

# Senegal Roads Rehabilitation Project Impact Evaluation

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## Baseline Report

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## TABLE OF CONTENTS

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<b>1. INTRODUCTION .....</b>	<b>1</b>
<b>2. EVALUATION DESIGN AND DATA.....</b>	<b>4</b>
2.1 Logic Model and Key Research Questions .....	4
2.2 Impact Evaluation Design .....	7
2.3 Sampling.....	11
2.4 Baseline Data Collection.....	12
<b>3. HOUSEHOLD CHARACTERISTICS AT BASELINE.....</b>	<b>20</b>
3.1 Demographics of Households .....	20
3.2 Non-Agricultural Employment and Income.....	23
3.3 Agricultural Production and Market Access .....	27
3.4 Road Quality and Access to Various Facilities.....	29
<b>4. ENTERPRISE CHARACTERISTICS AT BASELINE.....</b>	<b>35</b>
<b>5. DIFFERENCES BETWEEN TREATMENT AND COMPARISON GROUPS .....</b>	<b>40</b>
5.1 Baseline Differences in Household Characteristics .....	40
5.2 Baseline Differences in Enterprise Characteristics .....	43
5.3 Baseline Differences in Community Characteristics .....	44
<b>6. CONCLUSION .....</b>	<b>46</b>
<b>REFERENCES .....</b>	<b>47</b>
<b>APPENDIX A.....</b>	<b>48</b>

## TABLE OF EXHIBITS

	Page
Exhibit 1: Distribution of Senegal Compact Funds.....	2
Exhibit 2: Geographic Location of Senegal Compact Activities .....	3
Exhibit 3: Roads Rehabilitation Project Logic Model .....	5
Exhibit 4: Illustration of Selection of Treatment and Comparison Areas .....	8
Exhibit 5: Treatment and Comparison Areas for RN2 .....	9
Exhibit 6: Treatment and Comparison Areas for RN6 .....	11
Exhibit 7: Sample Size Requirement .....	12
Exhibit 8: Distribution of Sample Sizes by Intervention and by Treatment Status.....	14
Exhibit 9: RN2 Treatment Area .....	16
Exhibit 10: RN2 Comparison Area.....	17
Exhibit 11: RN6 Treatment Area .....	18
Exhibit 12: RN6 Comparison Area (RN5).....	19
Exhibit 13: RN2 Household Characteristics.....	20
Exhibit 14: RN6 Household Characteristics.....	21
Exhibit 15: RN2 Household Head and All Members' Characteristics.....	22
Exhibit 16: RN6 Household Head and All Members' Characteristics.....	23
Exhibit 17: RN2 Employment and Income of Household Members .....	25
Exhibit 18: RN6 Employment and Income of Household Members .....	26
Exhibit 19: RN2 Agricultural Production and Commercialization .....	28
Exhibit 20: RN6 Agricultural Production and Commercialization .....	29
Exhibit 21: RN2 Household Head's Opinion on Road .....	30
Exhibit 22: RN6 Household Head's Opinion on Road Quality.....	30
Exhibit 23: RN2 Road Access to Various Facilities .....	31
Exhibit 24: RN6 Road Access to Various Facilities .....	33
Exhibit 25: RN2 Enterprise Characteristics .....	35
Exhibit 26: RN6 Enterprise Characteristics .....	37
Exhibit 27: RN2 Household Treatment/Comparison Differences.....	41
Exhibit 28: RN6 Household Treatment/Comparison Differences.....	42
Exhibit 29: RN2 Enterprise Treatment/Comparison Differences .....	43
Exhibit 30: RN6 Enterprise Treatment/Comparison Differences .....	44
Exhibit 31: RN2 Community Treatment/Comparison Differences .....	45
Exhibit 32: RN6 Community Treatment/Comparison Differences .....	45
Exhibit 33: Datasets for Senegal Roads Survey.....	48

## 1. INTRODUCTION

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Basic infrastructure facilities are public goods, and their inadequacy is a significant cause of failure among poor nations (Warr, 2005). In recent years, roads have been extensively championed as poverty alleviation instruments by donor institutions and are regarded as a key to raising living standards in poor rural areas. By reducing isolation, improved roads decrease vulnerability and dampen income variability (Van de Walle and Cratty, 2002).<sup>1</sup>

Senegal remains a poor country despite a recently positive economic performance (GDP growth rate of 4% in 2013). As of 2011, 46.7% of the population lived below the national poverty line. To address concerns that poor road conditions have hindered economic growth (only 35.5% of the total roads were paved as of 2005),<sup>2</sup> the government of Senegal is implementing a roads rehabilitation project using funds from the Millennium Challenge Corporation (MCC). By rehabilitating selected national roads, MCC will improve access to domestic and international markets. In addition, communities along the rehabilitated roads will have improved access to important services such as schools and hospitals.<sup>3</sup>

In order to produce empirical evidence about the effectiveness of this project and inform future poverty alleviation programs and strategies, the MCC Compact incorporated monitoring and evaluation as a key function within the program implementation mechanism. MCC has contracted with IMPAQ International to carry out rigorous impact evaluations of the Roads Projects.

On September 16, 2009, MCC entered into a USD 540 million Compact agreement with the Republic of Senegal. The Republic of Senegal and the Millennium Challenge Account in Senegal (MCA-S) established an autonomous body to manage the work of this Compact effectively. The Compact entered into force in September 2010, initiating the 5-year timeline for project implementation. Compact funds have been strategically invested in two projects:

- Roads Rehabilitation Project (RRP)
- Irrigation and Water Resources Management (IWRM) Project

As indicated in Exhibit 1, USD 324.7 million, or approximately 60% of the total Compact budget is devoted to the Roads Project, followed by USD 170.0 million for the IWRM project (31%), USD 41.5 million for Program Administration and Audit (8%), and USD 3.7 million for Monitoring and Evaluation (M&E) (1%).

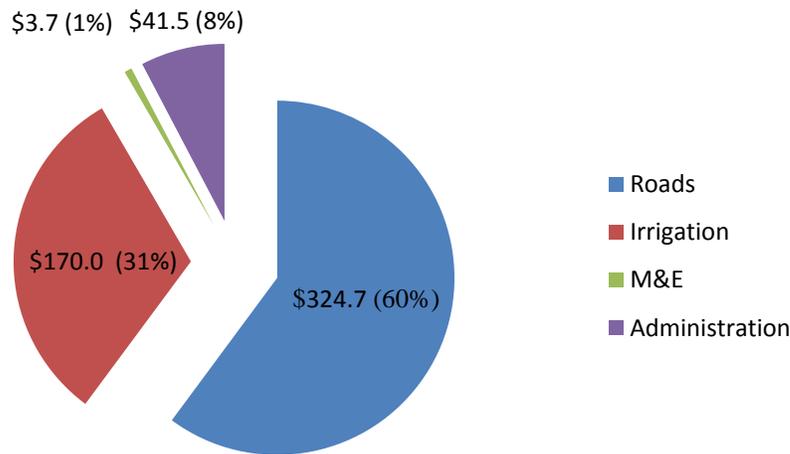
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<sup>1</sup> In a study of rural China, Jalan and Ravallion (1998) found that a higher density of roads in a given area lowered the probability that households in that area would be poor.

<sup>2</sup> World Bank World Development Indicators (<http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG> accessed July 29, 2014).

<sup>3</sup> Van de Walle and Cratty (2002) found that in a Vietnam road rehabilitation project, the time needed to reach the closest hospital in cases of serious injury declined by three-quarters of an hour.

**Exhibit 1. Distribution of Senegal Compact Funds  
(USD Millions)**



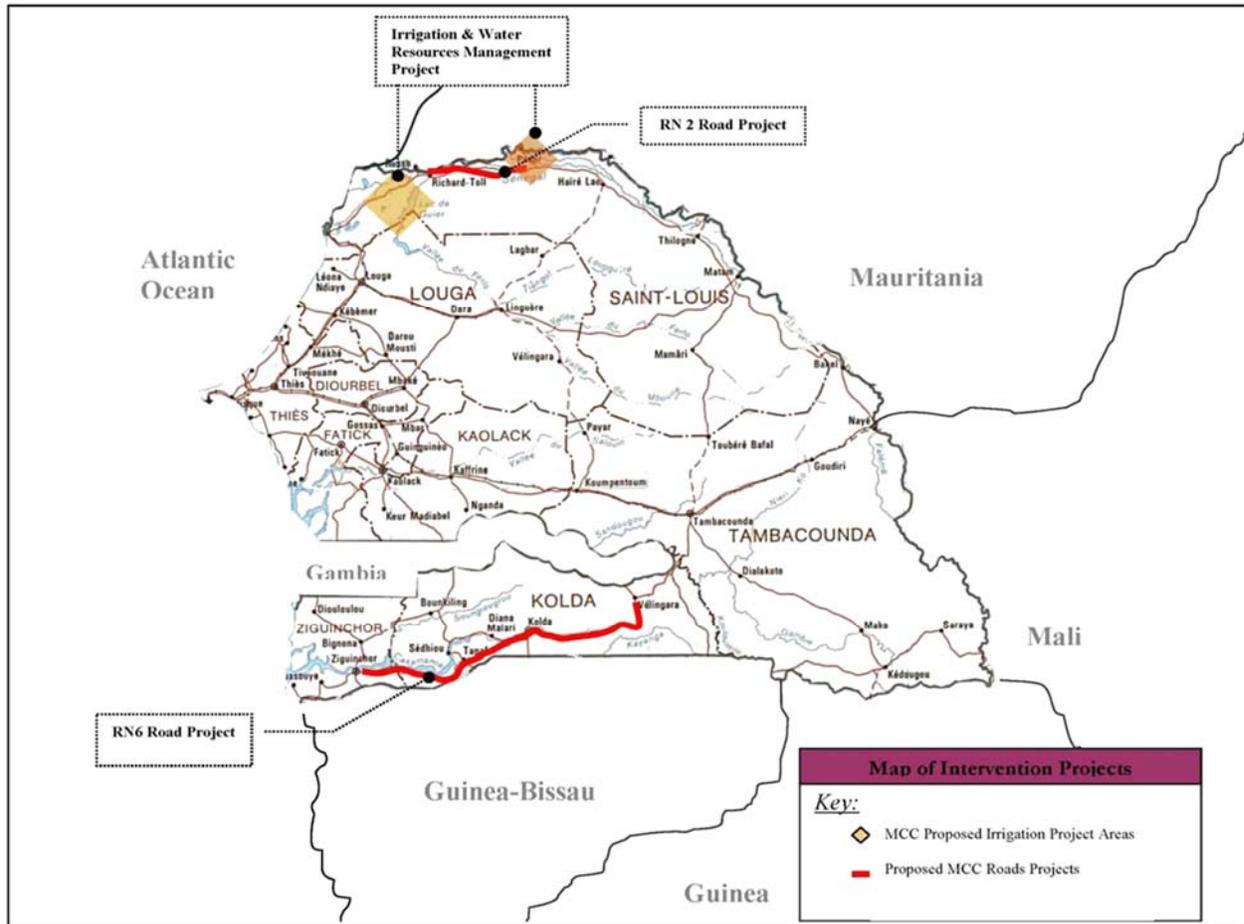
The Roads Rehabilitation Project (RRP) will implement the following activities:

- In the North, rehabilitation activities (strengthening, widening and replacing associated structures) of National Road 2 (RN2), covering around 120 kilometers (km) from Richard Toll to Ndoum (Exhibit 2); and construction of the new Ndoum Bridge. In the South, rehabilitation activities (strengthening, widening and replacing associated structures) of National Road 6 (RN6), covering at least 256 km from Ziguinchor to Kounkané; and rehabilitation of the Kolda Bridge.
- The RRP also contains environmental and social mitigation measures, which include (i) developing community reforestation plans; (ii) implementing an HIV/AIDS awareness program; (iii) relocating or resettling the families affected by the rehabilitation works; (iv) implementing an environmental awareness program for communities; (v) ensuring environmental monitoring; (vi) carrying out planting alignment; (vii) creating and/or removing weekly markets; and (viii) supporting initiatives related to the development of wooded areas.
- The rehabilitation of RN2 is expected to benefit some 21,000 households, or 250,000 people, over the next 20 years. There are currently about 9,290 households, or 111,500 people, residing within a 5-km radius, on either side of the RN2. The rehabilitation of RN6 is expected to affect some 102,000 households, or about 1.1 million people, over the next 20 years. There is currently a population of about 44,000 households, or 474,000 people, along the road.<sup>4</sup>

<sup>4</sup> Millennium Challenge Compact between the United States of America acting through the Millennium Challenge Corporation and the Republic of Senegal (2009).

In this report, we provide findings from the baseline data collected for the RRP. We describe household characteristics, as well as baseline values of measures that will eventually be used to assess the impacts of the RRP interventions. This report is structured as follows: Chapter 2 describes the impact evaluation design and data collection activities; Chapter 3 presents findings from the baseline surveys; Chapter 4 concludes with a summary of lessons learned and next steps for impact evaluation.

