

THE ADELANTE INITIATIVE
BRINGING THE SUGARCANE INDUSTRY FORWARD

RECOMMENDATIONS FOR INTERVENTION & RESEARCH

ZAFRA OCT. 2017 – APR. 2018
Ingenio San Antonio, Nicaragua



WE-Adelante Research Team

SEPTEMBER 2018

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Project Overview: Adelante Initiative

During the last decades, an epidemic of chronic kidney disease of undetermined cause (CKDu) has been detected among agricultural and other heavy laborers around the world. The cost has been thousands of lives lost with thousands sick and without access to adequate care. This not only has depleted the availability of a healthy workforce to the extent that we now see women in traditionally male dominated jobs, but it has begun to tear at the social fabric of communities where too many households are headed by widows whose sons face the same fate as their father's. There is a growing body of evidence that labor practices, specifically strenuous work in heat without sufficient rest or hydration, is a driver of the disease. Other factors, such as toxins (e.g., pesticide exposure, particle pollution) and infection, may play a role in the development of the disease. However, ongoing research is needed in the occupational setting. CKDu has no cure, but it is possible to address and further understand the disease by addressing known risk factors in the occupational setting. This allows for improved documentation of events linked to the onset and progression of the illness and make efforts to mitigate risks more effective.

The culmination of decades of CKDu research, labor practice assessments by La Isla Network (LIN) and Ingenio San Antonio (ISA), and coordination and collaboration among key stakeholders, has led to a new platform known as "The Adelante Initiative". This initiative will evaluate work practices and improve them with the best possible data while utilizing the learnings from the Worker Health and Efficiency Program (WE Program) and current practices at ISA. The Adelante Initiative provides what is essentially a dynamic lab at ISA, one of the most logistically competent mills in the Americas. This provides an incubator from which standards for effective occupational safety and health can be honed and then scaled to other industries and geographies. The Adelante Initiative's partners are: Bonsucro, La Isla Network (LIN), Nicaragua Sugar Estates Limited (NSEL), The Nicaraguan Sugar Producers Association (CNPA) and the German Investment Corporation (DEG).

LIN and ISA will provide the lessons learned from our efforts so that all stakeholders may benefit regionally and globally. Phase 1 (2017-18 Harvest) of the project provides the baseline from which we will develop improved interventions in Phase 2 (2018-19 Harvest). Phase 3 (2019-20 Harvest) will entail further refinements and the beginning of validating these efforts. Learnings will help inform the Bonsucro certification and be used to inform policy advocacy for worker protections on the state and international level. Together, Adelante partners will continuously improve sourcing, certification, production and loan provision standards. The outcomes produced from the Adelante Initiative will support all actors along the supply chain looking to ensure their sugarcane is sourced responsibly and in line with their procurement goals and mean tangible improvements for the workforce.

We are assessing risks, improving mitigations and work practices via evaluating and improving organizational systems, technology, tools, and more. We are validating all we do, and work to create scalable systems that can aid other large mills as well as smaller land holders and other industries. An essential component will be ensuring that the practices we create and validate together will become industry standard via interface with certifications, governments, the International Labour Organization and other bodies that require greater resolution in their efforts to assure a safe and secure workplace.

Project Deliverables and Timeline

1) Baseline data collection and results

Report on baseline renal function, dehydration markers, work history, and other indicators.

Submission Date: September 15, 2018

2) Assessment report of current work practices and risks, preliminary assessment of machete and current PPE

Submission Date: September 1, 2018

3) Assessment of Occupational Health and Safety Application

Submission Date: September 22, 2018

4) Analysis of baseline and follow-up biological and research data

Preliminary report on current health outcomes and other data from workforce based on Year 1 data collection

Submission Date: September 22, 2018

5) Recommended machete design

Report and work plan for production and assessment

Submission Date: September 15, 2018

6) Preliminary return on investment analysis of NSEL's occupational safety and health program

Report on return on investment compared to not having intervention

Submission Date: September 30, 2018

7) Recommendations based on findings pursuant to points 1, 2 and 4

Beta educational materials (online/downloadable) for educating relevant stakeholders on progress of project and relevant findings

Submission Date: September 30, 2018

8) Protocols for phase 2 and 3 health assessment and analysis of tools and improved intervention as well as community perceptions research

Formal protocols and timelines

Submission Date: September 30, 2018

Glossary

Research Terms

Acute Kidney Injury (AKI): A recently developed reduction in kidney function, from a baseline level which may be normal, or already lowered due to chronic kidney disease. May be transient but may develop into a chronic condition if the kidney function reduction is maintained for > 3 months. AKI is formally defined by KDIGO¹ as increase in creatinine by ≥ 0.3 mg/dL within 48 hours; or increase in creatinine to ≥ 1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or urine volume < 0.5 ml/kg/h for 6 hours.

Chronic Kidney Disease (CKD): CKD is when the filtering function of the kidneys is so reduced that it becomes a health problem, and this condition is maintained for more than three months. CKD often occurs without symptoms, but there is still an elevated risk of dying prematurely.

95% Confidence Interval (CI): The range of values within which there is a 95% probability that the true value occurs. It is a way of quantifying the uncertainty in an estimate that comes from chance.

Creatinine: A substance that emanates from the muscles, which is cleared from the bloodstream by the kidneys. Increased level is generally related to decreased filtration function of the kidneys. It is the most commonly used marker of kidney disease. The creatinine level also depends on age and sex, and factors like meat intake and muscle mass.

eGFR (estimated Glomerular Filtration Rate): An estimate of the volume of blood that passes through the kidney every minute. It is a more functional estimate of kidney function than the creatinine level. In this report it is calculated with the CKD-EPI equation which uses the creatinine level, age and sex. The reference value: > 90 mL/min/1.73m² (decreases with age).

EPA: United States Environmental Protection Agency. The EPA is an agency of the United States federal government whose mission is to protect human and environmental health.

Hematocrit: The volume percent of a blood specimen that consists of red blood cells measured after these red blood cells have been spun to the bottom by centrifuging the blood sample. Normal range for hematocrit is different between the sexes and is approximately 45% to 52% for men and 37% to 48% for women.

1. KDIGO is the leading global nonprofit organization developing and implementing evidence-based clinical practice guidelines in kidney disease.

OSHA: United States Occupational Safety and Health Administration. OSHA is an agency of the US government under the Department of Labor with the responsibility of ensuring safety at work and a healthful work environment. OSHA's mission is to prevent work-related injuries, illnesses and deaths.

Uric Acid: A product of normal metabolism. Levels increase with diabetes, obesity, gout, and other metabolic disorders, and diets rich in liver, red meat, sugar and alcohol. In the presence of kidney disease high levels of uric acid are observed. The role of uric acid as a cause of kidney disease is debated. Nevertheless, some treat high uric acid levels pharmacologically in an attempt to mitigate progression of kidney disease, without good clinical trials yet showing evidence of this being effective.

Wet Bulb Globe Temperature: The wet-bulb globe temperature is a type of apparent temperature used to estimate the effect of temperature, humidity, wind speed, and visible and infrared radiation on humans. It is used by industrial hygienists, athletes, and the military to determine appropriate exposure levels to high temperatures.

Job titles

Note that some job titles translate well directly into English whereas others do not, so Spanish and English terms are used.

Agrochemical applicators: Workers tasked with spraying pesticides, especially herbicides, directly onto the fields. They wear impermeable personal protective equipment (PPE) which makes heat stress a concern though their workload and work hours are shorter than for most field workers.

Acarreo: Workers who pick up, load and unload bags of seed from the seed cutting fields and transfer them to the fields that need seeding. These workers work in quick bursts lifting heavy loads and should have heat stress and hydration programs.

Burned sugarcane cutters: Workers that cut burned sugarcane. They are exposed to high heat, heavy workload, and fine ash during their workday. One of the heaviest jobs recorded by physiologists, this group is a priority for risk mitigation and assessment.

Gaviotas: These workers who work with the mechanical harvesters and where the cane transportation carts are located. They direct the tractor drivers where to unload the cane into the carts. They pick up the cane that is spilled in the process and they hook the carts to the trucks that transport the cane to the mill. They work 12 hour shifts. Their breaks for resting and hydration are not yet regulated.

Health Promoters: Field staff who educate workers on the importance of water, rest and shade, other health related topics and ensure compliance with policy. They help ensure workers have access to water, move tents and support hydration operators.

Hydration Operators: These workers help ensure water is accessible for the labor force. They carry large insulated backpacks with bolis and distribute them.

Irrigators:

There are five types of irrigation workers in the sugarcane fields.

1. **Drip irrigation repair worker:** Responsible for repairing damaged drip irrigation systems.
2. **Irrigation and drainage operator:** Evacuates surplus water, when the soil no longer has the capacity to absorb rain, or drain stagnant water to create aeration in the roots of plants and facilitate cutting work.
3. **Irrigation canal operator:** Responsible for maintaining the irrigation canals and direct water flow throughout the mill's gravity irrigation system.
4. **Sprinkler irrigation operator:** Maintains and operates the large sprinkler irrigation systems.
5. **Pivot irrigation operator:** This person is in charge of the operation and safety of the water cannon irrigation machines.

Paileritos: Cane cutters who manually cut the cane that a mechanical harvester may not be able to reach due to dips in terrain, telephone or electric poles or other obstacles. They also face long days and their risk mitigations should be prioritized.

Seeders: Using cuttings from cane these workers work rapidly to plant new fields for the next harvest.

Seed cutters: A job that we surmise is second only to burned cane cutting in terms of workload. These workers cut green cane into cuttings that are later used for seeding operations and then bag the cuttings before gaviotas load the bags for transport.

Reseeders: Mechanical harvesting often tears up the ratoons that form the roots for sugarcane to grow from. Reseeders are tasked with filling gaps that are torn up from mechanical harvesting and vehicle traffic on the fields.

Hydration

Boli: Single use rehydration solution packets containing an electrolyte heavy mixture in disposable plastic bags.

Thermos: An insulated personal water receptacle for workers. The predominant model at the mill hold 4.8 liters (1.3 gallons), some other models at the mill are 9 liters (2.4 gallons) and 2 liters (.53 gallons).

