

## Economic impact of CRSP's investment in the development and dissemination of improved cowpea varietal technology: New evidence from Senegal

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Since the early 1980s, the Senegalese Institute of Agricultural Research (ISRA) has worked with the Dry Grain Pulses Collaborative Research Support Program (CRSP)—formerly the Bean/Cowpea CRSP and now called the Legume Innovation Lab—on developing improved varieties of cowpea. One of the outcomes of this long-term, collaborative research investment has been the development and release of three short-cycle, semierect varieties: Mouride, released in 1991; Melakh, released in 1995; and Yacine, released in 2005.

Because of the critical role played by the seed system in facilitating gains from the release of improved varieties in recent years, Pulse CRSP investments in Senegal have included the expansion of ISRA's efforts in seed production and multiplication, especially of Melakh and Yacine. In 2010, ISRA's seed production efforts generated 2.5 metric tons of breeder seed and 23 metric tons of foundation seeds. Through a network of farmer organizations and NGOs, the increased supply of foundation seeds has been converted into increased production of certified seeds, and, in recent years, the country has met 50 to 60 percent of its annual demand for cowpea seed.

This brief summarizes the results of an adoption survey conducted in 2010 to assess the impact of cowpea research and seed system development efforts in three main cowpea growing regions in Senegal: Diourbel, Thiès, and Louga. Results from this survey and past impact studies are used to derive the estimates of cowpea varietal adoption over time and the gains in yield from the adoption of improved varieties. An economic surplus modeling approach is used to estimate aggregate benefits from the adoption of improved varieties. These benefits are then compared to the costs of research on cowpea improvement and variety dissemination to derive rate-of-return estimates on these investments.



*Cowpeas growing in a farmer's field in Senegal*

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### Key Findings

- In the 2010 season, Pulse CRSP-developed improved varieties represented 42 percent of total area planted to cowpeas in Diourbel, Thiès, and Louga.
- Yield improvements from improved varieties were mixed, with significantly higher yield improvements seen in Louga compared to Thiès and Diourbel.
- Economic surplus analysis indicates positive returns on investments in cowpea research and development in Senegal. The present value of net benefits is estimated at \$78.6 million. The IRR is estimated at 17.9 percent and was more than 8 percent less than every sensitivity scenario performed.

## Data and Method

Data for this study are drawn from several sources. In the 2010 rainy season, the Direction de l'Analyse de la Prévision et des Statistiques (DAPS) in Senegal performed a comprehensive national survey of agricultural households. For the three study regions, a majority of cowpea-growing households in the sample were resurveyed in 2011, along with additional households, to gather information on adoption of specific varieties as well as socioeconomic characteristics and production and consumption behaviors of these households. This information was used to estimate adoption rates and farmers' assessment of the advantages and disadvantages of improved versus traditional varieties.

Adoption rates for 2004 were taken from a previous research impact study. Adoption rates between 2005 and 2010 were estimated using a logistical adoption curve. National and regional production and area planted were taken from FAOSTAT. Annual prices for cowpea in Senegal were derived from data published by the Agence Nationale de la Statistique et de la Démographie (ANSD).

Research costs for CRSP's investments and ISRA expenditures on varietal research were derived from data provided by the CRSP management office and the author of the previous impact study in Senegal. CRSP costs were available through 2010 and were projected through 2020. ISRA research expenditures were only available through 1996 and were projected for later years as an average of the last three available years.

