MLN Research Station, Naivasha

A brief and visitors' guide

CIMMYT MR
International Maize and Wheat Improvement Center

KALRO
Kenya Agricultural & Livestock Research Organisation

CIMMYT - the International Maize and Wheat Improvement Center - is the global leader on publicly funded maize and wheat research and related farming systems. Headquartered near Mexico City, Mexico, CIMMYT works with hundreds of partners throughout the developing world to sustainably increase the productivity of maize and wheat cropping systems, thus improving global food security and reducing poverty. CIMMYT is a member of the CGIAR System Organization and leads the CGIAR Research Programs on MAIZE and WHEAT. The Center receives support from national governments, foundations, development banks and other public and private agencies.

The Kenya Agricultural and Livestock Research Organization (KALRO) is the premier national institution bringing together research programs in food crops, horticultural and industrial crops, livestock and range management, land and water management, and socio-economics. KALRO promotes sound agricultural research, technology generation and dissemination to ensure food security through improved productivity and environmental conservation. KALRO's mission is to develop and disseminate appropriate agricultural technologies in collaboration with stakeholders. KALRO further contributes to the sustainable improvement in livelihoods of Kenyans by increasing agricultural productivity, and postharvest value of agriculture.

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1. Background

The KALRO/CIMMYT Naivasha sub-station for maize lethal necrosis (MLN) research occupies part of KALRO Naivasha Research Centre and the Dairy Research Institute (DRI) located in Navasha, Nakuru County. The Dairy Research Institute has a mandate to carry out dairy research and development programs in the eastern Africa.

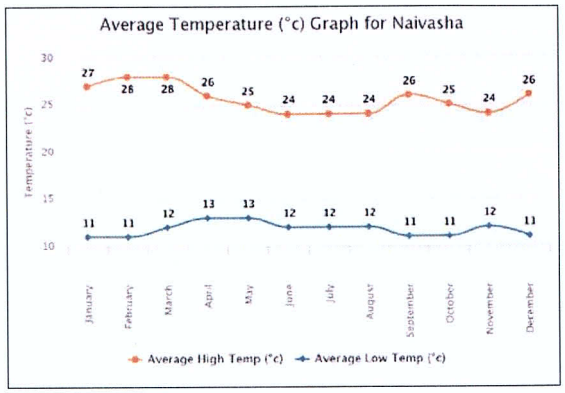
About Naivasha

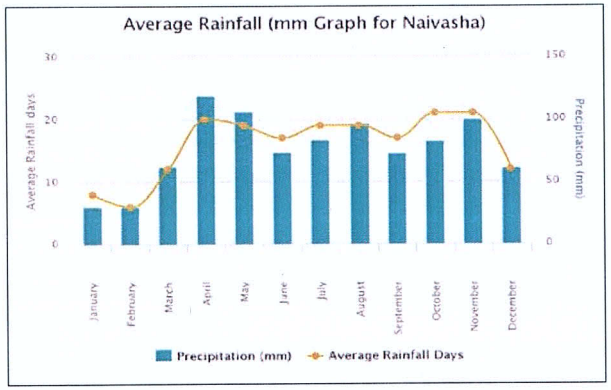
Naivasha is about 85 km from Nairobi along the Nairobi-Nakuru Highway. The MLN Research station is five kilometres away from Naivasha town.

Naivasha lies within longitudes 36 degrees 23' 43" E and latitudes 36 degrees 23' 43" E and GPS Coordinates: 0° 41' 22" S; 36° 23' 43" E. The farm is surrounded by Lake Naivasha to the South East, agro-pastoral Kikuyu community to the East and the pastoral Maasai community to the South. Previously, Naivasha was a hunting ground for licensed hunters of wild game animals. It is also world popular location for boating and bird watching. Naivasha is a market town in Nakuru County, lying North West of Nairobi. The town has a total population of 181,966 (2009 census). The main industry is agriculture, especially floriculture.