### Exhibit 2: Geographic Location of Senegal Compact Activities



## 2. EVALUATION DESIGN AND DATA

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In this chapter, we provide a brief discussion of the design and data sources for the evaluation of the Roads Rehabilitation Project. A more detailed discussion of these topics is available in the evaluation design report (Benus et al. 2012).<sup>5</sup> The evaluation will focus on how road improvements affect households and enterprises in Senegal.

This report presents findings from an analysis of the household, community, and enterprise survey data collected at baseline. It also presents the key research questions that the evaluation will address, the impact evaluation identification strategy and estimation methods, as well as the sampling and statistical power of the baseline survey.

### 2.1 Logic Model and Key Research Questions

The long-term goal of the Senegal Compact is to reduce poverty and enhance economic growth. Investments in road infrastructure can help Senegal to achieve this goal. In Exhibit 3, we present a logic model that illustrates potential causal pathways through which road rehabilitation projects may lead to poverty reduction. The model moves from the problem statement and activities and outputs, through short and medium term outcomes and the 10 to 20-year impact of the project in the North and the South of the country.

The road sector plays a critical role because 99% of goods produced in Senegal are transported by road. Because the selected road segments of RN 2 and RN 6 have a commercially and politically central geographic location, and also because of their poor initial state, their rehabilitation should have a detectable positive effect on local populations (column 3, 4 and 6.) Implementers rehabilitate the road segments of RN2 and RN6 under the supervision of MCC and MCA (*Activities*). The byproduct of the activities performed is the rehabilitated roads: 120 km and 256 km of RN2 and RN6 road segments, respectively (*Outputs*). Note that unexpected delays in the implementation have occurred because of environmental factors, such as extreme weather and civil unrest. There may also be other factors that affect the Road Rehabilitation Project. For example, there could be cost overruns that reduce the length of roads that end up being rehabilitated (*Outputs*), thus affecting fewer beneficiaries than planned (*Outcomes*).

The last three columns of Exhibit 3 show the impact evaluation outcomes of the road rehabilitation project. Some outcomes may be realized immediately upon completion of the project, while others may take longer to materialize. Once the RRP implementation is complete, it is expected that the time and cost required to travel to a certain destination via the rehabilitated roads will be reduced. The targeted road segments are also likely to be used more frequently due to improvements in quality. These outcomes are expected to be realized shortly after the completion of the roads (*Short-Term Outcomes*).

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<sup>5</sup>Benus, J. et al. (2012): *Evaluation Design Report: Impact of the Roads Senegal Project Senegal*, IMPAQ International report submitted to MCC in March 2012.

The completion of the road rehabilitation is also expected to unlock economic and social opportunities for households and individuals using the road (*Medium/Long-term Outcomes*). For example, the project may improve market access to buy and sell products. It may also be easier and cheaper to find inputs needed for production activities for both formal enterprises and informal household economic activities. Due to the reduced time and cost of travel on the rehabilitated roads, households may enjoy easier access to basic facilities such as schools and health centers. Furthermore, there may be more employment opportunities due to increased demand in markets accessible via the improved roads. Lastly, the value of land and assets along the rehabilitated roads is expected to rise as demand for the road use rises.

**Exhibit 3: Roads Rehabilitation Project Logic Model**

	Problem	Activity/ Sub-Activities	Outputs (Years 1-5) 2010 - 2015	Short-term Outcomes (Year 5) 2015	Medium/Long-term Outcomes (Years 6-10) 2016 – 2020	Impacts (Years 10-20)
Rehabilitation of the RN2	The Roads Rehabilitation Project is designed to increase beneficiary access to domestic and international markets through improved road quality and a reduction in travel times and costs. The road sector plays a critical role in Senegal. About 99% of goods produced in Senegal are transported by roads, and 95% of domestic travel is done by road.	- Rehabilitation of the RN2 - Construction of the Ndioum bridge	- Temporary employment - 120km of the RN2 rehabilitated - Construction of the Ndioum bridge and	- Improvement of road quality  - Increase in traffic on the RN2 and RN6	- Increased economic opportunities for households  - Increase in commercial flow and opportunities  - Increase in business income	- 250,000 project beneficiaries  - Increased income/ consumption of beneficiaries
		- Social and Environmental Mitigation - Social and Gender Integration	-Implementation of the RAP -Implementation of social and gender aspects	-Reduction in travel times  -Reduction in travel costs  -Better accessibility to basic social services		
Rehabilitation of the RN6		-Rehabilitation of the RN6 -Construction of the Kolda bridge	- Creation of temporary employment linked to construction -256km of the RN6 rehabilitate	- Improved access to national and international markets		
		- Social and Environmental Mitigation - Social and Gender Integration	-Implementation of the RAP -Implementation of social and gender aspects			

Long-term outcomes include higher earnings and enterprise revenues, increased economic opportunities, and better levels of human capital and health status. If sustained over time, these outcomes can serve as long-term engines for economic growth and poverty reduction. Based on the logic model, some of the research questions regarding expected outcomes of the project can be summarized as follows:

**Research Question 1:** *Did the RRP reduce the travel time and costs to households/enterprises located near the rehabilitated roads?*

To address this question we will use data collected from households and enterprises focusing on the travel time and costs to reach primary services, markets, schools and health centers.

These are the short-term outcomes of rehabilitation activities expected as a direct result of improved road conditions.

**Research Question 2:** *Did the RRP lead to increased opportunities for employment and income among beneficiary households?*

In this question, we investigate whether the availability of roads upgraded to functional standards unlocks economic opportunities for households and enterprises near the rehabilitated roads. We will use employment and income information from the household survey data to determine if the road improvements led to greater employment and income.

**Research Question 3:** *Did the RRP lead to increased access to health and education services?*

Aside from the direct economic impacts in terms of income and employment, other *social* opportunities can be unlocked through the project. For example, improved road conditions may make it easier for children to go to school. This could translate into higher educational attainment. Information about access to education and other services will be collected for each household member and will be used to evaluate this issue.

**Research Question 4:** *Did the project affect business opportunities and enterprise revenues?*

The economic activity of enterprises can be directly affected by improved roads as a result of better access to markets in which to sell their products. Also, enterprises will be able to obtain raw materials and inputs at better prices and reduce their transportation costs. These effects will be investigated using specific questions from the enterprise survey.

**Research Question 5:** *What is the ex-post Economic Rate of Return (ERR) of the RRP?*

An important component in the decision of project investments is to investigate whether the project is warranted based on a cost-benefit analysis. The results obtained from the impact evaluation allow us to better measure the benefits (accrued to households and enterprises) of the road rehabilitation project. Together with estimates of the costs of the interventions (provided by MCA-S), we will use the impact evaluation results to update the ex-post ERR. This will allow us to compare the ex-post ERRs with the ex-ante ERRs originally used for the Compact investment decisions.

**Research Question 6:** *How are the benefits of the projects distributed among subgroups of the population such as gender, age and income?*

In answering this question, we will investigate whether the benefits of the project accrue differently to different subgroups. Specifically, we will disaggregate results by gender and socioeconomic status. For example, we will investigate whether road rehabilitation impacts employment opportunities differently for males and females, or whether it affects the probability of going to school differently for boys and girls.

**Research Question 7:** *How do the long-term impacts of the RRP compare to other typical infrastructure investments, per dollar invested?*

To answer this question, we will compare the effects per dollar invested in the RRP with comparable effects of other infrastructure investments. Specifically, we will conduct an in-depth literature review of similar infrastructure investment projects in other developing countries. Once we have gathered the data regarding outcomes, we will build a simulation model that can use these outcomes as inputs to forecast different possible scenarios of long-term benefits to be accrued by the RRP.

## **2.2 Impact Evaluation Design**

Impact evaluation focuses on answering the quantitative question of how the program affected beneficiaries. In theory, to be able to correctly account for this we would like to be able to record the outcome of interest for each individual in two situations: when they receive the intervention and when they do not receive the intervention. Unfortunately, as with all interventions, at a given point in time we can only observe the beneficiaries of the program under the scenario in which they receive the intervention. Thus, evaluations can only rely on the observation of individuals who do not benefit from the program to measure the outcome of interest in the absence of the program. A comparison of the outcomes of beneficiaries and non-beneficiaries provides an estimate of the average impact of the program.

However, this simple comparison presents a potential complication if beneficiaries and non-beneficiaries have different characteristics related to the outcome of interest. This problem is referred to as selection bias. A straightforward way to address the problem of selection bias is through an experimental design in which road segments are randomly assigned to either a treatment group (i.e., selected for rehabilitation) or to a control group (i.e., selected not to be rehabilitated). Such a design is rarely used in road evaluations because the selection of segments to be rehabilitated is typically based on a variety of factors, including the economic rate of return, political factors, social factors and environmental factors.

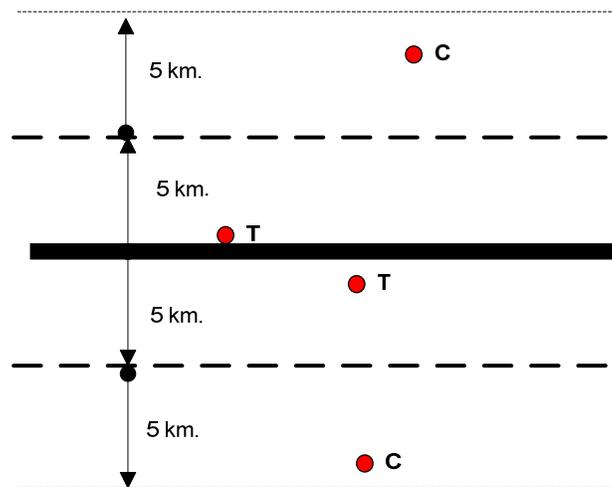
Although a random assignment design is considered the most rigorous evaluation approach, randomly selecting which roads would be rehabilitated was deemed infeasible. In a quasi-experimental approach, program impacts are estimated by comparing treatment group outcomes with outcomes from a comparison group chosen to be as similar as possible to the program group on all characteristics that might affect the outcomes and the program participation. For the impact evaluation design of the RRP we proposed to use a quasi-experimental design that is often used to assess rural infrastructure projects, i.e. difference-in-differences (DID).

The DID approach essentially compares the pre- and post-intervention change in outcomes in the treatment group to the pre- and post-intervention change in outcomes in the comparison group. In a roads rehabilitation project, households and enterprises located near the rehabilitated road

are typically considered the treatment group members since they are most likely to be affected by the road improvements. The treatment group is, therefore, often selected from among all households and enterprises located within a set distance from the rehabilitated road. For example, one proposed approach is to select a sample of individuals and enterprises located within 5 km of the rehabilitated road as the treatment group. An alternative approach may be to use the households living within a specific walking time to the road (e.g., 30 minutes).

The appropriate selection of the treatment group is only part of the challenge. We must also identify the counterfactual through a careful selection of comparison group members. One suggested approach is to identify a comparison group that is located farther from the rehabilitated roads than the treatment group (between 5 and 10 km). This is illustrated in Exhibit 4.

**Exhibit 4: Illustration of Selection of Treatment and Comparison Areas**

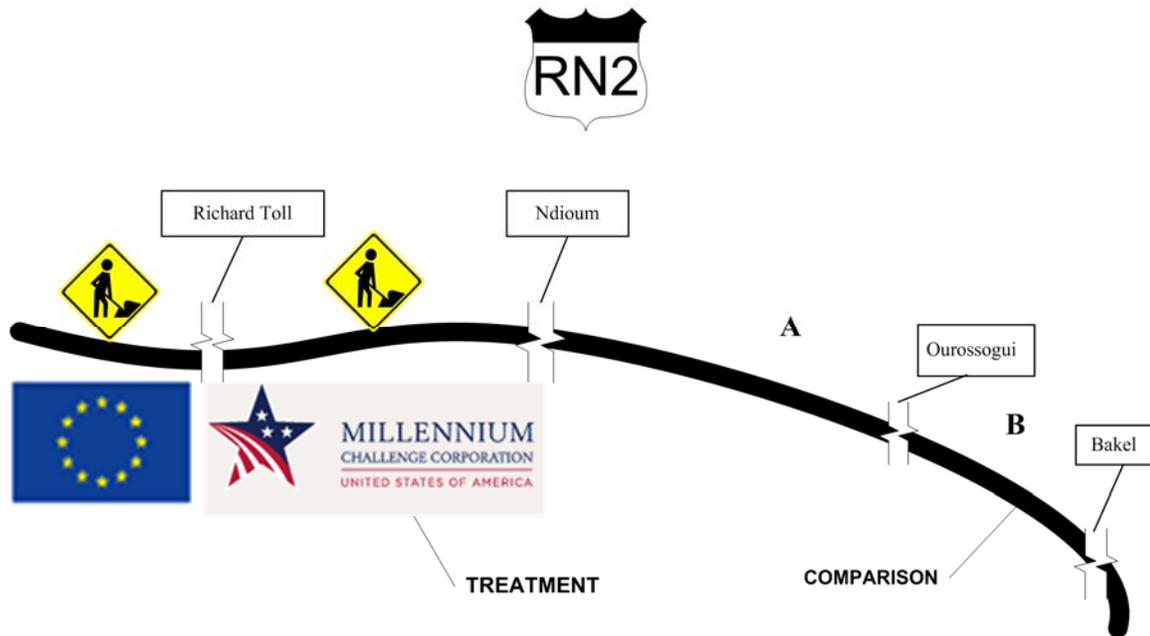


The rationale for this design is that units (households and enterprises) in the vicinity of the road are likely to be affected by the road (Ts), while those that are farther away may not be affected (Cs). This design assumes that the comparison group units (i.e., units farther from the road) are similar to those located near the road. This assumption, however, is problematic since those units that chose to locate farther from the road may not need the benefits that an improved road may provide. As a result, selecting Ts and Cs based on distance (or access) from the road may not be appropriate since the two groups differ in terms of important characteristics. A better design would be one in which both the Ts and the Cs are near a national road that, at baseline, has similar characteristics (level of degradation, economic conditions, etc.). In the current study, the Ts would be households and enterprises that are near a rehabilitated road, while the Cs would be near a similar road not scheduled for rehabilitation in the near future. This design is illustrated in Exhibit 5.