## Results

### Adoption Rates

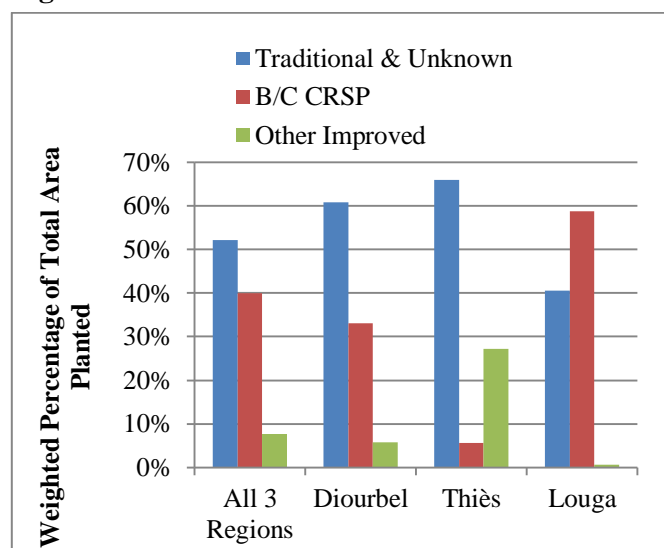
Survey results indicate that the adoption rate for the three CRSP varieties—Melakh, Mouride, and Yacine—in the study regions is 42 percent and for all improved varieties 48 percent. Thus, the adoption rates of improved varieties (IVs) in the study regions significantly surpassed the plateau rate of 3.58 percent estimated in 2004 by the previous cowpea impact assessment study. This change primarily reflects the focused efforts in the past four to five years by the government of Senegal, FAO, NGOs, farmers' organizations, and, more recently, the Dry Grain Pulses CRSP on multiplication and dissemination of breeder seeds and certified seeds of Melakh and Yacine.

Adoption rates within the regions differ significantly (fig. 1). Adoption is much higher in Louga than in Thiès and Diourbel, with 58.8 percent of Louga's cowpea area cultivated with a CRSP variety. Of the three varieties, Mouride has the highest rate of adoption at 33.1 percent, Melakh following second at 24.7 percent, and Yacine at 0.9 percent. Louga is the only region where Mouride is still present; it also has the lowest adoption rate for Yacine of the three regions.

Diourbel has a lower adoption rate of B/C CRSP varieties at 33.1 percent. A significant amount of this is Yacine, which is grown on 28.8 percent of cowpea land. Melakh is grown on 4.3 percent of the area. Notably, 10.2 percent of land is grown as a mix of B/C CRSP varieties and other varieties.

Thiès had the lowest rate of adoption for B/C CRSP varieties in the sample, at 5.6 percent. Adoption of non-B/C CRSP improved varieties (identified as "other improved" varieties), however, is very high, at 27.2 percent. However, since there have been no known recent seed multiplication and distribution efforts for any other varieties in this region, these varieties are probably a mix of mislabeled traditional and CRSP varieties. To ensure an accurate evaluation, however, the economic analysis estimating the rates of return excluded other improved varieties reported in Thiès.

**Figure 1. Adoption of improved varieties in study regions**



Source: Cowpea survey 2011

**Table 1. Median grain yields by variety (kg/ha), 2010 season**

Region	Cowpea Varieties			
	Melakh	Mouride	Yacine	Traditional
Diourbel	218.0	No obs.	206.2	146.6
Thiès	460.7	No obs.	144.0	123.1
Louga	393.9	687.8	400.3	267.8

Source: Cowpea survey, 2011

### Cowpea Grain Yields

The yields of cowpea grain for the three CRSP varieties and traditional varieties (TVs) based on the survey results are presented in table 1. As reported, the yield of TVs ranged from 130 kg/ha in Thiès to 175 kg/ha in Louga. Reported yields of CRSP varieties were consistently higher than traditional varieties across all the regions. However, the yields of the three CRSP varieties varied significantly among regions, with the lowest reported yield difference between TVs and IVs in Diourbel and the highest in Louga (table 1).

### Importance of Green Pods

Researchers in Senegal developed early-maturing cowpea varieties to help farmers cope with the shorter rainy season and improve household food security during the “hungry period,” when food from the previous harvest is often depleted. The CRSP varieties—Melakh, Mouride, and Yacine—are all dual-purpose dry grain/fresh cowpea, semierect varieties that mature in fewer than 65 days. As such, they are available for consumption as green pods two weeks before traditional varieties. Households can either consume the pods and meet their food security needs during the critical hunger period or sell the green pods to increase and diversify their household income.

