# Advances in non-chemical postharvest disinfestation of fruits and vegetables using hot water treatment Phytosanitary Measures: Status and future

**Shepard Ndlela, Nelson L. Mwando, Rainer Meyhöfer, Subramanian Sevgan & Samira A. Mohamed**

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African Fruit Fly Programme

Programme Africain de la Mouche de Fruit

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Postharvest Disinfestation of Horticultural Crops

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**Horticulture sector**

Fruit and vegetable production play important role in country economy

- Ensures food security
- Source of income
- Creates employment
- Balanced diet (mineral & vitamins)

- **Direct damage:** 30-100%
- Annual loss of fruits and vegetables not fully comprehended
- **Indirect damage:** quarantine restrictions on trade & loss of export opportunities
- **Loss of livelihoods:**
  Loss of jobs, income, poor nutrition

# Phytosanitary requirements for export of fruits and vegetables to the EU

28.3.2019 EN Official Journal of the European Union L 86/41

## DIRECTIVES

### COMMISSION IMPLEMENTING DIRECTIVE (EU) 2019/523

**of 21 March 2019**

**amending Annexes I to V to Council Directive 2000/29/EC on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community**

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Council Directive 2000/29/EC of 8 May 2000 on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community ([1]), and in particular points (c) and (d) of the second paragraph of Article 14 thereof,

1. Originate in a country recognised as being free from *Thaumatotibia leucotreta*
2. Originate in an area established by the NPPO as being free from *Thaumatotibia leucotreta*
3. Originate in a place of production established by the NPPO as being free from *Thaumatotibia leucotreta*
4. Have been subjected to an effective cold treatment or another effective treatment

1. The fruits must originate in a country recognised as free from Tephritidae (non-European).
2. The fruits must originate in an area established as free from Tephritidae by the exporting country's NPPO.
3. No signs of Tephritidae have been observed at the place of production (farm/plantation) and its immediate vicinity since the beginning of the last complete mango cycle.
4. The mango must have been subjected to an effective treatment to ensure that it is free from Tephritidae, and the treatment data must be included in the phytosanitary certificate.

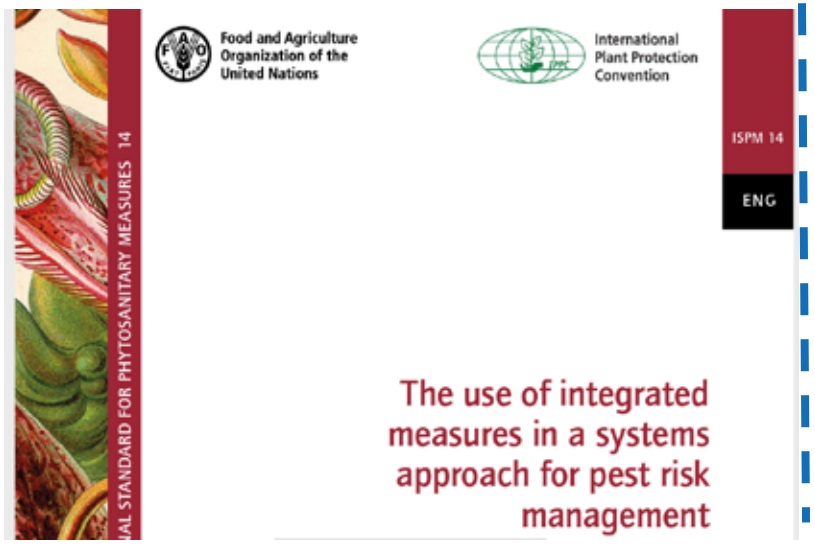
# Pest management approaches

## Preharvest management

- Semiochemicals
- Biological control
- Cultural practices
- Chemical control
- ???
- ???