As indicated in Exhibit 5, the European Union (EU) is rehabilitating the westernmost segment of RN2. The next segment of the road (120 km) is being rehabilitated with MCC funding. This area represents the treatment area in which the program group will be selected. One option is to select the adjacent segment of RN2 (segment A) as the comparison area. This design, however, may be problematic since the rehabilitation of the treatment area is likely to affect outcomes in the comparison area. A better design would be to select segment B as the comparison area. Segment B is described by government experts and stakeholders as similar in many respects to the MCC rehabilitated area. It is also far enough away that it is not likely to be influenced by rehabilitation activities in the RN2 treatment area.

Based on extensive discussions with infrastructure experts and local stakeholders, a consensus agrees that the easternmost segment of RN2 is similar to the treatment segment. Stakeholders agree that the level of road degradation of this segment and the economic activity and population along this road are similar to those of treatment roads. As a result of these similarities and in further discussion with MCC, MCA-S, and local stakeholders, we reached a consensus to use the road segments from Orossogui to Bakel as our comparison road to identify the counterfactual.

**Exhibit 5: Treatment and Comparison Areas for RN2**



We use a similar design to evaluate the impact of the rehabilitation for RN6. As indicated in Exhibit 6, RN6 is located in the southern part of the country where conditions differ significantly from those in the North. RN6 provides a link between the largest villages of the Casamance region and the rest of Senegal (Casamance is separated from the rest of Senegal by the Gambia). The MCC's RRP area runs from Ziguinchor to Kounkané.

Identifying a comparison road segment for RN6 is difficult due to the substantial variation in the level of degradation of different segments of RN6. One possibility discussed with stakeholders is to use the same comparison area for the rehabilitated RN2 segment as the comparison area for RN6. However, the consensus of stakeholders is that conditions along RN6 are sufficiently different from those along RN2 so that the comparison area selected for RN2 may not be appropriate to serve as a comparison area for the RN6 rehabilitation area.

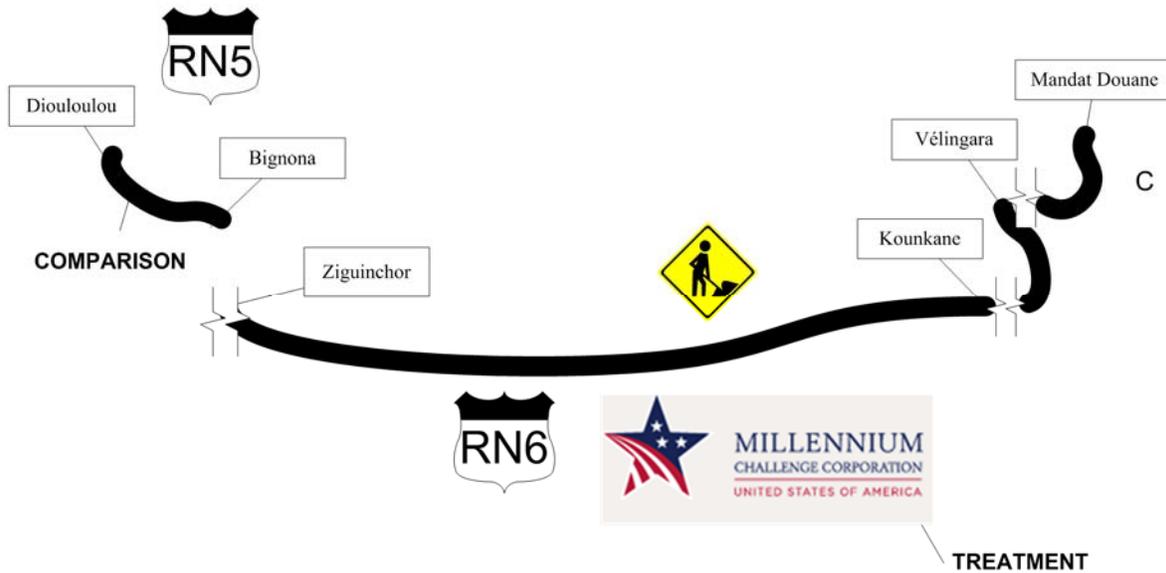
We also considered using the area near Tambacounda, east of Kounkané (Exhibit 6 Segment C), as a comparison group. However, this possibility was eventually discarded since rehabilitation of this segment is likely in the near future. After reviewing several potential comparison areas, MCC, MCA-S, and IMPAQ agreed that the most appropriate comparison road segment is not on RN6, but rather on RN5 (the Diouloulou-Bignona segment).

Following careful review of the alternative quasi-experimental evaluation approaches, we propose to use the difference-in-differences (DID) methodology to measure program impacts of the RRP. We will also consider combining the DID method with propensity score matching (DID-PSM). In the DID-PSM approach, once the treatment group is identified and selected, each treatment group member is matched with one or more units from a pool of households/enterprises that did not receive the treatment. This matching process creates a comparison group that is similar to the treatment group in many observable characteristics. The effect of the program is then measured by the difference in outcomes before and after the program intervention for the treatment group and the matched comparison group. The value added from DID-PSM is contingent on the assessment of the baseline characteristics of the treatment and control group samples. If the baseline characteristics are similar and few differences exist between the treatment and control samples, we will use DID alone. If there are significant differences between the two samples on a number of baseline characteristics, we will combine DID with PSM.<sup>6</sup>

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<sup>6</sup> DID-PSM estimators cannot guarantee, however, that the selection bias mentioned earlier will be completely addressed. Furthermore, for PSM to reduce bias, the data must include a rich set of variables related to program participation (Smith and Todd, 2005).

**Exhibit 6: Treatment and Comparison Areas for RN6**



### 2.3 Sampling

We use statistical power analysis to calculate the minimum sample size required to detect an effect of a given size. Identifying an appropriate sample size for our impact evaluation depends on various factors and assumptions, including a desired effect size, target power and significance level.<sup>7</sup> For the desired effect size, we used information on the magnitude of benefits from the Beneficiary Analysis provided by MCC. The power of a statistical test is the probability of detecting a true effect when it truly exists. The significance level is the probability of falsely detecting an effect when it does not exist.<sup>8</sup> We calculate the minimum sample sizes required to detect an effect of a given size for each of the combinations of the most commonly used power and significance levels. Using the present value of benefit stream as a share of annual income of about 10% and the per capita GNI of USD 820 in the ERR spreadsheet from MCC, we estimate that approximately \$20 ( $\approx 820 \times 0.1 \div 4$ ) of benefits are expected to be generated from the RRP per household for the first 5 years. Using the assumption that standard deviation is about 20% of the per capita GNI, we estimated the following sample sizes are required to identify the expected benefit.<sup>9</sup>

<sup>7</sup> The effect size for the difference-in-differences analysis can be defined as the mean difference between the differences of an outcome in a treatment group from baseline to follow-up time point and the differences of an outcome in a control group for the same period. By dividing the effect size by the combined standard deviation from both groups, we obtain the standardized effect size to be used for the power analysis.

<sup>8</sup> The most commonly used significance levels are 5%, 1% and 0.1%.

<sup>9</sup> See Evaluation Design Report for details.

### Exhibit 7: Sample Size Requirement

	Power		
	80%	90%	95%
<b>Significance Level = 0.1%</b>			
<b>Sample Size</b>	2668	3267	3806
<b>Significance Level = 1%</b>			
<b>Sample Size</b>	1825	2325	2784
<b>Significance Level = 5%</b>			
<b>Sample Size</b>	1227	1642	2031

As indicated in Exhibit 7, using the least restrictive criteria for the power and test size (80% power and a 5% significance level), we would need at least 1,227 households in each of the treatment and comparison groups. Thus, the minimum total household sample size is 4,908 (=1,227\*4). As mentioned, this is the minimum required sample size for the least restrictive assumption for power and test size. For more robust results, we would need larger sample sizes. However, given the trade-off between the statistical rigor and the budgetary constraints faced by MCA-S, we have selected the smallest sample size consistent with a rigorous impact evaluation.

In discussion with MCC and MCA-S, we concluded not to use the power analysis regarding the sample-size requirement for the enterprise survey, due to lack of information about the number of enterprises along the treatment and comparison roads. Instead, we relied on the input of MCA-S staffers knowledgeable in business conditions for enterprises along RN2 and RN6. We then proposed a survey sample of approximately 600 enterprises.

## 2.4 Baseline Data Collection

The implementation of the evaluation design described in the previous sections requires data on key outcomes of interest for both households and enterprises. These data should be collected from the sample of treatment and comparison group households/enterprises at baseline (i.e., prior to the road rehabilitation) and again in the follow-up period. For this purpose, MCA-S contracted ANSD (*Agence Nationale de la Statistique et de la Démographie*) to administer all baseline surveys. ANSD developed the survey instruments, with inputs from MCC, MCA-S and IMPAQ.

Baseline data were collected using in-person interviews from households and enterprises located along the treatment and comparison areas. The baseline survey collected data on background characteristics and key outcomes of interest (income, use of the roads, and various economic activities) for both households and enterprises. The survey instrument recording household data was structured in several sections that collected the following information:<sup>10</sup>

- Demographic characteristics of household members
- Employment and revenues of household members
- Household food and non-food consumption (whether a household has consumed certain types of food and the frequency of purchase)
- Salary and non-agricultural income of household members
- Household assets (e.g., type of home, access to electricity, etc.)
- Household members' use of the road, including frequency of use, and time and distance traveled to various destinations such as local market, communal market, school, health infrastructure, and workplace
- Agricultural/Livestock production and commercialization: amount of production realized and sold by crop

A separate questionnaire was developed to gather information on enterprises. This data collection effort is essential to gain a full picture of the impact of the RRP. The survey collected detailed information on the type of enterprise activities, the quantity of goods produced and sold, the costs related to the commercialization of goods and the purchase of raw materials, the size of the enterprises in terms of employees and capital equipment, revenues, and use of the road in the same areas in which the heads of households were interviewed. In particular, the survey instrument to collect enterprise data was structured in several sections that collected the following information:

- Information on the entrepreneur
- Characteristics of the enterprise: e.g., primary activity, workers employed, mobile equipment and machinery (tractors, etc.)
- Production and commercialization: e.g., the amount of sales from products and services, destination of products and services, use of the road to deliver the products/services, distance traveled on the road
- Difficulties encountered in the entrepreneurial activity, including whether the enterprise has difficulties obtaining credit, recruiting personnel and difficulties related to the access of the road.

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<sup>10</sup> A detailed list of all datasets corresponding to the various sections of the questionnaires is provided in Appendix A.

To supplement data on households and enterprises, ANSD also fielded a survey on the communities in the treatment and comparison areas in which the households and enterprises are located. The community questionnaire was administered to some representative members of the village (heads of the village, religious representatives, entrepreneurs and teachers), and includes the following sections:

- Identification of the respondents for the community survey
- Population characteristics of the village (number of men and women, main ethnic groups, etc.)
- Village infrastructures (schools, hospitals and police stations)
- Assessment of poverty at the village level
- Community projects in the previous three years
- Agricultural and livestock activities
- Environmental and other shocks in the village (extensive deforestation, excessive rains, etc.)
- Land conflicts
- Prices of agricultural products

The MCA-S data collection contractor ANSD collected baseline data from households and enterprises along the RN2 rehabilitation area (i.e., the road segment between Richard Toll and Ndioum), the comparison road segment for RN2 (i.e., the road segment between Orossoguoi and Bakel), the RN6 intervention area (RN6 from Ziguinchor to Kounkané) and the RN6 comparison area (RN5 from Diouloulou-Bignona). The timing of these data collection activities was as follows:

- Data collection in the North (RN2 treatment and comparison segment) took place in May and June 2012.
- Data collection in the South (RN6 treatment and comparison road segments) took place in October and November 2012.