Tank: 190 liter (50 gallon) barrels on transport

Refill station and water cooler: 38 liter (10 gallon) water coolers like those seen at most sports events.

Organizations

Bonsucro: The leading sustainable certification system for sugarcane production in the world.

CNPA: Nicaraguan Sugar Producer Association represents the growers and mills of Nicaragua, their president, Mario Amador, is also the current chair of AICA which is the regional equivalent for Central America.

DEG: The German Investment Corporation loans to private industry to aid development and advancement in developing countries.

ISA: Ingenio San Antonio is the mill where the Adelante Initiative's research takes place and is one of the leading and most competent mills in Mesoamerica.

LIN: La Isla Network is an NGO with a small core team that recruits leading investigators and researchers to tackle issues pertaining to CKDu and occupational health.

Lund University: Lund is a leading university in medicine, engineering and other disciplines in Sweden. Several Lund University professors have been long time collaborators of LIN.

Other

Healthy worker effect: The phenomena that a working population has a reduced prevalence or incidence of disease compared to a non-working population. This effect is due to the fact that the working population has been continuously selected for being healthy enough to work. Individuals with poor health and those susceptible to disease are likely to leave work.

Zafra: Season for sugarcane harvesting, in Mesoamerica typically between November to April.

Accompanying Documents

1. [Modified US Military Water Rest. Shade Schedule](#) is an exploration of the basis from which we should consider our design of intervention programs.
2. [Retrospective Database Report](#) shares assessments of the database itself while providing an initial analysis of the data while recognizing the limitations in the source material.
3. [Pilot Return on Investment Report](#) demonstrates the ROI for the occupational health programs among field workers at the mill as well as outlining a way to improve the ROI, including the provision and creation of data sets by the mill that will help better measure the ROI in the coming years.
4. [Agrochemical Handling Report](#) gives an overview of current conditions and recommendations for agrochemical mixing and application.
5. [Draft Recommendations Spreadsheet](#) provides a table so that Adelante Initiative members can prioritize both the audience and the key areas of interest as we move to the next phase and create recommendations and guidance for a wider audience.

Executive Summary

Background

The epidemic of chronic kidney disease of undetermined causes (CKDu) among agricultural workers in Central America motivated the WE Adelante study described in the report *Baseline Data Collection (DEG Report 1)*. It is generally accepted that heavy, demanding, physical labor puts workers at risk of heat stress that can harm the kidneys. In an effort to prevent this, the sugarcane farming and processing company, Ingenio San Antonio (ISA), has developed an intervention program. LIN was asked to determine if their program is sufficient, if improvements are needed and to assess whether such improvements are effective at limiting damage to the kidneys while addressing other occupational risks.

Our initial approach during the harvest season 2017-2018 was to evaluate the sufficiency of the current intervention program. We have followed several groups of workers during the harvest season primarily to see how the different degrees of the current intervention relate to reduced incidence of renal dysfunction. At the same time, we made observations to help understand the occupational risks that may be associated with renal dysfunction with a special focus on workload (e.g., a burned cane cutter has the highest workload, while an office administrator has the lowest). These findings can be found in *Impact of Prevention of Heat Stress and Dehydration on the Renal Function of Sugarcane Field Worker (DEG Report 4)*.

This report is intended for the members of the Adelante Initiative so that we may take stock of the findings from the first year and begin adjusting the scope and focus of the work as needed, while directing efforts towards improved protection of the workforce.

Project Objectives

The general objective of the Adelante Initiative is to evaluate the current occupational health interventions, and to determine if cane cutters, seed cutters and drip irrigation repair workers maintain stable renal function over the course of three harvests. If current interventions are found to be inadequate for one or more worker categories, improvements to the present interventions will be recommended based on field observations and research findings. The efficacy of those improved mitigations will then be measured in the subsequent harvest. Successful interventions will be standardized and adaptation for other at-risk groups will follow.

Population, Location and Time Frame

The recommendations in this report are based on research that was carried out over one harvest at Ingenio San Antonio in Nicaragua (2017-2018). The work is planned to continue for at least two more years.

A total population of 609 workers was included for Phase 1, and analyzed in categories divided by job and workload. This included burned cane cutters on the high-end of the workload spectrum and office administrators on the low-end of the workload spectrum. Recommendations are based on preliminary analysis of this research, heat stress management guidelines identified from leading institutions and attention to known risks faced by sugarcane workers identified in scientific literature.

Key Recommendations

The full report is divided into two main sections, the first addresses intervention implementation and the second discusses research priorities.

Key Recommendations for Intervention Implementation:

- 1. The current interventions at ISA require a thoughtful redesign.*** By assessing temperature and looking at evidence-based best practices developed by the U.S. Military it is clear that current work/rest schedules are insufficient. However, by dedicating the appropriate resources we believe the WE Adelante research team and the ISA occupational safety and health team can create, implement and document the best, most feasible interventions.

2. Implementation matters as much as design. If not implemented effectively an intervention cannot protect people. It is essential that we assure proper implementation of interventions so we may:

- A. Protect workers. This is the primary consideration.
- B. Accurately assess whether interventions are effective. If an intervention is not well implemented we may erroneously conclude that the intervention was ineffective not because it was unfeasible or designed poorly, but simply because it was not adhered to due to issues with training and implementation. This could be detrimental to both policy development as well as present unneeded liability and risk for the mill.
- C. Address an emerging dialog among some in the research community that can be summarized as “even with interventions illness occurs, therefore interventions are not a priority since there must be other causes.” This logic assumes that if an intervention does not eliminate all disease it is not effective at all. This dialog damages the ability to gain support and buy-in to rigorously design and implement interventions that can be validated to improve worker kidney health. As a consequence, workers continue to be put at risk.

Key Recommendations for Research:

1. **Measuring workload and heat stress among all field worker categories is essential.** In order to develop efficient and effective interventions we must understand the relative workload in major job categories.
2. **Loss to follow-up is a serious challenge and results in a likely underestimation of disease in the workforce as reported in the cross-harvest analysis.** It is essential we dedicate the necessary resources to understanding the reasons workers left the workforce as well as have the ability to measure their relevant health parameters. This will add importantly to understanding the true efficacy of the intervention as even though findings are striking they are quite likely an underestimation, especially among burned cane and seed cutters.
3. **Assessing frequency and duration of breaks is essential.** By assessing break frequency and duration in association with workload levels we can determine if breaks are frequent and long enough to maintain work capacity.
4. **Assessing ongoing access to water and proper hydration practices is also essential.** Methods are needed to assess that sufficient water is available in the field and that there is adequate hydration of the workers in the different jobs and thus assure the planned intervention is adequate and implemented.

5. ***Management of health and related data at the mill can be improved and better utilized for understanding CKDu and the efficacy of interventions.*** As the [Retrospective Database Report](#) (DEG Additional Report) and [Pilot Return on Investment Report](#) (DEG Report #6) demonstrate, there is the need to improve the way data are recorded and managed electronically at the mill. This is an effort the WE Adelante research group is able to assist with. Improved management of these data and implementation of effective systems will help us better understand the efficacy of the intervention and likely provide further insights into CKDu as well as better serve ongoing needs of the mill's health and safety operations.
6. ***Coordination of the workforce participating in the study can be improved.*** During the loss to follow-up study it was discovered that a sizable number of workers initially believed to have left the workforce were still employed by Ingenio San Antonio. By working together we can assure we capture as much of the workforce as possible and essential data is not lost.

Conclusion

The Adelante Initiative is the only research-backed work on CKDu focused on reducing risks for the workforce. It is agreed that research on etiology should continue, but to wait for the final answers from this research would be irresponsible. There is already sufficient evidence to drive the development and implementation of interventions that, even with some uncertainty, can greatly enhance the health of workers today. This, not etiology, should be the focus of industry support as it is the area of most relevance and greatest potential impact by industry in addressing the disease.

The time to act is now. The findings to date make clear the need to improve interventions and assess their efficacy. There will always be challenges, but given what we know after Phase 1 of the initiative, it is now both unethical and a liability not to aggressively work to limit heat stress and kidney damage among the workforce utilizing our best available data and collective resources. It does not serve the company, the wider industry, or the development sector, not to make the necessary investments today. This team can surmount whatever barriers we are confronted with. However, financial resources to pursue what is clearly required, with a qualified team at the ready, should not be a barrier when some of the most powerful organizations in the region and the world are involved. It is unlikely we will have this opportunity again. Lives can be improved and extended if we we act with what we know now and with sufficient recourse to do so. Banks, certifications bodies and industry cannot in good faith continue business as usual given the findings from this collective effort and the ability we have to address this challenge together.

While CKDu may exist in other industries, the risks associated with AKI, heat stress and chronic disease facing workers in the sugarcane industry are due to occupational health and hygiene challenges in that industry. Regardless of what occurs elsewhere, the deficiencies documented must be addressed, and aggressively, so that we may protect the workforce at ISA. We can then utilize what we develop in Nicaragua to protect other workers along the supply chains at risk that are represented in CNPA, AICA, Bonsucro membership and the DEG client portfolio. An important thing to remember is that every industry player that has denied having this disease, who has since tested their workforce, has in fact had the disease among their workers. Absence of evidence is not evidence of absence. We must recognize that what we do here will have impact far beyond Nicaragua as it is extremely likely that CKDu is unreported and unaddressed throughout the tropics. As the globe continue to warm it will become a concern for even more populations. Together we can address this challenge efficiently and effectively. It will require appropriate support. The recommendations in this report are the first firm step in the effort to adequately provide relief for those at risk in the occupational setting.

This report is intended for the members of the Adelante Initiative so that we may take stock of the findings from the first year and begin adjusting the scope and focus of the work as needed while also directing efforts towards improved protection of the workforce. The report consists of two parts, i) recommendations specific to the current interventions being implemented and ii) recommendations for the research team and mill regarding research design, data collection and priorities.

This is meant to provide the basis of a deeper discussion of what we do and how we do it. This is also intended to help understand the importance of the sub-studies (analyzing workload, heat stress and hydration) in better assessing how adequately the interventions are protecting the workforce. These studies will yield further insights and recommendations. Therefore, this document should be considered a BETA version that will be improved via discussion and research. This document will also form the basis of stakeholder specific guidance documents that will be created via interaction with the current stakeholders and other parties we engage. The exercise of creating the first public facing recommendations should be undertaken as the first activity after baseline data collection. Drafts should be completed by December 15th of 2018.