Elevation rainfall and temperatures

Naivasha lies 1,884 metres (6,181ft) above sea level. The station receives between 120 and 131mm of rainfall coming in two seasons. The long rains season is between April and May while the short rains season is between October and January. This is a hot dry region with a mean annual temperature of 22.6°C, mean annual maximum of 28.6°C and mean annual minimum of 16.5C. The soil is alkaline.





Source : http://www.worldweatheronline.com/naivasha-weather-averages/rift-valley/ke.aspx

The word Lake Naivasha in Kiswahili – the fresh water lake widely spoken language in eastern, central and parts of southern Africa – means hot water. This is the weighty name of the Naivasha Dairy Research Institute of KALRO. Naivasha is a continental powerhouse when it comes to research and development (R&D).There is no maize crop grown in fields surrounding the MLN screening facility. This is why it is a preferred location for research on maize lethal necrosis.

Soils

The soils are well drained, very deep, dark reddish brown to dark red, friable sandy clay to clay (Acri- Rhodic Ferrassols) developed from undifferentiated basement system rocks.

2. Historical background

The Naivasha sub-center for MLN research has a total of 20 hectares (ha), of which 17 ha are under farming and 3 hectares for facilities. The facilities include ELISA diagnosis laboratory, office and meeting rooms, 2000 sq meters of greenhouse., 3500 sq meter of net houses, incineration unit, quarantine change room, pot and tools washing area, store room, pot mixing area, quarantine washing bay for vehicles, tools and implements, water reservoir and drip irrigation facility.

The sub-Center was established in 2013 by CIMMYT and KALRO – after the outbreak of MLN in 2011 – with donor support from the Bill & Melinda Gates Foundation (B&MGF) and Sygenta Foundation for Sustainable Agriculture (SFSA). Initially the MLN screening work started in 2014, however due to the challenges of water salinity and scarcity, the screening was halted for two planting cycles and resumed in 2015. During 2015 and 2016, additional facilities were established to cater for core research needs and support various partners in sub-Saharan Africa.

Fig.1: KALRO Dairy Research Insitute office, Naivasha

Fig. 2: KALRO – Naivasha guest house

About the Institute

The Dairy Research Institute (DRI) one of the KALRO's institutes, was established under the KALRO Act of 2013. It provides technical support to the dairy sector. The Institute has a national mandate focusing on dairy related research. The goal is to develop appropriate sustainable innovations and cost effective technologies that will enhance productivity, thereby improving quality of life, equity and wealth.

The current facility was established in 1903 then known as Agricultural Experimental Station. Initial interventions were in adaptation studies for exotic breeds, pasture and fodder studies, disease control, nutrition challenges and genetic improvement through artificial insemination. The Institute hosts the coordinating Centre of Regional Dairy Centre of Excellence (RDCoE) under the auspices of the Eastern Africa Agricultural Productivity Project. Kenya was identified as the appropriate host for the RDCoE due to its comparative advantage in the dairy industry in the region.

Kenya's dairy industry is constrained by inadequate feed resources, prevalence of diseases (especially tick borne), unavailability of quality replacement stock, low adoption of technologies, high cost of farm inputs (including fodder/pasture seeds), inefficient breeding services and low value addition.

3. KALRO/CIMMYT MLN screening and quarantine site

KALRO/CIMMYT MLN screening and quarantine site

KALRO/CIMMYT MLN screening facility in Naivasha occupies 20 ha. The screening is done on 17 ha. The main objective of the facility is to support public and private partners screen maize germplasm using artificial inoculation. The total screening capacity is 42,000 rows per season of each row with 13 plants (three meters). Partners can submit their germplasm for screening – which is done on a cost recovery basis.

