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Benefit-Cost Analysis

Improving Rice Productivity to Increase Rural Incomes and Food Security in Haiti

COPENHAGEN CONSENSUS CENTER

Haïti Priorise
Un plan de développement alternatif

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Academic Abstract

Agricultural productivity in Haiti is low and has experienced little growth in the past 50 years. National rice production relative to rice consumption has fallen five fold since 1985. We evaluate an intervention that aims to improve agronomic practices in irrigated rice production in the Artibonite, which supplies 75% to 80% of total rice production in Haiti. This intervention and our estimates of the associated costs and benefits are based on a recent randomized control trial (RCT) in the Artibonite. The bundle of agronomic practices at the core of the intervention is the System of Rice Intensification (SRI), which is claimed to be a pro-poor innovation that helps farmers meet their food needs while lowering water use and seed expenditures. Based on a seven year evaluation horizon, we find that the benefit-cost-ratios for all but the most optimistic scenario are below one, suggesting that the intervention as structured is unlikely to be cost-effective. Raising rice productivity by improving agronomic practices remains laudable, but achieving broad productivity gains is challenging. Our proposed intervention may not be cost-effective, but many farmers will find some combination of improved practices to be profitable and should be encouraged to experiment, evaluate and adopt such practices. Moreover, individual components of our intervention or a version that specifically targets rice farmers most likely to benefit from improved agronomic practices may have significantly higher benefit-cost-ratios.

Policy Abstract

Overview

Agricultural productivity in Haiti is low and has experienced little growth in the past 50 years. Total rice production relative to rice consumption has fallen five fold since 1985. We evaluate an intervention that aims to improve agronomic practices in irrigated rice production in the Artibonite, which supplies 75% to 80% of total rice production in Haiti.

Implementation Considerations

This intervention is based on a pilot and randomized control trial in the Artibonite. Improved growing practices entail higher private costs to farmers. Local irrigation associations would train, support and encourage farmers to adopt improved practices, which entails additional public costs. The bulk of the public costs – which are very small compared to the higher private costs borne by farmers – are required in the first three years. The intervention and our evaluation assumes that farmers will adopt the combination of practices that is best suited to them.

Rationale for Intervention

Adopting improved practices produces higher rice yields. As farmers and farm workers learn how to better implement these practices, they become more efficient and profitable. Over the seven years of our analysis, we project that Artibonite farmers will increase total rice production by 230,000 metric tons. On average, however, the increased private costs offset the value of this increased production. As explained in the paper, we do not account for any public health benefits or improvements in climate resilience due to increased local rice production.

Benefit Cost Table (at 5% discount rate)

Our proposed intervention is unlikely to be cost-effective. Many farmers will nonetheless find some improved practices to be profitable and should be encouraged to experiment, evaluate and adopt accordingly. Moreover, individual components of our intervention or a version that specifically targets farmers most likely to benefit from improved agronomic practices may have higher benefit-cost-ratios.

Intervention	Benefit	Cost	BCR	Quality of Evidence
SRI-A to improve rice productivity in Artibonite, Haiti	$43,735,864	$57,731,660	0.76	**Strong**: Experimental research design with solid internal validity. Limited to geographically concentrated area of Artibonite and by time horizon of study.

The Challenge: Low agricultural productivity

Haiti is the poorest country in the western hemisphere. Nearly 60% of Haitians live in poverty, and quarter of those live in extreme poverty.[1] Living standards are particularly low in rural areas where only 10% of the population have access to electricity and fewer than 8% have access to drinking water.[2] More than 85% of rural Haitians work in agriculture, which as a sector contributes a substantial 25% of the total GDP of Haiti.[3] Due to low productivity, however, these agricultural households typically cannot rely solely on agriculture for their livelihood: four out of five farmers depend on off-farm activities to supplement their income.[4]

Agricultural productivity in Haiti is low and has experienced very little growth in the past 50 years.[5] Productivity constraints and challenges abound, including poor infrastructure, ecological degradation, insecure land tenure, lack of investment, poorly developed input and output markets, and frequent climatic, political and economic shocks. Annual food demand in Haiti is growing by approximately two percent per year, but food supply is growing by only 0.4 percent. More than half of Haitians are undernourished, and the average caloric intake in Haiti is about 20% below the Recommended Population Food Goals of the Food and Agriculture Organization.[6] National rice production, which once fully met domestic rice consumption, now accounts for less than 20% of consumption.[7] To achieve poverty reduction and food security, both government and aid agencies have been increasingly investing in agriculture, hoping that increased productivity and farmer profits will improve food security and welfare for agricultural households.[8]

The Artibonite Valley (henceforth, the Artibonite) is the largest rice-producing region in Haiti. Between 75% and 80% of the country's rice, is grown in the Artibonite, home to the country's largest river and an extensive irrigation system. Yet, most of the Artibonite's 1.6 million people are affected by seasonal hunger and 43% face serious food insecurity. The rice value chain in the Artibonite is weak due to low productivity resulting from poor infrastructure, limited access to agricultural technologies and inputs, inadequate drying, harvesting, and storage facilities, and poorly managed, inefficient marketing systems. The ever-widening gap in Haiti between rising rice consumption – which has quintupled since 1985 – and falling rice production – which has stagnated – is filled with cheap rice imported from the U.S.[9]

Structural constraints on agricultural productivity are amplified by frequent tropical storms and hurricanes, exacerbated by depleted tree cover and inadequate disaster response infrastructure. Some regions in Haiti have faced several years of extreme drought in a row, while other regions face flash flooding and landslides from extreme rainfall events.[10] In October 2016, Hurricane Matthew destroyed all food crops and 90% of fruit and forest trees in the hardest-hit regions. The storm affected 2.1 million Haitians and caused damages to the agricultural sector estimated at $580 million.[11] Climate change is likely to increase such weather-related production risks due to rising temperatures, increasingly erratic weather patterns, and rising sea levels.

The Solution: Improved Production Practices in Rice

There are many conceivable responses to low agricultural productivity and high food insecurity. The intervention we evaluate as a potential solution aims to improve agronomic practices in irrigated rice production in the Artibonite. The scope and structure of the intervention includes elements that were piloted in 2012-14 and rigorously tested during a 2014-16 randomized control trial (RCT) in the Artibonite that we recently completed in collaboration with local partners and farmer associations. Our proposed intervention, described in detail in this section, is not a simple scaled version of the project that we tested in this RCT. Rather, the intervention includes refined and optimized elements of the RCT project based on lessons learned during these four years of piloting and testing. Because the intervention aims to change agronomic practices – a goal that is more complex and multidimensional than disseminating a fully embedded technology like a new rice variety – it is necessarily multi-pronged.

The bundle of agronomic practices at the core of this intervention is based on the System of Rice Intensification (SRI), which has received widespread attention as an ostensibly pro-poor innovation that helps farmers meet their food needs while lowering water use and seed expenditures. While SRI is often only loosely defined and can encompass different practices in different contexts, three specific practices commonly distinguish SRI from more traditional production practices in Haiti:

- **Early transplanting** of seedlings at 8-12 days old rather than the older 21-30 day seedlings planted in the traditional system. Since these very young seedlings have relatively tender and small roots and leaves, transplanting demands greater dexterity and shallower planting depths (1-2 cm).
- **Spaced planting** of single seedlings on a grid (typically, 20cm X 20cm), in contrast to random spacing of clusters of 3-6 older seedlings in the traditional system. As a result of this feature, a newly-transplanted SRI rice field looks more sparse and more fragile than a traditionally-transplanted field.
- **Intermittent irrigation** that allows fields to dry out periodically. In contrast, the traditional system keeps standing water in rice fields throughout the growing season. While alternate wetting and drying can induce better root growth and, thereby, more efficient nutrient absorption, it also allows weeds to flourish.

To maintain soil health, compost is a standard SRI recommendation as a replacement for chemical fertilizers. Because compost can be cheaper than chemical fertilizer, this component of SRI can translate into cost savings. However, compost is currently not widely available in the Artibonite and implementing a compost program on the scale we consider in this analysis is infeasible due to the lack of infrastructure and the volume of compost necessary to replace chemical fertilizer. We therefore do not include compost as part of our hypothetical intervention.

Note two important aspects of SRI in the context of our proposed intervention. First, SRI represents a radical departure from traditional practices and contradicts the conventional wisdom of generations of rice farmers. Farmers often express dismay at their first exposure to SRI as a result. Second, SRI fundamentally substitutes some inputs (seeds and water) with another (weeding and transplanting labor). Since labor costs can vary widely from household to household, so too can the economic tradeoff inherent in SRI.

