Klaas Biersteker

1925 -2005

Hoogleraar Gezondheidsleer

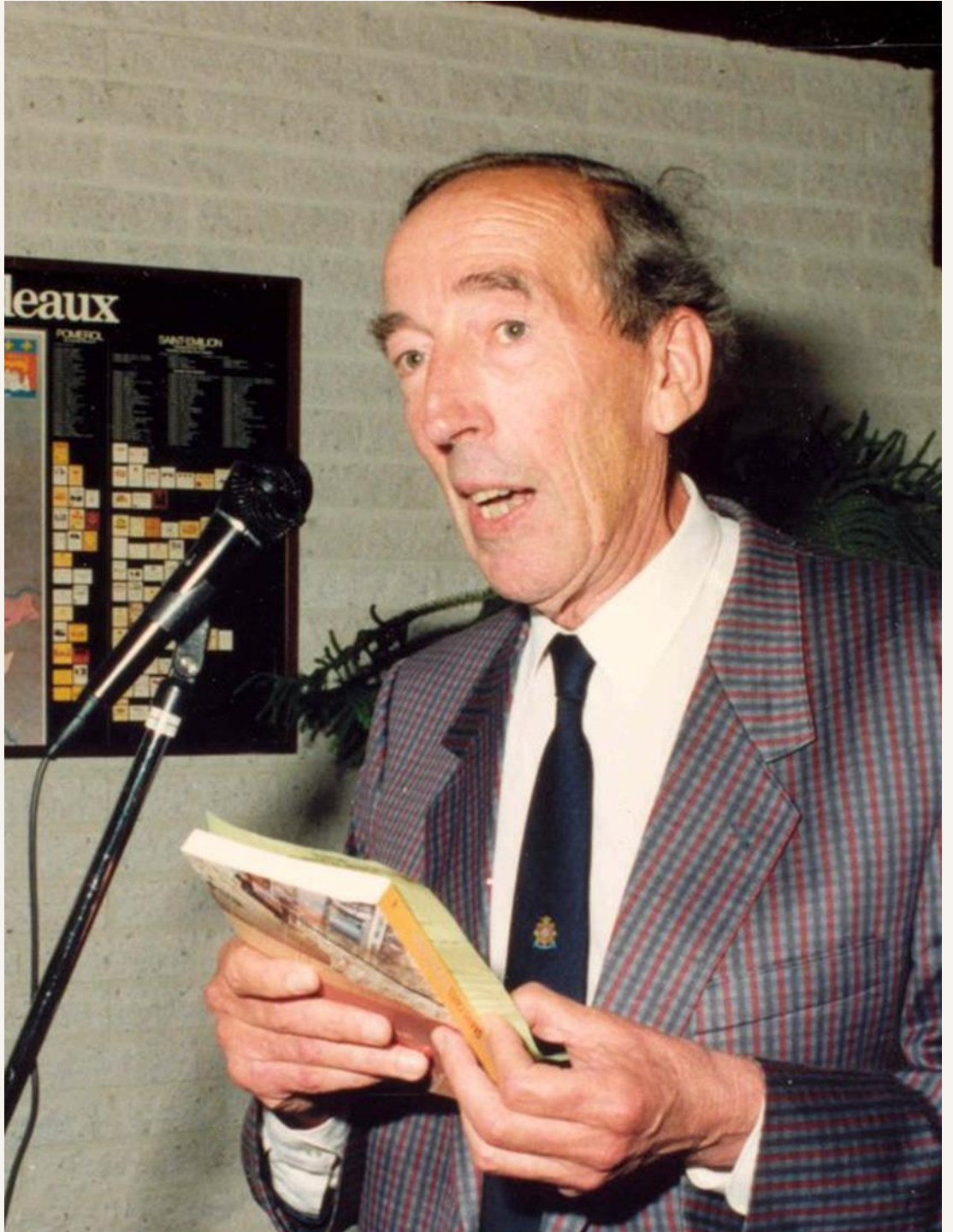
1975-1993

Wageningen

Initiator of

Occupational Hygiene

in The Netherlands



Conflict of interest Disclosure

☑ I have no real or perceived conflicts of interest that relate to this presentation

Impact Beyond the Impact Factor: **Protecting Workers in a Changing Climate**

La Isla Network
Presented by Jason Glaser, CEO
Jason@laislanetwork.org

An addressable but mortal risk: Occupational Heat Stress

Heat Stress

Environmental heat

+

Internal heat from muscular work

- Greater physical strain
- Hotter internal body temperature

Increased risk of heat stroke

Increased accident risk

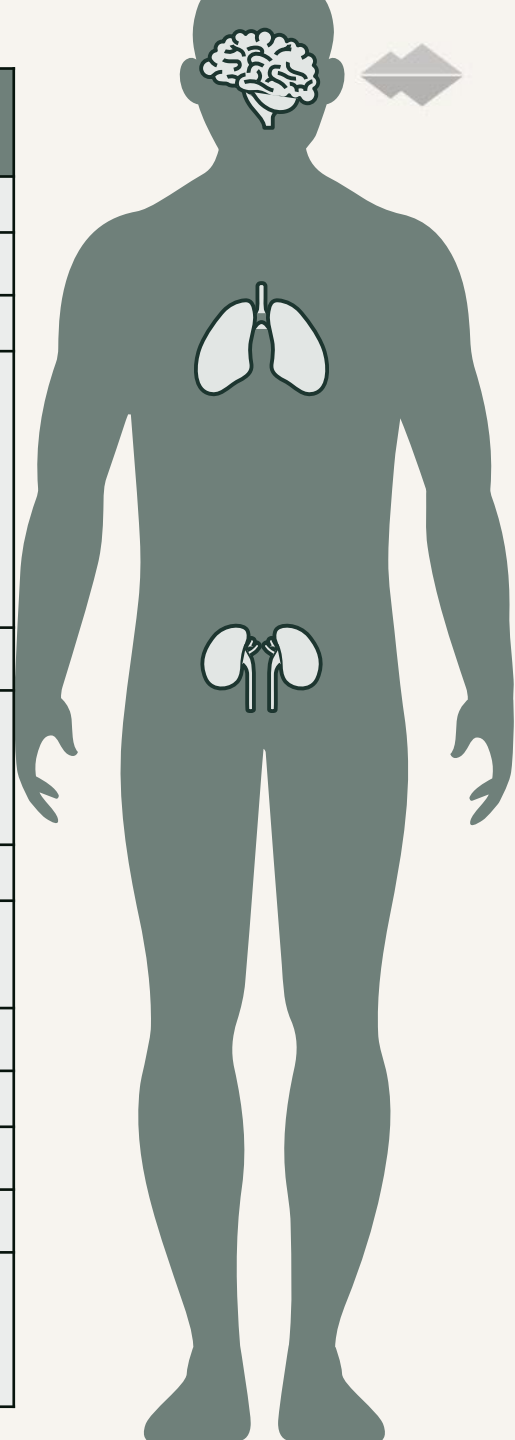
Reduced productivity

Increased risk of **AKI** and **CKD**

Early mortality

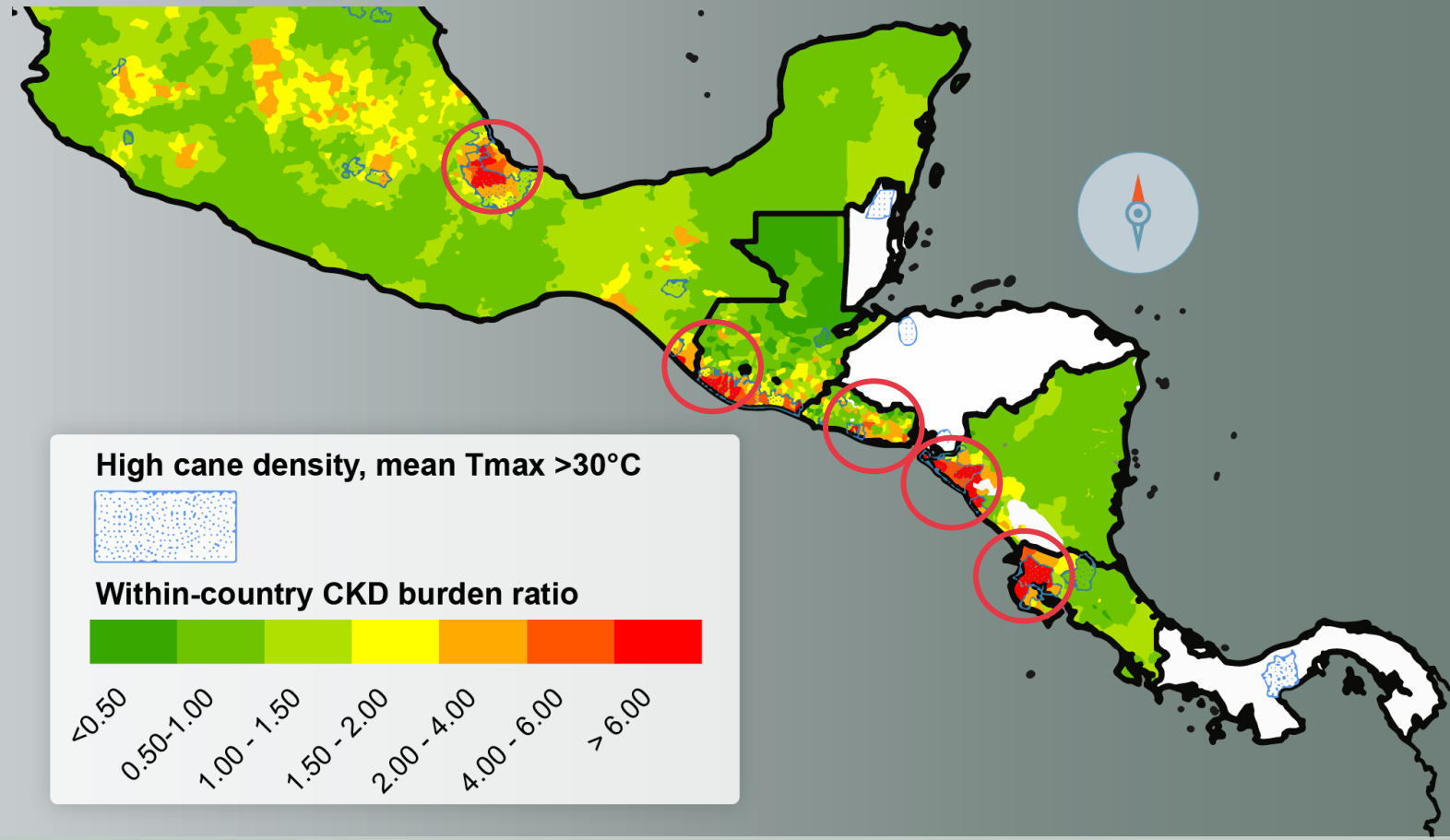
AKI: Acute Kidney Injury
CKD: Chronic Kidney Disease

	Classic Heat Stroke	Exertional Heat Stoke
Age/Sex Groups	Elderly and young	Predominant among working age men
Health status	Chronic illness	Healthy
Activity	Sedentary	Strenuous exercise
Drug use	Anticholinergics, diuretics, antipsychotics, antihypertensives, antidepressants	Usually no meds
Sweating	Usually absent	Often present
Lactic acidosis	Usually absent; poor prognosis if present	Common; may be marked
Rhabdomyalysis	Unusual	Frequently severe
Acute renal failure	< 5% of patients	25-30% of patients
Hypocalcemia	Uncommon	Common
DIC	Mild	Marked
CPK	Mildly elevated	Markedly elevated
Hypoglycemia	Uncommon	Common
Mechanism	Poor dissipation of environmental heat	Excessive endogenous heat production



In Mesoamerica there is a high incidence of CKD among young male laborers with the heaviest workloads

- **High incidence** in sugarcane cutters, brickmakers, gold miners and construction workers[1]
- Cane cutters were **12 times more likely** to suffer kidney injury than workers with lower workloads[2]
- CKD is **second leading cause of death** in El Salvador for young men under 42[3]
- Assessment of urine metabolites show signs of **higher gut permeability and inflammation.**[4]



1. Wesseling C, Glaser J, Rodríguez-Guzmán J, et al. Chronic kidney disease of non-traditional origin in Mesoamerica: a disease primarily driven by occupational heat stress. *Rev Panam Salud Publica*. 2020
2. *Hansson E and Glaser et al. Workload and cross-harvest kidney injury in a Nicaraguan sugarcane worker cohort. Occup Environ Med. 2019.*
3. Orantes-Navarro CM, Almaguer-López et al. *The Chronic Kidney Disease Epidemic in El Salvador: A Cross-Sectional Study*. *MEDICC Rev*. 2019
4. Raines NH, Leone DA, O'Callaghan-Gordo C et al. Metabolic Features of Increased Gut Permeability, Inflammation, and Altered Energy Metabolism Distinguish Agricultural Workers at Risk for Mesoamerican Nephropathy. *Metabolites*. 2023

CKD

Chronic Kidney Disease

CKDnt

Chronic Kidney Disease of Non-traditional Origin

Who Gets It?