Current status of MLN

Fig 3: Geographical distribution of MLN worldwide

MLN distribution in sub-Saharan Africa

In Kenya, the disease outbreak was first observed in September 2011, in the longisa division of Bomet County. By 2012 the disease symptoms were consistently observed in a number of counties in Nyanza, western and Rift valley provinces of Kenya. Since then the disease has been reported in Ethiopia, D.R. Congo, Rwanda, Tanzania and Uganda. It is observed that in Kenya, almost all commercial varieties are susceptible to MLN that causes 30 to 100 percent yield loss depending on the stage and severity. This facility aims to provide a quarantined and regulated environment to screen germplasm to develop MLN resistant / tolerant varieties to combat the disease.

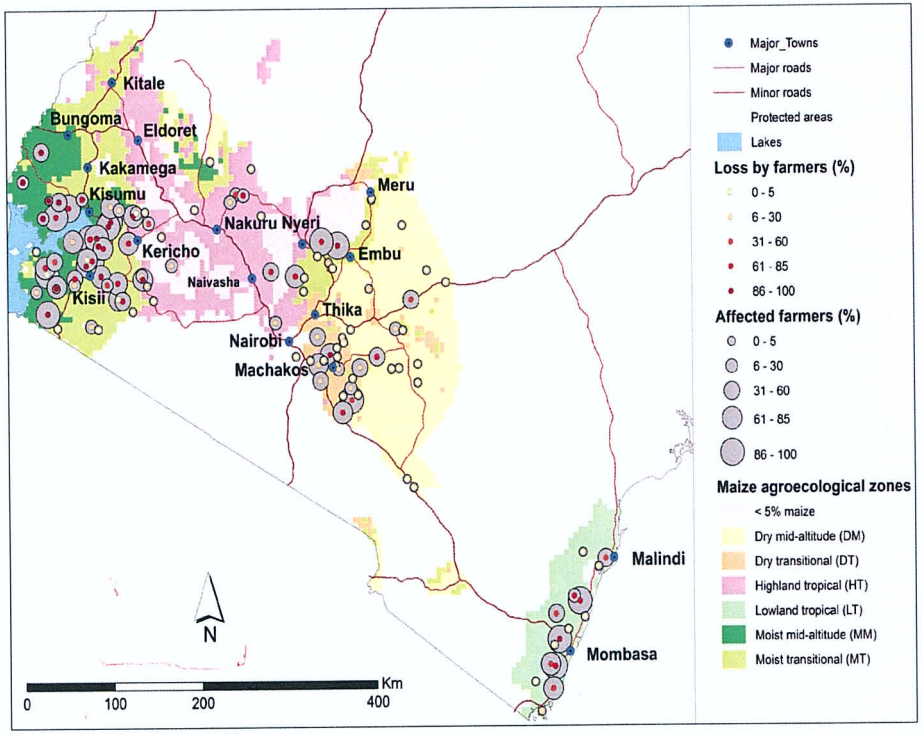


Fig. 4: MLN prevalence in Kenya

Disease symptoms of MLN

Maize Lethal Necrosis (MLN)
Causal viruses: Maize Chlorotic Mottle Virus (MCMV) and Sugarcane Mosaic Virus (SCMV)

Sugarcane Mosaic Virus (SCMV) symptoms

Maize Chlorotic Mottle Virus (MCMV) symptoms

Early MLN Symptoms

Mosaic and mottling

Mild mosaic and mottling

Shortened internodes; Severe chlorotic mottle

'Dead Heart' symptoms

Necrosis starting from the leaf margin, coupled with mottling

Premature drying of the husks

Severe chlorosis and leaf necrosis

Poor or no grain filling

Fig 5: Disease symptoms of maize lethal necrosis

Phytosanitation guidelines of MLN screening and quarantine facility

MLN is a viral disease caused by the synergistic co- infection of maize with Maize Chlorotic Mosaic Virus (MCMV) from the genus Machlomovirus in the family Tombusviridae and virus from the potyviridae mainly Sugarcane Mosaic Virus, (SCMV). Potyviruses are common. SCMV, in particular has been globally distributed, occurring in Kenya since 1970s. The emergence of MCMV in maize is generally sufficient to trigger MLN.

