they shall take on their load most of the environmental restoration operations (AGRFOR, unpublished). Its participatory application then enables rural communities concerned not only to take fully aware of the problems they face, but also to seize quickly the necessary knowledge and do not repeat the worst mistakes in the management of renewable resources.

Applied properly, and with a strategic vision enough, the introduction and spread of technology makes it possible not only to reduce and minimize the standard risks of conventional development projects and programs - as the precariousness of the positive results and the return back once ceased external intervention - but also to create the conditions to entrust an important development role to private or semi-private service facilities, farmers being able to get productivity gains, to support a good part of the costs intervention (AGRFOR, unpublished).

After a break of technical and socio-cultural period, a further advantage of this technology will be to promote the launch of agricultural service companies, or to ensure an important role to the private sector in the field of agricultural and rural development.

II.6. The terms of the system and its potential

II.6.1. The physical parameters

The following notes relate to the complex management Water / Soil / Biomass (WSB), as well as the parameters - physical and socio-economic - that characterize the Sahelian region, where the "system" was born and found, so far, its wider application (see Operation Acacia 1). With the necessary adaptations, the technology is applicable in all arid regions (AGRFOR, unpublished).

a) *The rainfall*

The proposed technology is targeted primarily to the collection and concentration of runoff water formed by the rains. In arid regions the rains, uneven but often intense, can give rise, especially around the watersheds, to wild outflows capable of eroding the soil and cause serious damage to the environment. The erosion, both water and wind, not infrequently assumes the appearance of a real calamity, which transforms fertile lands in sterile surfaces and lifeless. In fact, it is responsible not only for the loss of much of the same waters, but also the fertile layer and soil surface and organic material, which are torn and transported downstream. The control and management of these waters not only reduces the damage, but to preserve valuable resources for development. For these reasons, the conservation of soil and water must be considered absolute mind-primary option in any program of development in arid regions .

The best application of the "System" is between the isohiete from 150 to 450 mm / year, but pluviometry lower or higher are also usable, according the particular cases (AGRFOR, unpublished data). In arid regions useful rains, producing runoff, generally exceed 10 mm of rain; then it needs 2 or 3 important rains to allow the whole system to exert its effectiveness. In the area between 100 and 250 mm / year, finally, and for rich crops (fruit trees, vegetables ..), the system can be associated with the small irrigation (with groundwater), what, in addition to reducing the risk of salinization, allows the best use of available water resources.

Examination of the average rainfall in recent years is necessary to decide - also according to the nature of the soil to be treated - the right distance between the grooves. The results of the treatment will be much better as the initial options (distance between lines, the type of crop expected ..) have been made properly.

b) *The Soils*

For the better implementation of the "System”, soils to be treated should have a good structure and deep enough, and be free of large rocks or underground roots (AGRFOR, unpublished data). As to the physical, some rough indications on the Sahel soils, according to their morphological and soil characteristics are provided:

- pianori lateritic: poorly suitable, because too hard and strenuous for plows
- soils of "glacis": suitable for processing
- soils and sandy dune: poorly suited, because of high permeability
- soils interdune: suitable

- sandy-loam soils: suitable
- alluvial soils: suitable

The soils suitable intervention, including "glacis" and floodplains - generally uneducated because they are difficult to work with hand - represent a variable percentage, but certainly important cropland cultivated in the Sahel. In addition to the expansion of production areas, the application of the "system" has shown, on almost all types of soil, an increase in productivity and an improvement of the structure due to the contribution of organic matter. Given the importance of the role that technology has to play in arid regions, and to develop a rational strategy for the use, it would be useful to provide a general examination of the soils that respond better to treatment and their productive potential (AGRFOR, unpublished data).

c) The vegetation cover

The environmental restoration tends to recreate plant cover (herbaceous, shrub and tree) adequate, a necessary condition for ensuring sustainable development.

One of the first activities to be implemented is therefore the collection of seeds of forest species, to be made over the vesting period of the same and on the basis of the quantity requested (about 20 seeds for micro-basin, to be sown dibbling). These must be cleansed, stored and processed before being sown. The conservation of seeds should be done in the best possible conditions, so that their power germination is compromised. The conservation empirical system in the ash is valid when applied immediately after their collection and before the attack of pests.