- Monitoring
- Baiting
- Male annihilation
- Use of synthetic pesticides
- Parasitoids
- Biopesticides
- Sanitation

## Systems approach




## Postharvest management

- Disinfestation
- ???
- Disinfection
- ???
- Exclusion

- Irradiation
- Vapour Heat Treatment (VHT)
- Forced Hot Air Heating (FHAT)
- Fumigation
- Cold treatment
- **Hot Water Immersion treatment (HWT)**

# Hot Water Immersion Treatment (HWT)

**Mango**

- Ndlela, S., Ekesi, S., Ndegwa, P. N., Ong'amo, G. O., & Mohamed, S. A. (2017). Post-harvest disinfestation of Bactrocera dorsalis (Hendel)(Diptera: Tephritidae) in mango using hot-water treatments. *Journal of Applied Entomology*, *141*(10), 848-859.
- Ocitti, P., Ndlela, S., Akol, A. M., Muyinza, H., & Mohamed, S. A. (2021). Non-chemical post-harvest disinfestation of Bactrocera dorsalis (Hendel)(Diptera: Tephritidae) in Tommy Atkins mango using hot-water immersion treatment. African Entomology, 29(1), 238-247.
- Mwando N.L., Ndlela S., Meyhöfer R., Sevgan S., & Mohamed S.A. Postharvest Disinfestation of Bactrocera dorsalis (Hendel) (Diptera: Tephritidae) in cv. Tommy Atkins Mango using Hot Water Treatment Technique. In press.

**Bell pepper**

- Mwando N.L., Ndlela S., Meyhöfer R., Sevgan S., & Mohamed S.A. Development of Hot water phytosanitary treatment against the false codling moth *Thaumatotibia leucotreta* in bell pepper (*Capsicum annuum* L.) fruit postharvest. In prep.

**French beans**

- Mwando N.L., Ndlela S., Meyhöfer R., Sevgan S., & Mohamed S.A. Hot Water Treatment (HWT) Parameters for Postharvest Quarantine Control of Western Flower Thrips, Frankliniella occidentalis (Pergande) in Export French Beans. In prep.

# Hot Water Immersion Treatment (HWT)

**Hot Water Treatment Machine:**

- Double-walled, insulated with 50mm mineral wool and cladded with a 1.5 mm stainless steel sheet.
- Volume of 1600L
- Heating: 16 × 3kW immersion heaters, digital control panel with 0-100°C precision PT100 sensors (Type: TLS5R-E3A11J2+F3; and 48×48mm Precision Pid Temperature Controller.
- Hot water at 46.1°C circulated by a stainless-steel hot water pump with a flow rate of 4000 Litres Per Hour (LPH) and 12m head to maintain a uniform temperature.
- The machine connected to a Grant Squirrel data logger (SQ2020-2F8) with 16 thermocouple probes
- Treatment data from the logger downloaded to computer using Grant Squirrel View, version 5.1 software.

**Phase 1**

- Determination of developmental period of time for immature stages of the pest

**Phase 2**

- Determination of the most heat-tolerant immature life stage of the pest

**Phase 3**

- Large-scale validation

**Phase 4**

- The impact of HWT on Physical and chemical properties of the treated commodity

# Hot Water Immersion Treatment (HWT)

| Commodity | Temperature (°C) | Treatment duration | |
|---|---|---|---|
| | | Determined time (mins) | Range (mins) |
| Apple Mango | 46.1 | 68; 81.47 | 75.77-87.18 |
| Tommy Atkins (UG) | 46.1 | 86.7 | 77.830–99.880 |
| Tommy Atkins | 46.1 | 68; 72.63 | 70.32–74.95 |
| Bell pepper | 50 | 32; 44.2 | 43.22-45.24 |
| French beans | 45 | 7; 8.01 | 7.77– 8.24 |

## Major macronutrients

- Crude Protein
- Total Carbohydrates
- Total Sugars
- Ether Extracts

## Physical properties

- Moisture
- Dry Matter
- Crude Fibre
- Total Soluble solids
- Fruit Firmness
- Weight Loss

## Minerals

- Electrolytic Leakage
- Calcium Content
- Potassium Content
- Copper Content
- Total Iron
- Residue on Ignition

## Antioxidants

- Total Phenolics
- Total Antioxidant Activity
- Total Carotenoids
- β-Carotene content
- Vitamin A (Est. Activity)
- Aromatic Volatiles as Terpenoids

## Acidity

- pH
- Titratable Acidity as Citric Acid
- Titratable Acidity as Tartaric Acid
- Titratable Acidity as Malic Acid