Our proposed intervention takes SRI as both an “end” and a “means to an end”. For some farmers – for example, those with access to relatively inexpensive labor – wholesale adoption of SRI may generate real productivity and profit gains. For other farmers, the economic tradeoff posed by SRI makes much less sense, but it can nonetheless serve as a valuable means to an end: Exposure to SRI and its radical departure from traditional practices can catalyze learning and improved agronomic practices even among those disinclined to adopt SRI *per se*. Specifically, exposure to SRI seems to induce farmers to pay closer attention to their agronomic practices and to adopt improved production practices locals refer to as SRA (*Systeme de Riziculture Ameliore* in French), which shifts many practices in the direction of SRI but stops shy of wholesale SRI adoption (e.g., row-planting of younger seedlings in clusters of two or three). Some farmers may experiment with SRI as they learn about it, adopting only some components at first but possibly moving toward the full package over time. For many farmers, SRA can increase productivity and profitability. As a critical design element of this SRI-A intervention, farmers decide which elements to adopt based on their labor costs and other considerations. This self-selection into full SRI adoption or partial adoption (SRA) leverages the distinctly heterogeneous benefits associated with full SRI adoption.

Based on what we have learned while piloting and conducting the RCT, the hypothetical multi-pronged SRI-A rice productivity intervention we evaluate includes the following components:

1. **SRI demonstration plots.** One SRI demonstration plot will be established in each irrigation bloc (~215 hectares) by trained farmers.
2. **SRI-A training program.** Training will follow a 'train-the-trainer' approach in which lead farmers are trained and then provide training to other farmers in their irrigation bloc. While the training will specifically teach SRI practices, it will also encourage improved SRA practices. Farmers will be encouraged to experiment with SRI on at least a small portion of their cultivated land and to adopt SRA practices on all their remaining rice plots.
3. **SRI-A technical support.** The intervention will provide seasonal stipends to farmer trainers and partial salary support for technicians and extension agents from the local government's Agricultural Bureau (BAC).
4. **Coordination and implementation by local irrigation users associations.** Each irrigation bloc is managed by an association. These associations, which were created in 2009 throughout the Artibonite with support from the IDB, will provide the local institutional capacity to coordinate and implement the intervention. Although irrigation users associations do not

currently cover all the irrigated rice land of the Artibonite, ongoing IDB support aims to create additional associations to more completely cover the valley. We therefore design this SRI-A intervention to work through these associations and define the geographic scope of this intervention to be the roughly 28,000 ha of irrigated rice in the Artibonite, which accounts for nearly 80% of total rice production in Haiti.

5. **Agricultural credit expansion support.** Initial but declining support will enable local credit unions to lend directly to farmers in collaboration with local irrigation associations. This support will provide credit training to farmers to ensure sufficient understanding of agricultural credit, as well as partial and declining support to credit unions for administrative costs associated with initiating loans in the first two years (e.g., costs of mapping plots to estimate plot size as the basis for the credit limit). This element of the intervention aligns with a national campaign to improve farmers' access to credit.[12]
6. **Dredging and maintenance of primary irrigation canals and drains.** For the purposes of this intervention, it is important that the irrigation infrastructure is well maintained. Maintenance of the primary canals and drains requires heavy machinery and is the responsibility of the ODVA, a division of the Ministry of Agriculture that functions in the Artibonite. In recent years, this seems to have been done only when additional external support earmarked for this purpose is forthcoming (e.g., from NGOS like Oxfam America). We assume that some partial external support in the initial years of the program will be required for ODVA to properly dredge and maintain primary canals and drains and therefore include this partial support in the cost of the intervention. We assume that over time, the agency will be able to carry out its responsibilities without external funding. Irrigation associations are responsible for coordinating farmers to clean all secondary and tertiary canals and drains.
7. **Incentives to mototiller service providers.** To adopt improved practices, farmers must have access to sufficient and timely land preparation services. Many farmers hire in these services from a mototiller (two-wheeled tractor) service provider, but there are currently too few service providers to accommodate expanded cultivation of SRI-A rice. Support for these service providers could come in the form of vouchers given to farmers through the

credit union. These vouchers would reduce the per hectare land preparation costs to the farmer and thereby stimulate demand for these services. Alternatively, this incentive could come in the form of direct subsidies on the mototillers (or, equivalently, a reduction of the import tariff on this imported equipment). As the cost of these incentives is roughly offset by the benefits to the service providers, we do not include the incentive costs in this analysis.

The Evidence

Many development agencies and organizations have promoted SRI as a pro-poor innovation that could help small farmers meet their food needs while lowering expenditures on inputs such as seeds, water, and fertilizer.[13] In Haiti, development organizations and agencies have been promoting SRI since 2009, with demonstration plots, training of farmers in the SRI techniques, and agronomic trials to study the technique's appropriateness for the local context. SRI has been promoted in all regions of the country by local organizations (ODVA, CFL, FENAPRIH) international development organizations (Oxfam, World Hunger Relief, iF Foundation), foreign aid agencies (USAID's WINNER and Feed the Future programs), and academic institutions (FAMV-UEH, Cornell University). Agronomic trials conducted in 2012 by the Faculty of Agricultural and Veterinary Medicine of the State University of Haiti found SRI to have a 67% increase in yields over traditional methods, and estimated a 132% increase in profits. However, previous studies in Haiti have not rigorously estimated economic costs, particularly difficult-to-measure labor costs.

The global evidence on the productivity effects of SRI is mixed: a number of studies have found substantial increases in yield in a range of sites,[14,15,16] but crop scientists have challenged these findings as untested by conventional agronomic methods.[17,18] This controversy over yield increases seems to have further fueled passionate support for SRI among a growing set of proponents.

Household benefits of SRI are even more uncertain than agronomic results, and few studies have quantified the economic impacts of SRI on household welfare. Indeed, we are aware of no published RCT-based evidence of household-level SRI impacts. Because SRI requires higher labor inputs, adoption typically leads to either hiring more labor or reallocation of household labor from other economic activities. The resulting decrease in household income from other activities may offset the income increase from higher SRI yields.[19] SRI had been linked to higher incomes in some settings,[20,21] but adoption of SRI has been lower than expected in other settings, while substantial dis-adoption has been observed.[22] A study of the household welfare impacts of SRI in Indonesia found that, while SRI increased yields by 64%, in a setting with high labor market participation, households allocated household labor away from wage work towards SRI to the point where SRI had no significant impact on household incomes. [23]

Study Design

We draw on evidence from a multi-year evaluation of an SRI-based intervention in Haiti, conducted by Oxfam America in partnership with several local farmers' organizations.[24] Our study area is a region of the Artibonite with a large association of small-scale rice farmers – the Irrigation Association of Liancourt Artibonite (*AILA* for its initials in French) – and an established irrigation system that makes the alternate wetting and drying required by SRI feasible. The area was selected both for its physical suitability for SRI and for the relationship the implementing NGO, Oxfam America, had with the farmers' groups operating in the area.

The sample includes 748 farmers who cultivate land in four of the irrigation blocks located within the system managed *AILA*. Local collaborating partners selected four blocks that they deemed conducive to the implementation of SRI to be part of the program. Two of the blocks were randomly selected as treatment blocks. Prior to the implementation of the agricultural technology project, in February-March 2014, all study households completed an agricultural household survey, which was then repeated in the winters of 2015 and 2016, at the midline and end-line of the project. During each planting season, a small mid-season survey was conducted with a subset of farmers in order to collect some data closer to real time, when data on agricultural operations would be easier to remember accurately.

During the 2014 and 2015 planting seasons, farmers in the two treatment blocks received SRI training and support. This treatment consisted of training in SRI methodology along with technical support and supplementary agricultural credit.[25] The different components of the program and their allocation between the treatment and control groups are depicted in Table 1, with details about each component described below.

Table 1 Research program details

	Control Blocs	Treatment Blocs
General technical support	X	X
Water management	X	X
Land preparation credit	X	X
Supplementary weeding labor credit		X
SRI training & SRI-specific technical support		X

Training: The SRI training used a farmer-to-farmer approach in which the implementing NGO and collaborating agricultural technicians trained a subset of farmers were trained in SRI methodology. These trainer-farmers were then responsible for training some of the farmers in their farming block. Training took place in real time, as the training farmers implemented SRI on their fields to demonstrate the techniques to trainees.

Technical support for farmers: Technical support was provided by the local government's Agricultural Bureau (*BAC*) and the Faculty of Agricultural and Veterinary Medicine (*FAMV*) of the State University of Haiti. These technicians provided support for farmers in both the treatment and control group throughout the planting season. A group of farmers were also trained as monitoring agents to provide further monitoring and support to farmers.

Agricultural credit: Farmers in the program were offered the opportunity to apply for agricultural credit at a below-market rate. The credit limit for each farmer depended on the farmer's land area and whether or not the farmer was planning to practice SRI. All farmers were offered credit to cover the cost of land preparation, while SRI farmers were offered an additional amount of credit to cover the cost of weeding, the largest cost of SRI over traditional methods.