II.6.2. <u>The application of the technology to production systems</u>

To ensure a good yield of the UTM work (which proceed at a speed of 4-7 km / h) and reduce downtimes, it is necessary that the surfaces to be treated are sufficiently extended in the direction of length, which requires a preventive sensitization of population and the results that can be drawn (production increase, rapid growth of the trees, defense and protection from winds, etc ...) the visits to the interventions already made are of particular importance in this regard.

The introduction of the "system” in rural areas do not present particular difficulties or contraindications; for this, it is necessary that the mechanical treatment of the soils is made "<u>one-off</u>", (or one time on the same soils) and that the farmers are then able to ensure the maintenance themselves.

The agricultural sector is of course that priority. The operation of the system on cropland does not have to respect the property limits of the household plots. Therefore, when these are too small, the mechanical intervention can overcome the limitations (enough that the tractor driver raises the plow blade in correspondence of the same) to treat more parcels at the same time. The alignment of the grooves, or the orientation of the working lines, must be more or less perpendicular to the slope of the soil, so as to allow the best collection of the runoff waters (AGRFOR, unpublished data). The treatment of the soil, to be carried out in a dry (and in any case before the heavy rains), does not require a topographic survey, but only the indication of the surface to be treated, that a good driver can work in a more than satisfactory way. The distance between the processing lines of the grooves depends on three main parameters: the slope, the soil to be treated nature and permeability and the average rainfall of the intervention zone. With an average rainfall of 300 mm / year and an average of permeable soil, the working distance to be observed between a groove and the other may be of the order of 4-5 meters (AGRFOR, unpublished data). With lower rainfall - or a more permeable soil - this distance can increase up to 2-3 times. To better evaluate the relationship between average rainfall and the distance between the lines, it considers that the water collected from the micro-basins is formed by the rains that fall directly on the micro-basins, plus 50% of those who fall on the wings interlinear (surface runoff).

The treatment of cultivated land should be followed by the implementation of an agro-forestry mixed accommodation, necessary to protect crops, enrich the soil and reduce the evapotranspiration.

In this respect, it should be emphasized the importance of *Acacia albida* for the cultivated lands of the Sahel, whose optimum density is about 80 plants / ha (AGRFOR, unpublished data).

The traditional practice of protecting cultivated land by fences made with branches of thorny trees (very often or *Radiana Acacia nilotica*) is particularly destructive of the environment and must be replaced by the installation of hedges, also in a windbreak, to be achieved by direct seeding - or by cuttings - of a rut traced by the plow. This can be done also by combining several parcels. The direct seeding of appropriate species greatly facilitates this operation.

The processing of degraded or marginal lands, hard and low permeability (glacis, alluvial soils) can be done throughout the dry season. One of the most sandy soils and read (which still respond to treatment) should instead be delayed until the period preceding the arrival of the rains, because the poor house favors wind erosion and the silting up of the micro-basins. With good awareness and a good framing of the producers, each UTM can handle up to 1 000-1 500 ha / year, because you can meet the increasingly pressing needs of rural communities and to decrease the costs of intervention. The accommodation made for UTM eliminates the practice of re-seedling, frequent in the Sahel for later drought to the first rains, and still ensure the success of farming.

In order to ensure the maintenance of fertility, especially in the hardest-packed soil (glacis, alluvial plains), it is recommended to leave the lands cultivated after harvest - particularly of sorghum - the greatest amount possible of stubble, which, attacked by termites, they are integrated to the ground, significantly improving the structure of agricultural soils.

II.6.3. <u>Some objections responses</u>

The introduction of a mechanized technology in rural areas of developing countries raises some technical concerns and / or socio-economic as regards the employment of labor and management of the technology itself. These concerns - related to the fact that agricultural mechanization in Africa has experienced a long series of failures - resulting in our opinion insufficient analysis of the proposed technology and its specificity.

