# Sustainable production systems intensification in the Sahelian zone

## Niger case study

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LEARNING FROM INVESTMENT PRACTICES

# Lessons learned from the IFAD[1]-funded Promoting Local Initiative for Development in Aguié Project (PPILDA), Niger

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## Introduction

FAO uses the phrase "save and grow" to illustrate the concept of sustainable crop production intensification which aims to base agricultural production mainly on improving natural resources management. Sustainable crop intensification strengthens biodiversity and eco-systems approaches that better utilize the contribution of existing resources and plants' natural growth processes. Examples include practices that increase the rate of organic matter in the soil, improve water flow regulation or foster pollination processes and natural predation of pests to fight against plant diseases. Eco-systems approaches also include utilizing appropriate external inputs at the right time and in judicious amounts (FAO, 2011[2]). These holistic and systemic production and natural resource management approaches boost the health of the agricultural ecosystem. They do so by mobilizing local knowledge hand in hand with scientific and technical innovations[3] (soils, crops and varieties, water, biodiversity, plant protection, etc.).

Innovation is not just a simple transfer of research technology to the farming environment. It becomes truly effective when producers adopt it and then reinterpret it to adapt it to their situation (GRET, 2004[4]). Innovation is not only technical but may be economic, social or institutional. Producers are essential and active players in the innovation process, which implies the interaction of a wide range of stakeholders (government, private sector, universities, research institutions, producer groups, etc.). Together

1 International Fund for Agricultural Development (IFAD).

2 *"Save and grow. A policy maker's guide to the sustainable intensification of smallholder crop production"* FAO, Rome 2011.

3 Innovation implies a new combination of production factors (Bosc, Yung, 1999).

4 *«Jachère, fertilité, dynamiques agraires, innovations paysannes et collaboration chercheurs/ paysans».* Lavigne-Delville, Boutin, Castellanet, GRET coopérer 36, 2004.

they make up a "dynamic innovative system" that strengthens mutual learning (Calestous, J., 2000[5] ). This implies that each actor's resources and contributions, particularly in terms of knowledge (expertise and know-how) be mutually recognized, along with appropriate facilitation to set up links that allow exchange and learning. Applying this approach remains a challenge in many African countries, especially given the hierarchical relationships between actors; nevertheless, integrating participatory approaches and service provision based on producers' requests since the 2000s have brought about positive changes (Zoundi, SJ Hitimana, L., 2007[6]).

Sub-Saharan African societies are well versed in sustainable crop intensification techniques. However, these have only been promoted as a "development practice" in the last thirty years, with very varied adoption levels. An interesting example of this practice is the PPILDA, currently implemented in the South Maradi Region, Niger[7]. Crop intensification techniques have been successfully introduced using a participatory demand-driven approach based on users' demands and strengthening their capacity to design and implement initiatives and innovations. This learning is based on a process of continuous observation, experimentation, analysis, adoption and evaluation. Drawing on the PPILDA experience, this article examines the circumstances that have made it possible to shift from low yield extensive agriculture to intensive and sustainable farming. It also analyzes local innovation processes and conditions for adopting innovations in the Maradi agro-ecological zone. This last point raises the broader question of what factors actually promote adopting and widely disseminating (scaling up) innovations.

5 *«The new harvest. Agricultural innovation in Africa»*, Calestous Juma, Oxford University 2010.

6 *«Défis de l'accès des exploitations familiales aux innovations agricoles en Afrique de l'Ouest: implications institutionnelles et politiques»* Zoundi, Hitimana, SCAO OECD, Paris 2007.