Water management: The local governmental water management agency, with financial backing from the implementing NGO, provided support for cleaning the shared irrigation canals and drains. The agency cleaned the primary system of large canals and drains that require machine-cleaning. The irrigation association, also with funding from the NGO, organized a series of work days to bring farmers together to clean the smaller canals that can be cleaned with hand tools.

Because of the labor-intensive nature of SRI, the availability of household labor may be a key determinant of how successful a household will be in implementing SRI. One of the innovations of our study is that we attempt to measure the value of household labor in order to include the full cost of the labor requirements of SRI in the evaluation of its impacts. Nearly all households in our sample engage in some kind of off-farm work, so we can use the returns to off-farm labor as an estimate of the value of household members' time. We also asked farmers specifically what kinds of off-farm labor they were engaged in during the busiest weeks of the planting season - the week they transplanted and the week they weeded - in order to look more specifically at the value of farmers' time during the times when they are most likely to be labor constrained.

Results

While the program focused primarily on promoting the adoption of SRI, we observed more nuanced shifts in agricultural practices, including an increase in farmers implementing the *Systeme de Riziculture Ameliore (SRA)* in treatment areas as well as shifts in individual practices. In Table 2, we present the adoption rates of SRI, SRA, and SRT in both treatment and control blocks.

Table 2 SRI adoption by farmers in both program years

	2014		2015	
Rice system	Treatment	Control	Treatment	Control
Traditional (SRT)	328 (83.0%)	411 (96.3%)	329 (90.1%)	372 (98.4%)
Ameliore (SRA)	95 (24.0%)	31 (7.3%)	62 (17.1%)	17 (4.5%)
SRI	110 (27.9%	5 (1.2%)	63 (17.4)	3 (0.8%)
TOTAL	395	427	362	378

Farmers in treatment blocks changed their farming cultivation methods overall, regardless of whether they labeled their practices SRT, SRA, or SRI. Farmers were asked the age of seedlings at transplanting, number of seedlings transplanted in each group, spacing between (groups of) seedlings, and whether they practiced alternate wetting and drying. In Table 3 we present OLS results examining how the age at transplanting, number of seedlings, and spacing between seedlings varies based on what system the farmer claimed to be practicing and on whether the farmer received SRI treatment. The rice system practice was self-reported by the farmer, and “SRI*Treatment” and “SRA*Treatment” are interaction terms between self-reported rice system and treatment status.

We found, as expected, that SRI farmers transplant fewer seedlings, transplant at an earlier age, and plant further apart, than traditional farmers, while SRA farmers follow practices in between SRI and SRT. Interestingly, we also see that, even for farmers practicing traditional or SRA methods, being in a treatment block causes a shift towards more SRI-like practices. Both SRT and SRA farmers transplanted seedlings earlier if they were in the treated blocks, by two and three days, respectively. SRA farmers in treated blocs also planted their seedlings substantially further apart than those in untreated blocks. This indicates that, while actual adoption of the full SRI package is lower than expected, we do see a large shift in management practices even for those who did not report adopting SRI.

Table 3 Treatment shifts transplanting practices even for non-SRI farmers

Dependent variable:	Seedling Age	Number of seedlings	Spacing between rows
SRI	-14.9*** (1.93)	-2.88* (0.41)	10.2*** (1.57)
SRA	-4.55*** (0.68)	-1.25*** (0.15)	3.47*** (0.73)
Treatment	-2.10*** (0.24)	-0.22*** (0.062)	-0.0014 (0.38)
SRA*Treatment	-3.04*** (0.80)	0.026 (0.18)	5.26*** (0.86)

Household control variables included in regression analyses
Standard errors in parentheses

Throughout this analysis, we use an Intent to Treat (ITT) approach that evaluates the impact of the treatment program on all farmers who received the treatment, regardless of whether they adopted SRI. In the case of SRI, we observed that adoption of the technology was not simple: many farmers adopted parts of the technology without adopting the full package. An ITT measure captures this range of responses to the treatment, rather than focusing only on farmers who fully adopted the intervention. In Table 4 we present OLS results showing the impact of SRI treatment on rice yields. We observed a 14% yield increase for treated farmers.

Table 4 SRI-treated farmers obtain higher average rice yields

	Yield (kg per hectare)
SRI Treatment	762*** (181.1)
Average yield in control group (kg/ha)	5741
Number of Observations	685

Household control variables included in regression analyses
Standard errors in parentheses
Extreme outliers dropped from analysis

Farmers in our SRI treatment group incurred higher costs than those in the control group. SRI is known to have higher labor requirements than traditional cultivation methods, but we observe higher labor inputs for all treatment farmers, including those adopting traditional or improved methods. We observed that treated farmers hired 18% more labor than control farmers and contributed 22% more family labor. Farmers reported that due to the more careful, difficult work required for SRI, they also had to spend more time supervising laborers: treated farmers spent nearly 50% more time supervising workers than control farmers.

We also observed an increase for treated farmers in some non-labor costs, including land preparation, fertilizer, harvesting, milling, and transporting crops. Farmers were taught to till their land three times, based on the belief that tilling more deeply would help reduce weeds. As a result, treated farmers spent more than twice as much as control farmers on land preparation costs. The increase in fertilizer – treated farmers spent 19% more on fertilizer than control farmers – may be a result of farmers' willingness to invest more in their fields if they felt more optimistic about their yields. Typically SRI should reduce fertilizer expenses as the standard SRI package encourages the use of compost instead of chemical fertilizers, but compost was not available in the region of this study.[26] Finally, harvest, milling, and transport costs depend on the quantity harvested, so these costs rise with the yield increase. Treated farmers spent 21% more than control farmers on these harvest-related expenses.

Benefit Cost Analysis

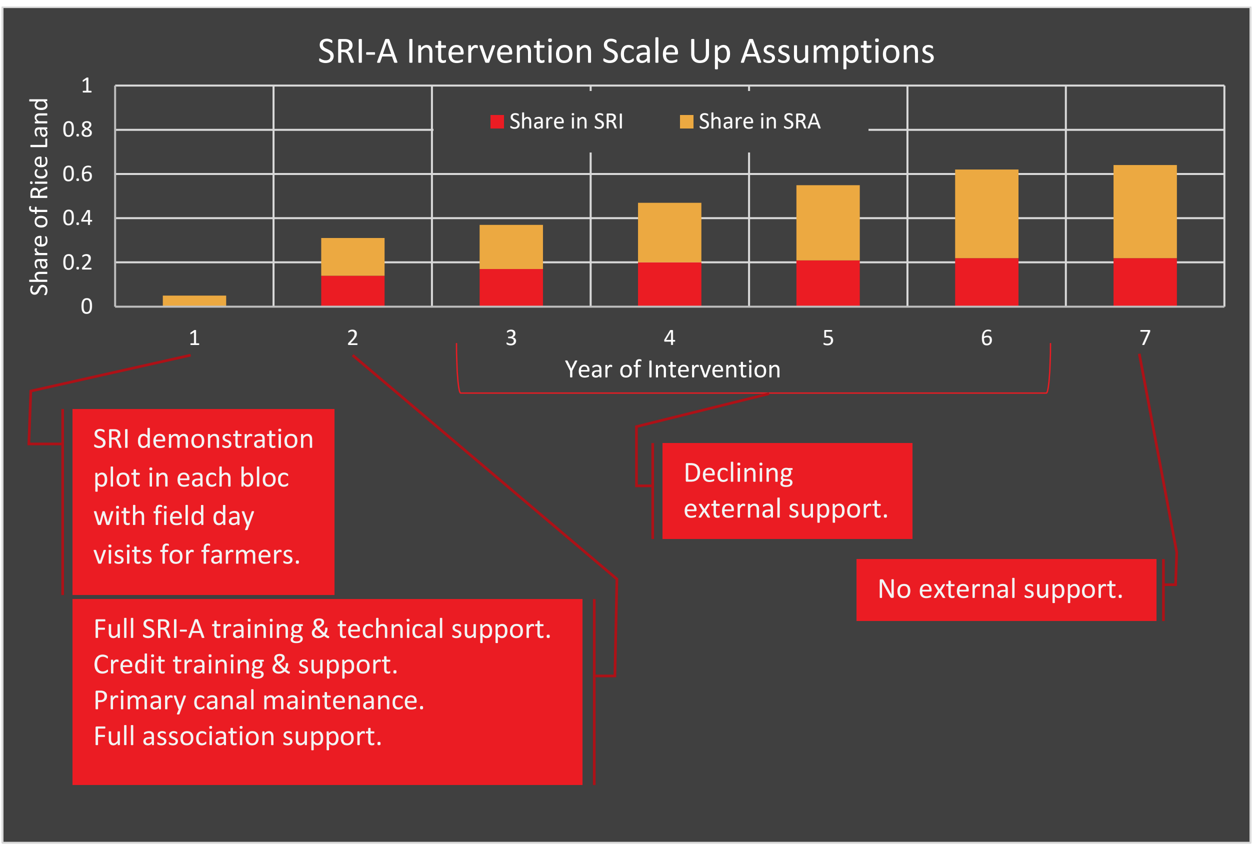
Context

In this section, we construct a Benefit Cost Analysis of the SRI-A intervention described above. Given the dominance of the Artibonite in aggregate rice production in Haiti, we evaluate the SRI-A intervention scaled to reach farmers cultivating land in all 130 irrigation blocs in the Artibonite. This encompasses 28,000 hectares of irrigated rice land. This scale up intentionally leverages the 18 irrigation associations responsible for coordinating farmers in these blocs.