## Sensory

- Taste

# Major Designs of Hot Water Treatment facilities

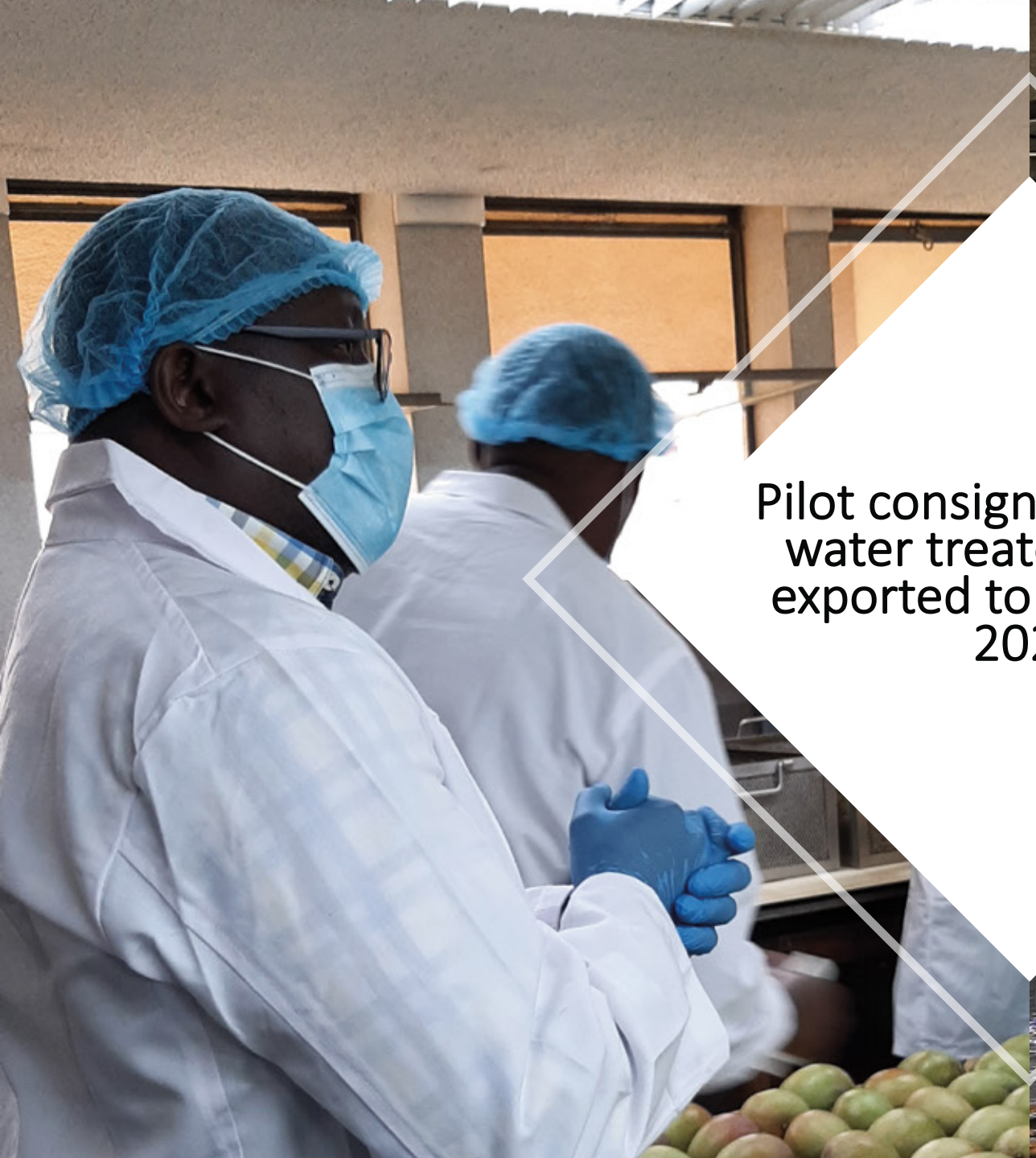
## Batch System /Jacuzzi System

- Most common
- Best to do techno-economic analysis

## Continuous Flow System

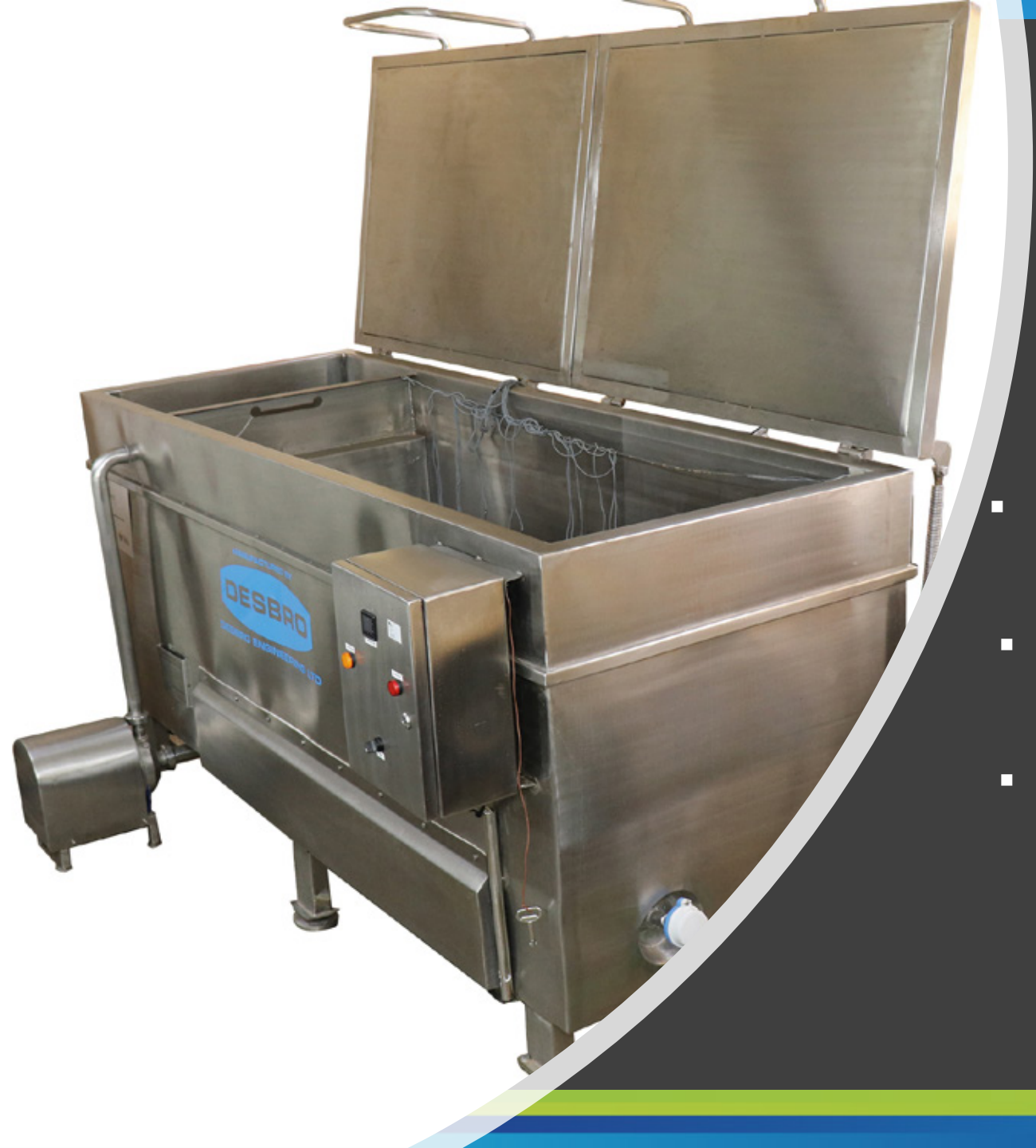
- Conveyor system
- Adjustable belt speed
- Guard against flotation

# Pilot consignment of hot water treated mango- exported to Italy in July 2021



# Prospects for Hot Water Treatment

- HWT is the future of sustainable postharvest treatment of fruits and vegetables
- Need for preharvest standards (particularly harvesting time and methods, transportation etc)
- Need for precision equipment
- Research at the molecular level is required to determine heat regimes that are not detrimental to finer qualities at the micro protein levels.
- Combination treatments must be explored especially for heat susceptible fruits and vegetables.
- Customization and harmonization of protocols to save cost




# Take home message

- HWT protocols for treating mangoes, bell pepper and French beans against the Oriental fruit fly, False codling moth and Western flower thrips are now available
- HWT is the future of postharvest treatments in Africa is standards are instituted and precision treatments promoted
- The private sector are free to choose the best HWT design based on Techno-Economic Analysis