Older people,
both males and females

Disproportionately
working age males

Risk Factors

Diabetes, hypertension,
obesity

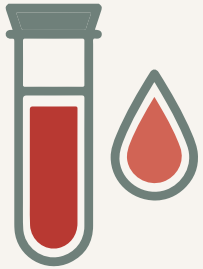
Strenuous labor, without
sufficient access to water,
rest and shade

How, where?

Proteinuria

Worldwide, more widespread
in developed countries

How, where?

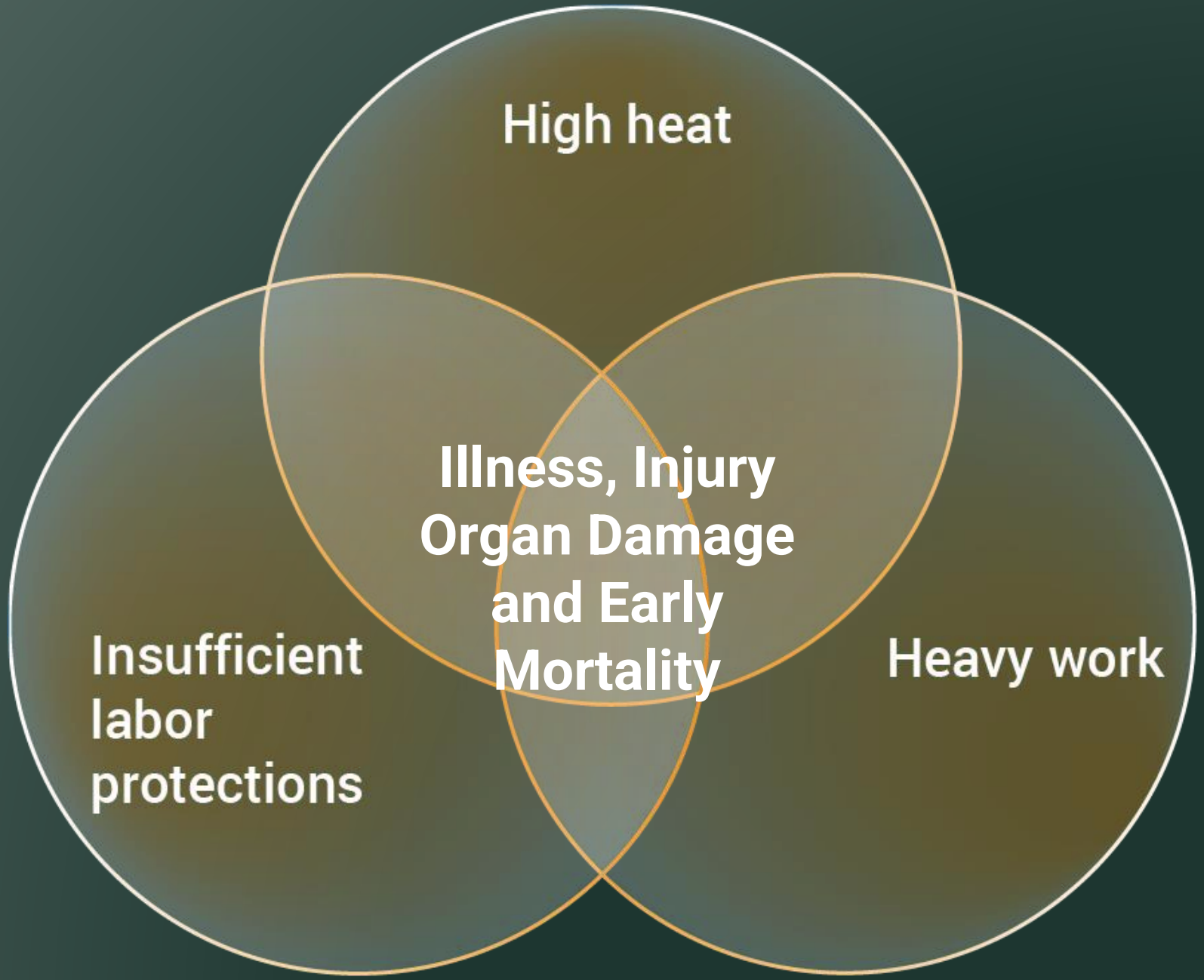


Serum
creatinine

Central America, South Asia
and other tropical lowlands

Causes

Strenuous work in hot environments without adequate protections is a key risk factor in manual workers.



Industries impacted: It’s not just agriculture








"The warming of our planet is unevenly distributed. Regions that are inherently hot, like Kuwait and the Gulf, are witnessing soaring temperatures unlike ever before. Public health policies and interventions need to be responsive to the subpopulations most vulnerable to heat in the region. "

Mary A. Fox, PhD, MPH
Assistant Professor at Johns Hopkins
Bloomberg School of Public Health

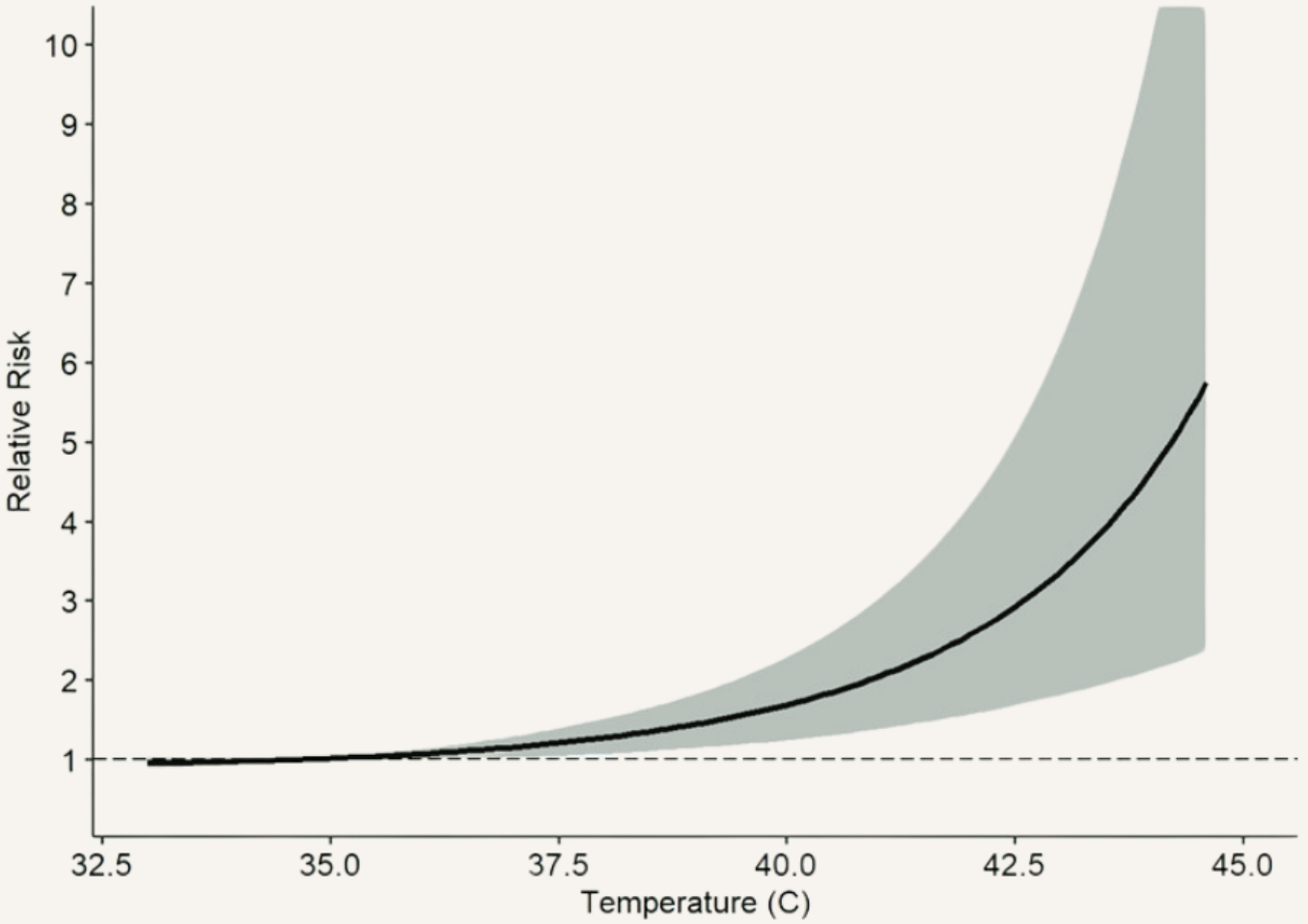
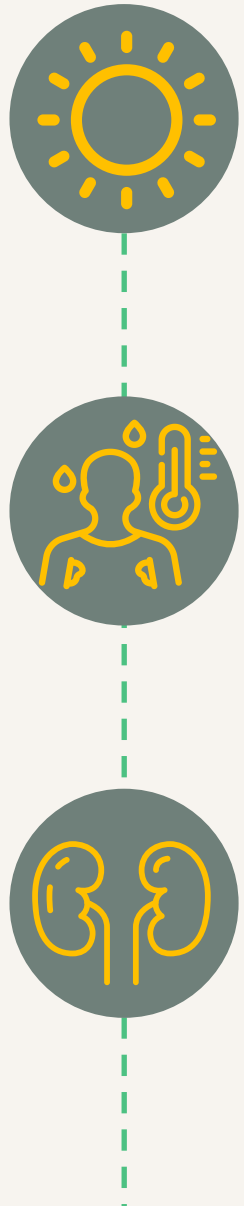


Figure: Relative risk of dying from heart disease and extremely hot temperatures in Kuwait.

LIN's work: Addressing Heat Stress and CKD

- **Standardizing prevalence research methods** to improve disease surveillance.
- **Studying causal associations** to better understand the risk factors of Chronic Kidney Disease of non-Traditional Origin (CKDnT).
- Take an **intervention approach** by applying leading hypotheses of the disease's causes in order to make targeted improvements of working conditions for at-risk populations.
- **Recommending evidence-based policy changes** to governments and companies seeking to respond to the Chronic Kidney Disease of non-Traditional Origin (CKDnT) crisis.