Exhibit 8 presents the number of households and enterprises for which data was collected:

**Exhibit 8: Distribution of Sample Sizes by Intervention and by Treatment Status**

	Household Sample Size	Enterprise Sample Size	Community Sample Size	Data Collection Period
<b>North</b>	1,248 T + 1,204 C	486 T + 565 C	44 T + 31 C	May–June 2012
	Total = 2,452	Total = 1,051	Total=75	
<b>South</b>	1,235 T + 1,228 C	512 T + 214 C	70T + 31 C	October–November 2012
	Total = 2,463	Total = 726	Total=101	

Source: RN2\_v8 data and RN6\_v7 data

Since there was no sampling frame that could provide information on the number of enterprises along the roads when the statistical power analysis was completed, a sample size of 600 enterprises was selected (as discussed in section 2.3). However, at the time of data collection, more enterprises were identified in the field than originally assumed and were thus included in the sample. We completed interviews with 1,051 enterprises in the treatment areas and 726 in the comparison areas.

Exhibits 9, 10, 11 and 12 provide a detailed graphic representation of the area around the roads in which the household, enterprise and village surveys were conducted. The maps depict the 5 km area around the road (in green) and the villages that were part of the sample (in purple). The households and enterprises that were interviewed are located within the green-shaded areas.<sup>11</sup>

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<sup>11</sup> Maps were created by ANSD.

### Exhibit 9: RN2 Treatment Area

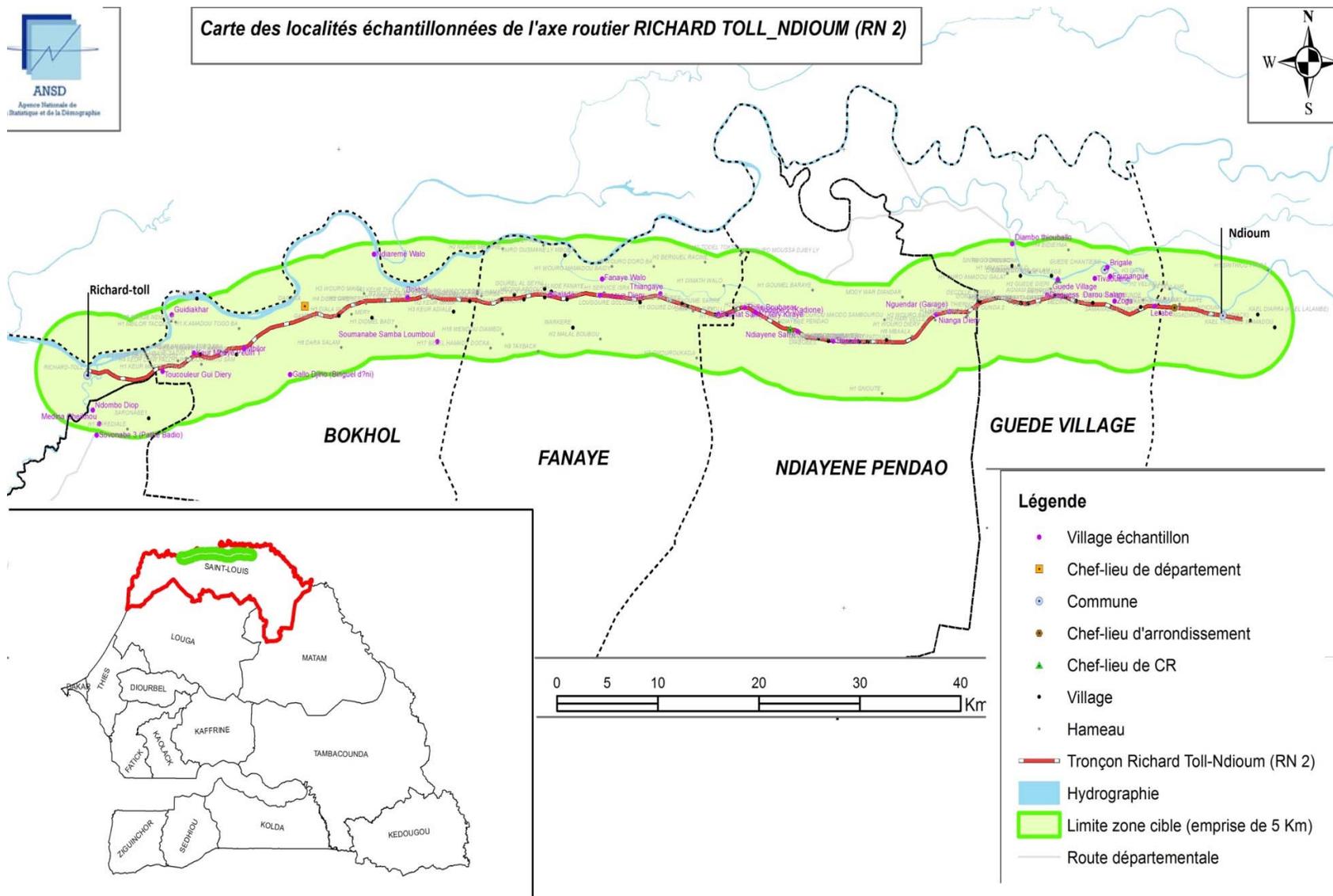
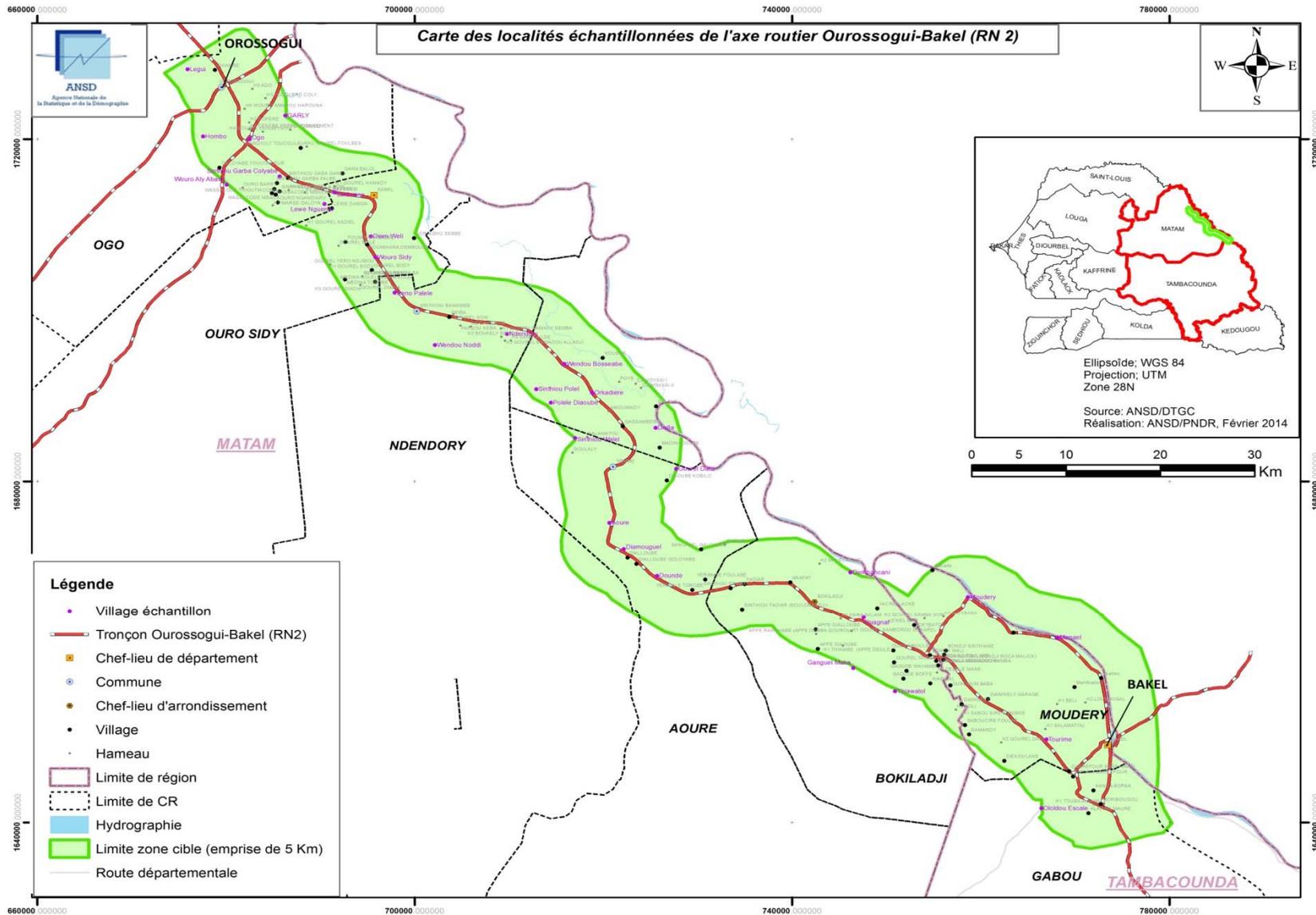


Exhibit 10: RN2 Comparison Area



### Exhibit 11: RN6 Treatment Area

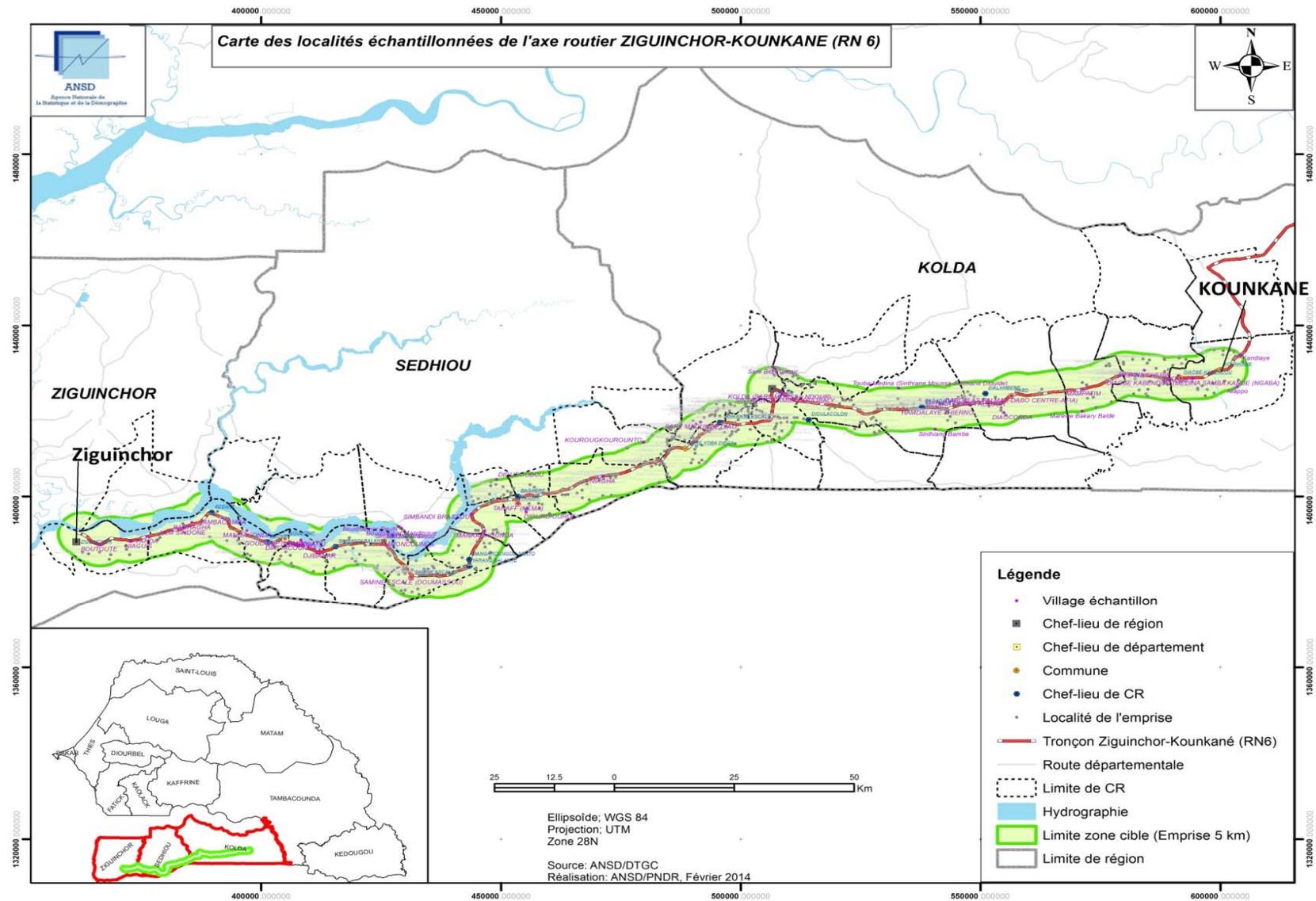
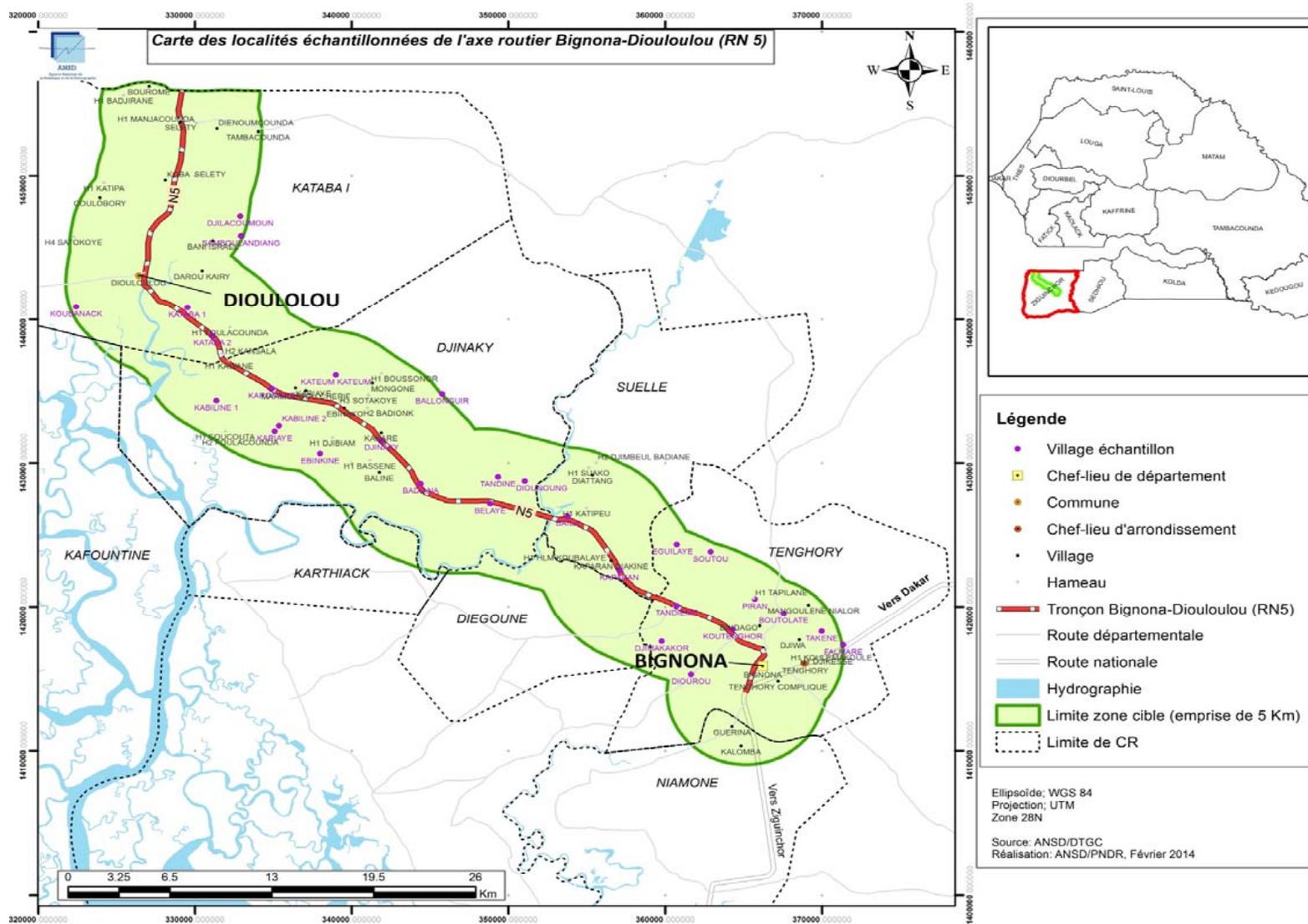