# Acknowledgement

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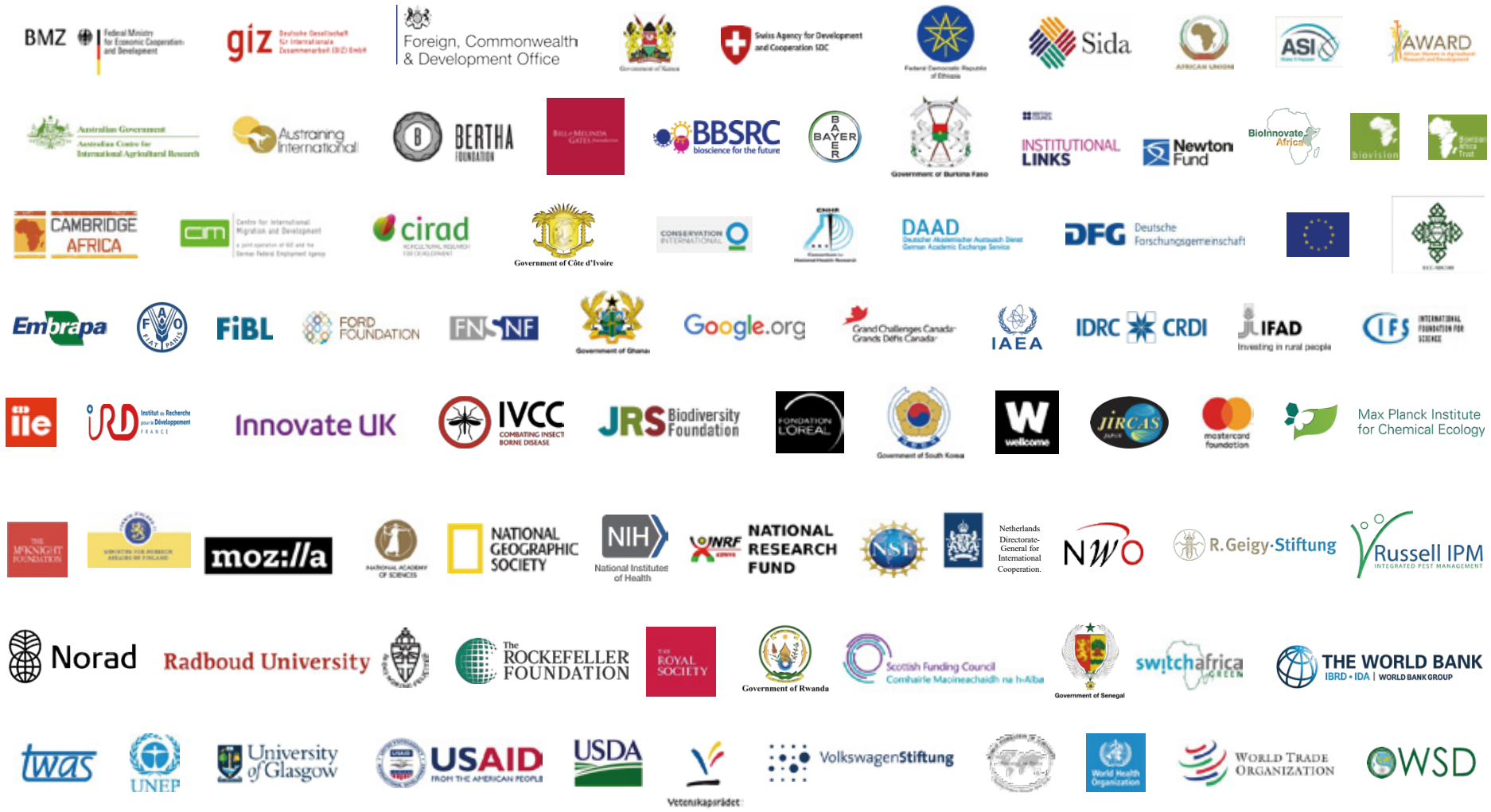




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# Thank you


**International Centre of Insect Physiology and Ecology**

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E-mail: icipe@icipe.org
Website: www.icipe.org

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