Methodology

This report relies on the findings from field observations and the analysis of biological samples and questionnaire data collected during Phase 1, conversations between mill staff and researchers, as well as some insights provided from constant monitoring of published research.

Section I - Intervention Implementation

Implementation of Interventions at ISA and Possible Limitations of Efficacy

The current interventions at ISA are, to our knowledge, the most rigorous occupational health efforts implemented in the Latin American sugarcane sector. They are an important effort to reduce the risks faced by the workforce at Ingenio San Antonio. However, having reviewed the findings from Phase 1 of the Initiative it appears they are not yet sufficient or robust enough to protect burned cane cutters from loss of kidney function over the zafra. It is possible the current program is approaching an adequate level of protection for less physically demanding jobs, but this requires further follow-up to be confident of this observation. If we look back at the Laws et al study from Boston University², it was clear other job categories were at risk of decline in kidney function, which suggests there may be adequate protection of workers facing less intense workload exposures. This underlines the importance of understanding the workload exposures and kidney function among all field worker categories at the mill.

Field observations during last zafra suggest that the principles of the intervention program were not always successfully translated into daily practice at the job site in any of the groups studied. Great care should be taken to assure that existing or improved intervention protocols are followed and that these provide sufficient hydration, accessible shade areas, and adequate break times.

Implementation of these interventions must be rigorously assessed in the fields, especially for the burned cane cutters. As of now it is unclear whether the current intervention solely needs to be implemented with greater rigor, whether it requires a design overhaul, or whether the high work demands required of manual burned cane cutting are fundamentally incompatible with human health. Further understanding of these points should be considered a priority for Phase 2.

When two mechanical harvesters failed, new manual cutters had to be hired rapidly and there were no new supplies with which to provide intended protection. Resources for the intervention were split between the new cutting groups and existing cutting groups during the period of highest temperatures, corresponding with end of harvest data collection. With water coolers and tents divided between groups in an effort to provide some protection for all, the result was likely insignificant protection for everyone. The absence of sufficient coverage likely contributed to the high rate of declined kidney function documented in the burned cane cutter workgroup. Unexpected events are bound to happen in a complicated operation like a sugar mill. Going forward, no worker should be hired without proper safety protections in place.

2. Laws RL, Brooks DR, Amador JJ, Weiner DE, Kaufman JS, Ramirez-Rubio O, et al. Changes in kidney function among Nicaraguan sugarcane workers. *Int J Occup Environ Health*. 2015;21(3):241–250.

It is recommended that a bodega be created to store extra tents, water coolers, and thermoses so that mechanical failings or other unseen eventualities can be rapidly adapted to. This is a necessary investment if the occupational safety and health program is to be successful.

The following recommendations begin with general recommendations for each of the field worker teams that were part of the WE Adelante study as well as considerations for those workers not yet covered under a systematic intervention protocol. Specific recommendations then follow for each of the work groups in the study.

General Considerations and Recommendations

Hydration

It is important that all field workers and health promoters have rapid and easy access to sufficient potable water. All field workers should have personal water receptacles and access to water coolers, under shade, that can be refilled by tanks carried on worker transport. For worker categories who move from site to site throughout a day, like some irrigation operators, shaded refill stations should be set up throughout their work area. This will require job specific interventions that we will have to be designed via observation and consultation with the mill. This should be considered a priority.

ACCESS

All studied groups require tents that include a water cooler refill station. This expedites water provision by hydration operators and for workers who may want to refill their water on their own.

Among all groups that the research team visited, they were told that the hydration operator, together with the health promoters, could be flagged down to refill empty water bottles for field workers. Across all the groups visited the researchers did not observe this practice, though did find workers with little or no water left in their bottles.

This emphasizes the importance of having sufficient amounts of water close to where people are working. Hydration outcomes will be better if workers can refill their own water. Sufficient hydration is less likely if workers have to walk long distances, wait for 1-2 people serving the entire work team to come by, or need to walk several hundred meters to the tank on a bus to fill their thermos—a process that could take over 20 minutes. Therefore every field worker should have:

- ~ ***1 personal insulated thermos, 2-4.8 liters (.53 and 1.3 gallons) depending on job category.***



Personal insulated thermos
Photo credit: Bonsucro / Joe Woodruff

~ Access to a 38 liter (10 gallon) insulated water cooler for refilling personal containers which is stored under a mobile shade tent. The tent should be moved by health promoters and other field support staff as workers move in the field. Shade and water should be as close as possible and never more than 75 meters³ from workers.



Photo credit: Bonsucro / Joe Woodruff

~ Ten gallon water coolers weigh approximately 38 kg therefore at least two workers should be tasked to carry these when they need to be moved.

Moving water coolers. The researchers observed some workers who have placed the orange water cooler ahead of them amidst uncut cane so they reach it at a time that makes sense to them and their work pace. This should be encouraged if the workers think it helps maintain their productivity. It is recommended to observe the groups who utilize this practice and ascertain if there are any apparent advantages or disadvantages in terms of meeting their hydration needs.

3. Walking 75 meters over uneven ground requires approximately 2 minutes. To ensure breaks are effective at both lowering body temperature and heart rate, as well as being conducive to production, it's essential breaktime is not squandered on arriving to a suitable resting location.



The mobile tents with a water cooler are an essential part of an effective and efficient intervention.

- ~ **A 190 liter (50 gallon) water receptacle should be kept on transport vehicles** and be easy for health promoters to access and distribute water to the 38 liter (10 gallon) insulated thermoses. It is understood that this is the current practice and is mentioned here so the full hydration program is reflected in the recommendations.

QUANTITY

- ~ **ISA policy is that workers should drink about one liter of water per hour.** Hitting this target will require continuing education of the workers and more rigorous observation by health promoters and hydration operators. Researchers observed that water consumption was likely lower than reported. Often, refill stations did not require resupply from the transport vehicles' water tank despite a many workers exhausting all easily available water before the end of the workday.
- ~ **A calculation of average water consumption based on hours worked and resupply/amount left at refill stations** should be considered. This approach could be included in health promoter training and be supported by a feature in the future OSH app for health promoters.
- ~ **Boli compliance requires improved assessment** as seen in the field observation report.

- ~ It should be noted that it is still uncertain what the average amount of water and boli consumption should be. However, the ISA policy of one liter of water and one boli per hour every hour seems a reasonable place to start for field workers. ***Of note is that overhydration can also be a danger and this risk should be monitored.*** Assessing water and boli consumptions separately should be planned.

QUALITY

ISA's policy of dumping unused water every day and refilling at the mill's water source should continue. If logistical complications make this impossible, then every two days should be the norm. Note that if a significant quantity of water is leftover after two days there may be an issue of insufficient consumption occurring among the workforce. If unused water is not changed out regularly (a minimum of every two days) from larger receptacles the water will take on a plastic taste and be unpleasant to drink.

Many workers are from rural settings and are not accustomed to drinking chlorine-treated water, which is why they are sensitive to the taste of chlorine. Assuring that water is not overly chlorinated and aerating the water before filling tanks or bottles could help minimize the taste of treated water to encourage increased consumption. The news of the installation of a reverse osmosis water purification system at the mill may address some of the concerns about the taste of water cited by workers.

- ~ ***ISA should continue testing the mill's water sources twice a year. These tests should be measured against the U.S. EPA's drinking water regulations (40 CFR Part 141).***
- ~ ***Water should be as cool as possible***, therefore, all field workers should have insulated personal receptacles like those that burned cane cutters have. Water coolers should be stored under shade.
- ~ ***Water should be aerated*** in the process of resupplying the refill stations from the tanks. The hand pumps at ISA that transfer water from the barrels into the water coolers should address this.

EQUIPMENT HYGIENE

Clear protocol for thoroughly cleaning water coolers and tanks on a bi-weekly basis should be assured. In addition to scheduled bi-weekly cleanings, the protocol should also require that cleanings take place in the event that water becomes contaminated.

BOLI MANUFACTURING

Invest in exploration of biodegradable plastics for boli manufacturing. Bolis at ISA provide an effective system for hygienic hydration delivery as they are single use disposables. However, this creates an environmental concern due to the large amounts of petroleum based plastic waste generated. Given the growth in bioplastics, including those produced by sugarcane, it is worthwhile to explore if the boli can be fabricated using a material that has fewer long-term consequences for the environment.

The orange boli is not well liked by a significant number of workers in each work group studied. To help increase compliance it is suggested to conduct a survey to ascertain the degree to which this is true across the workforce. If the orange boli is sufficiently disliked we recommend eliminating or changing the flavor to encourage boli consumption compliance.

Rest

MANDATED AND ORGANIZED

At ISA, breaks are mandatory and regimented for the workers in the WE Adelante research groups. Workers are also allowed to rest whenever they feel they necessary between mandated breaks. One consideration that applies across the teams studied is that hydration operators, health promoters and supervisors should also rest under shade during break times or have alternative break times if their services are required during the breaks of field workers.

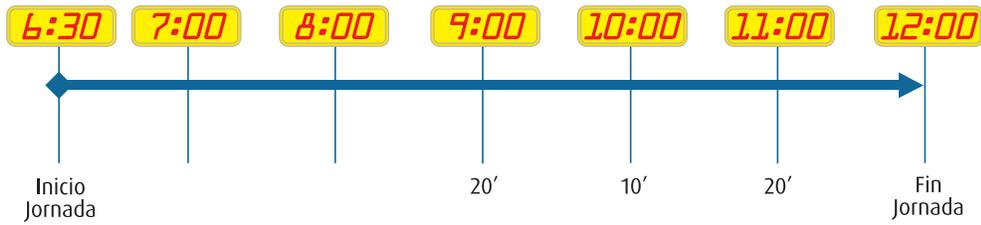
Researchers concluded that current breaks are insufficient, but it will require further study to arrive at ideal rest/work schedules. Creating effective interventions for all field workers will require job specific interventions that will have to be designed via observation and consultation with the mill. This should be considered a priority. The WE Adelante research team is prepared to work with the occupational health staff to develop the best work/rest schedule requirements in response to changes in WBGT measurements. Insights may be gained from colleagues at the United States Army Institute of Environmental Medicine (USARIEM) to inform this work.