We assume a seven year timeline for scaling up the SRI-A intervention to cover the Artibonite and for achieving substantial improvements in agronomic practices. As depicted in the Figure 1 below, the intervention begins with an SRI demonstration plot being established in each bloc. Throughout that first season, the responsible technician will convene several farmer field days in collaboration with the responsible irrigation association. The intervention fires on all pistons in year two and includes the SRI-A training and technical support, agricultural credit training and support, support for cleaning primary canals and drains to ensure the irrigation infrastructure is in good working condition, and direct support to irrigation associations to enable them to coordinate these activities and encourage farmers to adopt these improved practices.

We first construct and evaluate a benchmark for the SRI-A intervention that is based on assumptions we consider to be favorable but defensible. We then present several scenarios that are yet more optimistic, including a best case scenario based on the most favorable set of assumptions.

Figure 1 Overview of SRI-A intervention timeline with assumed diffusion of improved practices by land area devoted to SRI and SRA.



SRI/SRA Adoption

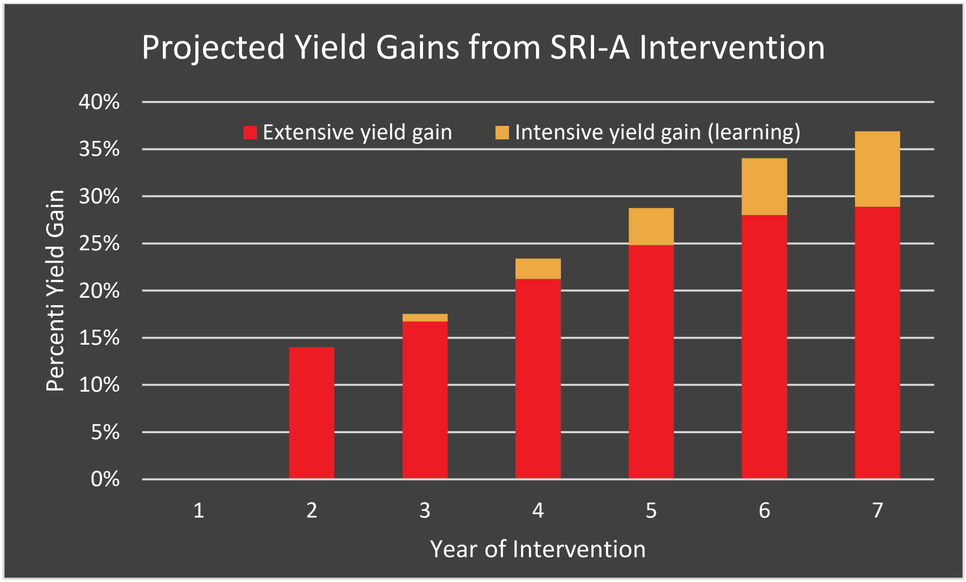
The objective of this intervention is to enable and encourage farmers to adopt the improved SRI and SRA practices. Our evaluation therefore hinges on the expected impact of the intervention on the adoption path of these practices. As depicted in Figure 1, we assume that both SRI and SRA adoption increase over the seven years of our analysis, reaching adoption rates of 22% and 42%, respectively, by year 7. These paths are admittedly speculative, but we consider these paths to be defensible as they build on the experience of the Oxfam RCT. We attribute all of this assumed adoption of SRI and SRA to the intervention (i.e., we assume zero adoption in the absence of the intervention). This seems to be a safe assumption in the case of SRI practices, but perhaps less so in the case of SRA practices, which may diffuse among farmers in a piecemeal fashion in the absence of the intervention. This assumption obviously tips the scales slightly in favor of the SRI-A intervention.

Benefits

The direct benefits of this SRI-A intervention come in the form of higher rice yields. We assume that important follow-on benefits at the household-level in the form of higher income, improved food security and reduced vulnerability all hinge on the direct productivity gains attributable to the SRI-A intervention and, hence, focus on increased rice yields as our primary measure of benefits.

To calibrate the expected yield gains from this intervention, we lean on the RCT evidence presented above and assume an initial yield gain of 14%. This estimated yield gain in the RCT is the overall net effect of some farmers shifting to SRI and others adopting components (we will refer to this partial adoption broadly as SRA). In a similar manner, we assume this percent yield increase arises from a mix of SRI and SRA practices that emerge from farmer adoption choices. Building on this initial yield gain, we then forecast the subsequent yield gains across the seven year intervention as composed of two components. First, we assume the yield gain increases proportionally as new land is allocated to SRI and SRA as depicted in Figure 1. This represents an extensive yield gain as it is due to an expansion in the amount of land cultivated with improved practices. Second, we assume that farmers achieve an additional yield gain by learning and refining their implementation of these practices. Although this speculated learning gain is not based on evidence from our RCT because it was not designed to detect learning dynamics, we are confident that over time farmers will learn and improve their implementation of these agronomic practices. We assume an annual learning rate of 5%, which seems optimistic but defensible. Figure 2 shows the resulting projection of yield gains attributable to these two sources yield improvements.

Figure 2 Projected yield gains from SRI-A intervention from expanding land in improved practices (extensive) and from assumed learning (inte*int*nsive).



To extend these projected yield gains to aggregate rice production in the Artibonite, we must make an assumption about baseline rice yields. We have projected yields gains as a percentage of baseline, so a higher baseline rice yield translates into larger projected benefits of the intervention. Between 2010 and 2014, Haiti's average rice yield was 2.5 tons per hectare, and yield has been increasing slightly, by an average of 2.4% per year over the past decade.[27] Yields in the Artibonite are the highest in the country, due to more favorable growing conditions, particularly widespread irrigation. A study of rice productivity in the Artibonite in 2007 found average rice yields of more than 4 tons per hectare.[28] Baseline data from our RCT are consistent with these higher average yields and indicates average yields in the control blocs of over 5 tons per hectare (see our regression results in Table 4). Because our own yield data is the most recent and most rigorous data from the Artibonite, we use the average yield in our control blocs as the baseline for evaluating this intervention. We acknowledge that this may be an optimistic assumption as other blocs in the Artibonite may have less water control than our blocs, but we believe it is defensible given the recent increase in rice yields across the region and Haiti as a whole.

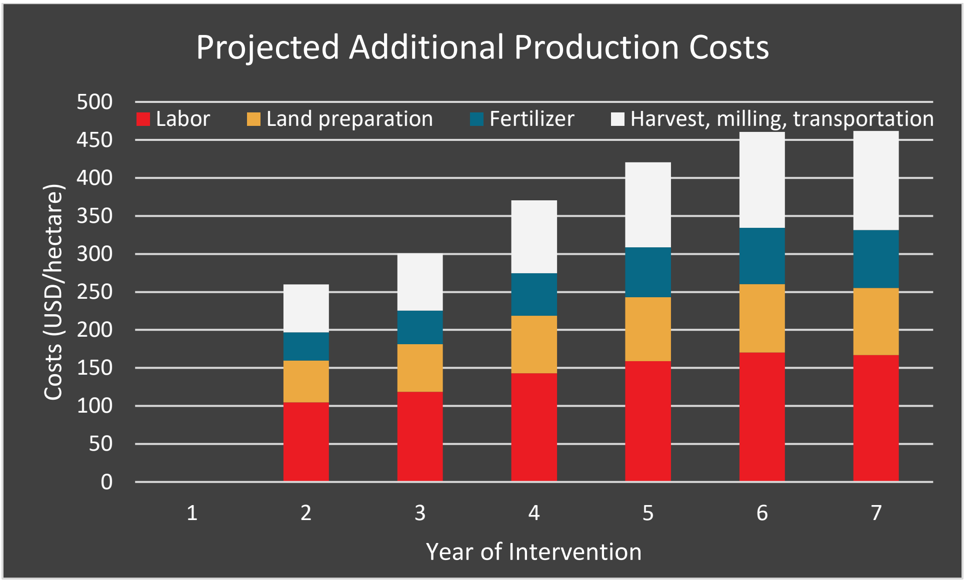
Finally, to value this aggregate increase in rice production in the Artibonite, we must assume a rice price in the local market. We use the median sales price reported by farmers in our sample and current exchange rate, which yields a rice price in the local market of $236 per metric ton. We assume this price is constant over the seven years of the intervention because we have no reason to expect it to systematically increase or decrease over this time.

