IFAD
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IMPACT ASSESSMENT PLAN

Chad

Programme d'Appui au Développement Rural dans le Guéra (PADER-G) et Projet d'Amélioration de la Résilience des Systèmes Agricoles au Tchad (PARSAT)

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Introduction

The document describes the plans for two linked impact assessments of rural development projects financed by IFAD in Chad: an ex-post impact assessment for the "Programme d'Appui au Développement Rural dans le Guéra (PADER-G)" and an ex-ante impact assessment for the "Projet d'amélioration de la résilience des systèmes agricoles au Tchad (PARSAT)".[1] In undertaking this double effort, IFAD is attempting to fill the large knowledge gap evident from how very little is known about the impact of projects for smallholder farmers on their food insecurity and hunger (Stewart et al., 2015) in very poor and food insecure countries such as Chad where one third of the population is considered to be in severe food insecurity status (FAO, IFAD and WFP, 2015: 45).

The two projects offer an ideal setting for the conduction of a combined assessment of the baseline for the PARSAT and of the impacts on key indicators of the PADER-G, given the possibility of using the same control group for both PADER-G as well as for PARSAT, thereby making a PARSAT impact assessment particularly cost-effective. As such, it offers the opportunity to broaden the basis of analysis to include IFAD's third strategic objective on improved resilience to climate change, which is not being sufficiently addressed in PADER-G, but plays an increasingly important role for reducing rural poverty in Sub-Saharan Africa.

The PADER-G project was approved on 15 December 2010 for a total amount of USD 20.1 million, of which IFAD provided USD17.4 million. Project activities were completed on 30 December 2016 with a disbursement rate close to 100% (IFAD 2016). The main objective of PADER-G was to support poor rural households and smallholder farmers in Guéra, a region among the poorest and most food insecure of Chad. The project sought to address the basic needs of food security through safe access to drinking water, rural road construction, managing risks of food shortage, access to financial services and strengthening farmers' organizations (FOs).

The PARSAT project was approved on 1 December 2014 for a total amount of US$36 million, of which IFAD provided US$17.2 million as regular funds and US$5 million as part of its Adaptation for Smallholder Agriculture Programme (ASAP). The main objectives of PARSAT are to sustainably increase both seasonal and off-seasonal agricultural production through climate change adaptation

[1] Initially, only the PADER-G project was proposed as part of the IFAD10 Impact Assessment Initiative. Clearly, conducting an additional impact assessment has cost implications in terms of data collection and analysis. However, there are several benefits that outweigh these costs: (i) The government of Chad and the Country Programme Manager expressed a particular interest in PARSAT for learning purposes and future designs; (ii) PARSAT is implemented by the same management unit as was PADER-G which facilitates communication and access to data; (iii) The control group for PADER-G beneficiary villages can be used as a control group for PARSAT, thereby making a PARSAT impact assessment particularly cost-effective; (iv) The roll-out for PARSAT beneficiary and non-beneficiary villages is already known; (v) For PARSAT, both the difference-in-differences approach and propensity score matching can be used; and (vi) with PARSAT, the impact assessment will also focus on IFAD's third strategic objective on improved resilience to climate change which is not being sufficiently addressed in PADER-G, but plays an increasingly important role for reducing rural poverty in Sub-Saharan Africa.

measures and to diversify the sources of income for the rural poor. PARSAT has three main components. The first component, which represents 58% of the planned costs, focuses on improved water collection and management for agricultural use, intensification of resilient production systems and cross-cutting support measures. The second component (19% of the planned costs) is built around the optimization of economic activities through rural road construction, post-harvest facilities and income-generating activities. Lastly, the third component (23% of the planned costs) relates to coordination, administration and financial management of the project.

The objective of the IA plan is to provide a detailed description of all the elements needed to ensure a rigorous ex-post (for PADER-G) and ex-ante (for PARSAT) IA of the two projects, the approach and the methodology used. Successfully conducting an IA implies i) estimating the causal relationship between the projects' activities and the indicators measuring the intended impacts specified in the Theory of Change and in the Logical Framework, ii) understanding the mechanisms that lead to the observed impacts, iii) investigate the presence of spillovers and unintended impacts. Moreover, the information contained in this document shall serve as a guidance for activities to be conducted as well as the purpose of keeping track of the same and for future reference of RIA staff members in charge of continuing and completing the ex-ante IA.

The effort towards conducting a rigorous ex-post IA for the PADER-G and an ex-ante IA for the PARSAT project should be seen in light of the reciprocal and shared willingness of all the actors involved to improve the understanding of the projects' performance towards the achievement of their objectives. Furthermore, providing evidence of the effectiveness of the projects constitutes an invaluable opportunity for local governmental bodies to learn which mechanisms are more effective in benefiting the smallholders, how the projects succeeded in obtaining the benefits or what obstacles hindered full benefit achievement, which concrete actions could be taken to obtain even higher benefits, how much the projects contributed to the economic results of its beneficiaries[2] as well as to improving their welfare.

The two projects offer a good setting given their geographic scope, their aligned timeline, as well as the clear identification strategy and targeting criteria of the beneficiaries. With specific regard to IFAD, this assessment constitutes part of a portfolio-wide set of impact assessments that will be used to assess the overall poverty-reduction impact of IFAD projects. Conducting rigorous IA is also of relevance to the governments of recipient countries, in this case Chad, to help driving future policy making and investments.

The following sections outline the theory of change and the main impact assessment questions as well as the impact assessment design, including the sampling and data collection strategy. The last section outlines the overall work plan with concrete timeline and deliverables.

[2] Henceforth we shall refer to *beneficiaries* as the group that received the treatment, while we will refer to *eligible* households as to those households that satisfied the targeting requirement, but may or may not have been selected to be part of the project's activities.

Theory of change and main impact assessment questions

a. Understanding the PADER-G and PARSAT approaches and theories of change

The target population of PADER-G in Guéra lives in small, remote villages which lack basic infrastructure such as access to safe drinking water, proper sanitation facilities, access to health and education services and access to financial services and transportation (IFAD 2010). For over 87 per cent of the population the most important source of income is subsistence smallholder agriculture (Boutna 2016). Yet, agriculture production lacks basic materials and equipment and is increasingly affected by unpredictable and scarce rainfalls. Yields of basic cereals rarely surpass one tonne by hectare and are not sufficient to cover food security needs throughout the year. In fact, during the lean season, men have no other option than leave their villages to work as day-talers to secure their family's basic food needs. But wages that they are paid are often so low that they have to take out loans with usurious interest rates. In addition, farmers have no alternatives than buying seeds right at the beginning of the planting season when prices are highest.

Against these extreme challenges of food insecurity, the PADER-G project sought to secure the basic needs of the affected population in Guéra through investments in basic infrastructure and related community capacity building, to smoothen impacts of the lean season via a well-functioning and organized cereal bank combined with facilitated access to credit and financial services. Nonetheless, given the disconnect of the various components in selecting beneficiaries, particularly with regard to road construction, water and sanitation and farmer's organization, the IA focuses on cereal banks, for which beneficiaries are clearly identifiable[3]. Financially, activities related to cereal banks represent a major component of PADER-G's actual expenditures (IFAD 2016).