Exhibit 12: RN6 Comparison Area (RN5)



### 3. HOUSEHOLD CHARACTERISTICS AT BASELINE

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#### 3.1 Demographics of Households

In this chapter, we review the demographics of the households included in the RN2 and RN6 sample. Exhibits 13 and 14 describe the size and structure of the households in our sample. On average, the sample households have approximately ten members. This result is consistent with the average rural household size found in the General Census of Population and Housing (2013).<sup>12</sup> The overwhelming majority of families include at least one child younger than age 18. Overall, the structure of the households is quite similar in the two samples.

**Exhibit 13: RN2 Household Characteristics**

Characteristics	Percentage of Households
<i>Household Size</i>	
5 or fewer	18.2%
6	9.1%
7	9.3%
8	9.5%
9	8.2%
10 or more	45.7%
<i>Number of Children Under 18</i>	
0	4.4%
1	6.6%
2	10.0%
3	13.0%
4	13.7%
5 or more	52.0%
Sample size	2,452

Source: RN2\_v8 data

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<sup>12</sup> ANSD (2014), Recensement Général de la Population et de l'Habitat, de l'Agriculture et de l'Élevage (RGPHAE) 2013.

**Exhibit 14: RN6 Household Characteristics**

<b>Characteristics</b>	<b>Percentage of Households</b>
<b><i>Household Size</i></b>	
5 or fewer	18.6%
6	8.2%
7	9.4%
8	9.2%
9	9.3%
10 or more	45.3%
<b><i>Number of Children Under 18</i></b>	
0	6.3%
1	6.1%
2	9.4%
3	12.4%
4	13.8%
5 or more	52.0%
<b>Sample size</b>	<b>2,463</b>

Source: RN6\_v7 data

Exhibits 15 and 16 present a detailed summary of the heads of household in the RN2 and RN6 samples. As shown in the exhibits, 23% and 30% of the household heads were age 60 or above, and the average age of household heads was 52.2 in the RN2 sample and 50.2 in the RN6 sample. The RN2 sample contains more female-headed households (24%) compared to the RN6 sample (13%). A substantial proportion of household heads in both samples (83.8% in the RN2 sample and 65.7% in the RN6 sample) received no formal education. It is worth noting that the educational attainment in the RN6 sample is higher than in the RN2 sample. Specifically, approximately 45% in the RN6 sample have at least a primary education, compared to only 25% in the RN2. Exhibits 15 and 16 also provide information on marital status of the heads of household. The most distinctive pattern of Senegalese marriage is polygamy, which is confirmed in our data. At least 30% of the respondents in the two samples have multiple spouses.

**Exhibit 15: RN2 Household Head and All Members' Characteristics**

<b>Characteristics</b>	<b>Household Head</b>	<b>All Household Members</b>
<i>Gender</i>		
Female	23.5	54.8%
<i>Age</i>		
Under 30	5.1%	67.9%
30–39	16.8%	10.8%
40–49	20.9%	7.5%
50–59	22.8%	5.7%
60 and Older	30.0%	6.2%
Average	52.2	24.1
<i>Formal Education completed by adults (16 and up)</i>		
None	83.8%	75.2%
Primary	11.3%	14.7%
Junior High	2.6%	8.0%
High school or above	2.4%	2.1%
<i>Family Type of Household Head</i>		
Single	11.3%	
Single spouse	56.3%	
Multiple spouses	31.6%	
<b>Sample size</b>	<b>2,452</b>	<b>22,161</b>

**Exhibit 16: RN6 Household Head and All Members' Characteristics**

<b>Characteristics</b>	<b>Household Head</b>	<b>All Household Members</b>
<i><b>Gender</b></i>		
Female	13.0%	50.9%
<i><b>Age</b></i>		
Under 30	5.0%	70.5%
30–39	18.4%	10.4%
40–49	25.9%	7.8%
50–59	21.8%	5.1%
60 and Older	23.0%	4.8%
Average	50.2	23.0
<i><b>Formal Education Completed by adults (16 and up)</b></i>		
None	65.7%	55.3%
Primary	20.4%	19.8%
Junior High	7.2%	17.4%
High school or above	6.7%	7.4%
<i><b>Family Type of Household Head</b></i>		
Single	11.4%	
Single spouse	55.6%	
Multiple spouses	32.7%	
<b>Sample size</b>	<b>2,463</b>	<b>22,101</b>

Source: RN6\_v7 data

### **3.2 Non-Agricultural Employment and Income**

This section summarizes non-agricultural employment and incomes for the households in the RN2 and RN6 samples. Exhibits 17 and 18 describe non-agricultural paid work and incomes during the last 30 days. In addition, the exhibits identify the non-farm income sources of the sample during the last 30 days (for respondents age 10 and above). The overall pattern of income is that respondents in the RN2 sample have a higher income than those in the RN6 sample.

As illustrated in Exhibits 17 and 18, a very small fraction of individuals in the RN2 and RN6 samples participated in non-farm employment during 30 days before the survey date. Only about 5% of respondents had non-farm employment in either sample, and the average income is similar (about 57,000 FCFA) but the median for non-farm paid work is higher in RN2 (40,000 FCFA) than in RN6 (25,000 FCFA).

As is often the case in a developing country context, the largest source of (paid) work outside of the household for the RN2 sample is the informal sector (29%). However, this category places second (18%) in the RN6, behind public work (20%). Respondents who worked in the public sector had a higher average income for this work than those in the formal and informal private sectors. Possible reasons could be that once employed in the public sector, one's job is more regular and more likely to be full-time, or that those who get public sector jobs might be more qualified. Also note that the distribution of the public sector income data is much tighter, with means and medians closer to each other and the standard deviation smaller than in other income data. This seems to point to recall and computation issues in the rest of the income data: It is easier to report the amount of one's monthly salary from the public sector than it is to give a figure for other, irregular, incomes.

Many of the households (9%) also report some non-farm business income. The average income from this source was higher in the RN2 sample, about 60,000 FCFA, than in the RN6 sample where it was only 40,000 FCFA. Another interesting trend in the data is that respondents in the RN2 sample are more likely than those in RN6 to receive government transfers (6% vs. 2%) and those who do receive them get more (the median is 35,000 FCFA for RN2 and 10,000 FCFA less in RN6).

**Exhibit 17: RN2 Employment and Income of Household Members**

<b>Panel A: Paid work</b>	<b>Mean</b>	<b>Median</b>	<b>S.D.</b>
<b><i>Employment and Compensation in Last 30 Days (Respondents Age 10 and Above)</i></b>			
Any paid work outside of household	5.7%	-	-
Income from paid work outside of household (Conditional on employment) (FCFA) <sup>13</sup>	57,675	40,000	64,447
<b><i>Sources of Non-Agricultural Paid Work in Last 30 Days (Respondents Age 10 and Above)<sup>14</sup></i></b>			
Any public sector salaries	13.0%	-	-
Public sector salaries amount (FCFA)	117,596	110,000	81,586
Any formal private sector salaries	15.2%	-	-
Formal private sector salaries amount (FCFA)	82,135	64,500	119,415
Any informal sector salaries	29.3%	-	-
Informal sector salaries amount (FCFA)	46,036	30,000	84,009
<b>Sample size (paid work)</b>	<b>953</b>		

<b>Panel B: Other (non-farm) incomes</b>	<b>Mean</b>	<b>Median</b>	<b>S.D.</b>
Any non-farm business income	9.3%	-	-
Non-farm business income (FCFA)	60,853	28,000	208,688
Any rents, annuities, dividends or commissions	0.5%	-	-
Rents, annuities, dividends or commissions amount (FCFA)	63,090	35,000	90,892
Any transfers including pension, food aid, scholarships, social insurance and other government support	5.6%	-	-
Transfers including pension, food aid, scholarships, social insurance and other government support amount (FCFA)	66,721	35,000	115,880
Other assistance or gifts	5.8%	-	-
Assistance or gifts amount (FCFA)	31,106	15,000	78,742
<b>Sample size</b>	<b>22,161</b>		

Source: RN2\_v8 data

<sup>13</sup> Amounts in this table are conditional on receiving income in that category.

<sup>14</sup> Categories below may overlap

**Exhibit 18: RN6 Employment and Income of Household Members**

<b>Panel A: Paid work</b>	<b>Mean</b>	<b>Median</b>	<b>S.D.</b>
<b><i>Employment and Compensation in Last 30 Days (Respondents Age 10 and Above)</i></b>			
Any paid work outside of household	5.2%	-	-
Income from paid work outside of household (Conditional on employment) (FCFA) <sup>15</sup>	56,622	25,000	74,813
<b><i>Sources of Non-Agricultural Paid Work in Last 30 Days (Respondents Age 10 and Above)<sup>16</sup></i></b>			
Any public sector salaries	19.7%	-	-
Public sector salaries amount (FCFA)	141,344	150,000	81,532
Any formal private sector salaries	8.6%	-	-
Formal private sector salaries amount (FCFA)	147,074	50,000	460,395
Any Informal sector salaries	17.8%	-	-
Informal sector salaries amount (FCFA)	33,001	22,500	51,244
<b>Sample size (paid work)</b>	<b>800</b>		

<b>Panel B: Other (non-farm) incomes</b>	<b>Mean</b>	<b>Median</b>	<b>S.D.</b>
Any non-farm business income	9.1%	-	-
Non-farm business income (FCFA)	39,360	20,000	123,251
Any rents, annuities, dividends or commissions	0.2%	-	-
Rents, annuities, dividends or commissions amount (FCFA)	29,752	15,000	45,984
Any transfers including pension, food aid, scholarships, social insurance and other government support	1.6%	-	-
Transfers including pension, food aid, scholarships, social insurance and other government support amount (FCFA)	48,007	25,000	96,647
Other assistance or gifts	2.4%	-	-
Assistance or gifts amount (FCFA)	24,492	15,000	31,162
<b>Sample size</b>	<b>24,795</b>		

Source: RN6\_v7 data

<sup>15</sup> Amounts in this table are conditional on receiving income in that category.