Costs

The costs associated with this SRI-A intervention come primarily in the form of higher private on-farm production costs. We base these costs on the measured production cost changes in our RCT. We include only the costs for which we observed significant impacts on cost for treated farmers in our study. One notable cost that is excluded is the cost of seeds: SRI proponents claim that, because of the seedling spacing, SRI should reduce seed costs. However, we did not observe lower costs for farmers in our study. Seed costs constitute less than 9% of total non-labor costs, on average, so even if we had observed a decrease in seed costs, it would be unlikely to have a large overall impact. Similarly, we have omitted the cost reduction that would result from a shift from chemical fertilizers to compost because, as noted above, implementing a compost program at the scale necessary is infeasible in the foreseeable future.

Since our regression estimates of these cost increases are – like the yield gains above – based on the mix of SRI and SRA adoption that emerges from farmer adoption choices, we use the same approach to extrapolate from our estimated cost increases to the seven years of the proposed intervention. In this case, the expanding acreage in SRI and SRA increases the average production costs per hectare (extensive margin). We assume that learning leads to efficiency gains that reduce the labor and land preparation costs associated with these improved practices by 5% per year (intensive margin). Again, we do not have direct evidence of this learning effect from our RCT, which was conducted over only two growing seasons. We believe, however, that it is plausible that learning by workers and a deepening of the local custom hire mototiller market will generate modest efficiency gains. In contrast, fertilizer costs are not a function of local learning, and harvest, milling and transportation costs are simply proportional to the total amount of rice harvested. Figure 3 displays the resulting projection of production cost increases associated with the SRI-A intervention measured as average additional production costs per hectare. The effect of our assumed efficiency gains in labor and land preparation is evident in the decline share of these costs relative to total costs.

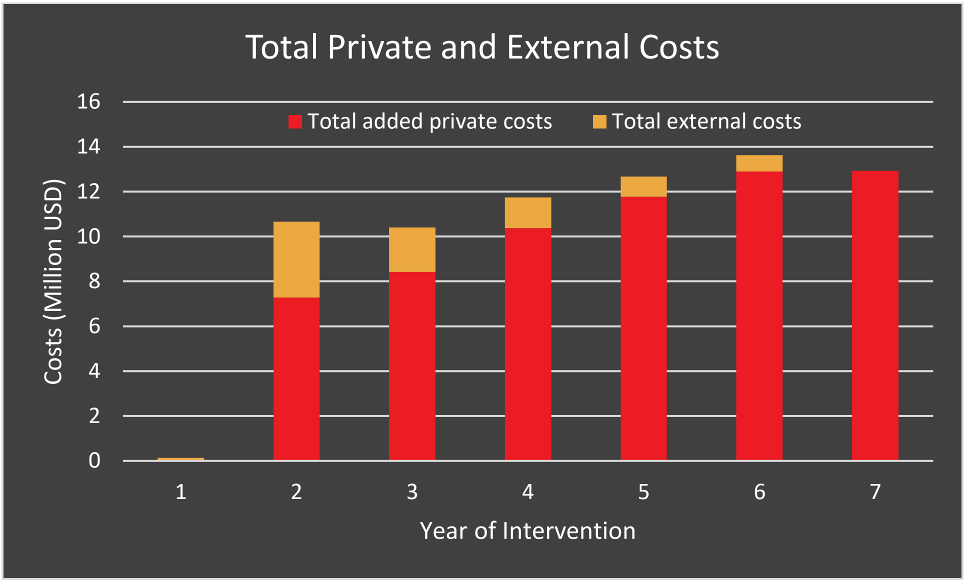
Figure 3 Projected increase in production costs based on estimate costs and assumed expansion in improved practices.



In addition to these induced increases in private production costs, we account for the external cost of supporting the various elements of the intervention. These external costs are particularly significant during the aggressive scale-up years described in Figure 1. We have collaborated with Oxfam America – the implementing partner in the RCT described above – to estimate these direct external costs over the course of the seven year intervention. The majority of these external costs provide support to each bloc in the Artibonite for SRI-A training and technical support, credit training and support, and canal cleaning. We assume that all of these intervention costs fade over time as adoption of improved practices diffuses through the valley. This assumption implies that the banks engaged in agricultural lending reach a sustainable equilibrium of lending with no external support after year four of the intervention, which is conceivable if optimistic. It also implies that the ODVA is able to continue the program of cleaning primary canals and drains, which it is expected to do as a routine part of its responsibilities.

In addition to these bloc-level external costs of the intervention, we account for direct support provided to the irrigation associations that are the key implementation intermediaries in this intervention. This support also fades over time as the need for direct coordination and training diminishes after year three and four. The resulting share of private and external costs associated with the intervention are shown in Figure 4.

Figure 4 Total private and external costs projected by year of the intervention.



Discount Rate

Since both the costs and benefits of this SRI-A intervention accrue over the seven year evaluation horizon, we convert the nominal costs and benefits into present value using 3%, 5% and 12% discount rates.

Results

The Benefit Cost Ratios (BCRs) that emerge from this analysis of the SRI-A intervention defined above and the costs and benefits as described are reported in Table 5.

Table 5 Benefit Cost Ratios for the SRI-A intervention with different assumed discount rates.

Intervention	Discount	Benefit	Cost	BCR	Quality of Evidence
SRI-A to improve rice productivity in Artibonite, Haiti	3%	$48,098,829	$62,989,719	0.76	**Strong**: Experimental research design with solid internal validity. Limited to geographically concentrated area of Artibonite and by time horizon of study.
	5%	$43,735,864	$57,731,660	0.76	
	12%	$32,018,835	$43,428,896	0.74	

Taking our benchmark projections as given, we find that the BCR is well below 1.0. It is noteworthy that in our judgment our benchmark projections, while defensible, are intentionally favorable. Even with this relatively favorable benchmark, our proposed SRI-A intervention does not pass a simple BCR test. Next, we consider several alternative scenarios and present some limitations for a deeper discussion of these results.

Scenarios

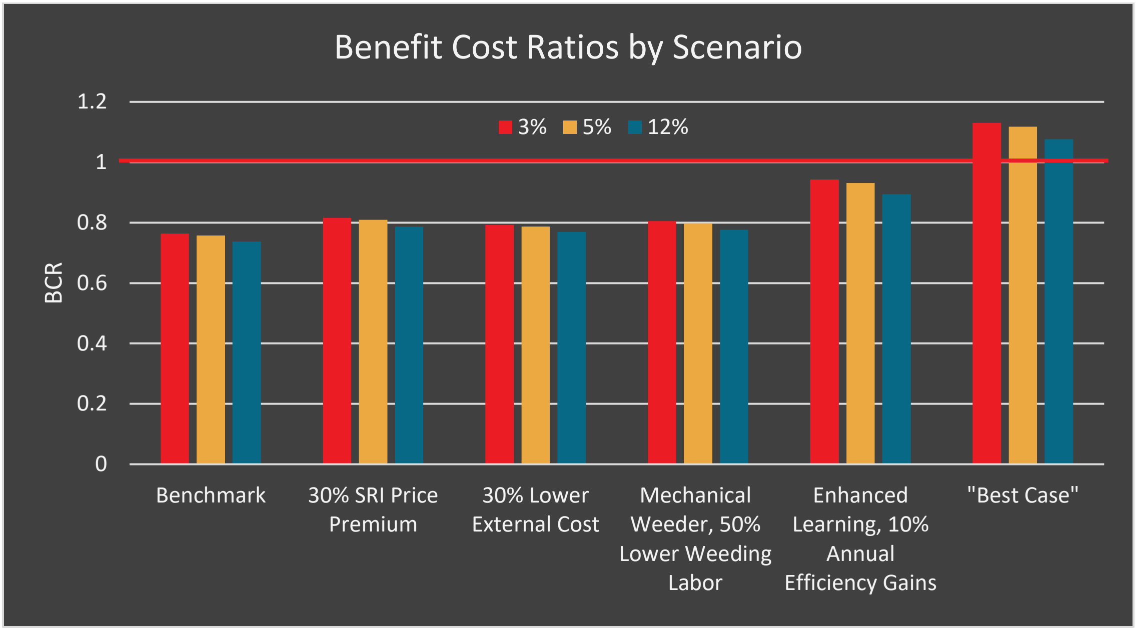
We next evaluate five favorable scenarios to determine whether our SRI-A intervention may provide a better BCR under alternative sets of assumptions. Each of these scenarios emerged in part based on feedback from local stakeholders and experts. While we believe these scenarios to be conceivable in the Artibonite context, they also seem too optimistic to be incorporated into the benchmark set of assumptions.