PARSAT's target approach is also centred around the rural poor people in Chad that lives in small, remote villages that are almost entirely dependent on smallholder agriculture to make their living. Its main focus area is the department of Guéra, but it also covers parts of the Fitri and Dababa departments. What makes it different from PADER-G is that the project invests in agricultural water resources rather than in domestic water and sanitation facilities and that it promotes climate change adaptation techniques that are supposed to smoothen the effects of weather conditions on food security and income from agriculture.

The main thrust of the ex-post impact assessment relates to the effects of cereal banks on food security and agricultural production. IFAD invested USD 2.4 million in the construction of 66 cereal banks – of which 20 exclusively for women - and an additional 0.6 million in the capacity building of user associations (COGES or "comité de gestion"). The main purpose of cereal banks is to smoothen the

[3] Activities related to FOs and roads are almost entirely disconnected from other project activities and have only benefitted a few villages. Moreover, the FO component foresaw very heterogeneous services for its members, was focused on rather well-off and market-oriented farmers, and only disbursed 38% of its originally foreseen budget (IFAD 2016).

grain consumption of households over the agricultural cycle by providing grains in the lean season that the beneficiary households need to return in the harvest season with an in-kind interest rate that cover operational costs (Bhattamishra 2008). Cereal banks of PADER-G were also supposed to set up a mechanism that supports cohesion and cooperation among households in case of low harvests or temporary or permanent disability of certain villagers (see also Gyau, et al. 2014).

Despite the fact that IFAD and other donors have invested in these banks over the last decade in Sub-Saharan African countries like Chad and Niger, there is limited and, at best, ambiguous evidence on the actual success of these investments. Most recently, a study by Gross, Guirkinger and Platteau (2016) demonstrated that cereal banks can have a positive effect on food and nutrition security using a randomized approach in 40 villages in Northern Burkina Faso. The results revealed that interventions had a large and positive impact on body mass index for both adults and children as an indicator for food and nutrition security improvement. It also appeared that the effect is more significant for those who are living in remote areas. Also Meethal Reji (2013) concludes that grain banks in 39 villages in India showed a significant impact on food security, especially for those who were excluded from the targeting of government programs. The success of those grain banks was attributed to the simplicity and transparency in the bank operations, and cultivating healthy relationships with local leaders and beneficiary families.

Liu (2016), on the contrary, claims that the problem of food security cannot be solved by cereal banks alone, but only by a comprehensive strategy including food production, animal health, and livestock management. Kent (1998) shows that the failure rate of cereal banks reached up to 90 percent in Niger within five years of the project's inception, and over 80 percent in Burkina Faso after the end of the external support due to miscalculation of potential costs (e.g. costs of physical losses), embezzlement, and poor management. Kent even claims that cereal banks could harm food security through breaking the traditional relationships between traders and villages. Also Bhattamishra (2012), Mariko, Malik and Mohamoud (2012) and Davis (2015) found that the lack of adequate storing facilities, delay and non-payment of loans, limited capital, lack of training, lack of business acumen among villagers and mismanagement are among the many obstacles for ensuring success and sustainability of cereal banks.

Regarding PARSAT, investments in improved agricultural water collection and management amount to around US$10.7 million and include the rehabilitation and construction of water collection sites for different types of crops (US$9.9 million) and the establishment of users' associations and capacity building of their management committees (US$0.8 million). This is complemented by an investment of around US$2.8 million in 800 farmers' field schools that are supposed to benefit 20,000 farmers in the intensification of resilient production systems for cereals (millet, sorghum), and other crops (e.g. groundnut, sesame, market garden crops).

In a recent systematic review Waddington and White (2014) have shown that FFS are effective in inducing change to agricultural practices and improving yields, but only as long as the FFS are done in small scale and on a pilot basis. There are also doubts about the sustainability of these programmes as FFS depend on highly-skilled trainers that – especially in the context of Chad – might not always be available. Yet, what has not been shown so far is whether FFS are effective in promoting climate-smart agriculture and how farmers in Sub-Saharan African countries like Chad adapt to climate change by implementation of new practices and technologies.

Another element of innovation in PARSAT's approach is that it combines the FFS investments with the aforementioned infrastructure investments (at least in a critical number of villages). It is expected that the latter will serve to expand the amount of land devoted to agriculture and to improve the quantity and reliability of water supply, which will lead to improved crop diversity and, hence, improved income and food security (Knox et al., 2013). The overall rationale is that a combination of these investments can lead to improved resilience to climate change through improved agricultural production and diversification of agricultural crops especially during the lean season (Lin, 2011). Together, these outcomes are expected to increase food security and assets and reduce child malnutrition. Compared to PADER-G, PARSAT clearly follows a less traditional approach and seeks to seize opportunities for agricultural production and diversification of crops, rather than securing the status quo through the establishment of cereal banks. Which of the two approaches is more successful in reducing rural poverty and food insecurity remains to be seen.