Please refer to the accompanying document, [Modified US Military Water.Rest.Shade Schedule](#).

OSHA's Water.Rest.Shade program is rooted in the US military's heat stress research, which dates back to World War II. Their program provides a platform that may guide how to balance the recommendations used to protect human health, based on decades of research in hot climates, and the production demands of the modern marketplace. The challenge is to balance an equation that does not harm health but allows for productivity. However, if the equation does not protect health then the current methods are insufficient and alternative approaches and remediations must be considered.

Current work/rest schedule for burned cane cutters

Corte de caña manual



Current work/rest schedule for field workers other than burned cane cutters



Water/rest and hydration recommendations adapted from U.S. military research,

Lighter Workload		Medium Workload				Heavy Workload	
<ul style="list-style-type: none"> • Health Promoters • Hydration Operators • Pivot Irrigation Operator • Spray Irrigation Operator • Supervisors 		<ul style="list-style-type: none"> • Agrochemical Applicators • Drip Irrigation Repair • Gaviotas • Acareo • Drainage and Irrigation Operator • Irrigation Canal Operator 				<ul style="list-style-type: none"> • Burned Cane Cutters • Seed Cutters • Seeders • Reseeders • Paileritos 	
Heat Category	WBGT °C	Lighter Work		Medium Work		Heavy Workload	
		Work/Rest (min)	Water Intake (liter/hr)	Work/Rest (min)	Water Intake (liter/hr)	Work/Rest (min)	Water Intake (liter/hr)
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3	29-31	NL	3/4	40/20 min	3/4	30/30 min	1
4	31-33	NL	3/4	30/30 min	3/4	20/40 min	1
5	>33	50/10 min	1	20/40 min	1	10/50 min	1
Additional Notes:							
• Work/rest times and fluid replacement volumes are designed for 4 hours of total work, or more in the specified heat category. Working more than 8 hours is not recommended, not including rest.							
• Fluid needs can vary based on individual differences and exposure to full sun or full shade +/-, 1/4 liter							
• NL=No limit to work time per hour							
• Rest=minimal physical activity seated and under shade.							
• CAUTION: Overhydration can be deadly as well. Fluid intake should not exceed 1.5 liters per hour and daily intake should not exceed 11.5 liters.							
• If doing moderate medium or heavy work and wearing impermeable PPE (Agrochemical applicators) add 5 Celsius							
• Note that current workload classifications are based on the mill's assessment and our observations to date. The only way to properly designate will be to measure the heart rate of a subset of each field worker group.							

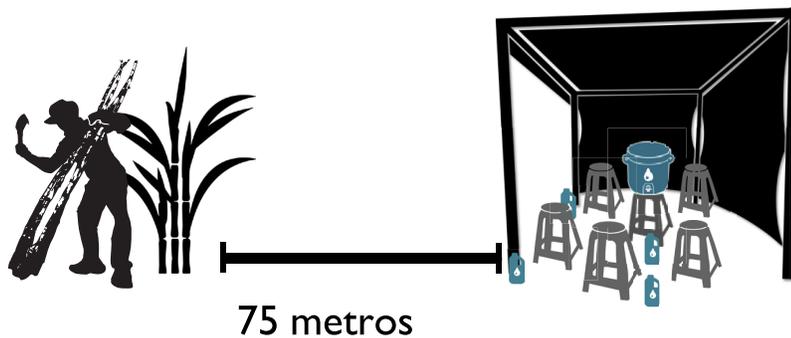
When comparing the current rest schedules with the modified US military Water.Rest.Shade schedule and assessing the retrospective and cross harvest data, the need to design and implement new rest schedules that effectively protect health is apparent. While understanding that the parameters of the modified table are likely impossible to implement while having an operationally viable mill, it is important to recognize that we developed the table to demonstrate how far off the current schedules are from what is recommended by the leaders in the field. The modified table provides us with a foundation to work from. By working together we believe it is possible to balance the equation between operational reality and human health. In finding that balance we must keep in mind that damage to health due to work, specifically relating to heat stress and kidney function, is the red line that we must not cross.

Work/rest schedules should be tailored to workload and job category. The work intensity category (Lighter, Medium and Heavy) for each work team will be based initially on field observations combined with the mill's own estimates. These estimates will be improved by measuring the workload for each work category. The number and length of breaks will be determined by measuring the internal core temperature and heart rate of workers over the workday and understanding if the frequency and duration of breaks are sufficient. For example, if core temperature and heart rate do not lower sufficiently during a rest period, it should be extended. Further, if workers are coming into breaktime already surpassing a safe core temperature, or with a dangerously prolonged elevated heart rate, then an earlier break time is needed.

During the next two phases LIN will work to develop an app that allows adaptation for present conditions so OSH teams can adapt to real time exposures as measured by WBGT matched with workload and job category.

ACCESS

It is essential that access to rest is easy so that recuperation at breaktime is as effective as possible. No worker should be more than 75 meters away from shade.



SEATED REST WITH SUFFICIENT SPACE

Successful rest is relaxed rest. Standing during a break, or looking for a comfortable place on the ground in a field to sit, will cut into an effective rest period. Stools should be provided to all workers to rest during their break. Stools used by seed cutters and burned cane cutters provide a good model. Proper rest requires sufficient tent coverage to provide shade for all workers to be seated with sufficient space during breaks.

TRANQUIL REST

It is recommended that worker education occurs at the beginning of the harvest in the form of organized charlas, and that appropriate materials are created for workers to take home. Safety and training briefings can also be done at set times during the week, at the beginning of a shift. During a break, after demanding physical work, is not an effective setting to transmit information. In the case of education at work, less can be more. Further, there is a longstanding body of evidence showing that when workers have time to communicate amongst themselves during breaks, new ideas that lead to productive, if informal, systems can emerge that will benefit the workers and the company.

Shade and cooling

COVERAGE AND ACCESS

In general, there are not enough tents in any of the work groups observed. Tents need to be moved or positioned so that all workers have quick and easy access to them. **It is recommended tents not be more than 75 meters from any one worker.** This will improve efficiency but also ensure break time is spent resting and not walking to a tent over difficult terrain. **There should not be more than 15 people per tent.** If tent numbers are difficult to increase work teams can be created that alternate break times. For example, if one team (Team A) breaks for 10 minutes, while another (Team B) continues to work, the other team then would replace the resting team as they return to work. At the next break the team that rested second would rest first. One challenge in such a set up would be to assure sufficient and rapid access of water to both team A and B.

All types of field workers require access to shade and mandatory breaks in easily accessible shade. This may be a unique challenge for some types of workers such as the irrigators who dig irrigation trenches and are therefore often on the move throughout multiple sites in one day. However, the WE Adelante research team is eager to work on this challenge with the mill's OSH team.

TENT MATERIAL

The groups the researchers visited had one of three kinds of shade provided: a portable tent with three sides made out of black fine screen material, a portable tent with three sides made out of green higher quality fine

screen material, or a tarp top attached to a mobile clinic or bus (only at the mechanized harvest). Researchers were told that ISA is in the process of converting all of their shade tents to the green material, a move the research team agrees with. The lighter color and the best quality material possible will aid in reducing UV exposure and temperatures in the shade.. It is important that all field workers have access to this material as soon as possible.

COOLING BANDANA AND COOLING VESTS

Consideration should be given to the possible advantages of new technologies in wearable cooling equipment. It is possible that manual cane workers in particular require special consideration in terms of cooling opportunities that are effective and cost efficient.

- ~ Cooling bandanas, such as the Ergodyne Chill-Its 6700CT model, last 3-5 hours in the field and could be passed out around 9:00 am as temperatures begin to increase markedly.
- ~ Hyper cool evaporative vests could be considered for field workers as well, though they are more costly, when considering scale of the field workforce. Cane cutters could be considered for testing these vests as this group is relatively small.
- ~ Flexi-freeze vest models with insertable ice packs may address the problems pesticide applicators have due to the unbreathable nature of their protective clothing.

The suitability of such technologies need to be probed in the field on small scale first.

Specific Recommendations for Sugarcane Cutters

Water and Hydration

One 38-liter refill station can only serve about eight 5-liter insulated personal thermoses or thirteen 3-liter sized personal water receptacles. During the researcher's observation day there were 109 cane cutters, and four tents. Meaning that each water cooler was serving 27 people. The tank on the bus could have refilled the coolers, but we did not see that occur. Assuming that each worker had a 5-liter thermos prefilled, and that workers require at least 1 liter/hour in such hot conditions, then the thermoses should have been emptied, or close to it, and then refilled from the bus tank. We did not see that in our observations.

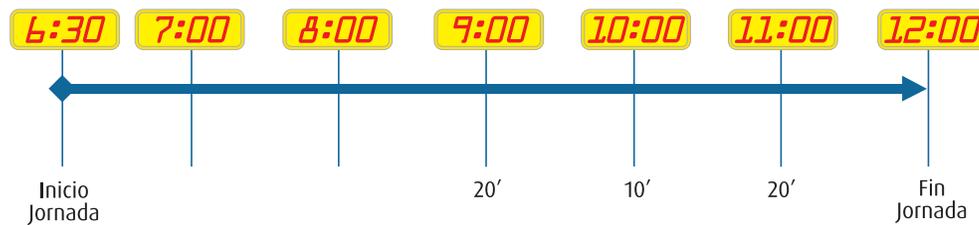
- ~ Ensure water coolers are available under tents and that these are refilled as needed.

Rest

As noted in the accompanying document, [Modified US Military Water Rest Shade Schedule](#), it may be impossible to provide the rest and work ratio recommended from years of research to workers in sugarcane fields. However, we should endeavor to find the point where we are keeping workload and internal core temperature at levels that are not endangering health. This will be an ongoing conversation and analysis.

~ **Prioritize burned cane cutters schedule.** Taking into account the current rest schedule shown below, the recommendations adapted from the US Army, and the results from the cross harvest analysis, it is recommended to prioritize improving the rest schedule for burned cane cutters. A good first step would be the introduction of a break at 8:00 am when WBGT is already likely to be at level 2 (Green). The idea of a longer day with more rest should not be dismissed, though this will need to be assessed.