<sup>16</sup> Categories below may overlap.

### 3.3 Agricultural Production and Market Access

The Roads Rehabilitation project aims to increase beneficiaries' access to domestic and international markets through improved roads. About 99% of goods produced in Senegal are transported by road and about 95% of domestic travel is done on roads. From the discussion of the RRP logic model, we would expect to see reduced barriers for agricultural commercialization due to increased RN2 and RN6 quality. Exhibits 19 and 20 present baseline information on household agricultural revenue, which is highly dependent on the economic opportunities facilitated by better transportation and road quality. In addition, the RRP household survey also solicited respondents' perceptions related to barriers for agricultural commercialization.

The two areas are quite different in terms of their agricultural production. Following with the patterns of the data, households in the RN2 area generate higher average and median incomes than those in the RN6 area. Yet most households (54%) in the RN6 sample receive some agricultural income whereas only 28% of them do in the RN2 area. Although average income from animal revenue is higher in the RN6 sample, it seems to be caused by outliers, as the standard deviation is high. Indeed, the median revenue for animal products, is more than twice smaller in the RN6 sample. We see the same large difference with the median crop revenue. Overall, the distribution of agricultural incomes has a much higher variance and a much smaller median for the RN6 sample than that in the RN2 sample.

Panel B in Exhibits 19 and 20 shows individual perceptions of difficulties in conducting business. The proportions in Panel B of the exhibits are percentages of people who said they had difficulty selling their production and who responded yes to a binary question about whether a given factor (as in poor roads) is a cause of this problem. These variables discriminate between causes pertaining to the equilibrium in the market (insufficient demand or low sales price) and conditions of access to the market. Low sales price is the reason that is cited most often for not selling their goods for both animal and crop products, within both the RN2 and the RN6 samples. However, roads are cited as a problem by a fourth of respondents having difficulty selling their production in the RN6 areas, whereas only a small fraction of respondents mention roads as a hurdle in the RN2 area.

**Exhibit 19: RN2 Agricultural Income and Market access**

<b>Panel A: Household farm income</b>	<b>Mean</b>	<b>Median</b>	<b>S.D.</b>
<i>Farm Production</i>			
Any crop revenue	27.9%	-	-
Crop revenue for the last season (FCFA)	367,848	200,000	456,995
Any animal revenue	21.6%	-	-
Animal revenue for the last season (FCFA)	278,899	120,000	524,246
Any agricultural revenue (crops + animal)	42.0%	-	-
Total revenue from agricultural production (FCFA)	387,242	201,950	544,286
<b>Sample size</b>	<b>2,452</b>		

<b>Panel B: Individual perceptions<sup>17</sup></b>		
<i>Barriers to Marketing</i>		
	Crops	Animal Products
Insufficient demand	12.1%	14.0%
Difficult access (poor roads, isolation, etc.)	4.8%	11.1%
Sale price too low	59.3%	50.4%
Other reason	23.8%	24.5%

Source: RN2\_v8 data

<sup>17</sup> Conditional on having difficulty selling crop or animal product.

## Exhibit 20: RN6 Agricultural Production and Commercialization

Panel A: Household farm income	Mean	Median	S.D.
<i>Farm Production</i>			
Any crop revenue	53.8%		-
Crop revenue for the last season (FCFA)	166,452	75,000	580,943
Any animal revenue	21.1%	-	-
Animal revenue for the last season (FCFA)	315,556	45,000	2,328,020
Any agricultural revenue (crops + animal)	57.9%	-	-
Total revenue from agricultural production (FCFA)	257,914	82,500	1,507,871
<b>Sample size</b>	<b>2233</b>		

Panel B: Individual perceptions <sup>18</sup>		
<i>Barriers for Marketing</i>		
	Crops	Animal Products
Insufficient demand	13.7%	13.0%
Difficult access (poor roads, isolation, etc.)	24.5%	12.9%
Sale price too low	54.2%	70.2%
Other reason	7.6%	3.9%

Source: RN6\_v7 data

### 3.4 Road Quality and Access to Various Facilities

Exhibits 21 and 22 describe the household heads' perceptions of the quality of roads for the RN2 and RN6 samples. The segments of the roads described in the exhibits depend on the location of the households.

- RN2 sample:
  - ▶ Households in the treatment area are associated with the road segment from Richard Toll to Ndium.
  - ▶ Households in the comparison area are associated with the road segment from Orossogui to Bakel.
- RN6 sample:
  - ▶ Households in the treatment area are associated with the road segment from Ziguinchor to Kounkané.
  - ▶ Households in the comparison area are associated with the road segment from Diouloulou to Bignona in the RN5.

<sup>18</sup> Conditional on having difficulty selling crop or animal product.

The majority of the household heads (79% in RN2 sample and 85% in the RN6 sample) in our samples perceived the road quality to be poor. Less than 10% of the household heads rated the quality as good. The quality-rating pattern is very similar for the RN2 and the RN6 samples. In the same section of the household questionnaire, the survey also asked about the time it takes to walk from home to the road. In both the RN2 and the RN6 samples, the walking time to the road averages around half an hour.

**Exhibit 21: RN2 Household Head’s Opinion on Road Quality**

<b>Description of Current Road Quality</b>	
<i>Road Condition</i>	
Very good	1.4%
Good	6.2%
Good enough	12.7%
Poor	79.4%
Impractical	0.3%
<i>Road Access</i>	
Road usable year-round	63.2%
Time to walk to road (minutes)	29.57
<b>Sample size</b>	<b>2,452</b>

Source: RN2\_v8 data

**Exhibit 22: RN6 Household Head’s Opinion on Road Quality**

<b>Description of Current Road Quality</b>	
<i>Road Condition</i>	
Very good condition	1.9%
Good condition	2.3%
Good enough condition	7.6%
Poor condition	85.0%
Impractical condition	3.2%
<i>Road Access</i>	
Road usable year-round	73.6%
Time to walk to road (minutes)	35.98
<b>Sample size</b>	<b>2,463</b>

Source: RN6\_v7 data

RN2 and RN6 sample households reported their modes of transportation to markets and public service facilities, along with their associated travel time and cost (see Exhibits 23 and 24). These include access to local weekly markets (loumas), communal/regional markets, and markets outside of Senegal (as in Gambia, which is relatively close to the RN 6). Respondents were also asked about access to health service facilities, schools, and where they work. For example, in order to reach the local market 38% of the individuals in the RN2 sample walked, about 22% of them used carts, and another 24% utilized public transportation. The average travel time to get to the local market was about 20 minutes, and the cost was 264 FCFA. Looking across road access

to all these facilities, public transportation is an important mode for most of them. The travel time and cost varies substantially depending on the type of facility.

**Exhibit 23: RN2 Road Access to Various Facilities**

Characteristics	Mean	S.D.	N
<b>Road Access to Local Weekly Market</b>			
Modes of transportation			
- Walk	38.0%	-	4801
- Bicycle/Tricycle	0.4%	-	4801
- Cart	22.4%	-	4801
- Small motorcycle (< 125 cm3)	0.3%	-	4801
- Large motorcycle	0.1%	-	4801
- Public transportation	24.0%	-	4801
- Passenger car	0.2%	-	4801
- Other	14.6%	-	4801
Travel time (minutes)	20.44	24.20	3928
Travel cost (FCFA)	264	852	3995
<b>Road Access to Communal Market</b>			
Modes of transportation			
- Walk	15.1%	-	2,739
- Bicycle/Tricycle	0.4%	-	2,739
- Cart	24.5%	-	2,739
- Small motorcycle (< 125 cm3)	1.0%	-	2,739
- Large motorcycle	0.2%	-	2,739
- Public transportation	31.2%	-	2,739
- Passenger car	0.4%	-	2,739
- Other	27.2%	-	2,739
Travel time (minutes)	29.77	35.43	1,805
Travel cost (FCFA)	522	2,397	1,832
<b>Road Access to Market Abroad</b>			
Modes of transportation			
- Walk	0.5%	-	177
- Bicycle/Tricycle	9.1%	-	177
- Cart	2.9%	-	177
- Small motorcycle (< 125 cm3)	0.4%	-	177
- Large motorcycle	0.0%	-	177
- Public transportation	52.9%	-	177
- Passenger car	0.0%	-	177
- Other	34.2%	-	177
Travel time (minutes)	98.45	80.37	98
Travel cost (FCFA)	2,919	7,194	128

Characteristics	Mean	S.D.	N
<b>Road Access to Health Facility</b>			
Modes of transportation			
- Walk	36.2%	-	1,229
- Bicycle/Tricycle	0.2%	-	1,229
- Cart	21.2%	-	1,229
- Small motorcycle (< 125 cm3)	0.1%	-	1,229
- Large motorcycle	0.0%	-	1,229
- Public transportation	39.7%	-	1,229
- Passenger car	0.7%	-	1,229
- Other	1.9%	-	1,229
Travel time (minutes)	23.96	28.08	1,206
Travel cost (FCFA)	262	649	1,202
<b>Road Access to School</b>			
Modes of transportation			
- Walk	55.9%	-	254
- Bicycle/Tricycle	2.9%	-	254
- Cart	2.5%	-	254
- Small motorcycle (< 125 cm3)	0.7%	-	254
- Large motorcycle	0.0%	-	254
- Public transportation	34.9%	-	254
- Passenger car	1.1%	-	254
- Other	2.0%	-	254
Travel time (minutes)	24.30	24.14	259
Travel cost (FCFA)	235	819	246
<b>Road Access to Workplace</b>			
Modes of transportation			
- Walk	20.5%	-	548
- Bicycle/Tricycle	2.3%	-	548
- Cart	18.8%	-	548
- Small motorcycle (< 125 cm3)	1.8%	-	548
- Large motorcycle	1.5%	-	548
- Public transportation	43.3%	-	548
- Passenger car	4.6%	-	548
- Other	7.2%	-	548
Travel time (minutes)	40.15	58.26	536
Travel cost (FCFA)	612	2,128	520
<b>Sample size</b>	<b>16,279</b>		

Source: RN2\_v8 data

**Exhibit 24: RN6 Road Access to Various Facilities**

<b>Characteristics</b>	<b>Mean</b>	<b>S.D.</b>	<b>N</b>
<b>Road Access to Local Weekly Market</b>			
Modes of transportation			
- Walk	56.3%	-	1,411
- Bicycle/Tricycle	15.1%	-	1,411
- Cart	4.8%	-	1,411
- Small motorcycle (< 125 cm3)	3.1%	-	1,411
- Large motorcycle	0.7%	-	1,411
- Public transportation	19.4%	-	1,411
- Passenger car	0.2%	-	1,411
- Other	0.4%	-	1,411
Travel time (minutes)	34.54	35.11	1,403
Travel cost (FCFA)	137	481	1,282
<b>Road Access to Communal Market</b>			
Modes of transportation			
- Walk	50.0%	-	1,775
- Bicycle/Tricycle	13.0%	-	1,775
- Cart	5.3%	-	1,775
- Small motorcycle (< 125 cm3)	5.4%	-	1,775
- Large motorcycle	0.7%	-	1,775
- Public transportation	25.0%	-	1,775
- Passenger car	0.3%	-	1,775
- Other	0.3%	-	1,775
Travel time (minutes)	35.12	32.71	1,759
Travel cost (FCFA)	170	381	1,668
<b>Road Access to Market Abroad</b>			
Modes of transportation			
- Walk	10.0%	-	169
- Bicycle/Tricycle	41.5%	-	169
- Cart	3.9%	-	169
- Small motorcycle (< 125 cm3)	4.8%	-	169
- Large motorcycle	1.1%	-	169
- Public transportation	38.7%	-	169
- Passenger car	0.0%	-	169
- Other	0.0%	-	169
Travel time (minutes)	114.01	75.57	172
Travel cost (FCFA)	934	1,741	162

Characteristics	Mean	S.D.	N
<b>Road Access to Health Facility</b>			
Modes of transportation			
- Walk	60.5%	-	6,026
- Bicycle/Tricycle	12.3%	-	6,026
- Cart	2.0%	-	6,026
- Small motorcycle (< 125 cm3)	3.4%	-	6,026
- Large motorcycle	0.3%	-	6,026
- Public transportation	21.2%	-	6,026
- Passenger car	0.1%	-	6,026
- Other	0.2%	-	6,026
Travel time (minutes)	16.57	19.51	6,020
Travel cost (FCFA)	74	168	5,362
<b>Road Access to School</b>			
Modes of transportation			
- Walk	88.7%	-	2,183
- Bicycle/Tricycle	6.1%	-	2,183
- Cart	0.1%	-	2,183
- Small motorcycle (< 125 cm3)	0.5%	-	2,183
- Large motorcycle	0.0%	-	2,183
- Public transportation	4.5%	-	2,183
- Passenger car	0.1%	-	2,183
- Other	0.0%	-	2,183
Travel time (minutes)	24.27	34.77	2,178
Travel cost (FCFA)	20	201	1,988
<b>Road Access to Workplace</b>			
Modes of transportation			
- Walk	62.8%	-	984
- Bicycle/Tricycle	10.2%	-	984
- Cart	2.7%	-	984
- Small motorcycle (< 125 cm3)	7.3%	-	984
- Large motorcycle	1.0%	-	984
- Public transportation	14.6%	-	984
- Passenger car	1.1%	-	984
- Other	0.3%	-	984
Travel time (minutes)	37.15	44.96	976
Travel cost (FCFA)	197	746	858
<b>Sample size</b>	<b>16,509</b>		

Source: RN6\_v7 data

## 4. ENTERPRISE CHARACTERISTICS AT BASELINE

In this chapter we describe the characteristics of 1,051/726 enterprises in the treatment and comparison areas of RN2 and RN6. Exhibits 25 and 26 present the key characteristics of each sample: type of enterprise, attributes of the owner, production, transportation and difficulties in conducting business.