7 Financed by IFAD for eight years (2005 – 2012), PPILDA's budget is close to USD 17.6 million.

# The context of the PPILDA

### How farming systems have evolved in the South Maradi Region

Up until the 1950s, agricultural systems in the Maradi Region were based on slash-and-burn techniques. This involved clearing woodlands, cultivating them for a relatively short period (two to three years) and then leaving them fallow for approximately ten years, thus allowing for the tree cover to gradually return.
At first glance, this extensive system's effectiveness seems quite satisfactory (e.g. following clearing, rice yields equivalent to two tonnes/ha). However, as fallow was considered an essential component of this system (where only 25 percent of the arable land could be cultivated at the same time), this resulted in poor land productivity with yields of 0.2 tonnes/ha (Jouve 2000). During the first half of the 20th century, the population density was low in Niger and, thus, farmers were satisfied with this rationality as it allowed them to optimize the scarcest and most strategic production factor, namely labour. Indeed, labour productivity was adequate because the tilled soils were light and required little weeding, as weeds disappeared given the long periods of wooded fallow. Therefore, social control of the labour force determined and set production relationships, hence the strategic importance of social ties and networks (Raynaut 1984).

From the second half of the 20th century on, rapid population growth disrupted traditional farming methods in rural areas. Slash-and-burn agriculture became inadequate, land pressure led to reducing (or even eliminating) the fallow period, the main traditional means of managing soil fertility. It is estimated that this farming method reaches its reproduction potential limit with a density of 30 to 40 people/km$^2$. Today, the Aguié department has a population density estimated at 100 people/km$^2$, one of the highest in the Sahel. The limiting production factor consequently becomes the land factor, which generates property accumulation strategies. Indeed, the continued use of land leads to farmers asserting exclusivity rights (individual and/or family) and allowing *de facto* land privatization to emerge with the spread of monetized market transactions (Raynaut, 1984). Today, there are no land reserves left in the South Maradi Region and inheritance practices result in gradually shrinking plot sizes. Conflicts between farmers and herders have also arisen due to cropland encroaching on pastoral land, mainly in the lowlands that are used for grazing during the dry season. This also brings about a significant decline in tree resources (deforestation), which results in a degradation of the physical environment, greater soil erosion and continuous declining land fertility. Crop yields have decreased significantly and climate risks[8] increase with rainfall that is more erratic and poorly distributed over time and space.

## Typology and livelihoods of producers in the PPILDA area of intervention

As with any transformation, assets are redistributed among socio-economic groups along with the issue of the control of production factors. Land grabbing behaviour emerged as agricultural systems in the South Maradi Region transformed. The amount, quality and distribution of land in the village area have become important issues in the local economy as well as socio-economic differentiation factors, in a similar fashion to producers' abilities to accumulate livestock or acquire technical capital to intensify production. This has resulted in a marked differentiation between producers, based on their access to land and their accumulation ability (usually regarding the number of animals) with increasing differences between socio-economic groups.

8 The climate in the PPILDA area is of the semi-arid Sahelian type (450- 600 mm rainfall).

In the PPILDA intervention area, poor farmers have only one to four ha of arable land per household, and own very few animals, at most two to five small ruminants (PPILDA, 2008[9]). They practice extensive crop production, combined with working as employees on other farms or as seasonal migrants while, when possible, tapping remaining available forest resources.

The "middle" producer group has between five and nine ha of very uneven quality land per household (PPILDA 2008) that is sometimes distant from the village centre; fields that are closer to human habitations are the ones most fertilized with manure. This group of producers faces the challenge of using animal traction that results in extended crop areas and better weed control. They have a few heads of cattle (one to three) and about 20 small ruminants, which provide cash should crop sales be insufficient. They are also involved in petty trading.

9 Studies carried out by FEWS NET (2005) and Save the Children (2007) in the same intervention area confirm these results.

Lastly, the richest producers group enjoys abundant land surfaces of ten ha per household that are well distributed in proximity to the village: this group has already started to intensify their crop production. They invest in agricultural equipment (such as adopting animal traction), regularly spread manure, use carts and employ local labour to work in their fields. They are also raise cattle (at least four per household), have small ruminants (at least 15), a camel and a horse. They engage in trading as a complementary activity (PPILDA, 2008).