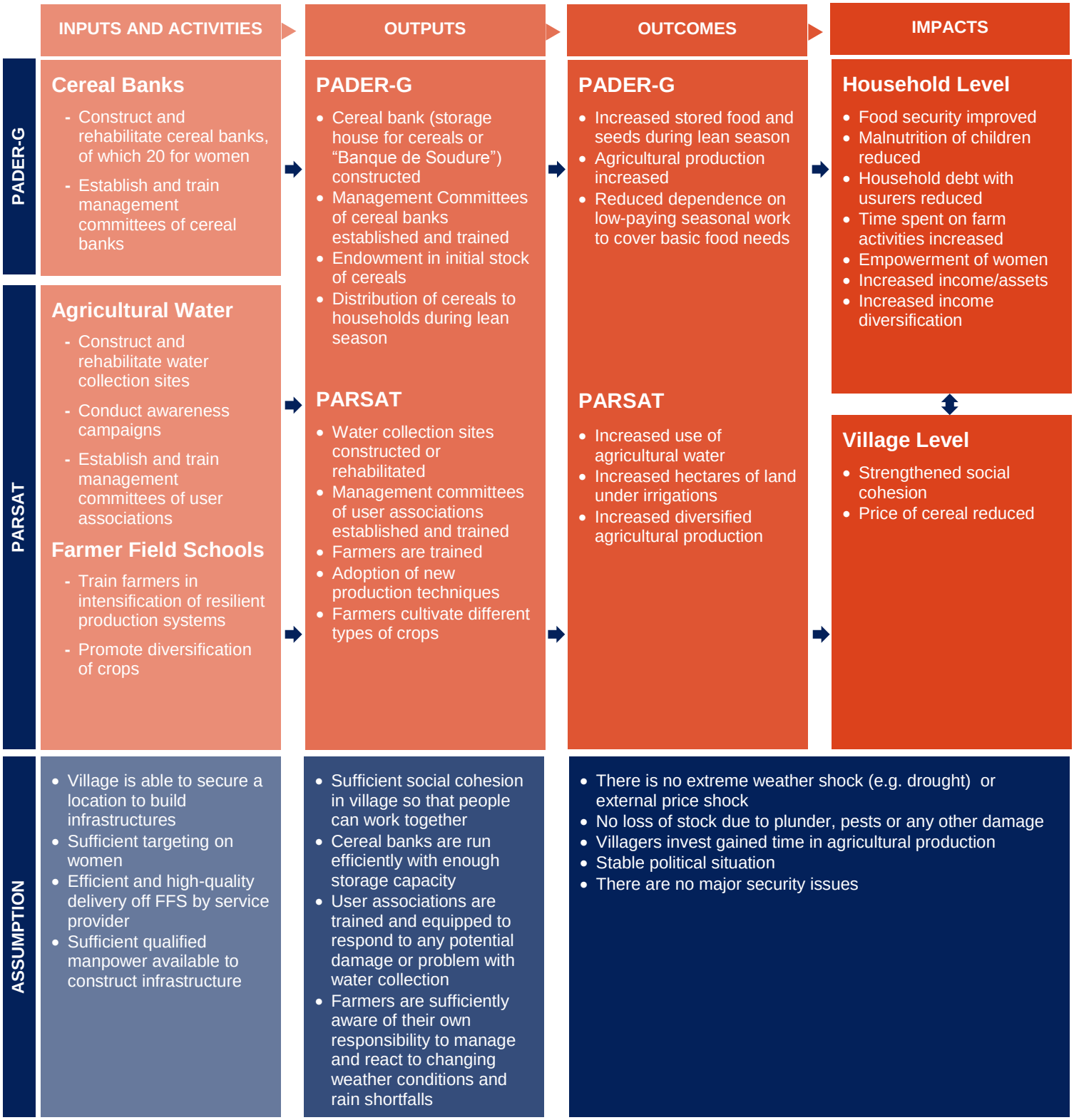
Figure 1 presents the logic behind both projects, their theories of change and the assumptions upon which the projects' activities are triggered so that the intended outcomes and impacts are realized. Clearly, the causal pathway is not linear and providing all instead of only a few of these activities to particular communities might create complementary effects. For example, combining water collection points with FFS in PARSAT project allows for effective access to agricultural water because farmers might not be able to know how to use water collection points without FFS.

The realization of the theory of change assumes that a certain number of conditions are met. These conditions or "assumptions" are here related to removing barriers that can impede the achievement of the expected outcomes or to enhance mechanisms that facilitate their achievement. In terms of the assumptions related to inputs and activities, it is assumed that a beneficiary village is able to secure a location to build infrastructures and sufficiently targets women for PADER-G; beneficiary village of FFS and infrastructure investments in agriculture water resources have sufficient qualified manpower available to construct or rehabilitate agriculture water infrastructure for PARSAT.

With regard to the outputs of PADER-G, sufficient social cohesion in villages is assumed so that people can work together on their community project. This assumption is likely to be met because one of criteria for the selection of a village to benefit from PADER-G project is its level of social cohesion. In addition, cereal banks will have an effect on food insecurity if they are run efficiently and provide enough room for storing cereals. It is also assumed that associations are trained and equipped to mitigate potential damages of the water points and secure their sustainable use.

With respect to the outputs of PARSAT, it is assumed that user associations are trained and equipped to respond to any potential damage or problem with water collection. This assumption is likely to be met because one of criteria for the selection of a village to benefit from PARSAT sub-component related to FFS and infrastructure investments in agriculture water project is the existence of traditional water wells for irrigation. The villages selected for this component have already experience using infrastructure investments in agriculture water resources. Therefore, these villages are more likely able to adopt and use in an efficient way more modern infrastructures. The last assumption is that there will be neither major security issues nor extreme weather shocks that might jeopardize the benefits expected from FFS and infrastructure investment in agriculture water.

Figure 1: Theory of change of PADER-G and PARSAT



b. Impact assessment questions

Following the logic of the respective theories of change, the questions are divided into two types, namely the main question potential impact and intermediate questions on the causal linkages between outputs, outcomes and impacts. The former focuses on assessing the impact of the project's interventions on the intended results, while the latter tackles the mechanisms through which those results are achieved.

Main questions (for both PADER-G and PARSAT)

1. Does the project lead to significantly increased food security and child nutrition?
2. Does the project increase agricultural production?

Intermediate questions

For PADER-G

a. Does access to cereals during the hunger season increase the timely cultivation of fields in the following season?

b. Are the effect of cereal banks on food security different if they are combined with access to safe drinking water?

c. Does the cereal bank alter social dynamics in the village (gender; social cohesion)?

d. Do access to cereal banks and/or to safe drinking water have an influence on health, off-farm labour and preferences for migration?

For PARSAT

e. Do farmers adopt new farming techniques?

f. Do the combined effects of FFS and infrastructure investments in agriculture water resources increase crop diversification (specially off season vegetables production), farmer income, food security and improve child nutrition?

Impact assessment design for PADER-G and PARSAT

a. Overall approach

The impact assessment design for PADER-G follows a mixed-method approach. It will collect quantitative data at the household and village levels from PADER-G and non-PADER-G villages and qualitative data from beneficiaries and financial service providers. The quantitative impact estimation will form the focus of the impact assessment, with the methodology consisting of a two-stage statistical matching design used to construct a robust counterfactual group of non-PADER-G households. The qualitative data collection will generate important insights into the mechanisms behind the observed results, particularly those related to women.

The first stage of the quantitative data collection will involve identifying PADER-G and non-PADER-G villages that share similar baseline characteristics related to both programme selection and outcomes. In order to achieve this, a propensity score matching will be performed based on the 2009 census data of all villages in the Guéra Region. The characteristics that will be used to perform the propensity score include: (i) the dominant ethnic group in the village; (ii) number of drinking water points in the village; (iii) number of primary schools in the village; (iv) number of health centers in the village; (v) number of storage case for cereal; (vi) existence of a weekly market; and (vii) number of microfinance institutions. Based on discussions with the program staff, the data collected for these variables are likely to be related to both programme selection and outcomes of this impact assessment. For each PADER-G village, at least two nearest matches from the non-PADER-G villages will be identified. The trimmed list of matched villages will be shared with the programme staff who based on their contextual knowledge of the Guéra Region will validate village selection and advise on non-PADER-G villages to exclude because of issues related to potential spillovers and contamination.

Table 1 shows that 38.7% of the 671 in the Guéra Region have received some sort of support from PADER-G. The sous prefectures which have received the broadest support are Eref, Kouka Margni and Baro (more than 60% of villages covered), while the least support was provided to Chinguil and Mokofi (less than 12% of villages covered).