Corte de caña manual



Lighter Workload		Medium Workload				Heavy Workload	
<ul style="list-style-type: none"> • Health Promoters • Hydration Operators • Pivot Irrigation Operator • Spray Irrigation Operator • Supervisors 		<ul style="list-style-type: none"> • Agrochemical Applicators • Drip Irrigation Repair • Gaviotas • Acareo • Drainage and Irrigation Operator • Irrigation Canal Operator 				<ul style="list-style-type: none"> • Burned Cane Cutters • Seed Cutters • Seeders • Reseeders • Paileritos 	
Heat Category	WBGT °C	Lighter Work		Medium Work		Heavy Workload	
		Work/Rest (min)	Water Intake (liter/hr)	Work/Rest (min)	Water Intake (liter/hr)	Work/Rest (min)	Water Intake (liter/hr)
1	22-27	NL	1/2	NL	3/4	40/20 min	3/4
2	27-29	NL	1/2	50/10 min	3/4	30/30 min	1
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Additional Notes:							
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When comparing the current work/rest schedule for burned cane cutters at ISA/SER to the recommendations for workers with a heavy workload (burned cane cutters) it appears likely that additional rest is required.

Shade and Cooling

NUMBER OF TENTS AND ACCESS TO SHADE

Currently, there are insufficient tents. Workers must walk too far for breaks or to refill water. Tents should be kept no more than 75 meters away from a cutting front and there must be sufficient tents so that all workers fit under the tents at breaks. While some fields have natural shade this is not always the case.

TENT MATERIAL

Cane cutter tents are still of the inferior black material. Switching to the green material observed in other field jobs is recommended for cane cutters.

COOLING DEVICES

Due to the preliminary evidence for high number of workers showing kidney dysfunction in this group, a test of the feasibility and efficacy of different cooling materials, such as the evaporation headband or evaporation cooling vest, should be evaluated during the coming zafra.

Re-Entry

Exposure to the sun is one danger, and in addition, burned cane cutters also face potential convective and conductive heat from the ground due to the burning of cane before cutting. It seems recommendable to ensure that at least 12 hours have passed between the completion of a burn and the entry of workers into the field. It would be relatively easy to verify that 12 hours is indeed sufficient by a brief experiment collecting WBGT data after a burn.

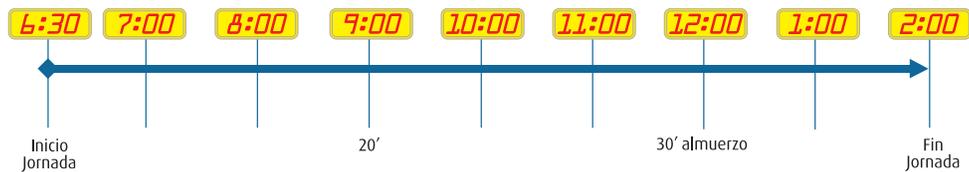
Recommendations for Seed Cutters

Water and Hydration

Ensure water coolers are available under tents and refilled as necessary.

Rest

Like burned cane cutters, seed cutters are at risk of heat stress and kidney injury. As with cane cutters, there is a need for increased rest periods. Given the workload seed cutters face, additional breaks at 8:00 am and 10:30 am are recommended. The duration of the breaks, including the 9:00 am break, should be decided together. Once in place we will need to review the new schedule's efficacy via measuring workload and core temperature.



Minutos de descanso obligation

Lighter Workload		Medium Workload		Heavy Workload			
<ul style="list-style-type: none"> • Health Promoters • Hydration Operators • Pivot Irrigation Operator • Spray Irrigation Operator • Supervisors 		<ul style="list-style-type: none"> • Agrochemical Applicators • Drip Irrigation Repair • Gaviotas • Acareo • Drainage and Irrigation Operator • Irrigation Canal Operator 		<ul style="list-style-type: none"> • Burned Cane Cutters • Seed Cutters • Seeders • Reseeders • Paileritos 			
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When comparing the current work/rest schedule at ISA/SER for field workers to the recommendations for workers with a medium (ex: Drip Irrigation) or heavy workload (ex: seed cutters) it appears likely that additional rest is required.

Shade

As with other workers, assure seed cutters have sufficient access as described in the general recommendations.

Specific Recommendations for Drip Irrigation Workers

Water

Ensure water coolers are available under tents and refilled as necessary.

Rest

All field workers should have a stool, including drip irrigation workers. Workers should have an increased number of breaks. The initial recommendation is the same break schedule as proposed for seed cutters. Here too, we will work together with the mill to identify an effective work/rest balance.



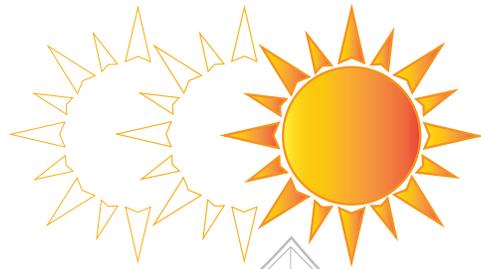
Lighter Workload		Medium Workload		Heavy Workload			
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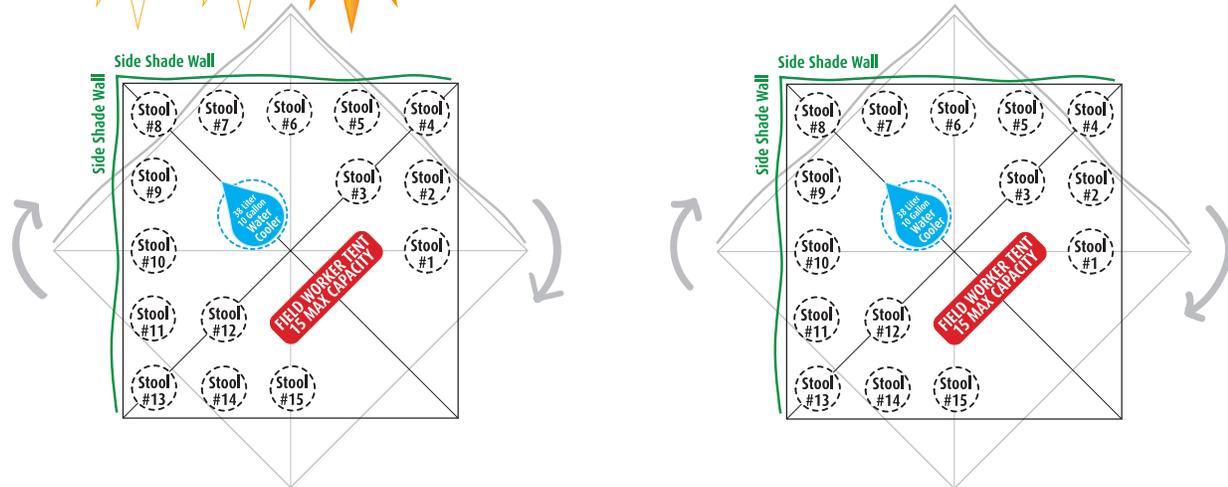
Shade

As with other workers, assure drip irrigation workers have sufficient access as described in the general recommendations.

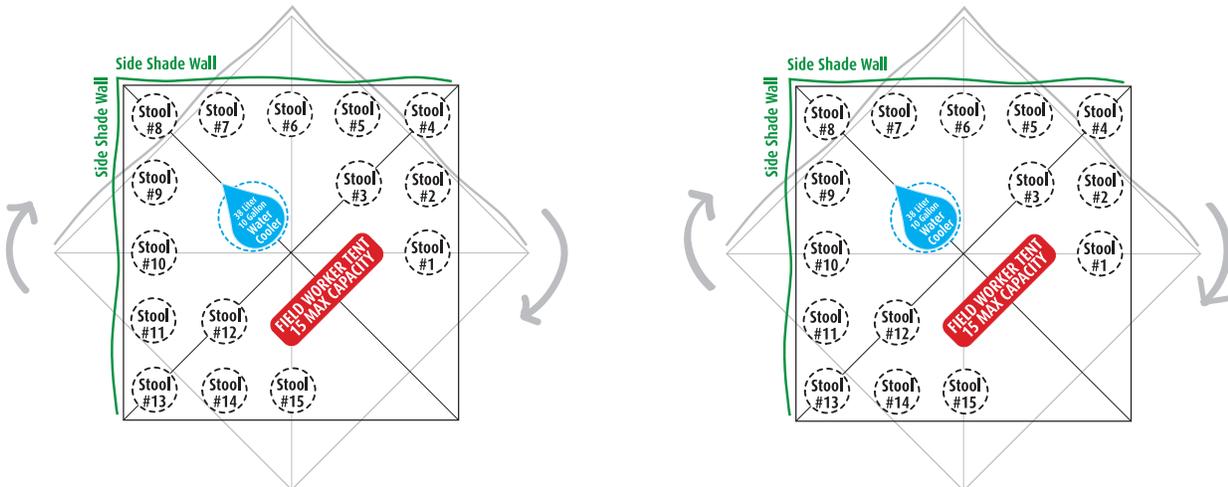
Tent overhead view for field workers.



**FIELD TENTS ARE MOBILE
AND NEED TO ADJUST AS SUN MOVES**



60 MAX CAPACITY FIELD WORKER SITE
1 Tent = 1 Ten Gallon Water Cooler x 15 Worker Stools



Other Field Workers

Utilizing the observations and the demarcations made in the *Modified US Military Water.Rest. Shade Schedule*, it is recommended to prioritize the design of new rest schedules with the assistance of the WE Adelante team for workers in the medium to heavy workload categories. Eventually, it will be necessary to accurately measure workload in each job category and measure efficacy of interventions. Additionally, some jobs do not yet have intervention plans and a priority for Phase 2 should be the design of interventions for these job categories with more challenging logistics.

Pesticide Applicators

This workforce has a markedly different set of exposures as well as a workday that is distinct from other field workers. A detailed document of observations and recommendations is found in the [Agrochemical Handling Report](#). There would be merit in including this group into our intervention improvement efforts. The researchers are available to work with ISA and Boston University to develop an intervention for these workers that limits their exposures to heat stress to a minimum.