# PPILDA's principle of intervention

Regardless of their socio-economic group, farmers in the South Maradi Region have endogenously developed their capacity for innovation and increased initiatives to fight against the degradation of their environment and regenerate their production capacities. These changes include not only technical practices (improved land clearing, intercropping, private pastures, weed management, etc.), but also social rules of access and use of natural resources (Yamba, 2004). Building on observing these change and innovation dynamics, IFAD has funded and supported the implementation of the Rainwater Collection and Management Programme (1989 to 1996), the Farmers' Innovations in Agroforestry Support Programme (PVIPAF) from 2000[1], and The Farmers' Initiatives and Innovation Support Programme (PAIIP), leading up to the PPILDA's intervention.

PPILDA is the most comprehensive programme and aims to reduce rural households' poverty in the Aguié department through a set of actions organized in four technical components:

(i) identifying and developing local innovations;
(ii) strengthening rural bodies and organization;
(iii) setting up the local initiatives and innovations support fund; and
(iv) strengthening the local supply of services.

To date, PPILDA has identified 30 initiatives and innovations of major interest in the fields of agriculture, natural resource management, income generating activities and food security.

1 The Maradi Rural Development Project (PDRM) and the Aguié Rural Development Project (PDRAA) provided support, amongst other interventions, between 1980 and 2000.

# Results[10] and discussion

## Conditions to move from low yield extensive farming to intensive and agro-ecologically sustainable agriculture

Intensifying cropping systems calls for examining the relative share of each production factor in the crop process, and the way these factors are combined. Technical operations are more or less labour or capital extensive, depending on the amount of work (or capital) invested per unit area (productivity). Often, farmers will seek to maximize returns on the scarcest production factor: in the South Maradi Region, this is land.

Increasing land productivity is largely a matter of acting on the productive potential of the soil and the use of inputs such as seeds, fertilizers and pesticides.

**1. Supporting the physical protection of soil.** Crop farming involves depleting the soil of available nutrients (especially nitrogen, phosphorus and potassium) needed for plant growth. If the system used to restore these particles into the soil, such as fallow in this Region, faces a crisis because of increased population density and thus pressure on natural resources, soils deteriorate. Given this observation, the project facilitated a process that has led partnering farmers to identify, improve and disseminate locally practiced innovations to protect the land's productive capacity. A large number of producers has adopted them and they are described here below:

**Assisted natural regeneration (ANR)** consists in preserving tree and bush stumps (80 to 150 per hectare) during clearing operations. Restoring tree cover in agricultural areas has slowed the desertification process as it protects soils against wind and water erosion. It has also

10 This methodology consists in analyzing available data within the PPILDA monitoring and evaluation unit, assessment reports, and interviews conducted with the team, partners and beneficiaries of the project during supervision missions.

resulted in enhanced soil structure, increased water holding capacity[11] and improved fertility thanks to added organic matter (tree litter decomposition). Although the project has not demonstrated the effects of ANR on increasing crop productivity, a recent study conducted by the University of Niamey has revealed a considerable yield increase for millet, depending on the trees' density and age[12]. Other effects are related to the tree cover - mainly *Guiera senegalensis Piliostigma reticulatum* and *Dychrostachys cinerea* - that increases the availability of shrub fodder for livestock feed, used by pastoralists and agro-pastoralists[13]. Finally, in the villages where producers have adopted this technique, they cover their needs for fuelwood and even generate revenue through the sale of forest products and by-products[14]. In the North[15] of the Aguié department, this initiative's participatory development process has led to the creation of a rural market for ANR wood, the only one of its kind in Niger. In total, 9 919 ha have been regenerated naturally through support in 65 villages, benefitting 6 000 producers.

**Recovery of degraded lands** involves anti-erosion works such as half-moons and soil benches. The half-moons are 4 m by 4 m in size and built on erosion slopes. Woody bushes that are valued by the local population are planted on the ridges, including A*cacia senegal, Bauhinia rufescens* and *Piliostigma reticulatum* while grasses are sown on the reclaimed land. The microclimate thus created keeps moisture, which helps to combat drought. A small agro-forestry park has been created in the space of three years. The positive impact on forage availability and plant biodiversity can be clearly observed. Moreover, people have diversified their incomes by exploiting forage resources (fodder and grass seeds). About 260 ha of land have been reclaimed and 58 000 trees planted with a 90 percent success rate.