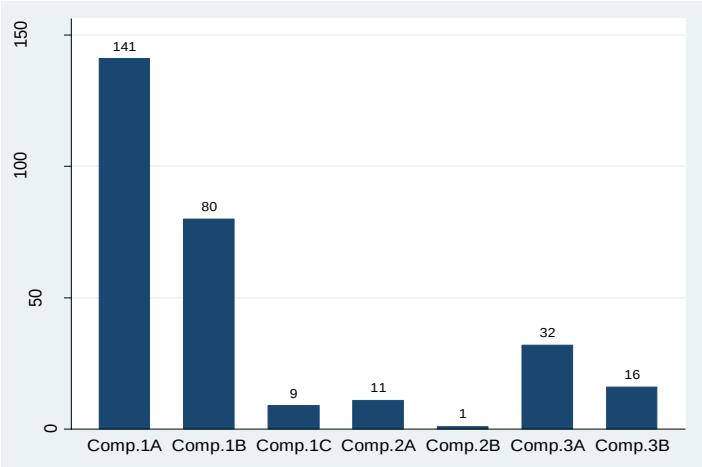
Table 1: Coverage of PADER-G interventions in Guéra Region

Sous Préfecture	Non-PADER-G villages	PADER-G villages	Total villages	PADER-G coverage
Commune de Bitcho	18	14	32	43.8%
Bang-Bang	12	17	29	58.6%
Baro	16	30	46	65.2%
Bitkine	74	37	111	33.3%
Chinguil	60	8	68	11.7%

Sous Préfecture	Non-PADER-G villages	PADER-G villages	Total villages	PADER-G coverage
Eref	7	18	25	72.0%
Kouka Margni	6	24	30	80.0%
Mangalme	14	20	34	58.8%
Melfi	60	25	85	29.4%
Mokofi	90	5	95	5.3%
Niergui	29	34	63	54.0%
Mongo	25	25	50	50.0%
Niergui	0	2	2	100%
Total	411	260	671	38.7%

Once the data has been collected, the second stage will involve producing the final impact estimators through a second round of Propensity Score Matching. This will involve calculating the average difference in the outcomes of pairs of treatment and control households, matched according to baseline villages-level data and household-level data that is relevant both to the likelihood of the participation in PADER-G, not affected by PADER-G and linked with the main outcomes of the impact assessment. The effectiveness of this latter round of matching is contingent on a large number of high-quality matches being available from the sample of PADER-G and non-PADER-G households, which explains why the first round of matching will be conducted: so that the likelihood of good matches being available is maximised. The specific comparison on which this impact assessment will be based will be between households living in villages that have received a "status quo" support service (i.e. no access to a component of PADER-G) between 2012 and 2016, and household living in villages that have received services related to cereal banks (component 1B). Figure 2 shows that 80 villages benefitted from component 1B.

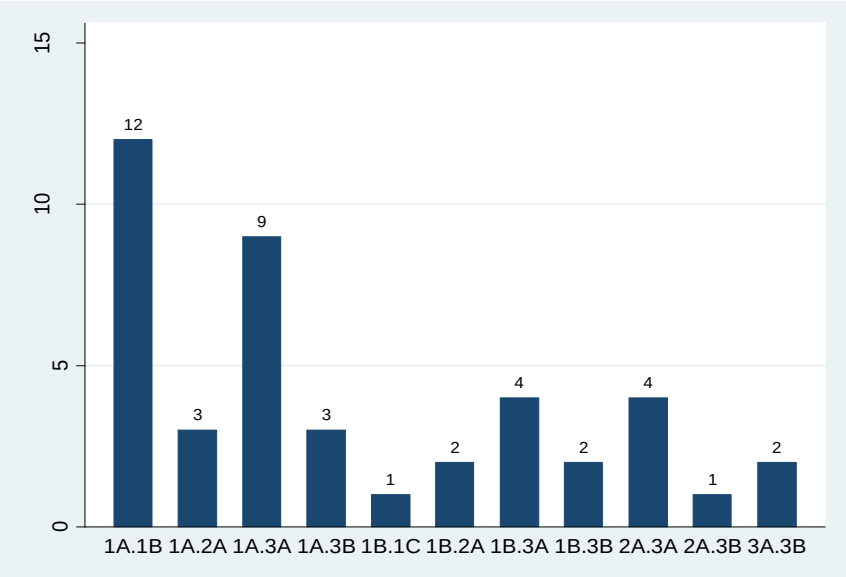
Figure 2: Distribution of different components of PADER-G



Notes Comp.1A "Improvement of access to drinking water and sanitation"; Comp.1B "Improving the availability of cereals during the lean season"; Comp.1C "Improving access to rural markets"; Comp.2A "Support for network restructuring and the professionalization of the microfinance management system"; Comp.2B "Support for network performance and sustainability"; Comp.3A "Support fund for the development of productive economic activities of FOs"; Comp.3B "Strengthening the organizational and technical capacities of FOs"

While most of the villages have only received activities pertaining to one component, a limited number of villages has received activities related to two components (see figure 3). This impact assessment will have two arms, the first arm will be constituted by villages which received only the component of cereal banks and the second arm will be constituted by comparison villages which received no support services from PADER-G.

Figure 3: Overlapping of different component of PADER-G



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The PARSAT impact assessment will collect quantitative data at the farmer and village levels, from both PARSAT villages and non-PARSAT villages. We will take the opportunity for the ex-post impact assessment of PADER-G to collect the baseline data for the ex-ante impact assessment of PARSAT. The endline data for PARSAT will be collected later. As this is a non-randomized impact assessment with the opportunity to collect both the baseline and the endline data, we will use two approaches to estimate the impact of PARSAT on the primary outcomes. First, we will use a propensity score matching and then combine it with difference-in-differences approach .

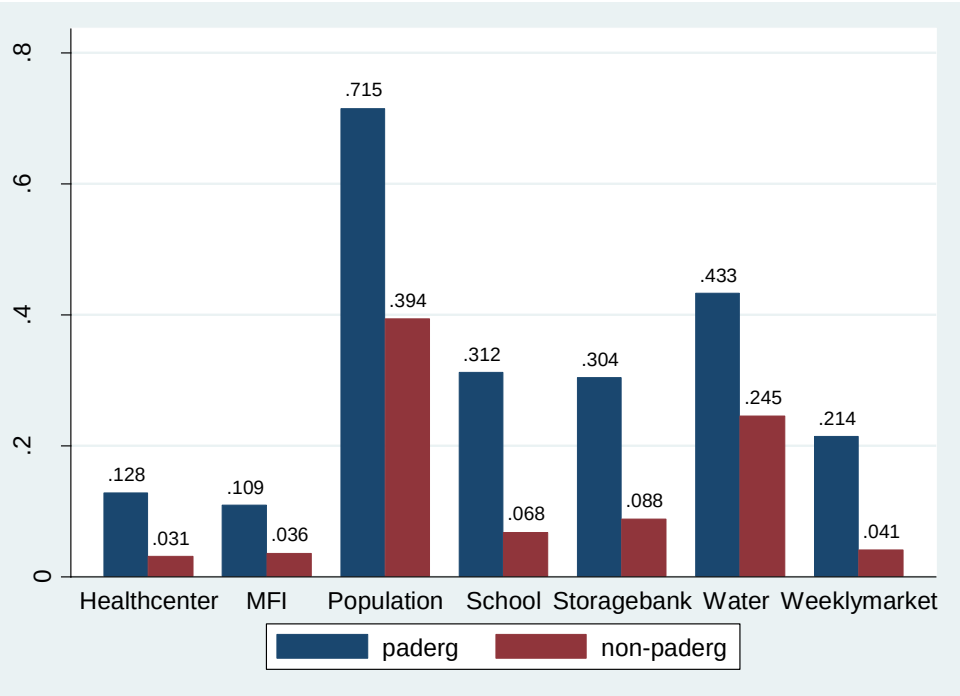
b. Addressing potential selection bias

The decision to employ statistical matching to produce the counterfactual used by this impact assessment is driven by the non-random selection of beneficiaries by PADER-G, which raises the risk of selection bias. Through the assessment of programme documents, discussions with programme staff and field visits conducted in eight PADER-G villages (Saraf,Gono, Bitkine (Istifack), Danglétat, Dougoul, Taro, Soulagnir, Chaouir) and one non-PADER-G village (Taro) we found that the section of villages to receive a PADER-G project follows both a demand driven approach and an assessment of needs and capacity to implement a project conducted by the management unit of PADER-G.