Health Promoters and Worker Education

The health promoters have an important job. For Phase 2, it is recommended that two aspects of their work are evaluated:

1. Determine how adherence to safety protocols and accident documentation are communicated to workers. While workers have a responsibility for their own wellbeing it is necessary to move beyond compliance and towards internalization of the changes needed to protect health.
2. Assess the training regimen. Sharing information during a needed break after heavy labor is likely ineffective. Structuring talks and training schedules for the beginning of the harvest, and at the beginning of selected workdays, may make training more memorable and impactful. Designing take home guides that are easy to understand for workers should be considered.

Designing and validating educational materials for the workforce should be an essential part of the coming phases of the Adelante Initiative.

Other Health and Hygiene Recommendations

Latrines and Hygiene Stations

ISA has thoughtfully provided latrines for field workers. Hygiene stations began to be implemented at ISA in the 2017 harvest, allowing for hand washing. It is essential that this is provided to all field workers in the sugar industry. Providing adequate and accessible latrines is important for hygiene standards and especially noteworthy for women. The presence of a latrine encourages women to drink more water, since it provides them with a safe place to relieve themselves.

Mobile Health Clinics

At ISA, each clinic has a doctor, nurse and a laboratory technician. Here are three such teams for the three mobile clinics. Undoubtedly, having a point of care for first aid is laudable, and for mills carrying out research on heat stress mitigations and hygiene improvements, the mobile clinic can serve as an excellent field base.

MISTING TENT

The misting tent is prone to damage, making mist more of a dribble of water. Also, its placement at the side of a large truck that radiates heat limits efficacy. This well intentioned heat stress mitigation should be adjusted and effectively maintained. Evaluating whether it is effective for cooling workers who have access to it is recommended.

DATA COLLECTION AND SUBSTUDIES

It is advisable that the WE Adelante researchers and OSH team at ISA think about how to utilize the mobile clinics as effectively as possible for questions that require spot checks and cross harvest measurements. With careful planning and coordination it is likely to more efficiently assess cross shift exposures, acclimatization and other important remaining research questions.

Anti-inflammatory Medication

It is well known that NSAID consumption, especially when dehydrated, can cause renal damage. Whether mills provide NSAIDs (nonsteroidal anti-inflammatory drugs) or workers consume them on their own, it is important to educate the workforce about the dangers. Field work is hard, it will likely cause muscle strain and inflammation in the best case scenario. Care should be taken to inform workers of the local names of anti-inflammatories. It should also be communicated that the consumption should be limited to only when necessary, and only when the worker is well hydrated.

Section II - Research Priorities

The Adelante Initiative has the unique objective to create and assess ways to mitigate some key drivers of CKDu, as well as to better understand the occupational factors. It is possibly the most impactful research design and allows for the creation of implementable changes that will help all stakeholders affected by CKDu, while extending and improving the quality of life for those at risk.

It is important to overcome the limitations and shortcomings of research done to date on CKDu in the occupational setting in sugarcane. In this section we address recommendations for the coming year and beyond. We pay particular attention to occupational risk and intervention assessment priorities, symptoms of heat stress and dehydration, biomonitoring and collection of other health data, machete design, screening equipment and serum creatinine cut off point, loss to follow-up, and data management and provision.

As we move forward into the next phases the time of simply reporting to the other parties will change to a more collaborative iteration of designing and evaluating the interventions as collaborators. Analysis will still be carried out by the WE Adelante group, but design, implementation, collection and insights from the other stakeholders, notably the OSH team at ISA, will be essential. The following should therefore be viewed as recommendations and observations that are applicable to all of us as a combined initiative.

Occupational Risk and Intervention Assessment Priorities

As expected, the risk of reduced kidney function at end of zafra was found to be highest among those considered to have the most physically demanding job. It is striking that burned cane cutters have almost 11 times higher rate of kidney function reduction compared to other manual field jobs (more than seed cutters and drip irrigation repair workers combined). Due to the heavy workload of seed cutters, and the fact that some seed cutters also had reduced kidney function at end of zafra, there is concern in particular about seed cutters and what will be discovered next zafra.

Overall, no clear associations between kidney function reduction and liquid intake or indicators of dehydration were observed in the current study, but there was a high proportion of kidney dysfunction among the burned cane cutters who had very concentrated urine at end of zafra compared to baseline. The absence of clear findings of an association could be due to inadequate means to record daily water intake or to misleading laboratory measurements of urine osmolality, which is a possibility if participants repeatedly were dehydrated while working but had time to rehydrate by time of testing. This should be further investigated with improved methods.

Differences in other occupational exposures that could interact with heat stress and dehydration to trigger or progress the development of kidney dysfunction should also be considered, specifically pesticide exposures, ash exposures and consumption of sugarcane during the workday.

Researchers are beginning to understand CKDu risk by job category for burned cane cutter, seed cutters, and drip irrigation repair workers. Risks among other field workers is currently not known. It is important to examine representative samples of all categories of field workers to understand where we need to mitigate risks. This also will permit understanding how many lives can be improved if we institute effective interventions throughout. Before anything, interventions for cane cutters and seed cutters remain a priority.

The WE Adelante group recommends developing the following research activities to assess and prioritize occupational risks by job categories:

1. Assess the burden of CKDu by job categories:
 - a. Future phases should aim to further quantify the burden of kidney disease in job categories studied and initiate efforts to do the same for the entire field worker population.
 - b. If resources are constrained, prioritization should be given to adding the various categories of irrigation workers to the cohort. These workers represent over 1000 people in the workforce. These are jobs that are unlikely to mechanize in the short to mid-term and will require thoughtful interventions due to the nature of the work. Many of the irrigators work on small teams, so it will be a challenge to design effective interventions.
 - c. Other work categories that have not been studied, and may have high risk of elevated creatinine according to an analysis of the retrospective database, include seeders. This is in accordance with a previous study by Boston University (Laws et al⁴). Reseeders also should be considered for inclusion in the research. The plan for next year is to measure irrigation drainage workers, seeders, reseeders, and weeders in addition to the groups already being studied.
 - d. Mill workers are starting with an intervention in the factory for heat stress. WE Adelante group is able to work with the mill to assess these interventions as well, starting with qualitative observations in Phase 2.

4. Laws RL, Brooks DR, Amador JJ, Weiner DE, Kaufman JS, Ramirez-Rubio O, et al. Changes in kidney function among Nicaraguan sugarcane workers. *Int J Occup Environ Health*. 2015;21(3):241–250.

2. Assessment of heat stress related characteristics for specific jobs:
 - a. Measurement of acute and chronic environmental heat load, including differences between burned and green cane settings and total day environmental heat exposure burden
 - b. Measurement of level of physical demand required for the different jobs
 - c. Assessment of metabolic heat load for specific jobs based on points a. and b.
 - d. Once workload and heat stress have been determined, job categories will then be divided into workload categories, lighter, medium and heavy. Interventions will be designed using a template for each category and adapted as required for the realities of a specific job. Initial planning for interventions will rely on observations and estimates made by ISA and the WE Adelante team.
3. Liquid access and intake
 - a. Protocols for assessment of water availability and use in the field should be developed. Tracking of water available on the worksite and its consumption during the work day can ascertain on average whether people are drinking what is reported. Such protocols could be implemented by field support staff while, in addition, field observation days by researchers are recommended.
 - b. Cross shift studies are likely needed for proper documentation of liquid intake. Enhanced hydration markers should be measured before, during and just after a shift.
4. Rest schedules

Evidence-based design of rest schedules (frequency and duration) should be initiated, starting with burned cane cutters and seed cutters and extending to other job categories in subsequent phases. This will involve measuring the heart rate and core temperature of subsets of workers in each category so we may ascertain whether current break frequency and duration is sufficient and adapt as required.
5. Assessment of exposures in addition to heat
 - a. Pesticides. Although it seems unlikely that pesticides are a main driver of CKDu in this worker population, this needs to be more carefully evaluated.
 - b. Ash. It is possible that ash causes an inflammatory response to workers who are both covered in it as well as breathing it rapidly while cutting cane. The impact of ash on perspiration and exacerbating heat stress due to solar radiation should be evaluated.
 3. Chewing of sugarcane (fructose) during workday. Excessive exposure to fructose (derived from sucrose from sugarcane) while dehydrated can theoretically create further stress on the kidneys.

Symptoms of Heat Stress and Dehydration

A symptom index for heat stress and dehydration could be a cost-efficient and manageable tool to routinely monitor heat illness among field workers and could eventually serve to reduce workers' risk for developing AKI

and CKD. There are several experiences with symptom questionnaires in the region, including data for Year 1 of the Adelante Initiative, but there are important linguistic and other contextual challenges for the development of a standard and validated index suitable for surveillance. Considering the many symptoms potentially associated with heat stress, dehydration, and kidney illness, it is expected that some will be found to be significantly associated by random chance. However, a cluster of similar symptoms of a non-specific inflammatory condition or heat stress (such as fever, nausea, weakness and headache) seem to be associated with kidney function reduction. This finding agrees with previous studies on heat stress symptoms and evidence of AKI among sugarcane workers presenting with fever, nausea, vomiting and back pain and among sugarcane workers [Crowe et al., 2015⁵; Fischer et al., 2017⁶].

Symptom questionnaires should be refined and validated to obtain better characterization of heat stress and dehydration symptoms in terms of temporality, frequency, severity and specificity:

1. A protocol for routine collection and analysis of symptoms, and their relation to kidney function, will be an outcome of the Adelante Initiative. The development of this protocol will include linguistic assessment of wording used for symptoms and analyses of symptom data collected among sugarcane workers in El Salvador with further development at ISA.
2. Especially, there is an urgent need to distinguish between infectious fever and overheating when assessing symptoms that occur in both. Workers may not make the distinction between fevers caused by overwork in heat and those due to infection as they can create identical symptoms. Report of fevers should be routinely documented and confirmed by mobile clinic/health worker teams according to a standard clinical protocol. A separate infectious disease study protocol could rule in, or out, the association between infectious disease and CKDu/eGFR decline.
3. A separate study could be designed to assess the impact of testing workers reporting these symptoms to identify workers at early stages of reduced kidney function, and potentially, to evaluate early treatment of these workers.