Very few enterprises fall into one of the traditional categories of business legal form. The business owners in our sample are, on average, 35 to 44 years old and only 10 to 13% female. A majority of the enterprise owners were in a monogamous marriage while about 20–30% in both samples were living in a polygamous relationship. Business owners had, on average, a similar schooling level compared to the general population, as described in section 3.1. For example, in the RN6 sample, less than 50% of the business owners had no formal education. But only 20% of them had education higher than primary level.

As evident in the panel titled Production and Transportation, the majority of the businesses (49% in the RN2 sample and 63% in the RN6 sample) used national roads for their transportation needs, highlighting the importance of rehabilitating RN2 and RN6 for surrounding enterprises. As a key outcome measure of RRP for enterprises, the survey also contains information on the total amount of sales. For the RN2 sample, the average total service sales for the last 30 days is a little over FCFA 1,000,000, and for the RN6 sample, the average total service sales is about FCFA 480,000.

Business owners also reported the difficulties they had in conducting business in their region. Road quality is their top concern among all the noted difficulties. In the RN2 sample, 68% of the enterprise owners listed road quality as an important barrier to conducting business. In the RN6 sample, the percentage is even higher at 87%.

**Exhibit 25: RN2 Enterprise Characteristics**

Characteristics	Mean	S.D.
<i>Enterprise Legal Form</i>		
Public company (SPP)	0.0%	-
Public limited company (SA)	1.3%	-
Limited liability company (SARL)	0.3%	-
Limited partnership (SCS)	0.1%	-
General partnership (SNC)	0.1%	-
One-man limited liability company (SURL)	0.4%	-
Anonymous company (SUA)	0.3%	-
Economic interest grouping (GIE)	1.0%	-
Other	96.5%	-

Characteristics	Mean	S.D.
<b>Entrepreneur Characteristics</b>		
Age	36.93	12.40
Female	10.9%	-
Marital status		
- Polygamous	19.8%	-
- Monogamous	54.6%	-
- Single	24.1%	-
- Widowed	0.6%	-
- Divorced	0.9%	-
Completed Formal Education		
- None	66.1%	-
- Primary	23.6%	-
- Middle	4.6%	-
- High	4.3%	-
- Post secondary	1.4%	-
<b>Enterprise-Owned Vehicle</b>		
Has motorized vehicle <sup>19</sup>	14.9%	-
Vehicle maintenance cost last 30 days (FCFA)	55,288	222,456
<b>Production and Transportation</b>		
Total value of services sold in the last 30 days (FCFA)	1,016,607	1,220,000
Total value of products sold in the last 30 days (FCFA)	483,792	651,236
Transportation cost for products and services sold in the last 30 days (FCFA)	21,538	39,163
Raw material transportation cost in the last 30 days (FCFA)	6,664	21,175
Main types of roads used		
- National roads	49.2%	-
- Regional roads	0.3%	-
- County roads	3.7%	-
- Tracks	23.8%	-
- Urban roads	8.9%	-
- N/A	14.1%	-

<sup>19</sup> N=156, including 78 respondents with one motorcycle (3 with two,) 5 with an agricultural vehicle, 3 with an industrial vehicle, 9 with a private vehicle, 17 with a small truck and 4 with a large truck.

Characteristics	Mean	S.D.
<i>Difficulties in Conducting Business</i>		
Access to credit	42.2%	-
Staff qualification	19.8%	-
Low equipment level	40.8%	-
High taxes	32.2%	-
Insufficient raw materials	51.6%	-
Insufficient demand	59.1%	-
Competition	48.7%	-
Quality of roads	68.1%	-
Geographic isolation	27.9%	-
Burdensome regulations	7.0%	-
Lack of proper storage	31.2%	-
Lack of access to land	27.0%	-
Other	24.9%	-
<b>Sample size</b>	<b>1,051</b>	

Source: RN2\_v8 data

#### Exhibit 26: RN6 Enterprise Characteristics

Characteristics	Mean	S.D.
<i>Enterprise Legal Form</i>		
Public company (SPP)	0.2%	-
Public limited company (SA)	3.6%	-
Limited liability company (SARL)	0.0%	-
Limited partnership (SCS)	0.0%	-
General partnership (SNC)	0.0%	-
One-man limited liability company (SURL)	0.0%	-
Anonymous company (SUA)	0.0%	-
Economic interest grouping (GIE)	11.9%	-
Other	84.3%	-

Characteristics	Mean	S.D.
<b>Entrepreneur Characteristics</b>		
Age	40.81	12.70
Female	15.6%	-
Marital status		
- Polygamous	31.2%	-
- Monogamous	51.5%	-
- Single	15.4%	-
- Widowed	1.3%	-
- Divorced	0.6%	-
Completed Formal Education		
- None	48.6%	-
- Primary	32.4%	-
- Middle	0.0%	-
- High	11.2%	-
- Post Secondary	7.1%	-
<b>Enterprise-Owned Vehicle</b>		
Has motorized vehicle <sup>20</sup>	47.3%	-
Vehicle maintenance cost last 30 days (FCFA)	12,039	34,736
<b>Production and Transportation</b>		
Total value of services sold in the last 30 days (FCFA)	478,787	2,022,872
Total value of products sold in the last 30 days (FCFA)	524,305	1,440,342
Transportation cost for products and services sold in the last 30 days (FCFA)	41,472	270,114
Raw material transportation cost in the last 30 days (FCFA)	57,084	1,038,915
Main types of roads used		
- National roads	63.0%	-
- Regional roads	2.6%	-
- County roads	1.1%	-
- Tracks	29.2%	-
- Urban roads	4.1%	-
- Others	0.0%	-

<sup>20</sup> N=336, Including 322 respondents with at least one motorcycle, 4 with an agricultural vehicle, 1 with a private vehicle, 4 with a small truck and 2 with a large trucks and one with a bus.

Characteristics	Mean	S.D.
<i>Difficulties in Conducting Business</i>		
Access to credit	49.7%	-
Staff qualification	26.2%	-
Low equipment level	62.7%	-
High taxes	12.3%	-
Insufficient raw materials	44.5%	-
Insufficient demand	46.3%	-
Competition	32.8%	-
Quality of roads	87.2%	-
Geographic isolation	46.7%	-
Burdensome regulations	3.6%	-
Lack of proper storage	35.7%	-
Lack of access to land	23.7%	-
Other	62.0%	-
<b>Sample size</b>	<b>726</b>	

Source: RN6\_v7 data

## **5. DIFFERENCES BETWEEN TREATMENT AND COMPARISON GROUPS AT BASELINE**

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One important use of the baseline surveys is to compare whether the characteristics of households and enterprises in the treatment group are similar to those of households and enterprises in the comparison group prior to the intervention. In this chapter, we discuss the baseline equivalence of the study groups and examine the differences in key covariates and outcome measures. Using data from the baseline household survey, enterprise survey and the accompanying community module, we provide evidence on the differences between treatment and comparison groups at the baseline.

### **5.1 Baseline Differences in Household Characteristics**

Exhibits 27 and 28 present baseline differences in key individual and household characteristics that we discussed in section 3.1 for the RN2 and RN6 samples. During the comparison areas selection process, stakeholders agreed that the level of road degradation, the economic activity, and the demographic characteristics are similar for the treatment and comparison areas. However, we find substantial differences on some dimensions.

The mean of some demographic variables is different in the control and treatment groups. Although the average age is close to 24 years old and about half of respondents in both samples are women, there is a statistically significant differences in age and gender between the treatment and the control group in both the RN6 and the RN2 samples. However statistically significant, such small differences in age and gender are of no consequence in terms of the impact evaluation of the RRP. Perhaps more important is the difference in the level of education achieved. The treatment group appears to be more educated than the control group for RN2, but the reverse is true for RN6.

The mean of many income and revenue variables is also different between groups. In both the RN2 and the RN6 samples, more people report revenues, either agricultural or not, in the treatment group than in the control group. However, the difference in the level of revenue, for those who earn it, is not always significant.

Many road access variables measured by travel time and cost to different types of public service facilities such as markets and health facilities, are comparable between the treatment and comparison groups, but there are exceptions. For example, in the RN2 sample, the average travel time to school is 10 minutes higher in the treatment group, and this difference is statistically significant at the conventional level.

**Exhibit 27: RN2 Household Treatment/Comparison Differences**

Household and Individual Characteristics	Treatment Group	Comparison Group	Difference	p-Value
	Mean	Mean		
Age	23.7	24.4	0.8***	0.004
Female	52.6%	56.1%	3.5%***	0.000
Formal Education- none	65.5%	81.4%	16.0%***	0.000
Formal Education- primary	19.3%	11.8%	-7.5%***	0.000
Formal Education- junior high	12.0%	5.4%	-6.6%***	0.000
Formal Education- high school	3.2%	1.4%	-1.8%***	0.000
Any non-Ag business income	10.4%	8.6%	-1.7%***	0.000
Non-Ag business income	59,974	61,539	1,565	0.864
Paid work outside HH	8.6%	3.8%	-4.7%***	0.000
Income from paid work	61,060	52,880	-8,180**	0.054
Any crop revenue	56.3%	7.4%	-48.8%***	0.000
Crop revenue	410,822	133,572	-277,250***	0.000
Any animal revenue	27.3%	17.5%	-9.8%***	0.000
Animal revenue	311,938	241,832	-70,106	0.112
Any agricultural revenue	68.9%	22.7%	-46.2%***	0.000
Total agricultural revenue	458,843	230,509	-228,334***	0.000
Travel time- local market	21.36	19.66	-1.70***	0.028
Travel cost- local market	287	244	-43	0.113
Travel time- communal market	29.42	30.15	0.73	0.661
Travel cost- communal market	523	521	-2	0.987
Travel time- internat'l market	75.76	133.91	58.15***	0.000
Travel cost- internat'l market	1,840	5,246	3,406***	0.012
Travel time- health facility	21.06	30.74	9.69***	0.000
Travel cost- health facility	273	236	-37	0.368
Travel time- school	27.01	17.23	-9.78***	0.003
Travel cost- school	127	507	379***	0.001
Travel time- workplace	37.96	45.69	7.73	0.166
Travel cost- workplace	573	710	136	0.511

Source: RN2\_v8 data

Statistically significant at 10 percent (\*), 5 percent (\*\*) and 1 percent (\*\*\*).

**Exhibit 28: RN6 Household Treatment/Comparison Differences**

Household and Individual Characteristics	Treatment Group	Comparison Group	Difference	p-Value
	Mean	Mean		
	Treatment Group	Comparison Group	Difference	p-Value
Age	22.7	24.8	2.1***	0.000
Female	51.1%	49.3%	-1.8%**	0.049
Formal Education- none	58.6%	38.6%	-20.0%***	0.000
Formal Education- primary	19.3%	22.7%	3.4%***	0.000
Formal Education- junior high	15.8%	25.9%	10.2%***	0.000
Formal Education- high school	6.4%	12.8%	6.4%***	0.000
Any non-Ag business income	10.9%	6.1%	-4.8%***	0.000
Non-Ag business income	40,013	33,092	-6,922	0.473
Paid work outside HH	5.3%	4.5%	-0.9%*	0.073
Income from paid work	54,456	70,085	15,628**	0.041
Any crop revenue	62.6%	27.8%	-34.8%***	0.000
Crop revenue	271,529	94,898	-176,631	0.719
Any animal revenue	25.5%	15.6%	-9.9%	0.123
Animal revenue	147,553	75,475	-72,078	0.566
Any agricultural revenue	68.0%	39.5%	-28.5%***	0.000
Total agricultural revenue	288,635	92,234	-196,401	0.582
Travel time- local market	34.54	44.17	9.63	0.762
Travel cost- local market	137	70	-67	0.877
Travel time- communal market	35.42	33.25	-2.17	0.333
Travel cost- communal market	136	361	225***	0.000
Travel time- internat'l market	109.95	125.71	15.76	0.233
Travel cost- internat'l market	433	2,242	1,809***	0.000
Travel time- health facility	16.72	15.63	-1.09	0.130
Travel cost- health facility	70	92	22***	0.001
Travel time- school	25.34	19.84	-5.50	0.003
Travel cost- school	17	35	18	0.126
Travel time- workplace	37.28	36.19	-1.09	0.803
Travel cost- workplace	201	175	-26	0.723

Source: RN6\_v7 data

Statistically significant at 10 percent (\*), 5 percent (\*\*) and 1 percent (\*\*\*).