The villages in the target region of Guéra are informed of the existence of PADER-G and the possibility to submit an application to the management unit of PADER-G to receive a PADER-G project. In their application, the village selects the component of PADER-G they would like to receive. After receiving the application, the management unit of PADER-G conduct an assessment of needs and evaluate capacity of the village to implement and manage a PADER-G intervention. The following criteria were used for their assessment: (i) level of social cohesion of the village (i.e., whether the village has only one head of village or has two rival heads of village; whether there exists a sort of village assembly and/or committee to manage a community activity); (ii) main activities of village inhabitants (agriculture, livestock farming); (iii) size of the village (number of households); and (iv) the economic dynamic of the village captured by the existence of, for example, farmer organizations, traditional bank storage for cereals, etc.

Discussions during the field visit also revealed that some PADER-G villages were villages that benefited from the IFAD-supported PSANG II (Food Security Project in the Northern Guéra Region - Phase II) project implemented from February 2002 to December 2010. The reason for selecting villages that had already benefited from PSANG II was that it was found to be "easier" to start a new project in these villages. Thus, it appears that PADER-G villages are not necessary the poorest of villages in the Guéra Region. This is confirmed by Figure 3 which shows that, in 2009, PADER-G villages were better off than non PADER-G villages with regard to access to drinking water, healthcare, school, and others characteristics.

Figure 4: Situation of PADER-G and non-PADER-G villages in 2009 (baseline)



Notes: MFI: village has a microfinance; population: village has a population higher than median population (403 inhabitants) of villages in Guéra Region; water: village has a water point.

The situation of PADER-G and non-PADER-G villages prior to the inception of the programme represents a potential bias for the impact assessment which might lead to an over-estimation of the impact of PADER-G interventions. To overcome this problem, the propensity score will be performed

with the census data on all villages in Guéra Region conducted in 2009 to select the sample of PADER-G villages and non-PADER-G villages to survey. With data collected from the matched PADER-G villages and non-PADER-G villages, we will perform a second matching using propensity score method to produce the quantitative impact estimates. In addition, we will collect data on other potential existing programs in each village before PADER-G, during PADER-G and after PADER-G. We will also control for whether a village has benefited from PSANG II and/or other existing programs. In the multivariable regression, we will also control for baseline village characteristics collected in 2009.

PARSAT's target approach is similar to the selection process to receive a PADER-G project. The selection to receive a PARSAT project follows both a demand driven approach and an assessment of needs and capacity to implement a project conducted by the management unit of PARSAT. In addition, in the context of PARSAT and specifically related to the component selected for this ex-ante impact assessment, the management unit ensure that the village is located in a agroecology zone or geological sites suitable to vegetable production during off-season. The villages should be located in areas where access to groundwater for irrigation through water wells is feasible. Our discussion with the programme staff during our field visit indicates that villages that receive the PARSAT sub-components related to Farmer Field School (FFS) and investments in agricultural water resources are villages where farmers already grow off-season vegetables using traditional techniques and have traditional water wells for irrigation.

Our approach to address potential selection bias is as follows: first, after selecting the comparison villages (non-PADER-G villages), we will use these control villages and match them through the propensity score matching with PARSAT villages where the sub-components related to FFS and investments in agricultural water resources will be implemented in the future. We have the list of PARSAT villages where the sub-components related to FFS and investments in agricultural water resources will be implemented. Once, we have the list of matched villages, we will share this list with the programme staff of PARSAT so they can identify villages where vegetable production is not possible because the village is located in desertic areas where it is unlikely to have water wells for irrigation and where farmers in general do not grow vegetables. This selection of PARSAT villages and non-PARSAT villages will be the first approach to address potential selection bias. We will further address potential selection bias by using the difference-in-difference approach. The difference-in-differences approach controls for time-invariant unobserved heterogeneity. In particular, it compares the change in outcomes in the treatment group before and after the intervention to the change in outcomes in the control group during the same period, which helps in controlling for observed and unobserved time-invariant farmers characteristics that might be correlated with factors that affect both the selection for a PARSAT project and primary outcomes. As the first matching happened the village level for the selection of PARSAT villages and non-PARSAT villages, as the additional approach to address the potential selection bias, we will perform the propensity score matching at farmer level and use the difference-in-differences to produce quantitative impact estimates.

c. Potential spillover effects and contamination

Spillover effects are likely to occur if households in non-PADER-G villages benefit from PADER-G interventions. For example, if latrines and water points built by PADER-G villages reduce diarrhea

among children in PADER-G villages, prevalence of diarrhea among children living close to PADER-G villages might also be affected positively. Although positive spillover effects improve wellbeing of households living in non-PADER-G villages, such event can contaminate the results of the impact assessment if affected non-PADER-G villages are used as control villages.

In order to deal with potential spillover effects and contamination, for each matched PADER-G village, at least two nearest matches from the non-PADER-G villages will be identified. The trimmed list of matched villages will be shared with the programme staff who based on their contextual knowledge of the Guéra Region will advise on non-PADER-G villages to exclude because of issues related to potential spillover effects and contamination. We will use the same approach as in the case of PADER-G to address potential spillover effects and contamination in the an ex-ante IA for the PARSAT.

Sampling and data collection

a. Key indicators

In terms of the specific indicators that will be assessed in order to answer the research questions listed above and related to ex-post impact assessment of PADER-G, Table 2 outlines the primary outcomes, followed by the key intermediate household and community-level indicators outlined in Table 3.

