AGRODEP- Innovative Research Grant Proposal

Fertilizer Subsidy and Agricultural Productivity in Senegal

Abdoulaye Seck

Department of Economics

Cheikh Anta Diop University, Dakar

November 2013

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)

$$\mathrm{g}(X,Y) = \frac{1}{h(X,Y)}; with\ h(X,Y) = min\{h: hX \in L(Y), h \geq 0\}$$

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

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)

    $$ES_j = \beta_0 + \beta_1 SUB_j + X_j\phi + \varepsilon_j$$

    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)

$$\overline{ES}_b - \overline{ES}_{nb} = (\bar{X}_b - \bar{X}_{nb})\phi_b + (\phi_b - \phi_{nb})\bar{X}_{nb}$$

  - Generalized approach: Neumark (1988)

$$\overline{ES}_b - \overline{ES}_{nb} = (\bar{X}_b - \bar{X}_{nb})\phi^* + [(\phi_b - \phi^*)\bar{X}_b + (\phi^* - \phi_{nb})\bar{X}_{nb}]$$

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)