## 5.2 Baseline Differences in Enterprise Characteristics

We obtained survey data from 486 enterprises in the treatment group and 565 businesses in the comparison group for the RN2 sample. For the RN6 sample, we have 512 treatment enterprises and 214 comparison businesses. Exhibits 29 and 30 summarize the differences between intervention and comparison groups in each sample across various RRP-related characteristics. There are statistically significant differences between the two groups on a number of characteristics, especially for the types of roads used. For example, in our RN2 sample, there is a significant 20-percentage point difference in the proportion of enterprises that used national roads as their main transportation mode. A similar pattern emerges in the RN6 sample as well. The overall sales volume and transportation costs are comparable between treatment and comparison groups in both the RN2 sample and the RN6 sample.

**Exhibit 29: RN2 Enterprise Treatment/Comparison Differences**

Enterprise Characteristics	Treatment Group	Comparison Group	Difference	p-Value
	Mean	Mean		
Total sales in the last 30 days (FCFA)	1,553,904	526,719	1,027,185	0.190
Raw material transportation cost in the last 30 days (FCFA)	7,302	6,121	1,181	0.372
<b>Main types of roads used</b>				
- National roads	0.60	0.40	0.20***	0.000
- Regional roads	0.00	0.00	0.00	0.478
- County roads	0.08	0.00	0.08***	0.000
- Tracks	0.18	0.29	-0.11***	0.000
- Urban roads	0.06	0.12	-0.06***	0.000
Quality of road is main barrier for business	0.66	0.70	-0.03	0.283

Source: RN2\_v8

**Exhibit 30: RN6 Enterprise Treatment/Comparison Differences**

Enterprise Characteristics	Treatment Group	Comparison Group	Difference	p-Value
	Mean	Mean		
Total sales in the last 30 days (FCFA)	549,698	279,094	270,604	0.130
Raw material transportation cost in the last 30 days (FCFA)	24,300	134,473	-110,172	0.200
<b>Main types of roads used</b>				
- <i>National roads</i>	0.64	0.52	0.12***	0.002
- <i>Regional roads</i>	0.04	0.00	0.04***	0.005
- <i>County roads</i>	0.02	0.00	0.02	0.066
- <i>Tracks</i>	0.23	0.40	-0.16***	0.000
- <i>Urban roads</i>	0.04	0.05	-0.02	0.309
Quality of road is main barrier for business	0.90	0.81	0.09***	0.001

Source: RN6\_v7 data

### 5.3 Baseline Differences in Community Characteristics

In order to provide community contextual information and to supplement data on households and enterprises, we also conducted a survey of the communities in the treatment and comparison areas. The community questionnaire was administered to representative members of the village (such as the head of the village, religious representatives, entrepreneurs, and teachers). In the RN2 sample, 44 treatment villages and 31 comparison villages are included in the survey. In the RN6 sample, the size for treatment and comparison groups is 70 and 31, respectively.

Exhibits 31 and 32 present community characteristics by intervention status for the RN2 and RN6 samples. Due to the small sample size in each group, we do not conduct statistical tests for differences in mean characteristics across treatment and comparison areas. There are a number of differences related to the road access that stand out. For example, in the RN2 sample, it is clear from Exhibit 31 that road accessibility is better in the treatment villages at baseline, with only 30% of the villages showing difficulties to access the road in the rainy season. The corresponding proportion in the comparison area is over 50%. There are also differences in other infrastructures between treatment and comparison villages. For example, in the RN6 sample presented in Exhibit 32, 72.9% of the villages in the treatment area had households without electricity supply. In the comparison group, the proportion was 38.7%

**Exhibit 31: RN2 Community Treatment/Comparison Differences**

Community Characteristics	Treatment Group	Comparison Group
	Mean	Mean
Average population per village	1,333	3,905
Road accessibility		
- <i>Inaccessible year-round</i>	none	9.7%
- <i>Inaccessible in rainy season</i>	30.2%	51.6%
Proportion of households without electricity	41.9%	25.8%
Proportion of households without piped water	62.8%	25.8%
Proportion of villages that experienced land conflicts in the last three years	53.7%	52.1%
<b>Sample size</b>	<b>44</b>	<b>31</b>

Source: RN2\_v8 data

**Exhibit 32: RN6 Community Treatment/Comparison Differences**

Community Characteristics	Treatment Group	Comparison Group
	Mean	Mean
Average population per village	1,126	1,179
Road accessibility		
- <i>Inaccessible year-round</i>	26.1%	6.5%
- <i>Inaccessible in rainy season</i>	33.3%	38.7%
Proportion of households without electricity	72.9%	38.7%
Proportion of households without piped water	81.4%	80.7%
Proportion of villages that experienced land conflicts in the last three years	40.0%	45.2%
<b>Sample size</b>	<b>70</b>	<b>31</b>

Source: RN6\_v7 data

The fact that we find some economically and statistically significant differences between treatment and control groups is not entirely surprising given that the assignment to either geographical area was not random. Although we made every effort to find similar control groups, our DID methodology was chosen precisely because it allows us to control for such differences in the ultimate impact evaluation analysis. Although our DID evaluation design accommodates baseline characteristic and pre-intervention outcome differences, it is important to control for observable pre-existing differences between treatment and comparison households, enterprises and communities.

## 6. CONCLUSION

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The analysis of the RRP baseline survey data has two main objectives: (1) to describe the sample of households and enterprises at baseline and (2) to compare and contrast the treatment and comparison groups. In Chapters 3 and 4, we presented detailed descriptions of the households, enterprises and communities in our samples. In Chapter 5, we assessed the similarities and differences between the treatment and comparison samples. The results of our analysis are summarized below.

As one would expect, the RN2 and the RN6 samples are different in many aspects, but generally similar in that respondents are mostly uneducated and receive a large portion of their income from agriculture. However, households also receive a non-negligible part of their income from paid work or non-agricultural business activities. Both business and household respondents in RN6 expressed that the road quality was a concern more often than did respondents in the RN2 sample.

An important feature of the income and revenue data is their wide distribution. We find large standard deviations and medians that are often far smaller than the means. This suggests the need to pay particular attention to outliers in the next steps of analysis. Another feature of the income data is that the RN2 sample is better off than the RN6 in many dimensions. They get paid-work and non-farm income more often, and they earn more when they do. Their average and median farm revenues are also higher. Almost twice as many households in the RN6 sample report agricultural revenue than in the RN2 sample.

Looking ahead to the impact evaluation, our findings from the baseline data collected by the ANSD suggest using the income data with caution. Indeed, error margins in revenue data is not atypical in developing countries. This suggests that interim data collection should look carefully at outliers to pick up any potential inconsistencies in our baseline data.

Given the constraints in choosing the treatment and control groups, it is not surprising that there are substantial differences between treatment and control groups in both samples. As noted above, future analysis will have to make sure that such differences are not driven by outliers. Ultimately, the DID methodology is designed to address such differences at baseline.

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## APPENDIX A

In this section we present a more detailed description of the Senegal household, enterprise and village questionnaire modules and the corresponding datasets received. The survey consisted of the following three questionnaires:

1. Household questionnaire
2. Enterprise questionnaire
3. Community module

Each questionnaire comprises several modules, which in turn correspond to several datasets. The table below presents the various questionnaire modules and the corresponding datasets:

**Exhibit 33: Datasets for Senegal Roads Survey**

RN2		
	Questionnaire	Datasets
<b>Household</b>	Section 1: Characteristics of the household members (all members)	fichier_1.dta
	Section 2 : Education of household members (household members age 3+)	fichier_2.dta
	Section 3: Employment and Revenues (household members age 10+)	fichier_3.dta
	Section 4A: Household food consumption	fichier_4_6_7.dta
	Section 4B: Household non-food consumption	
	Section 5A: Wages and non-agricultural revenues (household members age 10+)	fichier_5a.dta
	Section 5B: Transfers, rents, pensions (household members age 10+)	fichier_5b.dta
	Section 6: household assets	fichier_4_6_7.dta
	Section 7: use of the road (household head)	fichier_7.dta
	Section 7: use of the road (household members age 10+)	fichier_7.dta
	Section 7: use of the road to go to local market (household members age 10+)	fichier_7.dta
	Section 7: use of the road to go to communal market (household members age 10+)	fichier_7.dta
	Section 7: use of the road to go to international market (household members age 10+)	fichier_7.dta
	Section 7: use of the road to go to health structure (household members age 10+)	fichier_7.dta
	Section 7: use of the road to go to school (household members age 10+)	fichier_7.dta
	Section 7: use of the road to go to workplace (household members age 10+)	fichier_7.dta
Section 7: use of the road to go to other places (household head)	fichier_7.dta	

RN2		
	Questionnaire	Datasets
	Section 8: access to the nearest services (household members age 10+)	fichier_8.dta
	Section 9: travels to the city (household members age 10+)	fichier_9.dta
	Section 10: agricultural production and commercialization	fichier_10.dta
<b>Enterprises</b>	Section A and B: information on the entrepreneur	section_a_b.dta
	Section C: characteristics of the enterprise	section_c.dta
	Section D: mobile equipment	section_d.dta
	Section E: production, commercialization	section_e.dta
	Section F: difficulties encountered in the activity	section_f.dta
<b>Community</b>	Module B: identification of respondents	fichier_identif.dta
		fichier_a.dta
		fichier_b.dta
	Module C: population	fichier_c.dta
	Module D: infrastructure	fichier_d.dta
		fichier_dss.dta
	Module E: poverty	fichier_e.dta
	Module F: education	fichier_f.dta
	Module G: health structure	fichier_g.dta
	Module H: community organization	fichier_h.dta
	Module I: agriculture	fichier_i.dta
		fichier_j.dta
	Module K: shocks	fichier_k.dta
	Module L: land conflicts	fichier_l.dta
Module M: salaries and wages	fichier_m.dta	
Module N: prices	fichier_n.dta	

RN6		
	Questionnaire	Datasets
<b>Household</b>	Section 1: Characteristics of the household members (all members)	fichier_1.dta
	Section 2 : Education of household members (household members age 3+)	fichier_2.dta
	Section 3: Employment and Revenues (household members age 10+)	fichier_3.dta
	Section 4A: Household food consumption	fichier_4_6_7.dta
	Section 4B: Household non-food consumption	
	Section 5A: Wages and non-agricultural revenues (household members age 10+)	fichier_5a.dta
	Section 5B: Transfers, rents, pensions (household members age 10+)	fichier_5b.dta
	Section 6: household assets	fichier_4_6_7.dta
	Section 7: use of the road (household head)	fichier_7.dta
	Section 7: use of the road (household members age 10+)	fichier_7_13.dta
	Section 7: use of the road to go to local market (household members age 10+)	fichier_7_15.dta- fichier_7_18
	Section 7: use of the road to go to communal market (household members age 10+)	fichier_7_19.dta- fichier_7_22
	Section 7: use of the road to go to international market (household members age 10+)	fichier_7_23- fichier_7_26.dta
	Section 7: use of the road to go to health structure (household members age 10+)	fichier_7_27.dta
	Section 7: use of the road to go to school (household members age 10+)	fichier_7_28.dta
	Section 7: use of the road to go to workplace (household members age 10+)	fichier_7_29.dta
	Section 7: use of the road to go to other places (household head)	fichier_7.dta
	Section 8: access to the nearest services (household members age 10+)	fichier_8.dta, fichier_8_32
	Section 9: travels to the city (household members age 10+)	fichier_9.dta
	Section 10: agricultural production and commercialization	fichier_10_36- fichier_10_39.dta
<b>Enterprise</b>	Section A and B: information on the entrepreneur	fichier_identif and section_b.dta
	Section C: characteristics of the enterprise	fichier_c.dta
	Section D: mobile equipment	fichier_d.dta
	Section E: production, commercialization	fichier_e.dta
	Section F: difficulties encountered in the activity	fichier_f.dta
<b>Community</b>	Module B: identification of respondents	fichier_identif.dta
		fichier_a.dta
		fichier_b.dta
	Module C: population	fichier_c.dta

RN6		
	Questionnaire	Datasets
	Module D: infrastructure	fichier_d.dta
	Module E: poverty	fichier_e.dta
	Module F: education	fichier_f.dta
	Module G: health structure	fichier_g.dta
	Module H: community organization	fichier_h.dta
	Module I: agriculture	fichier_i.dta
		fichier_j.dta
	Module K: shocks	fichier_k.dta
	Module L: land conflicts	fichier_l.dta
	Module M: salaries and wages	fichier_m.dta
	Module N: prices	fichier_n.dta