Biomonitoring and Collection of Other Health Data

Several lessons were learned that inform plans for next zafra. Some of these are administrative and some relate to the actual blood test analyses planned. Creatinine is the standard biometric to assess kidney function. Higher

5. Crowe J, Nilsson M, Kjellstrom T, Wesseling C. Heat-related symptoms in sugarcane harvesters. *Am J Ind Med.* 2015;58(5):541-8.

6. Fischer RSB, Mandayam S, Chavarria D, Vangala C, Nolan MS, Garcia LL, Palma L, Garcia F, García-Trabanino R, Murray KO. Clinical Evidence of Acute Mesoamerican Nephropathy. *Am J Trop Med Hyg.* 2017;97(4):1247-1256.

creatinine at baseline, even at relatively moderate levels, was a risk factor for further reduction of kidney function during zafra. This is expected but still informs the need to reconsider the serum creatinine cut off levels for the workforce (see below). The possible advantages of cystatin C as an alternative need to be considered. Uric acid (UA) levels were higher among those with reduced kidney function and is a known marker for reduced kidney function. It has also been hypothesized as a potential causal mechanism of CKDu. A slight reduction in hematocrit with incident reduced kidney function was very common and may be due to reduced kidney function in itself and/or the inflammatory response that seems to coincide with kidney function reduction. These results show the complexity of health biomonitoring in the population at risk. It is important to achieve the most effective, yet most cost-efficient set of health markers as feasible.

To comply with health-monitoring we recommend the following:

1. **Target molecules for biomonitoring should be continuously updated** to find the minimum set that will prove most valuable for early identification of kidney function abnormalities, disease, and progression.
2. **Pre-harvest biological samples need to have sufficient volume** for both the company's needs for screening and for the analyses and biobanking in Lund. This is something all parties overlooked in the initial year.

Screening Equipment and Serum Creatinine Cut-Off Point

Future studies should evaluate the impact of introducing more restrictive cut-offs for pre-employment kidney function. Careful consideration needs to be given to lowering the SCr level used as a cutoff for hiring. It appears that the current cutoff of SCr 1.3 is too high as this level of SCr implies considerable loss of kidney function in young people. For a typical 30-year-old male this translates to an eGFR of **73 ml/min/1.73m²**, while a normal value in a North American population is approximately **130** and the cut-off for chronic kidney disease (in absence of proteinuria) is **60**.

The purchase of an improved serum creatinine analyzer was a good investment by the mill and adds reliability to measurements used to estimate kidney health status. Those who should not work because of their risk for developing or progressing in their eGFR decline, and those who become ill during the harvest, will be correctly identified.

Improved machete

A protocol is being developed to continue development and evaluation of a new machete design.

1. ***In addition to assessment of productivity related to the new machete design there should be an assessment as to whether the new machete reduces the consumption of pain relievers.*** It is possible that a properly designed machete could reduce musculoskeletal pain and diminish the consumption of NSAIDs.

- a. *Workers should be informed on the risks of NSAID use and educated about the need to hydrate if taking these medication*

Loss to Follow-Up

Loss to follow-up occurs when individuals who were enrolled in the baseline data collection of a longitudinal study are not recorded during the follow-up data collections. Here we discuss this issue primarily in the context of CKDu and the decline in kidney function that we are most concerned about in this workforce.

Workers do not enter or leave the workforce for a variety of reasons. With CKDu this can be due to i) rejection of candidates for hire due to mandated cutoff points in levels of serum creatinine that predict kidney disease risk; ii) workers may move to other work or communities, or iii) they may no longer be physically capable of keeping up with some of the more physically demanding field jobs. The issue that emerges when these factors result in loss to follow-up is information about only those remaining in the study, and those who have become ill over a harvest may under represent the total work population affected. The true situation is likely more serious than findings from the cross-harvest data indicate. For example, it may be that those in the seed cutter category who were affected, left the workforce due to feeling too ill to continue or were dismissed or transferred to other job categories during the mid-harvest spot checks that ISA performs. The researchers end of zafra tests would not have discovered this. The decision to evaluate health at mid-harvest is appropriate, and after evaluating these findings and the end of harvest findings it is clear that such data can be essential to understanding both the scale of kidney function problems and differences or similarities between job categories. The data can also help accurately assess efficacy of the WE Adelante intervention as we go forward.

The 2015 Laws et al. study from BU showed that every worker category studied - burned cane cutters, seed cutters, irrigators, seeders and pesticide applicators - had some participants that had significant declines in kidney function. Preliminary retrospective analysis of ISA records, conducted by WE Adelante group, shows a similar finding. The preliminary analysis of the 2017-2018 cross harvest study, however, shows that burned cane cutters were significantly affected with a decline in kidney function (11 times more likely than other field workers to have a significant decline in kidney function over the harvest), seed cutters to a much lesser extent, and none of the irrigation repair workers. The problem of loss to follow-up complicates interpreting these findings as mostly showing only one job group affected. We must invest in follow-up studies to be sure we are not experiencing the healthy worker effect in the other job categories, meaning only those that remain healthy are being measured.

WE Adelante group was successful in organizing a quick and limited effort to locate workers who left after being employed in last year's zafra. This was done in cooperation with the mill, demonstrating the level of competence

and trust that has developed between the two parties. Although resources were not adequate to collect the most complete information (for example, the biological samples that would have added value), this effort did improve understanding of why workers left. There is need to have sufficient resources to interview and biologically monitor those that leave the workforce in order to reveal problems previously unrecognized. Resource allocation should be specific to address this important concern to avoid the shortcomings of every other study done to date on CKDu. The following are specific lessons and recommendations for loss to follow-up study for the next phase of research.

1. **Locating and monitoring those that leave the workforce:** Efforts to locate individuals lost to follow-up, assess their kidney function, and determine why they selected out of the zafra before it ended should continue with a formal plan before the next zafra and resources should be allocated to collect biological material from this population in a cost-effective manner. Assessment could be as simple as blood pressure, glucose/A1c, and serum creatinine. If determined to be reliable measured by point-of-care technology, this could allow for rapid and affordable assessment.
2. **Make contacting participants as likely as possible:** Participant address and phone number should be collected at baseline to simplify end of zafra health assessment of those who leave ISA during zafra. Besides a detailed home address, we consider collecting three numbers: Movistar, Claro (many have both brands) and those of a family member due to issue of people buying new sim cards. The work captain and/or recruiter will also be documented for each individual.
3. **Mid-zafra creatinine measurements should be integrated to the WE Adelante study** and measured using the same equipment as pre- and end of zafra creatinine. In the second year of the WE Adelante study, a random sample of material from blood samples should be sent to Lund for quality control and possibly biobanking. This merits further discussion with the ISA OSH team regarding biobanking. If results between Lund and ISA labs are the same from these samples, mill findings can be used in future work which would save resources.
4. **Decisions concerning removal from the workforce or temporary sick leave (“reposito”) during zafra must be made available.** This should include the reason that led to the decision, and the clinical findings in the cases related to heat illness or kidney disease. This will help us further understand who is affected and why.
5. **Patients with reduced kidney function at end of zafra who do not return for pre-zafra evaluation at next harvest, should be followed prospectively** to establish if this incident kidney function reduction progresses to CKD.

6. **Foremen and workers should be informed and motivated in order to enhance understanding of the purpose of the study and assure study adherence.** During our loss to follow-up study some workers were found not to have in fact left the workforce. Some were still working in a job category different from baseline, and one reported that he was told not to attend the examination by the foreman. Quite a few were temporarily off work due to sick leave (“reposito”) that often was due to elevated creatinine. It is important that we coordinate this information during the harvest to not lose participants in the study.

Data Management and Provision

Data collection and provision can and should be improved. The collection of routine health data by the ISA health staff provide an opportunity to monitor risk factors and health at low cost. Also, financial and economic data are collected. However, there were issues in terms of what is recorded and electronically available regarding health, economic and financial data, as well as how these data are organized. This makes the data less useful to ISA and complicates its use when ISA makes it available to the research team.

1. **Providing staff at ISA with training for health data collection is desirable.** Considering that questionnaire and physical exam health data are routinely collected by the mill before each zafra, and also to a lesser extent during zafra, it would be resource saving to train staff at the mill on how to collect these data with sufficient methodological quality, as well as additional data that would benefit research on the workforce. Using standardized and simplified questionnaire items will benefit ISA as well as the WE Adelante research.
2. **The development of an ongoing annual database of pre-employment survey and laboratory test results should continue.** Improvements to the system are in process to address some important limitations for use in research, building the return on investment (ROI) model, as well as for program management at ISA. The mill has made clear it wants to work with us to improve these models and systematize the collection of variables needed to do more effective analysis going forward, and in some cases improving what can be done to look at the retrospective health data. Please see the accompanying documents here outlining the ROI model and recommendations for improving it next year, as well as the assessment of the retrospective data. We also fully understand the limitations due to the current political events in Nicaragua.

Strengthened Field Observations

International Heat Expert and Hygienist Visit

Current work practice recommendations are made in part from relatively short site visits. Though the WE Adelante team is skilled and diverse, a week long visit in 2019 with the addition of leading heat stress and hygiene expert Dr. Vidhya Venugopal from India would serve the Adelante initiative in two key ways:

1. Provide a more intensive and longer observation period with the added expertise of Dr. Venugopal. This will yield further insights and facilitate new solutions.
2. The endgame for the Adelante Initiative is to make scalable models in diverse geographies and occupational settings. Being based in India and having experience with multiple occupations exposed to extreme heat stress, Dr. Venugopal will be essential to our building protective methods for other industries and geographies, especially in South Asia.

Additional Considerations

What follows are considerations regarding difficult challenges the research has brought to light. The WE Adelante researchers believe it is important to start these conversations sooner rather than later, so that the challenges can be addressed effectively for all stakeholders.

Consideration about Mechanization

The risk for decline in kidney function for burned cane cutters is so pronounced that we must consider that it may be possible that no intervention is sufficient. An informed assessment of what a transition to fully mechanized harvesting would look like, both regionally and globally, is warranted. While interventions for somewhat less demanding manual field work may be possible if there are sufficient protections in place, it may be that burned cane cutting carries too much risk to reasonably or responsibly continue. The ability to adequately protect cane cutters is something we plan to evaluate in Phase 2. This should be considered a priority and should inform the complicated discussion around mechanization and the necessary transition such an effort would entail.

