AGRODEP- Innovative Research Grant Proposal

Fertilizer Subsidy and Agricultural Productivity in Senegal

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Agriculture in Senegal

• Agricultural sector in Senegal:
  • 55 % of the labor force (3/4 in rural areas)
  • Direct/indirect sources of income: higher proportions of the population

• Contribution to GDP: 14.8 % (WB, 2011)

• Translation: low productivity
  • Farmer: more than 6 times less productive than the average worker.

• These figures contrast with the great economic and social potentials of the sector
Why increase productivity?

• Economic and social benefits associated with increased productivity:
  • Reduction of chronic food deficits
    • Case of rice (2010): domestic production = 604,043 tons; demand = 1.3 million tons
    • Foreign supply greater than domestic supply (FAOStat online)
  • Less vulnerability to foreign shocks (e.g. price)
  • Improved food security profile
    • Greater availability (quantity), access (price), utilization(?), stability(?)
  • Increased income and poverty alleviation
  • Economic growth, foreign reserves, etc.
Public support: subsidies

• These potential benefits: well understood by public authorities.

• Strong support mechanisms (financially)
  • Increased budget spending, 2002-2009: FCFA 55.1 billion to 170.2 billion (x3)
  • Improved composition of the budget: more capital spending

• Key element of the support scheme: subsidies (Abuja Declaration)
  • 2001-2011: FCFA 75 million to 36.3 billion (x484)

• Distribution:
  • Fertilizers (30%),
  • Groundnuts price support (27.8%)
  • Groundnuts seeds (13.7%)
  • Other seeds (8.3%)

• 2011/2012 campaign: fertilizer subsidies amounted to half of the 30.9 billion total subsidy envelope
Fertilizer subsidy and productivity

• Theoretical arguments in favor of a positive effect (Donavan, 2004; IFDC, 2003; Gladwin et al., 2002).
  • Increase in the use of fertilizers and other inputs as well, incentives to invest (“crowd-in” effect).
  • Expansion of the technical space and use of more efficient combinations.

• Less favorable arguments (Jayne, 2013; Xu et al., 2009; Nyirongo, 2005; Donavan, 2004).
  • Inelasticity of fertilizer demand (constraints on the usage of fertilizers).
  • Incentives to move away from more productive crops to more profitable, fertilizer-responsive ones (“crowd-out” effect).
  • Possibility of leakages (incentives to resell in neighboring countries with no program).
Fertilizer subsidy and productivity

- Need to weigh these series of arguments with respect to their relative ability to portray the productivity profile of the farming activity in the country in question.

- Policy relevance:
  - Re-assess the policy approach to supporting the sector in the face of low productivity and tight fiscal constraints.
  - Senegalese government’s plan to move away from subsidy: reduction from 0.5 to 0.3 percent of GDP over the next 3 years.
Research objectives

• Main objective: assess the impact of fertilizer subsidy on the agricultural activity in Senegal.

• More specifically:
  • Determine whether the subsidy programs have contributed to increased fertilizer use.
  • Measure the extent to which farmers’ responses to the incentives associated with the subsidy programs have been translated into greater productivity.
Methodology

• Step 1: measuring productivity
  • Allocative/Market efficiency: ability to produce at a lower input cost (less input)
  • Technical/Scale efficiency: maximizing output for a given set of inputs (more output)
  • Non-parametric approach: Data Envelopment Analysis (DEA)
    • Estimation of the efficiency envelope (production function)
    • Get the Shepard's (1970) distance function (linear programming)

\[
g(X, Y) = \frac{1}{h(X,Y)} \text{ with } h(X,Y) = \min \{ h : hX \in L(Y), h \geq 0 \}
\]

subject to: \( hX \geq k \sum_{j=1}^{J} \lambda_j X_j ; \quad Y \leq k \sum_{j=1}^{J} \lambda_j Y_j ; \quad 1 = \sum_{j=1}^{J} \lambda_j \; ; \; \lambda_j \geq 0 ; \; k > 0 ; \)
Methodology

- **Step 2:** Two-stage instrumental variable model of productivity scores
  - **Stage 1:** selection into the subsidy program (whether fertilizer subsidy has contributed to more fertilizer use)
    
    Potential instruments: social capital (duration in the area), political preferences (vote in 2012 presidential elections)
  - **Stage 2:** efficiency scores (impact of fertilizer subsidy on productivity)

\[
ES_j = \beta_0 + \beta_1 SUB_j + X_j \phi + \epsilon_j
\]

- $ES_j$: allocative and technical efficiency scores (alternatively) of decision-making unit $j$
- $SUB_j$: (1) dummy: 1 if $j$ used subsidized fertilizers; (2) fertilizer price coverage ratio
- $X_j$: vector of controls (farmers, farming activity, etc.)
Methodology

• Step 3 (optional): Decomposing any productivity differential due to fertilizer subsidy
  • First approximation: Oaxaca-Blinder approach (Oaxaca, 1973; Blinder, 1973)
    \[ \overline{ES}_b - \overline{ES}_{nb} = (\overline{X}_b - \overline{X}_{nb})\phi_b + (\phi_b - \phi_{nb})\overline{X}_{nb} \]
  • Generalized approach: Neumark (1988)
    \[ \overline{ES}_b - \overline{ES}_{nb} = (\overline{X}_b - \overline{X}_{nb})\phi^* + [(\phi_b - \phi^*)\overline{X}_b + (\phi^* - \phi_{nb})\overline{X}_{nb}] \]
Data

• Farm-level data already collected in the Senegal River Valley.
  • Purpose: assess the impact of government subsidy on farmers’ productivity.
  • Sample of 180 farmers.
  • Questionnaire:
    • General information: crops, ownership of land, to farmers’ organization, gender, etc.
    • Activity: output, inputs, prices, markets, infrastructures (storage, processing)
    • Subsidy: targets, price coverage, etc.
    • Finance: investment, loans, type of lenders, conditions, etc.

• Preliminary results:
  • No significant effect of fertilizer subsidy on farmers’ productivity.
  • Factors that matter: farmers’ organizations, duration on the activity, storage facilities, processing units.

• Implication: reduction/elimination of subsidy programs?
Data

- More data to be collected
  - Policy coverage: nation-wide.
  - The agro-ecological zone of the Valley not representative of Senegal’s agriculture (irrigation, infrastructure).
  - Lack of key information to correct for possible endogeneity of the self-selection into the subsidy program.

- Two more agricultural areas: Niayes and Bassin Arachidier

- Improved questionnaire:
  - Add questions on duration in the area and political preferences (instrumental variables).
  - Re-contact interviewees in the Valley.

- Additional research question: channels through which fertilizer subsidy affects productivity (“crowd-in” or “crowd-out” effects)
  - First-stage IV model (fertilizer use); decomposition approaches (other inputs/characteristics)