1. **Rice Sales by Weight.** In the Artibonite, unmilled rice (paddy) is sold by volume.[29] There are reports in Haiti and in the wider SRI literature that paddy produced via SRI is denser than paddy produced using other methods.[30] If farmers could sell their paddy by weight, they would therefore receive a premium for each bag corresponding to the increase in weight. In this scenario, we assume an SRI price premium of 30%, based on evidence showing a weight increase of approximately 30%. We further assume that this premium induces farmers to increase the share of land in SRI by 20% and to decrease the share in SRA by 10%.
2. **Low External Costs.** In this scenario, we assume that all external costs are reduced by 30%. Our baseline cost estimates are based on the costs incurred in the program studied in our RCT, but savings are imaginable with a scaled-up program. Such cost savings may be achieved, for example, by targeting the training and support to farmers most likely to adopt and benefit from improved practices. We assume that this reduction in external costs does not reduce the land area devoted to SRI and SRA or the associated yield gains.
3. **Mechanical Weeders.** Worldwide the additional labor required to weed is a primary concern for SRI. As a result, several mechanical weeders have been developed to make weeding more efficient. These weeders have been imported and tried in Haiti, but have failed to spread among farmers. We assume a manual mechanical weeder that reduces weeding labor by 50%. Since this changes the tradeoff posed by SRI, we assume that this induces farmers to increase the share of land in SRI by 40% and to reduce the share in SRA by 10%.

4. **Enhanced Learning.** We assume in our benchmark above that both farmers and workers reap efficiency gains at a rate of 5% per year due to learning. We assume in this scenario that learning-based efficiency gains are 10%. For farmers, this could reflect a combination of (i) farmers learning to implement improved practices more precisely and effectively and (ii) farmers best suited for implementing SRI-A aggressively expanding their land in SRI and SRA as they discover their better than average benefits. Enhanced efficiency gains from land preparation may be due to deepening of the custom hire mototiller market with more equipment and more operators innovating and creating new models of service provision. While we do not assume that the share of land in SRI and SRA change in this scenario, the scenario is consistent with the composition of land in these systems changing with better-suited land cultivate by better-suited farmers more quickly entering these improved systems.
5. **"Best Case.**" Our best case scenario combines all four of these scenarios. While this ideal scenario is unlikely in our judgment, it is not completely inconceivable as a "best case."

Figure 5 shows the BCRs that emerge from these five scenarios as compared to the benchmark BCRs. Clearly, the Enhanced Learning scenario most improves the BCRs of this intervention, which is sensible given that these assumed efficiency gains accrue over time and fundamentally improves the benefits to farmers. Only the "best case" scenario passes the simple BCR test.

Figure 5 Benefit Cost Ratios by scenario and discount rate assumption.



Limitations

Several limitations of this analysis merit some discussion. First, the RCT on which the initial estimates of benefits and costs are based provides rigorous, experimental evidence of the productivity effects a similar intervention, but it has its own limitations. To our knowledge, it is the most rigorous study of household-level outcomes due to SRI available, but it was conducted in geographically concentrated area in the Artibonite and spanned two years of SRI exposure. The projections we use above are therefore necessarily based extrapolation with defensible assumptions, but assumptions nonetheless.

Second, there are several potential dimensions of benefits that we are not able to capture in this analysis. For example, SRI is often claimed to improve the resilience of rice to lodging due to late-season storms. This may mean that SRI improves the resilience of rice production in addition to changing the expected yield in a given year. On the other hand, farmers report that SRI is more vulnerable to early season water shortages (when the seedlings are particularly frail), so the overall resilience of SRI to fluctuations in water availability is not clear. Explicitly evaluating resilience gains net of greater early-season risk is beyond this analysis.

Proponents of SRI also claim that SRI has substantial environmental benefits. In addition to reducing water use, the reduction of chemical fertilizers in favor of compost reduces harmful run-off and may improve long-term soil health. The intermittent irrigation practices may even reduce methane emissions as compared with continuous flooding.[31] As with the possible benefits of increased plant resilience, a quantitative assessment of these potential environmental benefits is beyond the scale of this analysis.

Another potential benefit we ignore in this analysis relates to prospective health benefits of having more locally-produced rice in Haiti and in the Artibonite in particular. Over the seven years of the SRI-A intervention we propose and according to our forecasts, Artibonite rice farmers produce 235,600 metric tons more rice as a result of improved practices. Given that markets are not perfectly integrated, more rice available in local markets may generate health benefits by reducing seasonal hunger and improving food security. The fact that cheap rice imported from the U.S. is substantially cheaper than locally-produced rice moderates this food security benefit: For those with access to markets, buying local is a luxury not everyone can afford. Because of these complexities, it is not obvious that producing more rice in the Artibonite – which is relatively well connected to markets – will necessarily lead to improved food security. Fully and carefully accounting for these complexities is beyond this analysis.

Finally, the SRI-A intervention we evaluate is but one configuration of program elements to encourage the adoption of improved practices. There could be alternative configurations that are more efficient and more effective. Moreover, there are components of our proposed intervention that may make sense as stand-alone interventions. For example, ensuring that ODVA consistently and completely maintain the primary canals and drains would almost certainly generate a BCR>1. Extending agricultural credit and deepening credit and input markets in the Artibonite may similarly have important impacts on agricultural productivity.

Broader Discussion

SRI has been widely promoted as an innovation in rice production practices that can dramatically improve yields and transform the lives of poor rice farmers. Our evaluation of a flexible SRI-A intervention that is optimized for the Haitian context suggests that, on the whole, investing in such an intervention does not appear to provide sufficient benefits to justify the higher production costs.

How can we reconcile low benefit-cost ratios with the passionate support SRI receives from key proponents – both in Haiti and in other contexts? We believe this contradiction reflects the fundamental economic tradeoff SRI poses to farmers: improved practices only make economic sense to a farmer if the additional costs entailed by the practices are more than offset by yield gains. In this case, the additional labor and land preparation costs are substantial on average, but labor costs in particular vary widely as different farmers tap household labor and hired labor in different proportions. Since these BCRs are based on averages, they do not account for variation in household labor across households. Distinctly heterogeneous benefits imply that low BCRs on average do not necessarily contradict glowing but isolated support from SRI among famers. The full analysis of the RCT explores these heterogeneous effects in detail.[32] Taking this heterogeneity into account, it is therefore entirely possible that BCRs for a SRI-A intervention that specifically targets famers with access to cheaper labor could be higher than 1.0. Such an intervention would be closer to our best case scenario where enhanced learning is fueled by effective targeting to those who stand to benefit most and rapid adoption (i.e., self-selection) by these farmers.

While this analysis addresses most of the primary considerations an SRI-A intervention might face and the factors that would most directly shape its benefits and costs, it cannot fully accommodate the broader local-economy effects that might be catalyzed by such an intervention. For example, more total rice produced in the Artibonite and available in local markets may induce more investments in improved milling and marketing capacity. Greater local demand for mototiller services may similarly catalyze local investments in agricultural mechanization and in the maintenance and repairs of farm implements. These could prompt a wider shift to mechanization beyond mototillers and increased productivity.

Finally, this analysis intentionally abstracts away from some secondary considerations that may be important. Haiti's reliance on cheap rice imported from the U.S. has been a concern for some. This reliance has increased steadily with population growth and agricultural productivity stagnation and shocks. For the 2016/17 marketing year, Haiti is set to import a record quantity of cereals, including – most importantly – rice.[33] According to our projections, the SRI-A intervention succeeds in increasing annual rice production by 50,000-68,000 MT by the end of seven year timeline. This would represent as much as a 35% increase in total national rice production. Our analysis does not directly value any benefits that others may perceive or receive specifically from greater self-sufficiency in rice production. The analysis also does not value increased resilience that may come from better crop establishment due to SRI. Such a benefit is a possibility and worthy of further research.

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[2] IFAD. 2016. "Rural poverty in Haiti." http://www.ruralpovertyportal.org/country/home/tags/haiti, Accessed 25 July 2016.

[3] World Food Programme. "Haiti Profile." https://www.wfpusa.org/countries/haiti/, accessed 31 January 2017.

[4] IFAD. 2016. "Rural poverty in Haiti." http://www.ruralpovertyportal.org/country/home/tags/haiti, Accessed 25 July 2016.

[5] Data from FAOSTAT: www.fao.org/faostat. Accessed 27 February 2017.