Data driven change often requires first changing research funding policy and prioritization

DEGREE study

Funders: UK-MRC and multiple site funders
Note: Active DEGREE program in Nepal

Adelante initiative

Funders: DEG, BMZ y GIZ

prep4change
prevention
resilience
efficiency
protection

Funders: Belmont Forum, Dept of State and Dept of Labor USA, FORTE

ENBEL
Connecting
HEALTH &
CLIMATE
CHANGE

Funders: European Commision

Providing guidance to:

PRO SALUTE NOVI MUNDI PAHO OPS
Pan American Health Organization

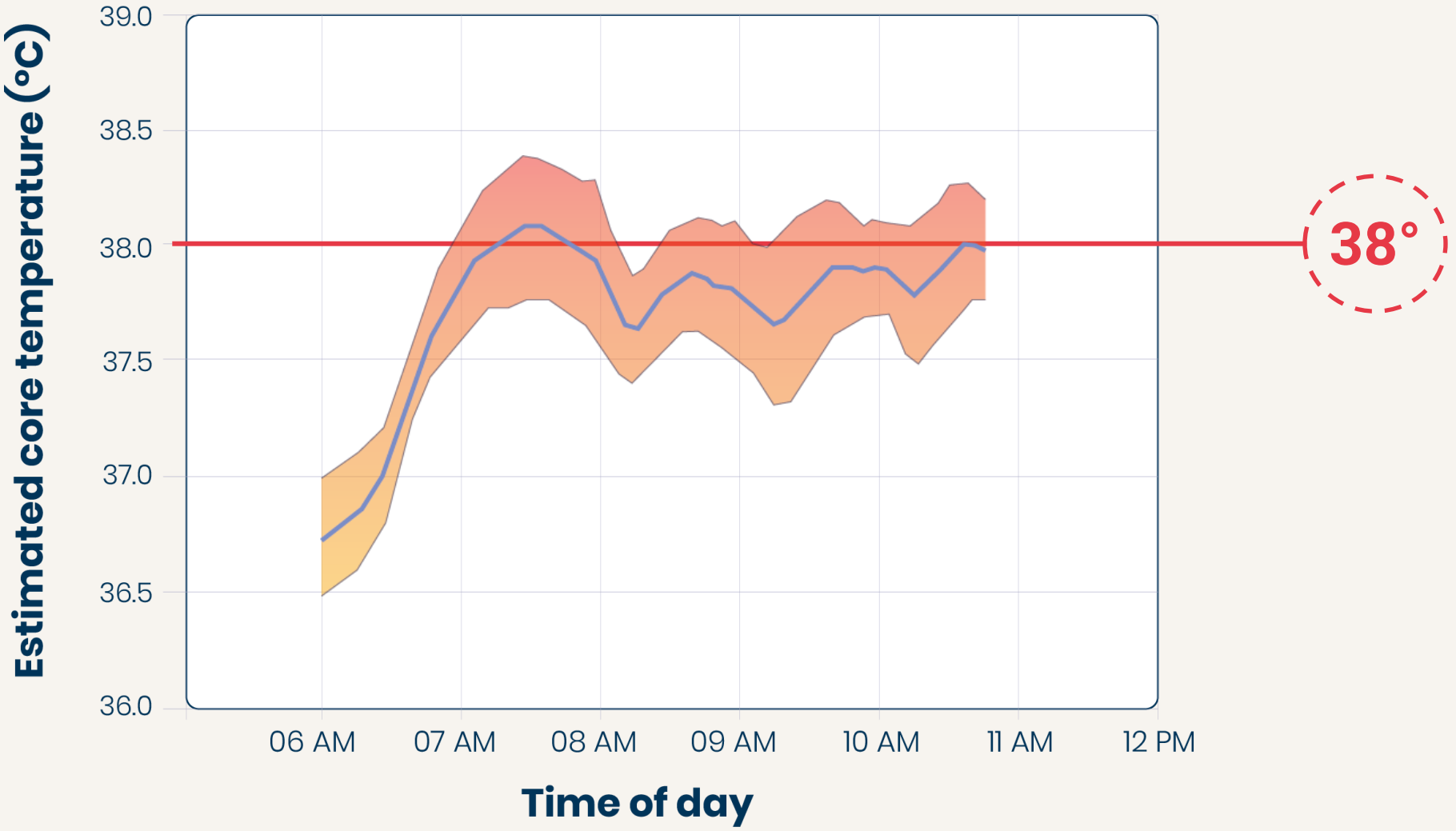
DEPARTMENT OF STATE UNITED STATES OF AMERICA

DEPARTMENT OF LABOR UNITED STATES OF AMERICA

Methods to address heat stress and kidney health in the sugar industry

- Develop Centers of Excellence (CoE) to serve as models for reducing harm and increasing productivity in each country
- The Adelante CoE in Nicaragua: benchmark for success (see Chavarría et al)
- First year baseline evaluation protocol to assess
  - Existing preventive measures for managing occupational heat stress
  - Cutters' X-harvest and X-shift workload, heat strain, kidney and heat illness
  - Knowledge, practices and policies (KAP) and Organizational OSH management
- Exchange experience: workshops, site visits, and joint training among mills
- Evaluate Return of Investment (ROI)
- Mapping of regulations and procedures of social protection systems
- Community studies near mills to assess
  - Prevalence of kidney disease
  - Socioeconomic impact of work-related kidney diseases

Those with highest core body temperatures have highest incidence of kidney injury. A key objective: Reduce dangerously high core temps



We do this by designing, assessing and assisting the implementation of occupational safety and health interventions through our transdisciplinary **Prevention, Resilience, Efficiency, Protection (PREP)** strategy.
Initial Program at Nicaragua's largest sugar producer.

Physiological exposure measurements in the field

Metabolic Rate

second by second time-motion analysis or real-time analysis

Heart Rate

beat by beat heart rate data using heart rate monitors

Core Temperature

continuous core temperature data using telemetric capsules

Mean Skin Temperature

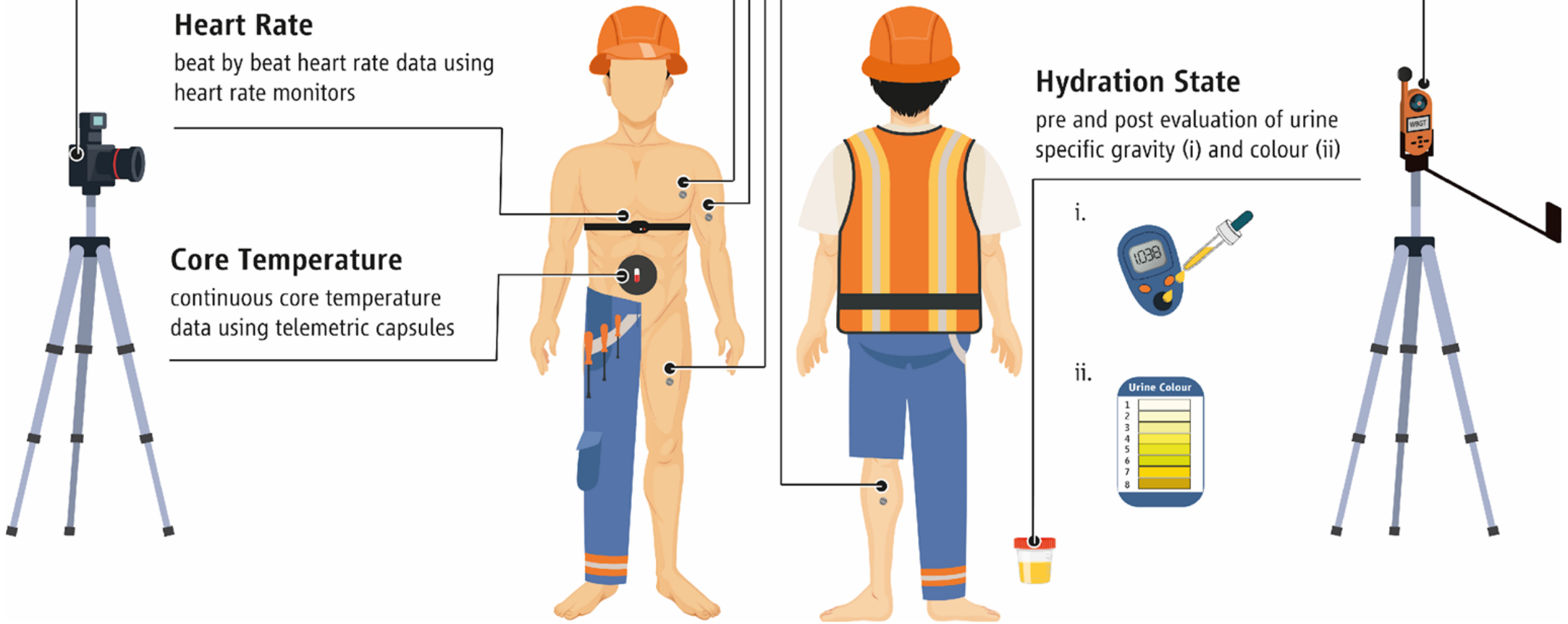
continuous skin temperature from four sites using wireless thermistors

Occupational Heat Stress

continuous environmental data using a portable weather station

Hydration State

pre and post evaluation of urine specific gravity (i) and colour (ii)



RSH+s

Rest | Shade | Hydratation + Sanitation

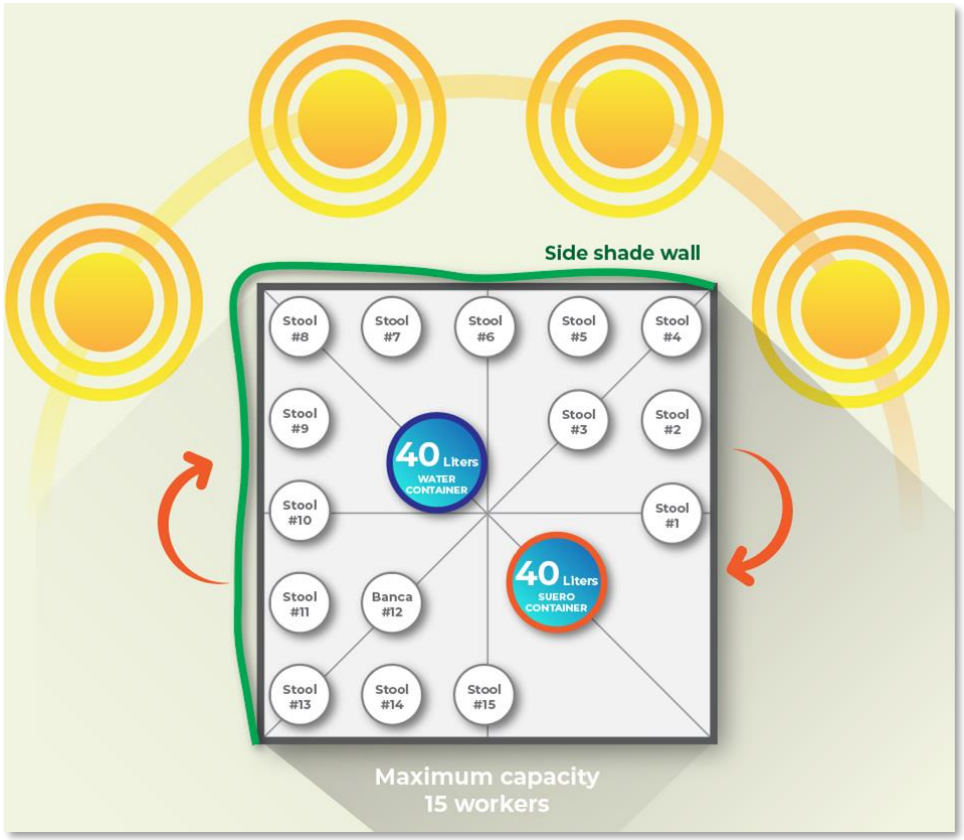
Scheduled breaks

Portable shade tents

Clean water and hydration beverages

Importance of good hygiene

Mobile Shaded/Cooling Rest: always within 25 meters of workforce



Hydration

Easy access to clean water

&

electrolyte solutions




Sanitation in the field

THE STEPS ARE SIMPLE, IMPLEMENTATION IS KEY

Outcome measurements for today's talk

1. **Incident Kidney Injury(IKI)**: Measure of decline in Kidney function over set period, in this case harvest

Defined as serum creatinine increase ≥0.30 mg/dL or ≥1.5 times the baseline value measured at preharvest with follow up sample being end of harvest.