**Covering the ground with Doum nuts (*Hyphaene thebaica*)**: Farmers have found that introducing doum palms (tuft or bush stage) in sandy fields offsets the soil's fertility continuous decline, counters climate risks that lead to stronger wind and water erosion and provides a way to reduce evapotranspiration. In addition, the Doum palm helps to maintain adequate levels of organic soil matter and is a source of raw material that families can transform (mat making).

**2. Improving soil fertility.** In addition to the activities mentioned above, PPILDA partnering farmers have developed simple and inexpensive innovations to enhance cropland fertility. For example, providing localized goat manure is done by placing a total of 150 to 200 g of goat manure into millet and sorghum planting holes, half during the thinning and half during the stem elongation stage. This technique on average allows to double the grain yield and increase millet or sorghum straw production by nearly 50 percent. It has the advantage to enable fertilizing large areas with small quantities of manure, thus making this possible for vulnerable households, particularly women who care for small ruminants and generally only have access to poorer and more remote land.

**3. Improving crop productivity through better use of agricultural inputs.** In six years, crop systems in the project area have changed for the better: (i) the use of new crop practices ranging from managing soil fertility (organic manure, ANR, mulching) to judicious use of chemical fertilizers (in micro doses), (ii) improving technical cereal operations, mainly regarding the millet seeding density, beneficial intercropping (cereals and legumes) and better disease and pest control through natural methods[16], and (iii) producing short cycle high yielding seed varieties[17] (HKP, Zatib, CT6 and SOSAT for millet) along with intercropping[18] them with other plant species (millet, cowpea, groundnut, sorghum).

The use of agricultural equipment is an effective way to increase agricultural productivity because it allows better management of crop

11 According to producers, ANR makes the first sowing after rains more successful, whereas previously they needed to sow 3 to 5 times due to violent winds burying plant sprouts.

12 Specifically: (i) 32 to 165 kg/ha for ANR of less than 3 years; (ii) 59 to 221.5 kg/ha for ANR of 3 to 6 years; and (iii) 120 to 209.5 kg/ha for ANR of 6 years or more.

13 Specifically: 30 to 45 kg of fresh shrub fodder are collected per day (summary document, UAM 2005).

14 Some households may earn up to 70 000 FCFA per year from this activity.

15 This part of the department was practically a desert in the 1980s. Farmers and researchers have reversed this trend by making ANR a standard practice. Most studies conducted by the PAIIP focus on this area and one of them resulted in opening up possibilities to creating a rural wood market.

16 Sesame and cereal seeds mixture to combat millet witchweeds and covering the fields with cut branches of Piliostigma reticulatum as the leaves give off odours when decomposing that repel floricultural insects.

17 Production of 300 tonnes of weather adapted seeds for 46 000 producers, thanks to the implementation of a seed producers network (PPILDA, 2011).

18 In the first project area of intervention, (Dan Saga), 80% of households adopted improved seeds.

calendars. In the Sahelian context, this entails the use of animal traction. PPILDA promoted the double row planter which saves considerable time compared to the simple drill seeder: one ha in two instead of five hours. However, given the low utilization rates of animal traction in the project area, double row planters did not have the expected success.

## Conditions for adopting crop intensification techniques and innovation in the project area

Once we recognize farmers' capacity to innovate and the relevance of their practical know-how, then the focus is no longer on "transferring" techniques with hypothetical intrinsic worth, but on supporting producers' innovation capacities (Bentz, 2002). This actually entails using individual and collective capacity to transform information, knowledge and locally experimented options into a social and economic activity. There is less focus on giving out information and more on promoting systemic practices and behaviours conducive to change (Calestous, J., 2000). Iterative and participatory approaches used by PPILDA have enhanced know-how, "making-others-do" and farmer innovations. Experience acquired through the Project enables to highlight the principles and conditions that favour innovation and their widespread adoption.