[6] Food and Agriculture Organization of the United Nations. 2015. "State of food insecurity in the CARICOM Caribbean." Bridgetown, Barbados: Food and Agriculture Organization of the United Nations.

[7] Food and Agriculture Organization of the United Nations. 2015. "State of food insecurity in the CARICOM Caribbean." Bridgetown, Barbados: Food and Agriculture Organization of the United Nations.

[8] Another concern, which is beyond the scope of this analysis, is the impact of cheap rice imports from the U.S. on Haitian rice markets and farmers.

[9] See Cochrane, N., N. Childs, and S. Rosen. 2016. "Haiti's U.S. Rice Imports" USDA Economic Research Service, RCS-16A—01. The political and economic concerns that this dependence on U.S. rice may be real, but they are also beyond the scope of this analysis.

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[15] Sinha, S.K., and J. Talati. 2007. "Productivity impacts of the system of rice intensification (SRI): A case study in West Bengal, India." *Agricultural water management.* 87:55-60.

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American Journal of Agricultural Economics. 86:869-888.
[20] Gathorne-Hardy, A., D.N. Reddy, M. Venkatanarayana, and B. Harriss-White. 2016. "System of Rice Intensification provides environmental and economic gains but at the expense of social sustainability? A multidisciplinary analysis in India." *Agricultural Systems* 143:159-168.
[21] Noltze, M., S. Schwarze, and M. Qaim. 2013. "Impacts of natural resource management technologies on agricultural yield and household income: The system of rice intensification in Timor Leste." *Ecological Economics.* 85:59-68.
[22] Moser, C.M., and C.B. Barrett. 2003. "The disappointing adoption dynamics of a yield-increasing, low external-input technology: the case of SRI in Madagascar." *Agricultural Systems.* 76:1085-1100.
[23] Takahashi, K., and C.B. Barrett. 2014. "The System of Rice Intensification and its Impacts on Household Income and Child Schooling: Evidence from Rural Indonesia." *American Journal of Agricultural Economics*, pp. 269{289.
[24] See Turiansky, A., T.J. Lybbert, R.Tescar, T. Bourdier, and M.R. Carter. "Who Benefits from the System of Rice Intensification (SRI)? Impact Evidence from a Randomized Control Trial in Haiti" Working Paper.
[25] This supplementary credit was calibrated to cover the average increase in weeding labor costs attributable to SRI based on earlier pilots and trials by our research partners. It was also conditional on adoption of SRI. Calibrated and conditioned in this way, it was designed to simply offset the additional costs associated with SRI and thereby enable liquidity-constrained farmers to adopt SRI.
[26] Proponents of SRI also claim that expenditures on seeds and water should be reduced. We did not observe lower seed expenditures in our treatment group so we do not include this in our analysis. In the Artibonite, farmers do not pay for water, so any water savings do not translate into financial savings for farmers.
[27] Data from FAOSTAT: www.fao.org/faostat. Accessed 27 February 2017.
[28] IDB. 2009. "Programme d'intensification agricole de la Vallée de l'Artibonite: Une contribution à la relance agricole en Haïti" 1 March. http://www.iadb.org/fr/infos/articles/2009-03-01/programme-dintensification-agricole-de-la-vallee-de-lartibonite,5520.html (Accessed 2 March 2017).
[29] Farmers report their harvest and sales quantities in volume. In our analysis, we have converted volume to weight based on the average density of rice produced in the Artibonite. To simulate sales by weight for higher-density SRI rice, we assume that the by-volume price of rice increases accordingly.
[30] Our agronomic partners in Haiti tested the densities of rice grown by different techniques in agronomic trials. They found that SRI was, on average, 25% heavier by volume. Others have found the same pattern (Thakur, A.K., N. Uphoff, and E. Antony. 2010. "AN ASSESSMENT OF PHYSIOLOGICAL EFFECTS OF SYSTEM OF RICE INTENSIFICATION (SRI) PRACTICES COMPARED WITH RECOMMENDED RICE CULTIVATION PRACTICES IN INDIA" *Experimental Agriculture* 46(1): pp.77-98). The mechanism behind this benefit is unclear. Some breeders speculate, for example, that it may be due to delayed harvest of SRI due to uneven grain ripening.
[31] Khosa, M. K., B.S. Sidhu, and D.K. Benbi. 2010. "Methane emission from rice fields in relation to management of irrigation water" Journal of Environmental Biology. 32, 169-172.
[32] See Turiansky, A., T.J. Lybbert, R.Tescar, T. Bourdier, and M.R. Carter. "Who Benefits from the System of Rice Intensification (SRI)? Impact Evidence from a Randomized Control Trial in Haiti" Working Paper.
[33] http://www.fao.org/giews/countrybrief/country.jsp?code=HTI

The System of Rice Intensification (SRI) in Haiti: Trajectory, Potential and Future Prospects

Haiti Priorise

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Foreword

The April 2008 food price crisis sparked renewed investment in agriculture, but the real question is this: what kind of agriculture is encouraged? In 2013, the United Nations Conference on Trade and Development (UNCTAD) reported that actions remain strongly focused on strengthening production, particularly with the slogan "more with less." This "solution" takes into account the resources available to our small farmers. This publication recalls the need to invest in the System of Rice Intensification for truly sustainable agriculture and food sovereignty. The SRI is an agro-ecological approach initially focused on increasing rice yields in manual planting out. Since the beginning of the 1990s, intensive rice systems have been promoted, because they allow yields of more than the 0.7 tons/ha generally obtained in the Artibonite valley when water can be controlled. The SRI notably involves transplanting fewer, younger and further-spaced plants grown in primarily aerobic soils rather than permanently flooded fields. The SRI brings various social, economic and environmental benefits. If supported by appropriate policies and investments, these benefits can be further strengthened to enable our small farmers to gain access to food sovereignty.

Context and Justification

According to researchers at the University of Cornel, the System of Rice Intensification (SRI) has increased production by four, reaching average yields on the farms concerned of 8 tons of rice per hectare. The SRI is more economical for farmers, who use 10 times fewer plants and 100 times less water than traditional farmers. The basic principle consists in transplanting younger rice plants (less than 15 days old compared to 30-day-old plants in normal techniques), giving them more space and limiting the water supply as much as possible. By alternating irrigation and drier periods, the SRI promotes the appearance of aerobic organisms (developing only in the presence of air), which in turn favor the growth of the plants. The necessary presence of these microorganisms also prevents the utilization of artificial pesticides. In addition, for each season in culture of SRI (System of Rice Intensification), the soil ecosystem improves and, therefore, so does the potential for future crop performance.

The System of Rice Intensification or SRI has thus attracted a great interest among those concerned with sustainable rural development in general and agriculture in particular. It has been demonstrated through research station trials and Malagasy farmers' experiments, as well as through experiments in other tropical countries (Uphoff et al., 2002), that the SRI increases yields considerably, if not spectacularly, and this is done with little or no purchases of external inputs. Given these results, it was natural to believe that the SRI could be particularly beneficial to the poorest farmers. However, despite the apparent benefits of the SRI, the method has not yet been widely adopted in Haiti. The predominant role of rice in household income, food, and land use in Haiti's rural environment suggests that increasing rice yields among smallholder farmers may have significant impacts on both Haitian poverty and the Haitian environment.

Produce More and Produce Quality to Ensure Food Sovereignty and Increase Household Incomes

This technique (SRI) consists in providing to the rice plant all the conditions necessary to optimize its growth. It limits the need for seeds by improving yields due to the multiplication of vigorous and productive suckers. This involves a careful transplanting of young plants (sprig by sprig at the two-leaf stage or two sprigs at the three-leaf stage) transplanted with spacing of more than 20 cm, extensive organic fertilization and perfectly controlled water management in order to avoid asphyxiation of the plants while stimulating their root development. The regular entry and evacuation of water, followed by manual weeding, favors the oxygenation of the soil and the availability of mineral elements for rice. In SRI (System of Rice Intensification), nursery stock is less than eight days old, while a 15-day plant can be planted in an SRA (Improved Rice-Growing System) although they have already begun to sucker. During the two weeks after transplanting, the soil is kept moist; watering and draining of the rice fields are alternated in SRI.

The SRI can meet the challenge of providing small farmers with low-input and non-labor-intensive techniques that increase yield and protect soil. In addition to better agricultural techniques, rice farmers also need quality inputs for rice production.