2**. Hospitalized Acute Kidney Injury** (h-AKI): Heat stress cases referred to company clinic and diagnosed with Acute kidney injury.

AKI Definition: Absolute increase in sCr ≥ 0.3 mg/dL (≥26.5 **µmol**/L) or ≥ 1.5 to 2.0 fold from baseline. Baseline is being designated by preharvest preemployment checks

3. **Productivity** (Burned Cane Cutters): tons cut per hour and per workday/shift per individual

4. **Return on Investment**:

$$ROI = \frac{(\text{value of benefits}) - (\text{value of investments})}{\text{value of investments}}$$

Costs used in this analysis included:

- those related to the number of acute and chronic kidney disease cases from 2015-2019;
- cost of electrolyte production;
- salaries for staff working on Adelante (lab techs, community health workers, estimates of the portion of the doctor's salary attributable to Adelante);
- the hours lost due to CKDnt;
- turnover costs (costs associated with hiring and training new workers);
- equipment for cutters (sun-blocking hats, water containers, tarps for shade);
- training costs for healthcare workers (generally);
- training and equipment costs related to worker surveys administered by healthcare workers;
- costs of treating dehydrated worker (including materials, portion of salaries for doctors and technicians, urine analysis costs, etc.);
- profit loss due to lower productivity associated with time taken off due to illness; and
- costs, not captured elsewhere, of operating two mobile clinics.

In order to estimate firm-level benefits derived from the intervention, we considered:

- savings in terms of reduced turnover costs;
- increases in labor productivity;
- savings in terms of lower treatment costs for chronic and acute kidney failure.

Other factors to consider

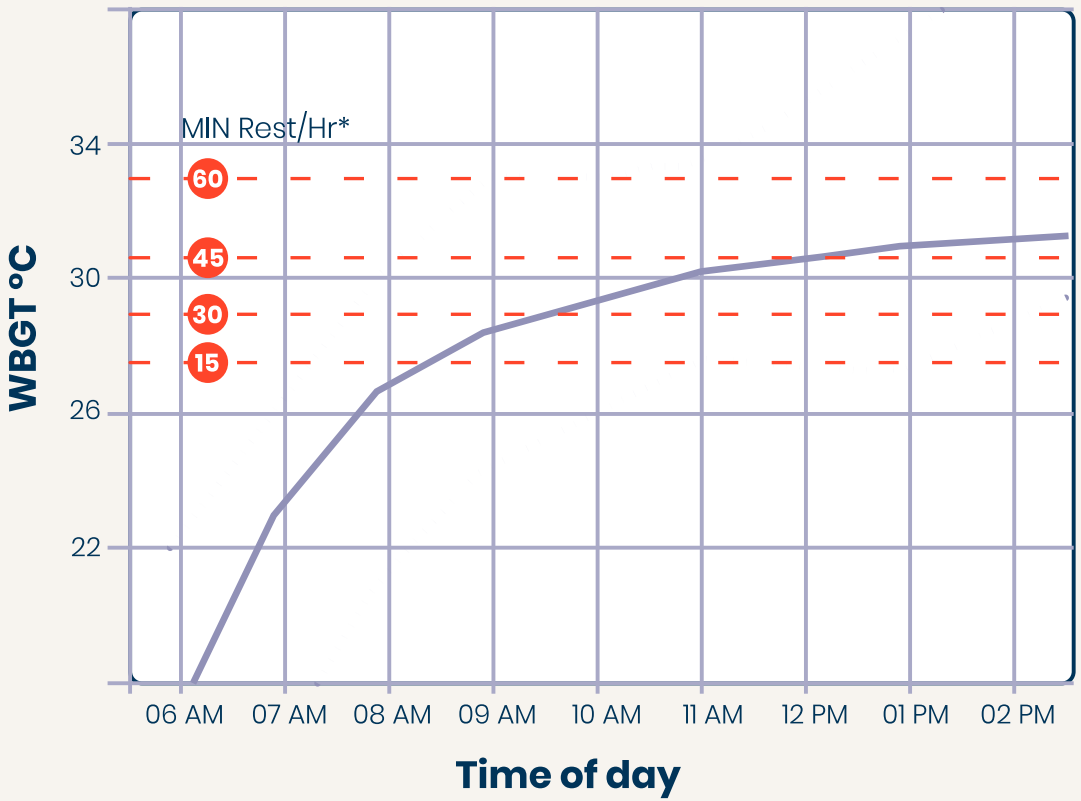
Acclimatization

Provision of safe place where workers can relieve themselves

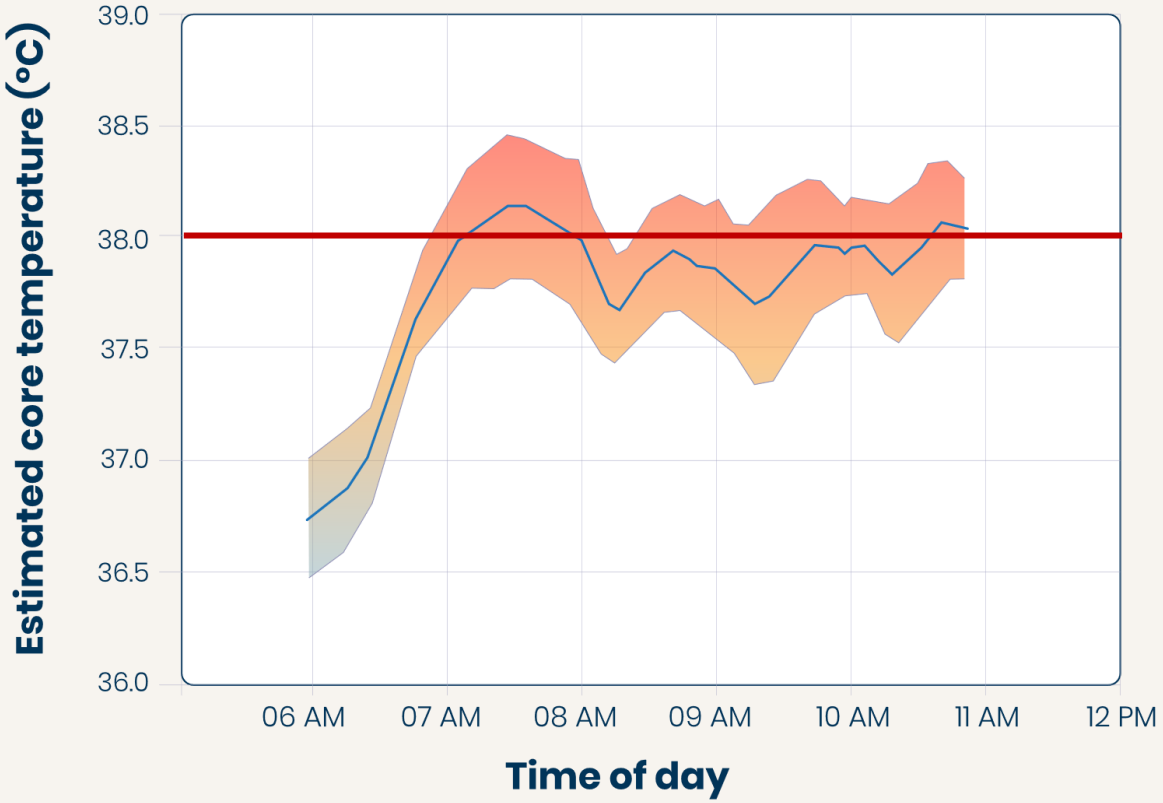
Sanitation

A key issue: current policy/recommendations were and are unattainable/ineffective

Environmental Temps and OSHA Rest Guidelines



Average core temperature of burned cane cutters (Harvest 2-Adelante)



ACGIH recommended work durations in Saudi Arabia

Low intensity work

	Acclimatized workers									Non-acclimatized workers								
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
06:00 – 07:00	60	60	60	60	60	60	45	60	60	60	60	60	45	15	15	15	60	60
07:00 – 08:00	60	60	60	60	30	45	15	60	60	60	60	60	30	15	15	15	15	60
08:00 – 09:00	60	60	60	60	15	30	15	30	60	60	60	60	15	15	15	15	15	60
09:00 – 10:00	60	60	60	60	15	15	15	30	60	60	60	60	15	15	15	15	15	60
10:00 – 11:00	60	60	60	30	15	15	15	30	60	60	60	60	15	15	15	15	15	60
11:00 – 12:00	60	60	60	15	15	15	15	30	60	60	60	60	15	15	15	15	15	60
12:00 – 13:00	60	60	60	---	---	---	---	15	60	60	60	60	---	---	---	---	15	60
13:00 – 14:00	60	60	60	---	---	---	---	30	60	60	60	60	---	---	---	---	15	60
14:00 – 15:00	60	60	60	---	---	---	---	60	60	60	60	60	---	---	---	---	15	60
15:00 – 16:00	60	60	60	60	15	15	15	60	60	60	60	60	15	15	15	15	45	60
16:00 – 17:00	60	60	60	60	15	45	30	60	60	60	60	60	30	15	15	15	60	60
17:00 – 18:00	60	60	60	60	30	60	60	60	60	60	60	60	60	15	15	15	60	60
18:00 – 19:00	60	60	60	60	60	60	60	60	60	60	60	60	60	15	15	15	60	60
19:00 – 20:00	60	60	60	60	60	60	60	60	60	60	60	60	60	15	30	15	60	60

The tables show the recommended maximum duration (minutes per hour) of continuous work based on the Threshold Limit Values of ACGIH

ACGIH recommended work durations in Saudi Arabia

Moderate intensity work

	Acclimatized workers									Non-acclimatized workers								
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
06:00 – 07:00	60	60	60	45	30	30	15	60	60	60	60	60	15	15	15	15	30	60
07:00 – 08:00	60	60	60	30	15	15	15	30	60	60	60	60	15	15	15	15	15	60
08:00 – 09:00	60	60	60	30	15	15	15	15	60	60	60	30	15	15	15	15	15	60
09:00 – 10:00	60	60	60	15	15	15	15	15	60	60	60	30	15	15	15	15	15	45
10:00 – 11:00	60	60	60	15	15	15	15	15	60	60	60	30	15	15	15	15	15	45
11:00 – 12:00	60	60	60	15	15	15	15	15	60	60	60	30	15	15	15	15	15	45
12:00 – 13:00	60	60	60	---	---	---	---	15	60	60	60	15	---	---	---	---	15	60
13:00 – 14:00	60	60	60	---	---	---	---	15	60	60	60	30	---	---	---	---	15	60
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17:00 – 18:00	60	60	60	60	15	15	15	60	60	60	60	60	15	15	15	15	15	60
18:00 – 19:00	60	60	60	60	30	30	15	60	60	60	60	60	15	15	15	15	15	60
19:00 – 20:00	60	60	60	60	30	30	15	60	60	60	60	60	30	15	15	15	15	60