Some important guidelines for workers and visitors at the site are listed below to help prevent any unintended spread of MLN.

Visitor requirements policy

No unauthorized person will be permitted into the MLN screening and quarantine site.

Authorized CIMMYT personnel access requirements.

- Visitors to the MLN quarantine and screening site will require prior authorization from the Director, CIMMYT Global Maize Program or his designate.
- All persons working in the MLN quarantine site must have dust coat and gumboot shoes. These are available at the facility and should remain at the site.
- Eating food, chewing gum, drinking water or other drinks and use of tobacco products inside the facility is strictly prohibited.
- Do not take seed, other plant parts or soil from the site.
- Workers, visitors and vendors must change from the field coats and shoes after working in the quarantine site.

Vehicle policy

- No unauthorized vehicles will be permitted within the facility.
- Utility vehicles accessing the facility will be appropriately disinfected upon exit.

Equipment policy

- Field equipment used during the MLN season will be designated for use only at the quarantine and screening site.
- Field equipment will be cleaned and inspected before storage.
- Use a 10 percent TSP or chlorine water solution or alcohol to wash or disinfect all equipment before returning them.

Plant material policy

- No plant materials or seeds will be allowed out of the site before, during and after the experiments.
- Neither selfing nor hybrid seed production are permitted in the screening facility.
- Employees and visitors, if carrying plant and plant materials from the crop area or green house, are required to dispose the plant and plant materials in the waste bin.
- Plant material (seeds) from outside must to be tested for quarantined pathogens before planting them in KALRO/CIMMYT facilities. It should be considered as quarantined material until its phytosanitary status is verified.
- Employees and visitors carrying plant and plant materials from the crop area or green houses for disease diagnosis purposes are required to submit the samples in a covered bag with necessary details.
- Only confirmed disease-free seeds from various partners are used to conduct MLN screening.
- All the materials including those used during the experiment will be incinerated after the experiment is completed with prior confirmation.

4. CIMMYT-Maize Improvement Programs

Plant pathology research

In Maize, Pathology MLN research efforts have been intensified at KALRO/ CIMMYT screening facility. Experiments have been conducted on various studies, individual virus such as SCMV and MCMV to identify key resistance sources, as well as high profile marker studies. Additional studies on host pathogen interaction, epidemiology, seed contamination, seed care experiment and seed treatment studies are also being carried out. In order to facilitate quality research, strict phytosanitation practices have been developed and being monitored regularly.

Seed health laboratory

The main aim of the laboratory based at the ICRAF campus in Nairobi is to strengthen strategies developed by CIMMYT for MLN management. These strategies are focused to avoid unintentional seed-borne transmission of MLN causing viruses (SCMV and MCMV) while ensuring safe germplasm movement across CIMMYT programs. This is achieved through internal seed testing of all maize germplasm entering and leaving CIMMYT for detection of MCMV and SCMV. This is in addition to the official regulatory testing at the Kenya Plant Health Inspectorate Services (KEPHIS) for safe import and export of maize germplasm.

The laboratory tests seed lots and leaf samples from Kiboko research station for MCMV and SCMV using Double Antibody Sandwich- Enzyme Linked Immunosorbent Assay (DAS ELISA). Between February and June 2016, over 700 samples (627 seed samples and 123 leaf samples) were tested for MCMV and SCMV. The seed samples were then submitted to KEPHIS for MLN testing before exported. This has facilitated shipment of maize germplasm from CIMMYT- Kenya programs to partners in three eastern Africa countries namely: Uganda, Tanzania and Rwanda.

New initiatives

Epidemiology and management

Studies on epidemiology have been initiated through the support from B& MGF. The studies aim to address the following aspects.