The principal strengths of the SRI techniques are as follows:

- Securing and increasing rice production. In the Artibonite valley and in Mirebalais (USAID, 2010), USAID/WINNER support enabled farmers to increase yields from 0.7 tons to 2 tons/ha on average
- Increased rice production in the rainy season and in off-season.
- The saving of seeds for equivalent or higher productions
- The possibility of reducing transplanting times because the number of plants to be transplanted is lower due to wider spacing, although the seedlings need to be handled more carefully
- Better use of available water

Thanks to the SRI, rice producers have seen their output increase significantly over the past two years. The increase in agricultural yield recorded over the past two years by USAID-supported producers in the North is explained by the introduction of new cropping techniques and high-quality inputs, more systematic supervision of farmers, training of farmers, etc. Experience has shown that the SRI produces higher and more stable yields than the traditional working system from the first growing season.

The Potential of SRI (System of Rice Intensification) in Haiti

When rice paddies can be managed to facilitate good water management, SRI is a productive and secure technique that requires seeds and manure or compost, and no or little mineral fertilizers, herbicides or pesticides. The possibility of increasing yields or reducing production costs varies according to the socio-economic contexts and rice cultivation habits, and the availability of organic manure to our farmers. However, on the basis of observed practices, technical elements of the SRI can often demonstrate themselves to be very relevant. This is evidenced by the range of results already existing in the Artibonite Valley and in the Central Plateau with the USAID/WINNER project.

Strengthening the Competitiveness of the Rice Value Chain

A rice value chain intervention benefiting small farmers consists of approaches that integrate them into this chain with the objective of increasing their incomes, first by improving producer prices (pricing policy) and by taking account of constraints in a coordinated manner. In Haiti, where rice is the main cereal consumed in both urban and rural areas, it is important not only to enhance export competitiveness but also to develop sustainable agricultural systems (especially the SRI), fight poverty and promote financial inclusion, particularly of the rural poor. To strengthen the competitiveness of the local rice value chain, the development support structures recommend a formalization of the relationships between stakeholders in the value chain. The value chain approach should focus on the interrelationship of the actors in the chain, that is to say, relations based on dialogue, the exchange of information, in short, on relationships of trust that can lead to commitments. The latter can be oral, that is based on an informal arrangement, or formalized through a written document (contracts).

- ✓ Focus on Rice Quality to Be More Competitive

Quality criteria are becoming increasingly important to our consumers. The actors in the rice value chain who wish play their cards right in the commercial game must therefore ensure that the rice they put on the market is of good quality and respect the standards set by the international community. Small farmers' adherence to the value chain must be strongly subordinated to their ability to meet international standards and product quality standards. These standards require strict compliance with certain health and safety rules in production processes. The intervention of public authorities through appropriate policies and market regulation could help to ensure social accountability for an equitable distribution of added value in the rice value chain.

The local rice sector is struggling to meet this demand, even though urban populations remain strongly anchored in rural areas and remain attached to traditional products. The market thus remains insufficiently supplied due to low productivity, irregular supply and quantity, lack of adequate infrastructure and services for consolidation, transport, processing and marketing.

Developing Adequate Public Support to Promote Agro-Ecological SRI Practices

The government's trade policies concerning rice imports and exports play a key role in ensuring that the supply and demand of rice is fully matched to our market, achieving prices that take into account the interests of each, and limiting the impact of global price volatility. The effectiveness of these policies also depends on the capacity of the sector to structure itself. Trade in rice is in fact massively distorted by the agricultural policies of the developed countries (USA, EU, DR), both in terms of border measures (tariffs, quotas, non-tariff barriers) and in terms of support for exports and domestic support. Support measures for supply chains and policies for the protection and regulation of markets must therefore be formulated and implemented in a coherent manner.

For this, the government must:

- Establish a national framework for the implementation of agro-ecological SRI production; invest in agro-ecological research, its dissemination and its teaching
- Encourage collaboration among farmers, local populations, extension workers, teachers and researchers in problem identification, experimentation and innovation
- Support agro-ecological SRI practices in their public procurement programs on food (for example, for schools, hospitals, etc.)
- With small-producer organizations, explore the viability and benefits of promoting a certification or other tools to support the sale of agro-ecological SRI products; consider the implementation of more direct aid (such as payments for ecosystem services) and measures to improve access to finance to support smallholders in their transition to agro-ecological systems; consider ways to ensure that the private sector can participate in efforts to deploy the agro-ecological SRI on a large scale (through incentives and disincentives/regulations)

- Create or strengthen regulatory and compliance systems on hazardous pesticides that can degrade systems and delay the ecological rehabilitation of land subject to intensive farming

The challenge will be to do everything possible so that researchers specialized in genetics, soil sciences and crop defense and protection are also able to have a global and future-oriented vision of the conditions under which the various types of farmers are exposed to competition on international markets and the implications of these markets for income and for becoming SRIs in Haiti.

Can Haiti's Tariff Policy on Rice Stimulate Rice Production?

From the beginning of the 1980s, we saw a change of context. First, from the point of view of ideas, there was a paradigm shift with the questioning of the Keynesian consensus, which has dominated economic reflection and debates on development since the end of the Second World War. A new intellectual context emerged which made the market the principal institution for regulating economies. This consensus called into question state interventionism insofar as it created distortions that are at the root of all imbalances in economies. The reestablishment of equilibrium required the state to withdraw from economic activities and to give the market a more important role in the regulation of economic activities. Particularly in the agricultural sector, the new policies adopted in the 1980s were characterized by a profound questioning of interventionism and a bet on the capacity of private actors to take charge and to ensure a resumption of agricultural production. Yet, a few years later, we realized that these new choices in agricultural development had not had the expected results.

- ✓ Haiti must have agricultural policies to regulate supply and hence agricultural incomes and the purchasing power of consumers:

First, on import by modulating the import duties according to our need. Using more effective tools than fixed tariffs, which are not sufficiently protective when the world price is very low and the exchange rate fluctuates, but either variable levies that guarantee a fixed price in gourdes or import quotas. It is this lack of supply control, accentuated by the dismantling of existing measures—a reduction in import protections and a "decoupling" of subsidies— whose effect, contrary to the predictions of the econometric models—which predicted that the liberalization of agricultural trade in the Uruguay Round would increase world prices—has been a collapse of these prices.

An increase in tariffs on rice would probably lead to higher prices in the domestic market, especially for mainly imported rice. Studies carried out in other developing countries in similar situations have shown that certain categories of producers would respond in a particularly positive way to rising rice prices, particularly over the medium term. Thus, a policy to increase rice prices in Haiti would likely result in increased rice production.

All of these reasons explain the importance the country should place on the agricultural question in the context of international trade negotiations. Improving current conditions in international agricultural markets and taking greater account of their concerns could help to accelerate economic growth. In this respect, market access issues are of paramount importance because of their impact on competitiveness both on the domestic and external markets of our agriculture.

- ✓ What Lessons in Terms of Trade Policy?

Analysis of the different scenarios suggests that our governments may be led to choose between favoring tariff revenues, on the one hand—which would protect local rice producers in the face of rising rice imports—, and, on the other hand, favoring consumer surplus. Indeed, projections show that significant liberalization is favorable to the consumer surplus but unfavorable in terms of tariff revenues. Significant and rapid liberalization could also be detrimental to our smaller, local farmers who are less competitive than the international competition. Limited liberalization and special and differential treatment, as has already been noted, appear to lead to a more limited reduction in tariff revenues and a less rapid increase in imports.

Protecting Small-Farmer Rice Seeds

Today, the development, production and distribution of seed varieties is in the hands of private firms. Everything now goes through the seed industry, which imposes its criteria of homogeneity and standardization. This approach has led to the disappearance of multiple varieties. The idea is, therefore, to return to a mode of production more adapted to the new challenges of resilience (climate change), of biodiversity (taste, etc.) and local autonomy. In our society, there is a renewed interest in the old varieties of rice (madame gougousse), sought after by a growing number of consumers. It is at once the diversity of colors and forms that attracts and, even more so, a rediscovered flavor. In the cultivated biodiversity fairs, it is not uncommon to notice, at the tasting stands for products of ancient varieties, people won over by emotion upon finding the subtle perfume of the delicious food of their childhood.

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Haiti faces some of the most acute social and economic development challenges in the world. Despite an influx of aid in the aftermath of the 2010 earthquake, growth and progress continue to be minimal, at best. With so many actors and the wide breadth of challenges from food security and clean water access to health, education, environmental degradation, and infrastructure, what should the top priorities be for policy makers, international donors, NGOs and businesses? With limited resources and time, it is crucial that focus is informed by what will do the most good for each gourde spent. The Haïti Priorise project will work with stakeholders across the country to find, analyze, rank and disseminate the best solutions for the country. We engage Haitans from all parts of society, through readers of newspapers, along with NGOs, decision makers, sector experts and businesses to propose the best solutions. We have commissioned some of the best economists from Haiti and the world to calculate the social, environmental and economic costs and benefits of these proposals. This research will help set priorities for the country through a nationwide conversation about what the smart - and not-so-smart - solutions are for Haiti's future.

Haïti Priorise

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