The tables show the recommended maximum duration (minutes per hour) of continuous work based on the Threshold Limit Values of ACGIH

ACGIH recommended work durations in Saudi Arabia

High intensity work

	Acclimatized workers									Non-acclimatized workers								
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
06:00 – 07:00	>45*	>45*	>45*	30	15	15	15	45	>45*	>45*	>45*	30	30	15	15	15	15	>45*
07:00 – 08:00	>45*	>45*	>45*	15	15	15	15	15	>45*	>45*	>45*	30	15	15	15	15	15	>45*
08:00 – 09:00	>45*	>45*	>45*	15	15	15	15	15	>45*	>45*	45	15	15	15	15	15	15	30
09:00 – 10:00	>45*	>45*	45	15	15	15	15	15	>45*	45	30	15	15	15	15	15	15	30
10:00 – 11:00	>45*	>45*	>45*	15	15	15	15	15	>45*	30	30	15	15	15	15	15	15	30
11:00 – 12:00	>45*	>45*	45	15	15	15	15	15	>45*	30	15	15	15	15	15	15	15	15
12:00 – 13:00	>45*	>45*	45	---	---	---	---	15	>45*	30	30	15	---	---	---	---	15	30
13:00 – 14:00	>45*	>45*	>45*	---	---	---	---	15	>45*	>45*	30	15	---	---	---	---	15	45
14:00 – 15:00	>45*	>45*	>45*	---	---	---	---	15	>45*	45	45	30	---	---	---	---	15	45
15:00 – 16:00	>45*	>45*	>45*	15	15	15	15	30	>45*	>45*	45	30	15	15	15	15	15	>45*
16:00 – 17:00	>45*	>45*	>45*	15	15	15	15	45	>45*	>45*	>45*	30	15	15	15	15	15	>45*
17:00 – 18:00	>45*	>45*	>45*	30	15	15	15	45	>45*	>45*	>45*	30	30	15	15	15	15	>45*
18:00 – 19:00	>45*	>45*	>45*	45	15	15	15	45	>45*	>45*	>45*	30	45	15	15	15	15	>45*
19:00 – 20:00	>45*	>45*	>45*	45	15	15	15	45	>45*	>45*	>45*	45	45	15	15	15	15	>45*

* should be confirmed by detailed analysis and/or physiological monitoring.

The tables show the recommended maximum duration (minutes per hour) of continuous work based on the Threshold Limit Values of ACGIH

ACGIH recommended work durations in Saudi Arabia

Very high intensity work

	Acclimatized workers									Non-acclimatized workers								
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
06:00 – 07:00	>45*	>45*	>45*	15	15	15	15	30	>45*	>45*	>45*	15	15	15	15	15	15	>45*
07:00 – 08:00	>45*	>45*	>45*	15	15	15	15	15	>45*	>45*	>45*	15	15	15	15	15	15	>45*
08:00 – 09:00	>45*	>45*	>45*	15	15	15	15	15	>45*	>45*	30	15	15	15	15	15	15	30
09:00 – 10:00	>45*	>45*	30	15	15	15	15	15	>45*	30	15	15	15	15	15	15	15	15
10:00 – 11:00	>45*	>45*	>45*	15	15	15	15	15	>45*	30	15	15	15	15	15	15	15	15
11:00 – 12:00	>45*	>45*	30	15	15	15	15	15	>45*	30	15	15	15	15	15	15	15	15
12:00 – 13:00	>45*	>45*	30	---	---	---	---	15	>45*	30	15	15	---	---	---	---	15	30
13:00 – 14:00	>45*	>45*	>45*	---	---	---	---	15	>45*	30	15	15	---	---	---	---	15	30
14:00 – 15:00	>45*	>45*	>45*	---	---	---	---	15	>45*	30	30	15	---	---	---	---	15	30
15:00 – 16:00	>45*	>45*	>45*	15	15	15	15	15	>45*	>45*	30	15	15	15	15	15	15	>45*
16:00 – 17:00	>45*	>45*	>45*	15	15	15	15	30	>45*	>45*	>45*	15	15	15	15	15	15	>45*
17:00 – 18:00	>45*	>45*	>45*	15	15	15	15	30	>45*	>45*	>45*	15	15	15	15	15	15	>45*
18:00 – 19:00	>45*	>45*	>45*	30	15	15	15	30	>45*	>45*	>45*	15	15	15	15	15	15	>45*
19:00 – 20:00	>45*	>45*	>45*	30	15	15	15	30	>45*	>45*	>45*	30	15	15	15	15	15	>45*

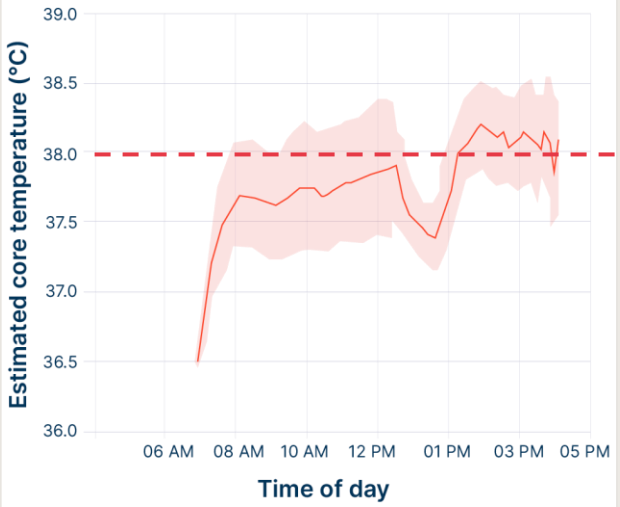
* should be confirmed by detailed analysis and/or physiological monitoring.

The tables show the recommended maximum duration (minutes per hour) of continuous work based on the Threshold Limit Values of ACGIH

Guidance and the sugar mill's rest schedule were insufficient

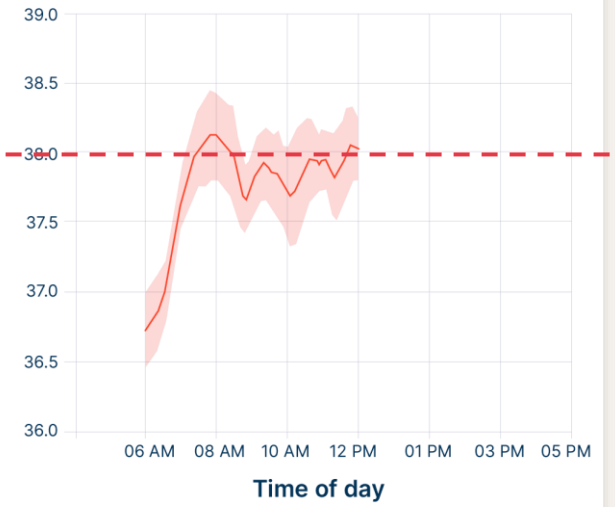
Harm Reduction: Design and Implementation must be considered equally as well as duration and intensity

No Intervention Site



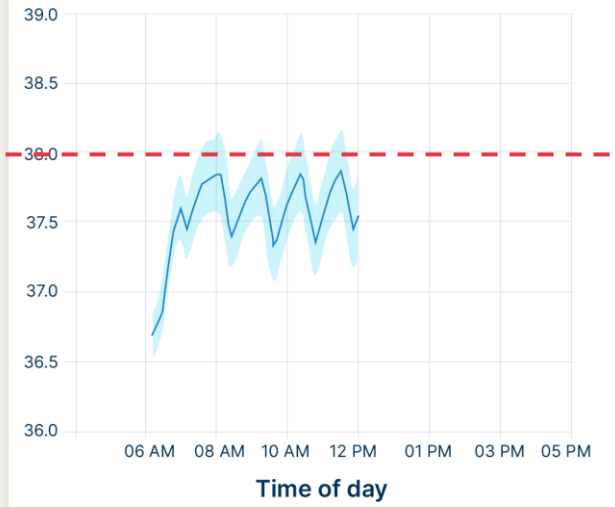
- 27% (2:09) of workday over 38 C
- 10% (60 min) of workday at rest
- Incidence of kidney injury over harvest: 21%

Phase 1 intervention



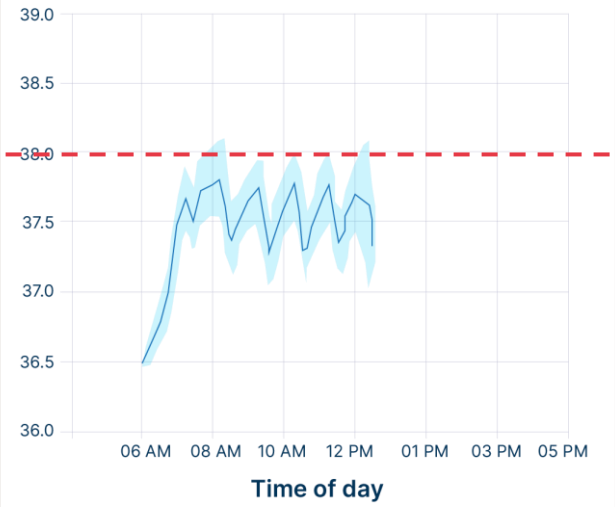
- 30% (1:45) of workday over 38 C
- 14% (60 min) of workday at rest
- Incidence of kidney injury over harvest: 6%

Phase 2 intervention



- 9% (1:45) of workday over 38 C
- 23% (80 min) of workday at rest
- Incidence of kidney injury over harvest: 5%

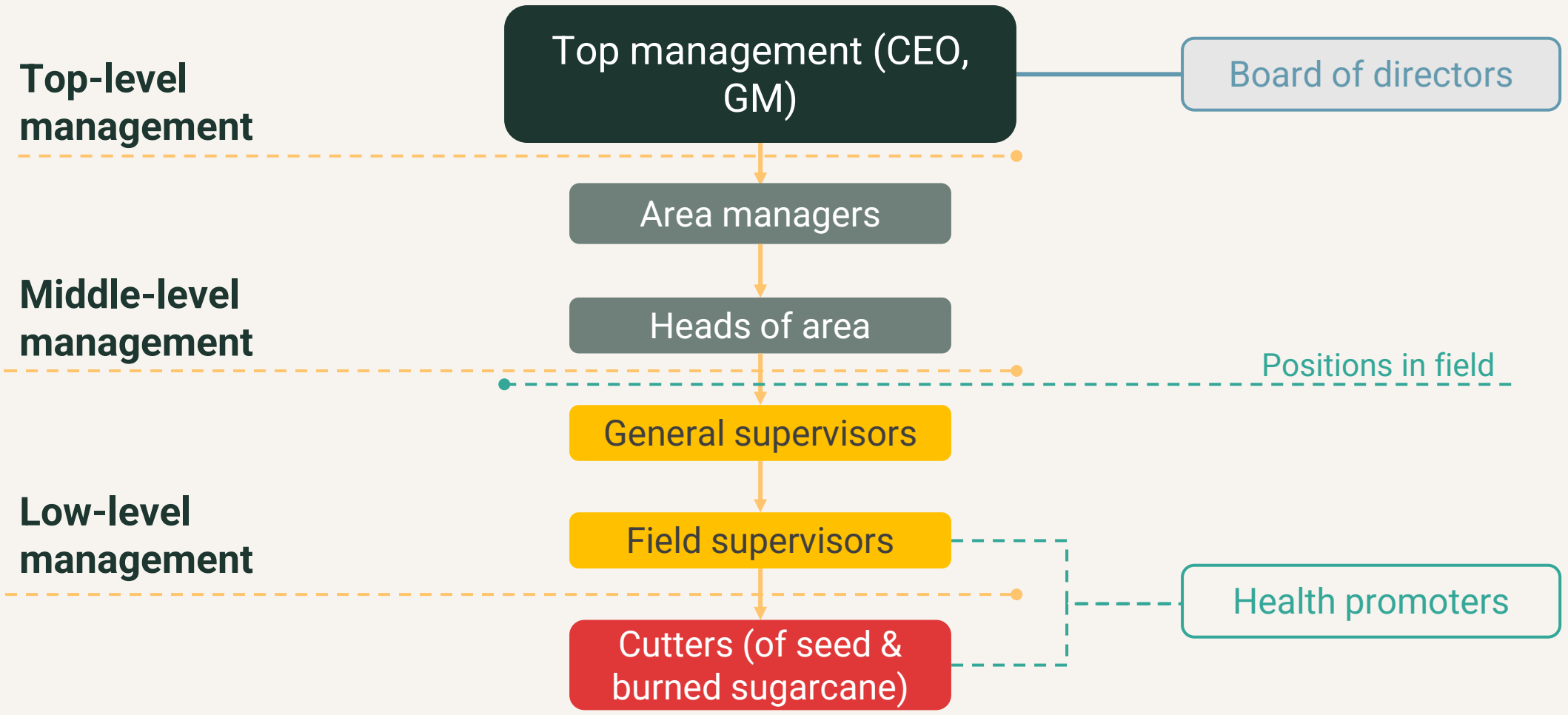
Organizational management intervention introduced