**Building on the interests and problems perceived by farmers to implement appropriate measures.** PPILDA puts forward a process with several steps, starting with villagers carrying out self-diagnoses to identify constraints and potential within their environment, local communities' major concerns and potential solutions. These solutions may be local, but they are often enriched by external inputs adapted to local conditions. This then leads to designing village (VAP) and inter-village (IVAP) action plans accompanied by a directory of relevant initiatives and innovations that the project and farmers can use for experiments. This participatory exercise involves key stakeholders: farmers, PPILDA professional staff, researchers, technical services and non-governmental organizations (NGOs). Within the village, all socio-economic groups are called on to express their problems and priorities and suggest appropriate innovations. This last point is crucial, because it is based on the premise that interests are not necessarily identical and shared, especially as producers may practice different production modes, depending on the socio-economic group to which they belong.

During the self-diagnostic exercise, the PPILDA team completes the initiatives and innovations directory by meeting individually with innovative farmers. The information collected helps to specify improvement and experimentation methods to test identified innovations that can bring about relevant improvement options. This clarification involves farmers, researchers and the initiative's managers. These ideas are tested simultaneously at the research station and in real environments (for entirely new experiences) or demonstrated on farmers' initiative plots when technical proposals have shown satisfying results at the research station.

A crucial step in this process is the self or participative assessment. It determines whether the innovations are relevant to expected results, given what problems need to be solved and what opportunities may be seized. In the case where the innovation is relevant and requires no improvement, it is socialized, that is to say, discussed with people for adoption. The final phase involves the innovation's assessment and capitalization. The project team carries out this exercise to measure the adoption rate of the innovation and its impact on the problem that needed to be solved.

The PPILDA team's main role is to facilitate linkages between farmers, technicians and researchers and encourage dialogue without prejudices based on mutual recognition of competencies. This creates the conditions for a genuine exchange based on listening and trust; it promotes learning and helps to mobilize the actors' resources and initiative potential to then reinvest them in development activities. For example, the Ministry of Agriculture's technical departments have shown great enthusiasm when learning about experimenting and disseminating technical innovation activities; they have now become strong advocates of the approach and have adopted it.

**Innovations are to be considered equally in social and in technical terms, within a systemic approach to sustainable crop intensification.** Beyond technical considerations, PPILDA's systemic approach takes into account the socio-cultural dimension of development activities and shows a strong interest in social, economic and organizational innovations. The relationship between technological and organizational innovation is evident; for example organizing and securing upstream supply when the innovation requires inputs or specific plant material is a prerequisite for sustainable crop intensification (GRET, 2004). PPILDA has encouraged the development of an extension support service by training young farmers organized in groups. This scheme has strengthened the capacity of 2 500 producers to intensify their crop production and improve their yields by 40 to 65 percent[19]. The project has been using innovative and participatory extension methods such as farmers' initiatives plots and fields of phyto-genetic diversity. Innovations have also been widely disseminated (and adopted) through farmer exchanges that have been promoted when organizing agricultural fairs and exchange visits between groups. The use of local rural radio (three radios in the project area) has also been a tool for learning and spreading innovations (programmes, debates, advertisement, etc.).

At times, social innovations have had a direct impact on agricultural production. For example, by providing poor farmers with access to cereals during the period when they usually sell their labour power to buy food (sometimes through credit), lean season banks[20] have allowed poor farmers to work in their fields at the right time (as per crop calendars), thus significantly improving their yields[21]. Another institutional innovation, participatory land registration (pilot issue of land titles), helped secure land, increase investment, increase agricultural production while promoting dialogue in case of conflict linked to land tenure.

19 Agricultural extension services have made it possible to increase the most vulnerable households' production to an average of 60 bunches of millet per hectare (750 kg/ha) on plots that only produced 12 to 20 bunches earlier. This guarantees vulnerable households five months of food security (two meals per day), throughout the year, compared to two months as reported in the baseline survey (PPILDA surveys, 2010).