We must therefore make a clear distinction between the superficial hydraulic arrangement of cultivated land, a necessary condition to start any kind of sustainable development, and conventional soil tillage (soil preparation for seeding), as the first operation is opposed to erosion, while the second, in the absence is placing, which it may not favor it. On a technical level the proposed intervention unifies these two functions (the fight against erosion and soil preparation), which helps to ensure not only a good seed bed, but also the increase of agricultural production and improving the fertility of soils.

The socio-economic level, in addition, the introduction of this technology not only does not create problems of employment of the workforce, but it can better plan the use, in the sense that frees itself from the heavy work to engage it in the works light and complementary resource management, system maintenance, environmental restoration and sustainable development.

As for the UTM management problems, given that it is a non-sophisticated technology, they can be solved by giving the equipment to average specialized structures (NGOs, public or private structures). You should also consider the environmental restoration is an increasingly urgent and which necessarily requires the use of appropriate forms of mechanization, as the test technology.

II.6.4 <u>The protection of bio-diversity and of 'agro-biodiversity</u>

In addition to the economic advantages, technical and socio-cultural, the spread of this technology makes it possible reversal of the degradation processes and saving the bio-diversity of plant and animal, both for the domestic species (agro-ecosystems) that for the wild ones (eco-natural systems).

One of the least known and most neglected effects of environmental degradation is indeed the disappearance, in addition to the natural bio-diversity, the so-called "agro-biodiversity", ie of the great variety of genetic and local ecotypes, both animal and vegetable, which the 'Man has selected over the centuries and are in danger of disappearing forever within a few years.

It is an extremely serious problem, and that is particularly the cultivated species (in the Sahel the disappearance of local ecotypes is already more than 75% of known varieties), which gives a further boost to environmental degradation and reduction of bio-diversity by creating farming and less and less rich nature, vital and diverse.

II.6.5. The agri-food emergencies and the fight against hunger in arid regions

This technology provides unexpected solutions, rapid and effective, to avert the risk of famine in arid regions, and set about solving the agro-food emergency situations, while creating the necessary conditions for a resumption of production processes in areas at risk desertification.

Indeed, as the agro-food crises do not arise suddenly almost never, but so to speak an incubation period, it would be enough time to intervene in high-risk regions for secure (with the conservation of soil and water) agricultural production and put the farmers concerned are able to help themselves to the solution of their problems. The hydraulic-agrarian arrangement of the cultivated land is in any case a necessary condition to ensure normal process of sustainable development. In most cases it would be therefore possible to solve on site and at low cost the most crisis situations. This possibility becomes more timely and necessary, given that the desertificazio-it continues to advance and the agro-food and environmental conditions worsen, especially in the African continent. Of course, this option requires a thorough review of the development strategies pursued so far; but if we consider the results obtained, that you can not really define satisfactory, this option is still to be achieved, since it carries important benefits, not only for developing countries but also for the world economy together.

III. CONCLUSION

A series of emergencies (agro-food, bio-climatic, health, socio-economic, political, etc ..), all more or less linked to environmental factors, threaten the security and future of this planet. These emergencies make us understand that it is necessary to profoundly change policies and development strategies and cooperation pursued to date. The arid regions of the planet are in some way part of the emerging and most advanced environmental issues. Solve the problems of these regions means not only to solve the most serious and urgent aspects of the development, but also safeguard the natural ecosystems of the planet, including its equatorial green belt, increasingly threatened by degradation and deforestation. In the preceding pages, we have reviewed several aspects of a simple and innovative technology, suited to arid regions and is characterized by an integrated approach to the three basic factors of development (Human / Nature / Technology).

This technology, introduced in the Sahel with the project "Operation Acacia," has proven to be able to ensure, at particularly low cost, conservative management of resources over vast tracts of land. Particularly appropriate for solving problems browsed and easily be integrated into the rural world, it is now necessary to recognize a higher priority over any other type of intervention. Faced with the huge problems still unresolved, is a duty of the international community to clarify as soon as possible all the aspects related to the use of this technology that arises today as the most effective, simple and cheap, to combat desertification and promote sustainable development even in aride regions. The time is of the essence, since it is easier to prevent than cure and destabilizing factors proceed everywhere at a faster rate than those of equilibrium and stabilization.

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