- 9% (1:45) of workday over 38 C
- 23% (80 min) of workday at rest

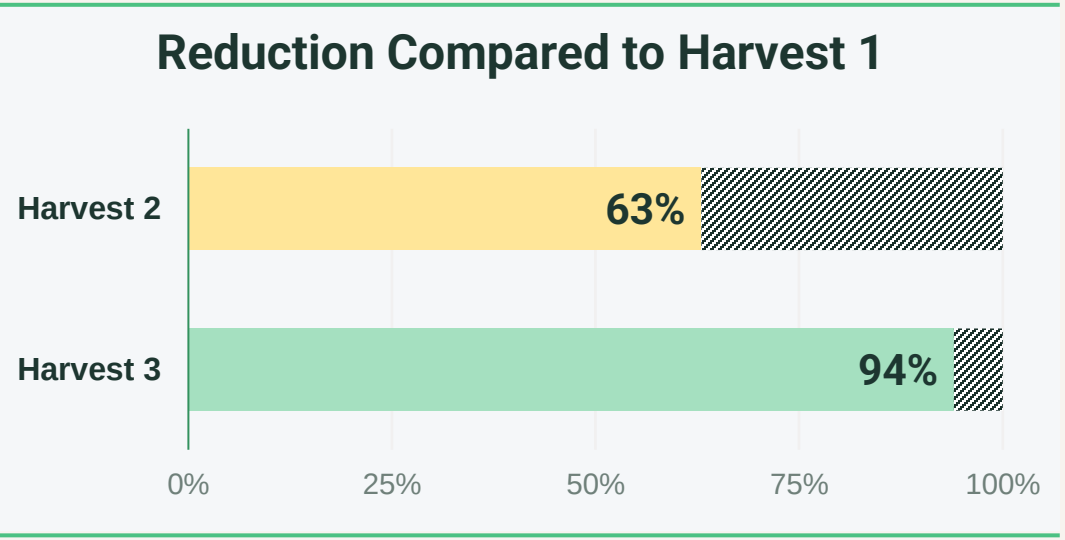
1% **Incidence of kidney injury over harvest**

Organizational assessment provides insights

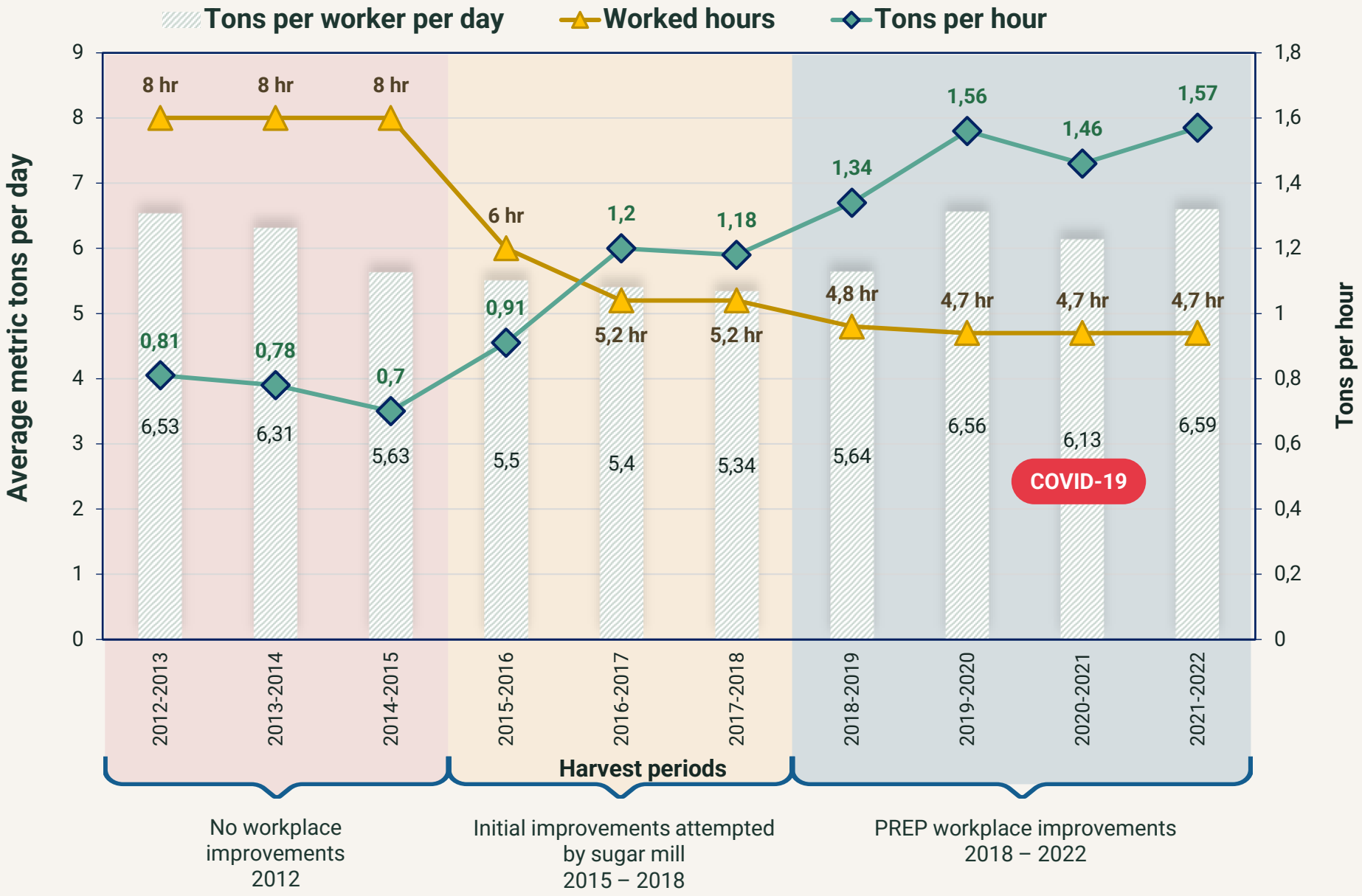


Reduction in Heat Related Illness associated Acute Kidney Injury (AKI)

Job	Workload	Harvest 1 2017-2018	Harvest 2 2018-2019	Harvest 3 2019-2020
		% of AKI	% of AKI	% of AKI
Cutters (Burned Cane and Seed)	Very High	9.4%	3.8%	0.6%
Drip Irrigation Repair + Field Support	Med/Low	3.9%	0.8%	0%



Increase in productivity and a Return on Investment



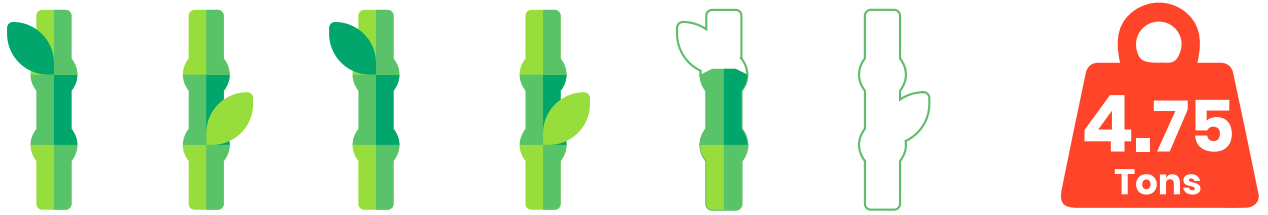
22%

Positive ROI in ISA by PREP and Adelante

With the investment in the occupational safety and health program, the sugar mill has obtained a positive return on investment.

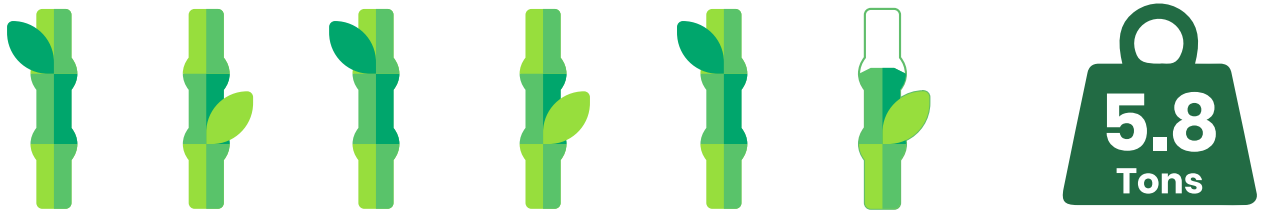
9 HOURS

Site 1: no program



8 HOURS

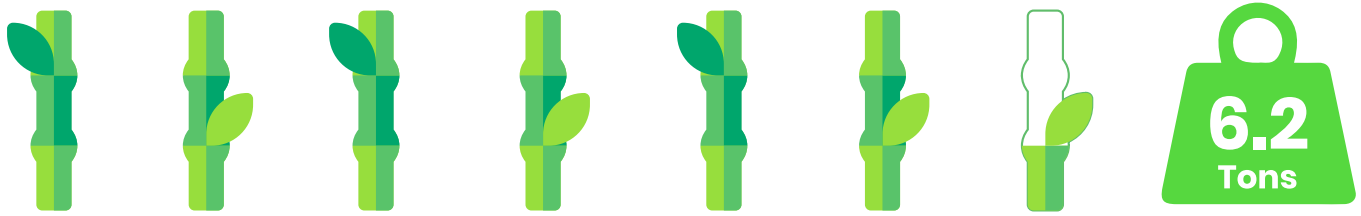
Pre Adelante Results (w/ insufficient program)



4 HOURS

Post Adelante results

Adelante initiative

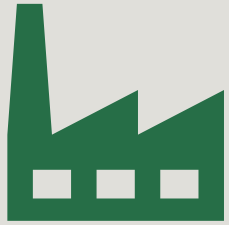


We need multisite, multi industry studies along these lines to design effective and efficient heat stress protections and inform regulations.