Table 2: List of key impact indicators and their intended measure

Indicators	Measure
Food security	Number of meals per day
Food security	Food Insecurity Experience Scale (FIES)[4]
Nutrition (diversity)	Dietary Diversity Index score
Nutrition (access)	Household Dietary Diversity Score[5]
Nutrition (quality)	the Food Consumption Score (FCS)
Nutritional status (0-59month)	Height for age Z score
Nutritional status (0-59month)	Weight for age Z score
Area of production	The total area of production
Food Production	Cereal production
Coping strategies	The Coping Strategies Index[6]

Table 3: List of key intermediate impact indicators and their intended measures

Indicators	Measure
Households level	
Stock of cereals	Duration of stock of cereals
Lean season	Duration of lean season (in months)
Farm work in other farms (hired farm workers)	Proportion of active household members who works in other farms
Price of the main cereal	Price of the main cereals in the closest market
Number of days worked by hired farm workers	Number of days worked in other farms during the last month by active household members
Access to safe drinking water	Proportion of households with access to safe drinking water
Access to improved sanitation facility	Proportion of households with access to improved sanitation facility
Access to loan	Proportion of adult household members who borrow money from a usurer
Interest rate	Interest rate charged by the usurer

[4] http://www.fao.org/in-action/voices-of-the-hungry/fies/en/
[5] http://www.fao.org/3/a-i1983e.pdf
[6] https://www.wfp.org/content/coping-strategies-index-field-methods-manual-2nd-edition

Amount	Amount borrowed from the usurer
Access to credit	Proportion of household members with access to credit from a microfinance
Distance to safe drinking water by women	Distance to safe drinking water by women in km
Time devoted to access to safe drinking water by women	Time devoted to access to safe drinking water by women in hours
Number of sick days	Number of sick days during the last 4 weeks
Depleting productive assets	Proportion of households depleting productive assets during lean season to provide food for the family
Community-level	
Strengthening the community dynamics	Involvement in community activities
Women empowerment	Women's participation in family decision-making

b. Quantitative sampling strategy

There are two aspects to consider for the sampling strategy of this impact assessment. First, the sampling strategy must ensure that the villages and household sampled are representative of the Guéra Region. Second, given that we will use the statistical matching to produce the impact estimates, the treatment and control households sampled should be similar enough that high-quality matches can be produced. In terms of achieving representativeness, this impact assessment aims to assess the impact of PADER-G intervention on all population exposed to this intervention. Thus, as the entire Guéra Region was the target for the PADER-G, we will ensure that villages sampled for this impact assessment are representative of all villages in the Guéra Region.

As can be seen from Table 4, although Barh-Signka department counts the highest number of villages (Panel A), the PADER-G was implemented more intensively in Guéra department, compared to other departments (Panel B). Consequently, a truly representative sample would reflect this by sampling a proportionately higher number of households from Guéra department. However, a lack of sufficiently matched treatment and control households for Guéra department will mean that a higher number of households could not be taken from this department. In short, taking in account the result of the matching between PADER-G villages and non-PADER-G, our goal will be to obtain a sample with villages from different departments representing proportion presented in Panel B of Table 4.

Table 4: Distribution of villages in Guéra Region

Department	Panel A. Distribution of villages		Panel B. Distribution of PADERG villages	
	Freq.	**Percent**	**Freq.**	**Percent**
Abtouyour	140	20.86	54	20.77
Barh-Signaka	248	36.96	38	14.62
Guéra	161	23.99	91	35
Mangalme	122	18.18	77	29.62
Total	671	100	260	100

Our discussion with the programme staff did not reveal a major heterogeneity in the implementation of PADER-G in different departments of Guéra Region that would justify a divergence of outcomes and might require stratifying the sampling by department and collecting samples of households from each department that are large enough to estimate the specific impact for each department.

For the ex-ante impact assessment of PARSAT, we will follow the same approach than for the ex-post impact assessment of PADER-G. In particular, although we will ensure as much as possible that the sample collected for this ex-ante impact assessment of PARSAT is representative of the distribution of households in different department of Guéra region and parts of the Fitri and Dababa departments, the final sample will mostly be the reflect of villages obtained through the matching process between the control villages (non-PADER-G villages) and PARSAT villages where the sub-components related to FFS and investments in agricultural water resources will be implemented in the future.

We perform power calculations by conduct a calculation incorporating various components of the comparison villages including the minimum expected change in the primary outcome variables, which produces a recommended sample size. As this impact assessment has multiple primary outcomes, power calculations will be performed for all the primary outcome variables with the value of parameters required available. The sample size of the outcome which requires the largest sample size among all outcomes will be choose as the sample size for the study.

The following equations from Djimeu and Houndolo (2016) was used to determine the appropriate sample size for the household survey.

For individual-level outcomes (continuous outcome), we used the following equation:

$$\delta = \frac{t_\beta + t_{\alpha/2}}{\sqrt{P(1-P)J}}\sigma_y\sqrt{\rho + \frac{1-\rho}{n}} \qquad (1)$$

Where δ= Minimum detectable effect; t_β= the critical value of the confidence interval; $t_{\alpha/2}$ = the critical value of the statistical power; σ_y =the standard deviation of the baseline outcome variable; P = Proportion of individuals assigned to the treatment group; J= Number of clusters; ρ =Intra-cluster correlation coefficient; n = Number of individuals per cluster; α = significance level; and β = desired power of the study.

For individual level outcomes (proportion outcome), we use the following equation:

$$J = 1 + \frac{(z_\beta + z_{\alpha/2})^2\left[\frac{\mu_0(1-\mu_0)}{n} + \frac{\mu_1(1-\mu_1)}{n} + k^2(\mu_0^2 + \mu_1^2)\right]}{(\mu_0 - \mu_1)^2} \qquad (2)$$

Where J= Number of clusters in each group; z_β = the critical value of the statistical power; $z_{\alpha/2}$= the critical value of the confidence interval; μ_0 =True (population) proportion in the absence of the intervention; μ_1= True (population) proportion in the presence of the intervention; k= the coefficient of

variation of true proportions between clusters within each group7; n= Number of individuals in each cluster; α = significance level; and β = desired power of the study.

Some parameters of the equations one and two are standard figures. Parameters with standard figures include **α** = significance level with a standard value equal to 5%; **β** = desired power of the study with a standard value equal to 80%; $\mathbf{z_{\beta}}$ = the critical value of the statistical power with a standard value equal to 0.84 ; $\mathbf{z_{\alpha/2}}$= the critical value of the 95% confidence interval with a standard value equal to 1.96; and **P** = Proportion of individuals assigned to the treatment group with a standard value equal to 0.5. In this impact assessment, the standard figures used are related to a two-tailed test because we assume that we do not know a priori the direction (positive or negative) of the impact of the intervention if an effect has occurred.

For other parameters including $\mathbf{\sigma_y}$ =the standard deviation of the baseline outcome variable; ρ=Intra-cluster correlation coefficient; μ_0=True (population) proportion in the absence of the intervention; and **k**= the coefficient of variation of true proportions between clusters within each group are estimated based on the most similar accessible existing dataset for which these figures are available. In particular, for this impact assessment, figures of these parameters for the primary outcomes and the intermediate are from three datasets. The first dataset "SYGRI (Système de Gestion des Résultats et de l'Impact)" contains data that was collected in November 2012 among 900 households living in 30 villages from the four departments of Guéra Region (Cisse et Tchoua, 2012). The second dataset "Enquête Banque de Soudure" contains data that was collected in June 2016 among 550 households living in 22 PADER-G villages and non-PADER-G villages (Boutna, 2016). Finally, the third dataset contains data that was collected in October 2016 among 750 households from 50 PADER-G villages and non-PADER-G villages (Tchoua, 2016). When we use data collected in PADER-G villages and non-PADER-G, for different parameters, only figures from non-PADER-G villages are used to perform power calculations. Finally, figures for **δ**= Minimum detectable effect and μ_1= True (population) proportion in the presence of the intervention are from are chosen based on our discussion with beneficiaries of PADER-G during our field visit in PADER-G villages.