20 PPILDA has created 229 lean season banks with a total stock of about 3 242 tonnes of millet, making it possible to help about 65 000 households, or around 450 000 persons who have less than one month's food during the lean season.

21 This innovation has also helped reduce poor households' debt and decapitalization. Beforehand, they would be forced to sell their small ruminants or pawn their land property.

**Reducing the risk and cost of innovation.** When rainfed agriculture relies on uncertain rainfall, producers must find benefits in testing innovation without too large of an investment, so as not to create risk. This is why PPILDA subsidized the process of action research in its experimental phase and dissemination. Moreover, scaling-up of innovations through farmer-to-farmer exchanges can significantly reduce transaction costs.

**Maintaining long-term commitment and promoting sustainability by strengthening the capacity of farmer organizations and the pursuit of economic opportunities.** As for any truly participatory approach, the process of action research has the disadvantage of moving slowly in its initial phase. In addition, all experimental work to recover soil fertility and natural resources management requires several years to attain visible results. Some technical innovations developed in the Aguié area, such as ANR or other agroforestry practices ("tassa" half moons) have been significantly up-scaled. However, they are close to their growth tipping point. By contrast, other innovations are very promising but are still implemented at a modest scale. Stakeholders' long-term commitment engagement is therefore a prerequisite to reach a maximum number of producers. PPILDA is a continuation of previous projects promoted by the Government of Niger, IFAD and other development partners. Its commitment to participatory and sustainable development spans over eight years.

Long-term commitment does not prevent taking stock on what makes activities sustainable. Indeed, if crop intensification is to be sustainable, it must have a positive impact on household economies by increasing their agricultural production and/or improving their income. This implies that rural organizations are given support to reorganize themselves so that they have the capacity to manage resources and develop economic activities around them. For example, the ANR and the recovery of degraded lands have generated revenue through the rational use of wood, fodder and forage seed and implementing management and collective protection rules for regenerated and recovered sites. Seed producer organizations' capacities have been strengthened in terms of producing improved seeds and the project has ensured market opportunities through purchase contracts. However, this approach is only sustainable if seed producers are supported to become part of the Niger seed value chain, independently of PPILDA.

The Support for Food Security and the Development of the Maradi Region Project (PASADEM), funded by the Government of Niger, IFAD and WFP will take over the PPILDA in late 2012, carrying forward the process built on the basis of investments and prior learning originating from 30 years of development practices promoted by projects since the early 1980s. The PASADEM will continue efforts to increase agro-forestry-pastoral productivity by designing and disseminating large-scale innovations and local initiatives and will link local agricultural innovation systems to local and regional markets. It will promote more professional farmer organizations and their relations with markets through a value chain approach that will ensure greater economic sustainability. It will also reduce and better manage climate risks, by improving the resilience of local communities to food and nutrition insecurity.

# Conclusion

Existing quantitative data, though partial, confirms a significant production increase and the fact that the biophysical environment (including biomass) and biodiversity have improved. Farmers' level of participation in project activities and adoption of innovations also demonstrate the relevance of the approach used and the recommended technical proposals. However, as for the rest of the Sahel, the sustainability of agricultural intensification efforts in the Maradi area is subject to the ever-present risk of drought, reinforced by climate change, which exacerbates extreme events. In this context, a single year of drought is a disaster for farmers, especially the poorest, as it destroys their capital and hampers their ability to invest in the medium and long term. It is therefore important to strengthen the practical, technical and organizational know-how allowing them to better manage natural resources (water, soil, forest, biodiversity). New mechanisms of adaptation to drought should be found at a technical (tillage, agroforestry, use of drought resistant varieties), social (lean season banks, nutrition, etc.) or economic level (relations with regional markets). To ensure sustainability, it is essential to support community and farmer organizations in designing their long-term strategic vision and their efforts to ensure their institutional and financial sustainability. As such, PASADEM, which will take over from PPILDA in 2012, is an instrument to finance and support the significant efforts carried out by rural communities in the Maradi Region to intensify local production systems through continuous innovation and adaptation to an ever more challenging climate and economic environment.

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