+9 Products

20+ Country Presence

Why now?



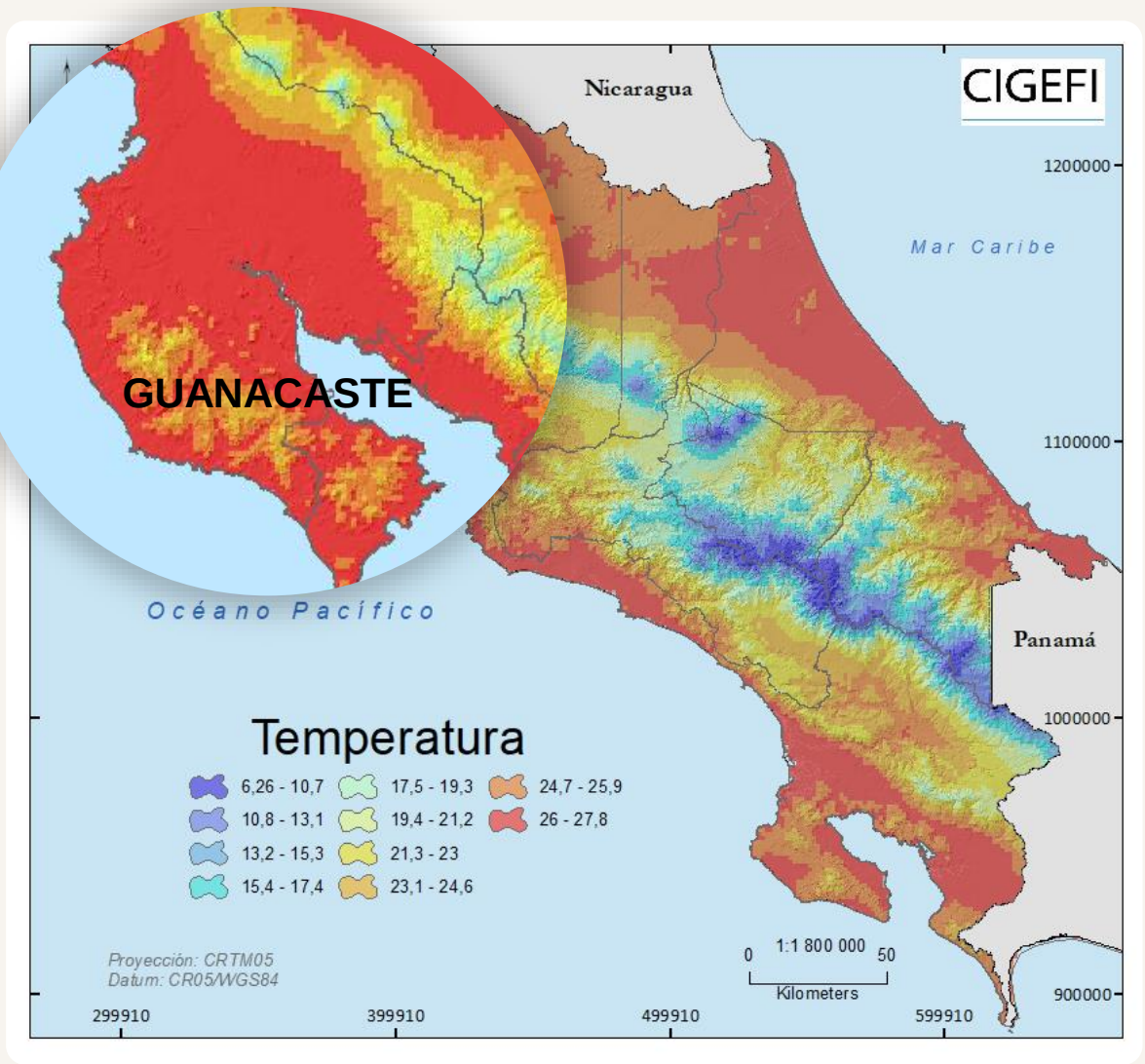
Industrialization of agriculture - rise of monocultures

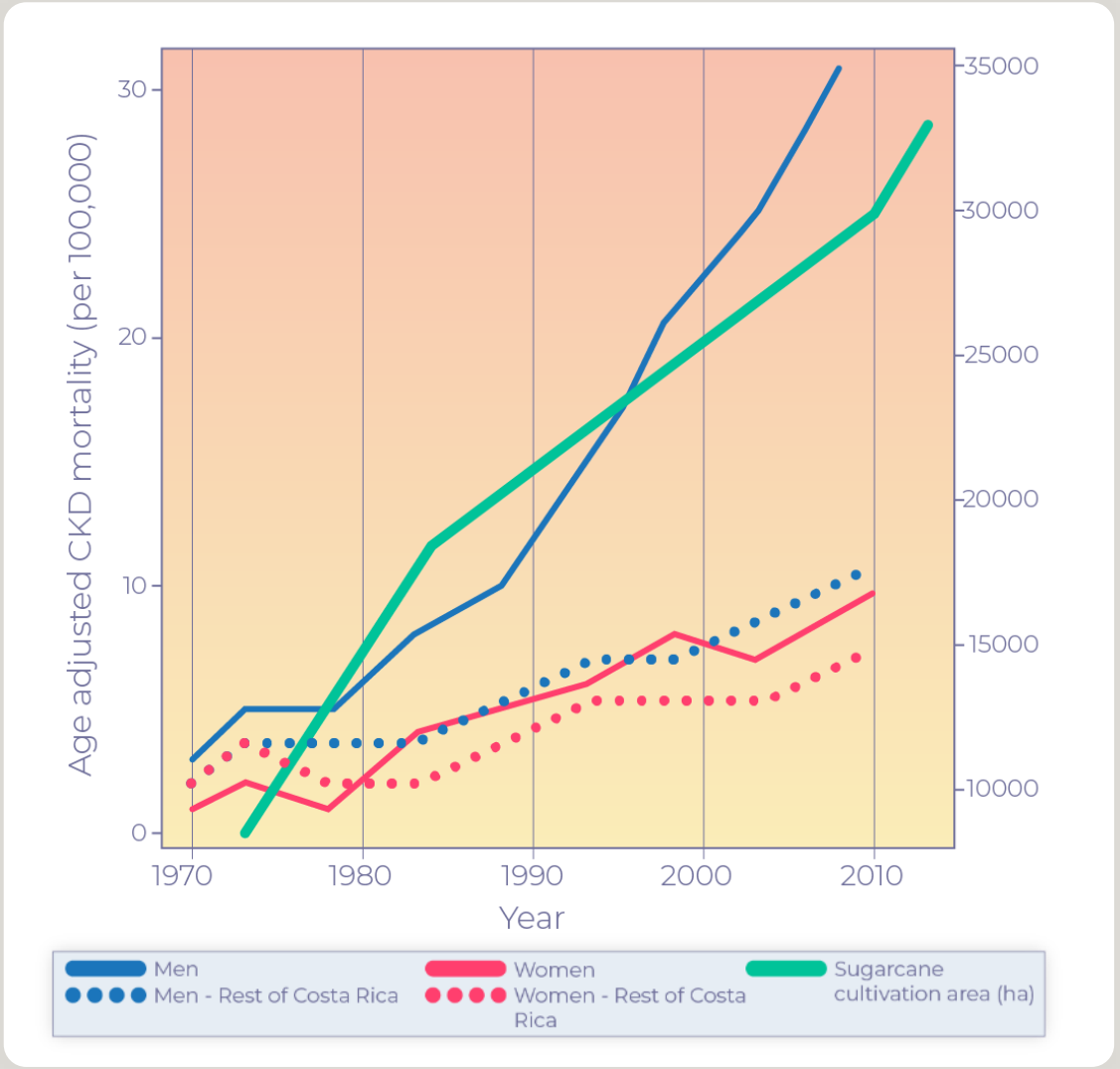
Piece rate work

Increase in research and surveillance

Warming climate

It’s not new: Costa Rica example of CKD mortality trends 1970-2012





Impact on society

Decrease in productivity

Reduced potential labour hours*

*470 billion potential reduction of labour hours globally, +37% increase compared to 1990’s