Using these parameters and the corresponding values based on the existing three datasets, Table 5 and Table 6 present sample sizes mainly for the primary outcomes and some intermediate outcomes that we are able to have required parameters to perform power calculations. Table 5 presents simple sizes for continuous outcomes while Table 6 presents simple sizes for binary outcomes.

Table 5: Sample size calculations with continuous outcomes

Parameters	Number of meals per day	Height for age Z score	Weight for age Z score	Weight-for-Height	Duration of lean season
φ	2.553	-1.382	-5.472	-7.080	3.227
δ	0.447	0.37	2.736	-3.54	0.9681
ϑ	17.50%	26.77%	50%	50%	30% (1 month)

[7] For binary outcomes, the relationship between the ICC and K is provided by the following formula: $ICC = k^2(\frac{\pi}{1-\pi})$ where ICC = Intra-cluster correlation coefficient; k= the coefficient of variation of true proportions between clusters within each group; π= is the probability of the binary outcome of interest (Pagel et al., 2011).

α	5%	5%	5%	5%	5%
β	80%	80%	80%	80%	80%
t_β	0.84	0.84	0.84	0.84	0.84
$t_{\alpha/2}$	1.96	1.96	1.96	1.96	1.96
σ_y	0.537	1.987	3.391	5.166	1.914
J	12	64	2	2	26
ρ	0.222	0.047	0.009	0.009	0.173
P	0.5	0.5	0.5	0.5	0.5
n	30	40	40	40	30
Sample Size $(n * J)$	360 farm households	2560 children in 1920 farm households	80 children in 30 farm households	80 children in 30 farm households	780 farm households

Notes: $\varphi =$ baseline mean value; δ= Minimum detectable effect; $\vartheta =$ Minimum detectable effect in % change; α= Desired significance level; β= Desired power of the design; $t_{\alpha/2}$ =t-value corresponding to the desired significance level of the test; t_β =t-value corresponding to the desired power of the design; σ_y=Standard deviation of outcome variable; J= Total number of clusters; ρ =Intra-cluster correlation coefficient ; P =Proportion of individuals assigned to the treatment group;n=Number of individuals per cluster

Table 6: Sample size calculations with individual-level outcomes (binary outcome)

Parameters	Proportion of household who experienced a food shortage in the past 12 months	Women empowerment (Participation in the decision process)
α	5%	5%
β	80%	80%
z_β	0.84	0.84
$z_{\alpha/2}$	1.96	1.96
μ_1	0.768	0.5832
μ_0	0.96	0.486
ϑ	20%	20%
n	30	30
J	8	30
k	0.057	0.00
n	30	30
Sample Size $(n * J)$	240 farm households	900 farm households

Notes:μ_0=True (population) proportion in the absence of the intervention; μ_1= True (population) proportion in the presence of the intervention; $\vartheta =$ Minimum detectable effect in percent change; α= Desired significance level; β= Desired power of the design; $z_{\alpha/2}$ =z-value corresponding to the desired significance level of the test; z_β = z-value corresponding to the desired power of the design; σ_y=Standard deviation of outcome variable; J= Total number of clusters;k= the coefficient of variation of true proportions between clusters within each group; P=Proportion of individuals assigned to the treatment group;n=Number of individuals per cluster

The largest sample size among all outcomes is the sample size requires to detect a 26.77% improvement in height for age Z score. The sample size required is 1920 farm households in 64 villages. However, as propensity score matching will be used to produce the impact estimations, which will involve some households without a sufficient match being dropped from the sample, 10% will be added to the sample

size. Thus, the final required sample size is given as 2100 farm households in 70 villages. This sample size is for a study with two arms.

In terms of the specific indicators that will be assessed in order to answer the research questions related to ex-ante impact assessment of PARSAT, Table 7 outlines the primary expected impacts of the PARSAT sub-components related to Farmer Field School (FFS) and in agricultural water resources.

Table 7: List of key impact indicators and their intended measure

	Indicator
Production	FCFA[8] per hectare:Lettuce
Production	FCFA per hectare: Tomato
Production	FCFA per hectare: Gombo
Area of production	the total area of production of Lettuce (ha)
Area of production	the total area of production tomato (ha)
Area of production	the total area of production of Gombo (ha)
Income	Farmer income
Food security	Food Insecurity Experience Scale (FIES)[9]
Nutrition (quality)	Food Consumption Score (FCS)
Nutritional status (0-59month)	Weight-for-Height
Nutritional status (0-59month)	Weight for age Z score

We perform power calculations for the ex-ante impact assessment of PARSAT. As this impact assessment has multiple primary outcomes, power calculations will be performed for all the primary outcome variables where with the value of parameters required available and the largest sample size among all outcomes will be choose as the sample size for the study. We used the equation 1 to perform these power calculations.

The corresponding values of different parameters are taken from the data collected from 94 farmers (48 farmers growing off season vegetables and supported by PADER-G in a pilot phase of FFS and investments in agriculture water resources and 46 farmers growing off season vegetables and not supported by PADER-G) in December 2016 (Kakiang, 2016). Values used are mainly from 46 farmers growing off-season vegetables and not supported by PADER-G. However, we used data from 48 farmers growing off-season vegetables are used to determine the value of minimum detectable effect. Based on the Table 8, the outcome which requires the largest sample size is the Tomato production. Therefore, the suggested sample size for this impact assessment is 1625 farm households in 65 villages. It is important to mention that although an increase of 75% of area of production of tomato and 70% of area of production of Gombo seems to be very important and might not be observed, with a sample size of 1625 farm households, our study is

[8] FCFA: Franc CFA, 1 FCFA is equal to 0.00175999 USD on July 18, 2017
[9] http://www.fao.org/in-action/voices-of-the-hungry/fies/en/

largely powered for the 6 others primary outcomes. Finally, assuming an attrition of 10%, we will have a final sample size of 1800 farm households in 72 villages. It is important to mention that 900 farm households in 36 villages used as the control group of the ex-ante impact assessment of PARSAT will be the same farm households used as the comparison group for the ex-post impact assessment of PADER-G, therefore, for the ex-ante of impact assessment of PARSAT, we will only collect data on 900 farm households in 36 PARSAT villages.