Survey results confirm that farmers consider green pods a significant contributor to their family’s food sources. Eighty-seven percent of farmers in the sample regard green pods as an important source of food before the cereal harvest and 80 percent view it as an important way to diversify their family’s diet. About 21 percent of farmers in the sample indicated that the green pods are an additional revenue source. Very few farmers in the sample, less than one percent, report that they do not harvest green pods.

Given the importance of harvesting improved varieties as green pods, the grain yields reported in table 1 underestimate the true value of production per ha of these varieties compared to traditional varieties. Although the harvest of green pods is significantly lower than that of dry grain, it is still significant. For



Senegalese women selling cowpea pods in a market

example, annual green pod to dry grain production in Diourbel was estimated to be 0.41 kg green pods for 1 kg of dry grain. Based on the price data reported in the survey for green pods and dry grain, the total production of cowpea was converted into value of production and outlined in table 2. It is notable that there is a clear gain in dollars per hectare from planting improved varieties.

**Table 2: Total value of cowpea production by variety**

	Total Value of Production (US\$/ha)
Melakh	300
Mouride	498
Yacine	186
Traditional	171

Source: Cowpea Survey 2011



## Rates of Return to Research Investment

Adoption rates from the 2011 survey and the 2004 study were used to project adoption curves for each variety within each region. Using these adoption curves and the dry grain yield gain estimates from improved varieties, economic benefits generated from the adoption of higher yielding Melakh, Mouride, and Yacine were estimated and compared with the value of research investment in cowpea breeding by the B/C CRSP and ISRA. The results indicate that the IRR for the project is 17.9 percent when projecting benefits through 2020 and 12.9 percent projecting benefits through 2010. The Net Present Value (NPV) using benefits through 2020 is \$78.6 million, at a discount rate of 4.25 percent.

The majority of program benefits come from the Louga region, due to the confluence of high adoption rates, significant yield improvements, and Louga producing the largest amount of cowpea in the country. Benefits are much lower in Diourbel and Thiès. In Diourbel, the smaller yield improvements from Yacine result in smaller benefits from adoption. In Thiès, the combination of low adoption rates and low yield improvements led to low benefits.

Sensitivity analysis was performed to measure the importance of different model parameters on the results. Under every sensitivity scenario performed with benefits projected through 2020, the IRR was greater than eight percent and NPV was positive. The most significant factors affecting program returns were estimates of the research costs and supply elasticity for cowpea.

Note that the estimated IRR and NPV do not include the value of green pods in estimating the incremental benefit stream attributed to improved varieties, nor

does the analysis include the contribution of cowpeas to household food security during the hungry season. Consequently, the estimated returns to research investment should be considered on the lower bounds of aggregate social impacts.

## Conclusion

Despite the probably underestimated benefits, the economic impact analysis found that CRSP and ISRA investments in cowpea varietal improvement have been profitable in Senegal. The high adoption rate of improved CRSP varieties in the three regions (42 percent) combined with the yield improvements from the semierect CRSP varieties led to overall welfare benefits significantly exceeding research, development, and extension costs. These findings attest not only to the success of the recent seed multiplication and distribution efforts in Senegal but also to the cowpea itself, which is a hearty crop well suited to the Senegalese environment.

While the adoption improvements in Louga have led to profitable gains, the lack of significant yield gains in Diourbel and questions about adoption in Thiès suggest a need for further research into farmer adoption patterns. Despite increased efforts on seed multiplication, the formal seed system is only able to meet 50 to 60 percent of seed demand each year. It would be worth examining the seed sector in greater depth to determine differences between seed production and distribution in the three regions. Such research could lead to a pathway for improving farmer access to certified improved seed, potentially increasing the adoption and impact of cowpea research efforts in Senegal.

### About this brief

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