Social impact

Impact on health services

Health impact of exposure to extreme heat

Impact on individual

Acute heat-related illness

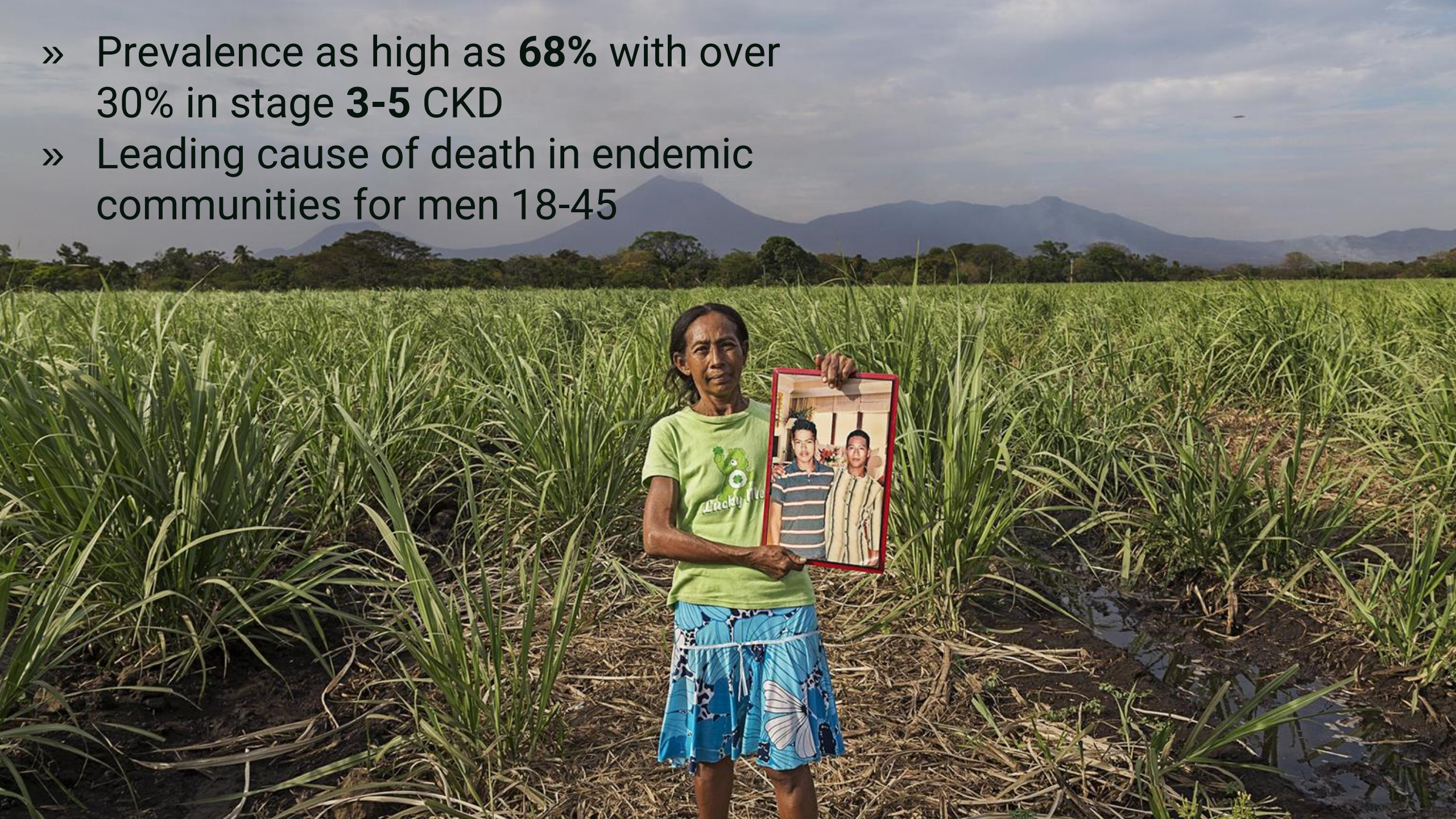
Increased risk of accidents

Long-term heat-related illness

Death

The Human Costs

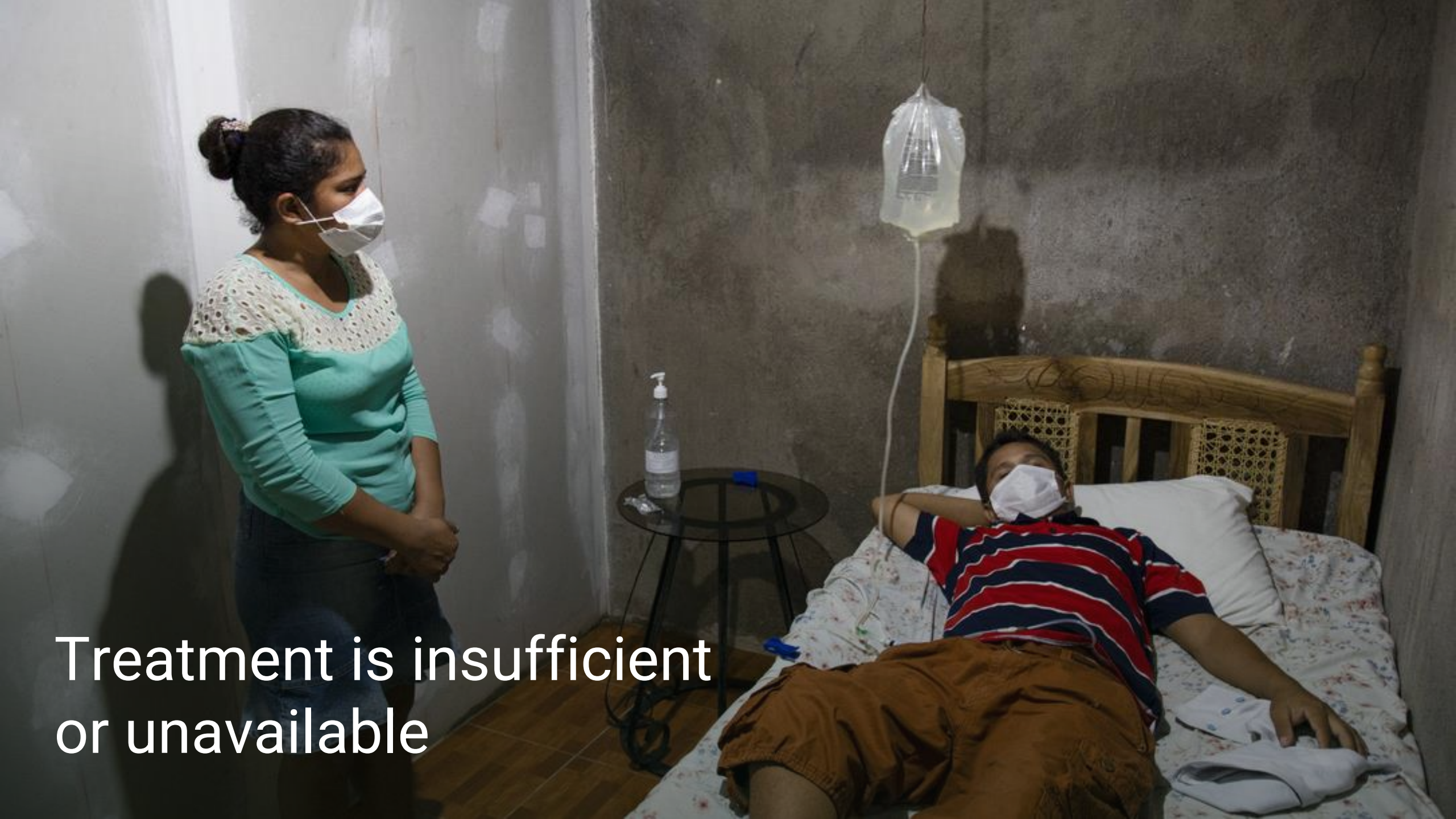
- Prevalence as high as **68%** with over 30% in stage **3-5** CKD
- Leading cause of death in endemic communities for men 18-45




67% Purchase
food on credit on a
weekly basis

36%

CKDnt households have taken out an interest-bearing loan at an average interest rate of 14%


Treatment is insufficient
or unavailable

Local and international disconnects

Impact on development and society is multigenerational:

22% of worker households impacted by CKD had a child enter the workforce to replace a sick or deceased parent

A Challenge in US and EU

HOME › NEWS › WORKFORCE & SKILLS

Turner Construction study shows workers at data center project negatively impacted by hot working conditions

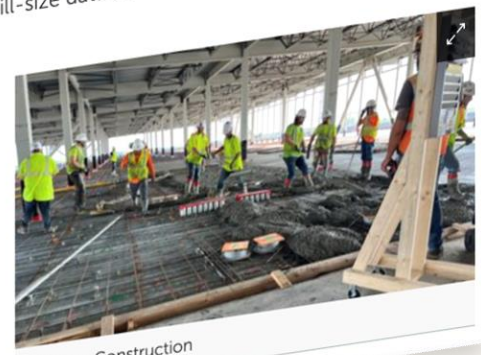
Workers at risk of "permanent effects" even on milder days

January 17, 2024 By: Georgia Butler 1 Comment

Tuner Construction has found health concerns during a study exploring the conditions for laborers working at a large data center project in Kansas City.

The study, carried out alongside the universities of New Mexico and Indiana and research consultancy La Isla Network, gave 33 workers a pill-size data collection device to swallow and measure their internal temperatures.

The device captured their internal temperature throughout the course of a working day, and found that 43 percent of workers experienced a peak core temperature exceeding 100.4°F (38°C), with four percent exceeding 101.3°F (38.5°C). The day in question was "cooler than typical [in] summer."



– Turner Construction

Those internal readings could, if prolonged, cause permanent health effects. It is important to note however that, according to the lead

https://france3-regions.francetvinfo.fr/grand-est/marne/epernay/canicule-quatre-morts-suite-a-des-arrets-cardiaques-dans-les-vignes-en-champagne-c-est-dramatique-2837759.html

6 deaths in the vineyards of Champagne and Bordeaux in Sept 2023 grape harvest due to heat stroke

"We experienced a period of intense heat, these activities expose us to major risks. With climate change, we must be able to stop the activity. [...] It's dramatic, it's serious, we're falling into the vineyards. And no one says anything.

Operations must be stopped in the event of hot weather. If the employer doesn't do it, the labor inspectors should be empowered to do it for them. It's urgent!".

Anthony Smith, union official at the Ministry of Labor in the Marne region of France

Heat Stress

Environmental heat
+
Internal heat from muscular work

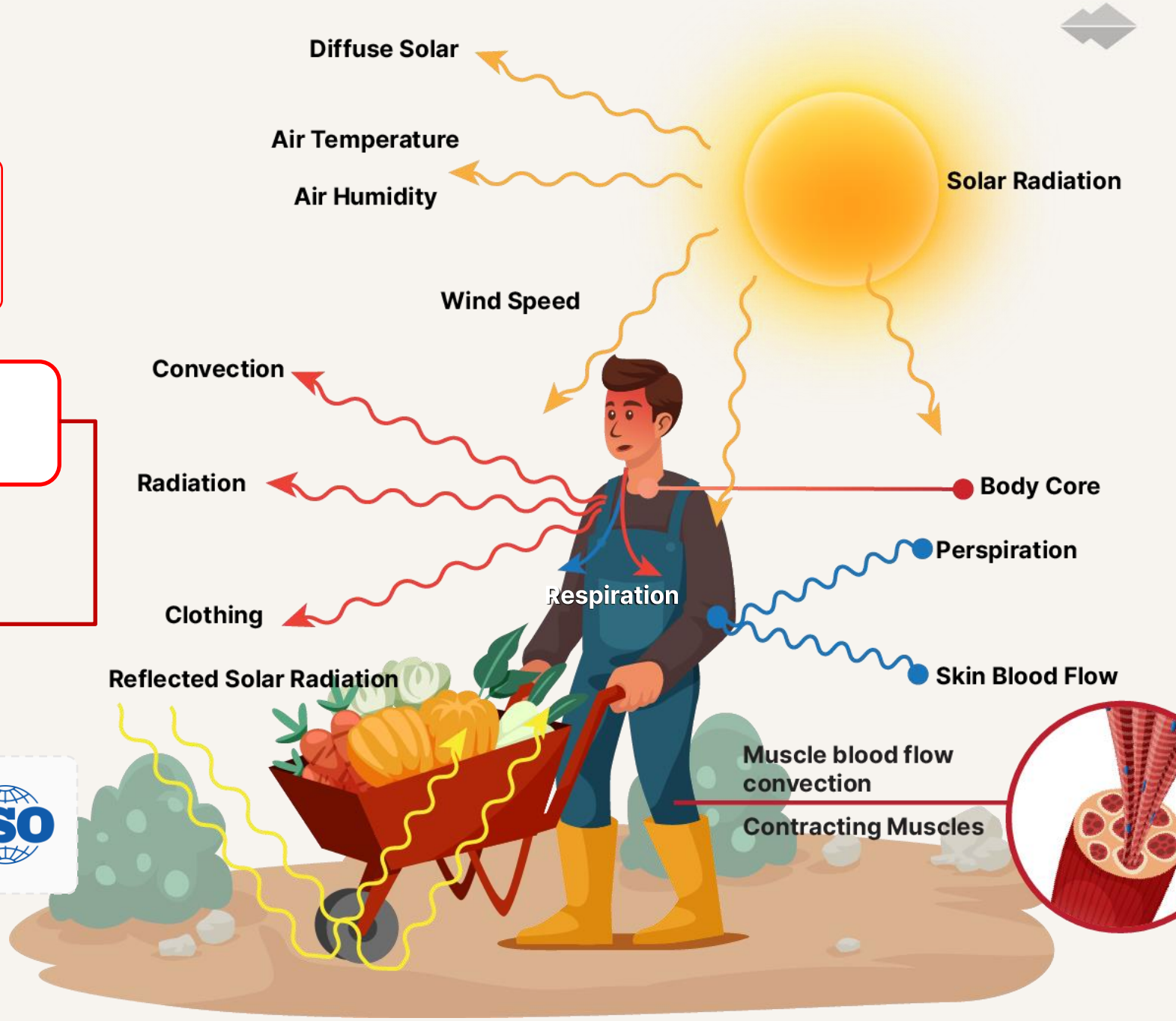
- Greater physical strain
- Hotter internal body temperature

Increased risk
- » **Heat stroke**
- » **AKI** and **CKD**
- » **Accidents**

Reduced productivity

Early mortality

Workers (clothed and hydrated) should be able to function effectively under given work conditions without exceeding 38 °C **(ISO 7243)**



AKI: Acute Kidney Injury
CKD: Chronic Kidney Disease

Thank you

And thank you to our colleagues and partners

Key partners and funders

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UNIVERSITY OF GOTHENBURG

UNIVERSITY OF BIRMINGHAM

Karolinska Institutet

BON SUCRO

THE UNIVERSITY OF NEW MEXICO

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