Table 8: Sample size calculations with continuous outcomes

	Lettuce Production (FCFA per hectare)	Tomato Production (FCFA per hectare)	Gombo Production (FCFA per hectare)	Lecture Area of production (ha)	Tomato Area of production (ha)	Gombo Area of production (ha)	Annual Farmer income FCFA
φ	83750	248001	311573	0.039	0.110	0.038	280395
δ	20938	76880	77894	0.011	0.0825	0.0266	35050
ϑ	25%	31%	25%	30%	75%	70%	12.5%
α	5%	5%	5%	5%	5%	5%	5%
β	80%	80%	80%	80%	80%	80%	80%
t_1	0.84	0.84	0.84	0.84	0.84	0.84	0.84
t_2	1.96	1.96	1.96	1.96	1.96	1.96	1.96
σ_y	44427	131474	159180	0.055	0.151	0.055	233975
J	6	65	6	28	60	59	56
ρ	0.000	0.70	0.000	0.002	0.550	0.415	0.000
P	0.5	0.5	0.5	0.5	0.5	0.5	0.5
n (famers per village)	25	25	25	25	25	25	25
Sample Size (unit) with two tail test	150 Farm households	1625 Farm households	700 Farm households	875 Farm households	1500 Farm households	1475 Farm households	1400 Farm households

Notes: $\varphi =$ baseline mean value; $\delta =$ Minimum detectable effect; $\vartheta =$ Percent change; $\alpha =$ Desired significance level; $\beta =$ Desired power of the design; $t_1 =$ t-value corresponding to the desired significance level of the test; $t_2 =$t-value corresponding to the desired power of the design; $\sigma_y =$Standard deviation of outcome variable; $J =$ Total number of clusters; $\rho =$Intra-cluster correlation coefficient ; $P =$Proportion of individuals assigned to the treatment group; $n =$Number of individuals per cluster

c. Qualitative sampling strategy

Carrying out a qualitative survey enables one to gain additional information about project targeting, implementation, and contextualizing the socio-economic and cultural setting in which the projects had taken place. Further, previous studies argue that qualitative information usually provides additional insights to the channels through which the project activities may be associated with the changes in the key outcomes indicators of interest related to the project (Rao and Woolcock, 2004 and Ravallion, 2003).

The qualitative survey will follow a similar sampling strategy as the quantitative household survey. The qualitative survey will also follow a qualitative survey methodology consisting of semi-structured interviews in the forms of FGDs and KIIs. RIA recommended that ten FGDs composed by at least 5-8 beneficiary and non-beneficiary farmers, with each ensuring gender and

youth representativeness. Ten KIIs are recommended to interview project implementation officers, village leaders, and head of the FFS group and head of the cereal bank association (women association).

The locations of these ten FGDs and ten KIIs were randomly within the matched treated and control villages for the quantitative data collection.

d. Qualitative and quantitative instruments

The Impact Assessment will include both qualitative and quantitative analysis and data.

a. Qualitative survey:

The instruments for the qualitative survey were designed and shared with the PMU and CIBLE for their comments. The instruments were subsequently translated into French and into Chadian Arabic.

The FGD interview scripts included questions on the local environment (social and economic background, agricultural and other income sources and support received), the project implementation (cereal bank, access to drinking water and sanitation, microfinance and farmer organisation) and impacts of the project (income sources, food availability, gender empowerment, resilience, social cohesion, migration and other changes). The key themes of the KIIs with village leaders included questions on the local environment (social and economic background, agricultural and other income sources and support received) and impacts of the project (income sources, food availability, gender empowerment, resilience, social cohesion, migration and other changes). The KIIs with the PMU PADER-G contained questions on the targeting and implementation of PADER-G project. Similar questions were included for the KIIs with the PMU PARSAT. The instrument for the KII with cereal bank association focused on the implementation and the impacts of the cereal banks. Similarly, for the FFS group, questions on implementation of FFS were included.

b. Quantitative survey:

The main data collection instrument for this evaluation will be a household survey with detailed information on agricultural production, water use, cereal bank, water users' association, access to sales, income, crop diversification, participation to FFS, and detailed information on associations, access to credit, migration and commercial activity. We will also conduct community and association level surveys. An outline of the questionnaire can be found in Table 9.

Table 9: Structure of the Survey Instrument

Section 1	Socio demographic characteristics: age, education, nr of kids, migration etc.
Section 2	Land operated and ownership: inventory, type, land title, etc
Section 3	Water uses and cereal bank
Section 4	Agricultural production
Section 5	Labor requirement, post harvest, storage, processing, sale

Section 6	Access to market, sales, transaction, contract
Section 7	Other income sources, self employment, wages, enterprises
Section 8	Access to credit and utilization
Section 9	Association and social capital
Section 10	FFS

Budget, deliverables and workplan

a. Planned budget

The data collection activities will be carried out by CIBLE SARL, team selected after a competitive tender process. CIBLE has proposed the following budget for the data collection activities (Table 10). All prices have been converted to US$.

Table 10: Tentative itemized budget

Items	Proposed cost (US$)
Qualitative data collection	40,000
Quantitative data collection	177,610
Staff cost	30,050
Margin company	25,473
Total	280,202

b. List of deliverables and workplan

As part of the impact assessment activities of the PADER-G and PARSAT projects, the associated deliverables, along with their tentative time to deliver those items, are shown in Table 11. At the completion of the impact assessment activities, we will have produce four sets of main deliverables.

1. A set of presentations on the impact assessment methodologies, which introduces the concepts, requirements, and implementation plan, along with some key considerations about how to incorporate impact assessment into project design and implementation.

2. Finalized qualitative KII and FGD guides and the final qualitative reports following the KII and FGD with the project management unit staff, selected village leaders, head of the FFS group and head of the cereal bank association (women association).

3. Finalized household and community surveys and their cleaned datasets, along with an enumerator guideline explaining how to conduct field interviews using the surveys.

4. An impact assessment report, which summarizes empirical findings from the analyses of household-level and community-level data and highlights key learning messages for future project design and implementation plan.

The deliverables are listed in table 11 along with the timeline.

Table 11: List of deliverables and timeline

Activity	
Data Collection	Completed by:
Finalization of the impact evaluation strategy	September 2017
Drafting preliminary survey quantitative and qualitative instruments and recruitment of survey firm	September-October 2017
Qualitative investigation: design and data collection	October 2017
Preparation of CAPI data collection for household and community surveys (finalization of questionnaires and programming of CAPI application)	October-November 2017
Analysis of qualitative investigation results	November 2017
Interviewer training and pre-test for household and community surveys	November 2017
Data collection for household and community surveys	November-December 2017
Data Collection	Completed by:
Data analysis	January 2018
Finalization of IA report	March 2018

Table 12 indicates the team member involved in this impact assessment and the main counterparts in the ICO, the PMU and the data collection team (CIBLE).

Table 12: Research team and main counterparts

Name	Role	Affiliation
Romina Cavatassi	Principal Investigator	RIA, IFAD
Tim Balint	Co-Principal Investigator	RIA, IFAD
Mohamed Abouaziza	Research Analyst (June 2017 to September 2017)	RIA, IFAD
Pierre Marion	Research Analyst (September 2017 to December 2017)	RIA, IFAD
Eric Djimeu	Evaluation Specialist (June 2017 to October 2017)	3ie
Deo-Gracias Houndolo	Evaluation Specialist (October 2017 to January 2018)	3ie
Valantine Achancho	Country Program Manager	Chad, ICO, IFAD

El Hadj Abdoulaye Mahamoud	Project Management Unit	Ministère de la Production, de l'Irrigation et des Equipements Agricoles, Government of Chad
Luc Billong Ramadji Nadjibaye Nguem	Research Manager Field Manager	CIBLE SARL

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