Consideration about Piece Rate

Preliminary evidence from our own research and publications of colleagues^{7,8,9,10,11} show that AKI and other severe health impacts are associated with excessive workload connected to piece rate. Being paid by ton cuts, or number of seed bundles packed, may encourage workers to push themselves beyond what is safe while also discouraging adherence to interventions. New paradigms of motivation, and worker protection are needed. Payment based on day, or hour, is not an easy transition for any industry and concerns around this topic are understandable. However, we should heed the data and begin thinking about alternatives as worker health should be a priority.

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8. Leite MR, Zanetta DMT, Trevisan IB, Burdmann EA, Santos UP. *Sugarcane cutting work, risks, and health effects: a literature review. Rev Saude Publica.* 2018;52:80

9. Vilela RAG, Laat EF, Luz VG, Silva AJN, Takahashi MAC. *Pressão por produção e produção de riscos: a “maratona” perigosa do corte manual da cana-de-açúcar. Rev. Bras Saude Ocup.* 2015;40(131):30-48. <https://doi.org/10.1590/0303-7657000075413>

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11. Rosa LA, Navarro VL. *Trabalho e trabalhadores dos canaviais: perfil dos cortadores de cana da região de Ribeirão Preto (SP). Cad Psicol Soc Trab.* 2014;17(1):143-60. <https://doi.org/11606/issn.1981-0490.v17i1p143-160>

Organization-Specific Recommendations

This document focuses on recommendations for ISA and the research group. The following are select recommendations and considerations for other members and supporters of the Adelante Initiative.

Recommendations Specific to CNPA and AICA

Utilizing data from Phase 1 of the Adelante Initiative, and comparing it to historical data from Boston University and ISA's own database, we will possibly conclude that interventions are effective for workers with less than maximum workloads. These workers historically were also at risk despite the focus long being only on burned cane cutters throughout the industry. What is also evident is that the current interventions at the mill with the most comprehensive program for field workers is not yet sufficient for burned cane cutters and seed cutters. CNPA and AICA should consider:

- ~ ***Prioritization of funding that supports the design and assessment of effective interventions.*** The findings of Phase 1 of the Adelante Initiative indicate the need for additional efforts even in the face of previous and ongoing interventions. Further design of heat stress interventions and evaluation of these interventions should be a priority.
- ~ ***Organization of a fact sharing meeting*** with support from LIN and ISA's OSH team. Such an event will help disseminate key findings so that mills and larger growers can begin preparing for the implementation of effective interventions.

Recommendations Specific to Bonsucro

Given the findings from Phase 1 of the Adelante Initiative, the labor standard in Bonsucro, and other certification bodies, require updating to adequately protect field workers in high heat settings. As Bonsucro is a multi-stakeholder platform this will require buy in from the secretariat, executive, membership and board. We recommend the following:

- ~ ***Prioritization of working with Adelante Initiative members to create relevant training and information materials*** to explain both the need and the way forward.
- ~ ***Prioritizing worker health as a fundamental part of the standard.***

Recommendations Specific to DEG

CKDu and heat stress are both risks that are found throughout DEG's client portfolio. With the Adelante Initiative we have the ability to:

- ~ ***Create validated guidelines to inform loan officers as they assess clients with these risks*** for suitability in receiving a loan.
- ~ ***Assure profits for the German state are not based on loan repayments by companies whose workers are negatively affected by addressable occupational risks.*** There has been much attention paid of late to the loans development banks are making and their net impact on the populations affected by the industries supported. Our goal is to help mitigate addressable risks.
- ~ ***Create a model that supports DEG clients in improving their practices via accompaniment and guidance.*** Loans could be made to clients who are not yet where the DEG would prefer them to be, but they would be contingent on the recipients committing to make improvements and disbursements of loans based on those improvements being validated.

Given what has been demonstrated in Phase 1 it is clear that CKDu and labor conditions continue to be serious challenges that are not adequately addressed. Development cannot entail only employment or support for a large employer. It must also assure that liabilities and costs are not passed onto states, communities or workers. With CKDu the cost to all three is exceptionally high, but we believe avoidable. It is our hope that together we can create a more viable model for development in the agricultural sector and other areas impacted by heat stress, AKI, and CDKu.

Next Steps for Multi-Stakeholder Recommendations

The original goal of this deliverable was to create draft recommendations for the wider industry and stakeholders based on the practices at ISA and the findings of the WE Adelante research team. In part, this has already been achieved in that many of the recommendations here form the basis for materials suitable for a wider audience. However, despite ISA having, to our knowledge, the most comprehensive worker health intervention program for field workers in the industry, it has become clear that even their efforts are not yet sufficient. Therefore, the focus of this document became how we can attain our shared objectives to improve how interventions are designed and implemented, as well as how we assess them. It's important that what the Adelante Initiative is recommending is effective. From a stronger foundation recommendations will have more credibility and greater impact.

The original goal is essential to the shared vision of all Adelante Initiative members and stakeholders. Therefore the next step should be ensuring all parties are in agreement with what is proposed in this document, and the resources necessary in order to finish what we have begun. Once we have agreement, we should work together, DEG, CNPA, AICA, SER/ISA, Bonsucro and LIN, and our shared networks to identify what elements are essential to different stakeholders. This will help us to best communicate the findings and the immediately obvious recommendations. This should be a joint effort if it is to be successful. Ideally, Beta versions for each audience can be created for January of 2019.

To help begin this dialog a spreadsheet has been created, [DRAFT Recommendations Spreadsheet](#) that can be downloaded and utilized by representatives from each party. Once each party has completed the spreadsheet (for example, over the next 30 days) LIN can collate the data and host a conference call so that we can agree to a version that represents our joint assessment of what information should be prioritized for each stakeholder.

From there we will begin designing the necessary training and information materials for those we have deemed the highest priority and focus on the aspects of the work most relevant to them. In order to gain sufficient support for the Adelante Initiative we will have to communicate our findings effectively and tell the story in a way that is effective for both a wide and targeted audiences.

Conclusion

Ingenio San Antonio should be commended both for their commitment to addressing the risks identified for their field workers and for their most recent efforts to begin to improve access to water and rest within the mill itself. However, there is still work ahead to translate what we have collectively learned with the most relevant scientific data into actions that best protect the workforce. In terms of the interventions themselves, this will require a thoughtful revised design to build on current initiatives. By dedicating the appropriate resources we believe that together the WE Adelante research team and the ISA occupational safety and health team can create, implement and assess the best, most feasible interventions. We must also not forget that implementation matters as much as design. If not implemented effectively an intervention cannot protect people.

The research effort informs the effectiveness of the enhanced interventions and gives us further insight into how best to protect sugarcane workers immediately and eventually protect other workers at risk of heat illness, AKI and chronic disease. Measuring workload and heat stress among all field worker categories is essential. Assessing frequency and duration of breaks in association with workload levels is essential to determine if breaks are enough to maintain work capacity and health. In concert with understanding workload, methods to assess sufficient available water in the field and adequate hydration of the workers in the different jobs should provide evidence that assures the planned intervention is implemented. Loss to follow-up was a serious challenge and resulted in a likely underestimation of disease described in the workforce that is reported in the cross-harvest analysis. It is essential we dedicate the necessary resources to understand the reasons workers left the workforce as well as their health.

Coordination of data and communication can be further improved. The work with LIN and ISA has gone extremely well. In this collaboration we have discovered two opportunities for improving communication and data collection that will help both the Adelante Initiative and the mill. As the [Retrospective Database Report](#) and [Pilot Return on Investment Report \(DEG Report 6\)](#) demonstrate, there is the need to improve the way data are recorded and managed electronically at the mill. This is an effort the WE Adelante research group is able to assist with. Finally, coordination of the mill's information on the workforce in the study can be improved. During the loss to follow up study it was discovered that a sizable number of the study population (n=38) believed to have left the workforce were still employed by Ingenio San Antonio. By working together, we can assure we capture as much of the workforce as possible and essential data is not lost. This is also an opportunity to better educate and involve all participants in our efforts.

The Adelante Initiative is the only research-backed work on CKDu focused on reducing risks for the workforce. It is agreed that research on etiology should continue. But to wait for the final answers from this research would be irresponsible. There is already sufficient evidence to drive the development and implementation of interventions that, even with some uncertainty, can greatly enhance the health of workers today. This, not etiology, should be the focus of industry support as it is the area of most relevance and greatest potential impact by industry in addressing the disease.

The time to act is now. The findings to date make clear the need to improve interventions and assess their efficacy. There will always be challenges but given what we know after Phase 1 of the initiative, it is now both unethical and a liability not to aggressively work to limit heat stress and kidney damage among the workforce utilizing our best available data and collective resources. It does not serve the company, the wider industry, or the development sector, not to make the necessary investments today. This team can surmount whatever barriers we are confronted with. However, financial resources to pursue what is clearly required, with a qualified team at the ready, should not be a barrier when some of the most powerful organizations in the region and the world are involved. It is unlikely we will have this opportunity again. Lives can be improved and extended if we act with what we know now and with sufficient recourse to do so. Banks, certifications bodies and industry cannot in good faith continue business as usual given the findings from this collective effort and the ability we have to address this challenge together.

While CKDu may exist in other industries, the risks associated with AKI, heat stress and chronic disease facing workers in the sugarcane industry are due to occupational health and hygiene challenges in that industry. Regardless of what occurs elsewhere, the deficiencies documented must be addressed, and aggressively, so that we may protect the workforce at ISA. We can then utilize what we develop in Nicaragua to protect other workers along the supply chains at risk that are represented in CNPA, AICA, Bonsucro membership and the DEG client portfolio. An important thing to remember is that every industry player that has denied having this disease, who has since tested their workforce, has in fact had the disease among their workers. Absence of evidence is not evidence of absence. We must recognize that what we do here will have impact far beyond Nicaragua as it is extremely likely that CKDu is unreported and unaddressed throughout the tropics. As the globe continue to warm it will become a concern for even more populations. Together we can address this challenge efficiently and effectively. It will require appropriate support. The recommendations in this report are the first firm step in the effort to adequately provide relief for those at risk in the occupational setting.