- Factors contributing to seed contamination versus seed transmission of MCMV.
- MCMV position in seed. Influence of genetic background and developmental stage of infection on MCMV.
- How long can MCMV persist in the soil?
- Most effective agronomic management practices for minimizing the incidence of MLN in endemic areas.

Disease diagnostics/survey/surveillance

Project on disease diagnostics/survey /surveillance has been initiated through the support USAID. The project aims to:

- Prevent the spread of Maize Chlorotic Mottle Virus (MCMV) from the MLN-endemic to non- endemic areas in SSA.
- Support the commercial seed sector and phytosanitary systems in the endemic countries, especially in eastern Africa, to produce MCMV-free commercial seed
- Promote the use of clean hybrid seed by the farmers.

Seed care studies

- Seed treatment with insecticides, which shall protect the plants from viruliferous insects up to eight weeks.
- Seed treatment using seed treatment chemicals.

Maize Breeding Projects

Breeding progress to develop `MLN resistant or tolerant maize hybrids in eastern Africa

- Development of virus-resistant crops is an economically viable and environmentally sustainable approach for disease control, but it requires identification of resistant genotypes, and incorporation of the resistance trait into agronomically desirable genetic backgrounds.
- Through the MLN screening and quarantine facility, CIMMYT and its partners have screened more than 100,000 maize germplasm since 2013, including elite inbred lines from CIMMYT and IITA, off-PVP lines from USA, experimental three-way and single-cross hybrids, and commercial varieties in eastern Africa under artificial inoculation.
- Promising MLN tolerant lines and hybrids have been identified. A total of nine MLN tolerant/resistant hybrids have either been released or recommended for release in Kenya, Tanzania and Uganda. An additional 22 MLN tolerant/ resistant hybrids are currently in national performance trials (NPTs) in eastern Africa.

Molecular breeding efforts on MLN

Trait-linked molecular markers, which will accelerate breeding progress for MLN tolerance, have been identified. Three large effect quantitative trait loci (QTL that are repeatable across multiple breeding populations) have also been identified. Resistance alleles for these QTL are being integrated into the elite germplasm pool using marker-assisted breeding strategies, both to enrich breeding populations for the favorable alleles as well as to introgress these alleles into important maize lines.

Resistance alleles have been introgressed into over 20 elite breeding lines, and final improved versions of these lines are currently in the final stages of selection. An additional 19 elite lines from eastern, southern and west Africa are currently in the conversion pipeline, with improved versions expected in 2018. Breeding population enrichment is ongoing with early generation selection using markers being practiced in elite breeding populations to support multiple breeding programs. Genome-wide selection strategies are also being employed to further improve MLN tolerance and to broaden the scope of MLN resistance donors being utilized. Finally, further discovery work is ongoing to understand which viral disease each QTL is providing resistance to further refine the genomic position of favorable alleles, and to identify new favorable QTL alleles from novel donor lines.

5. Physical resources at Naivasha

Fig 6: MLN site – Entrance gate

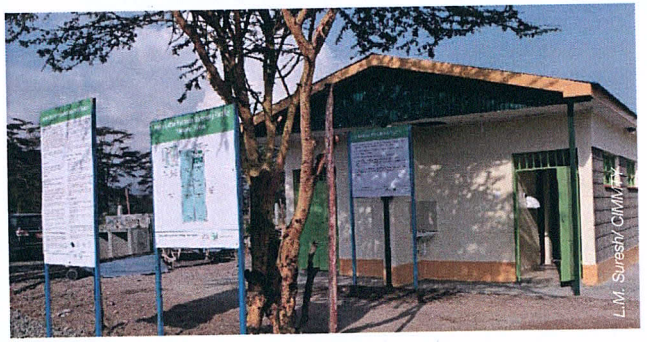


Fig 7: Changing room facility

Fig 8: Quarantine washing bay

Fig 9: Irrigation facility

Fig 10: Incineration facility

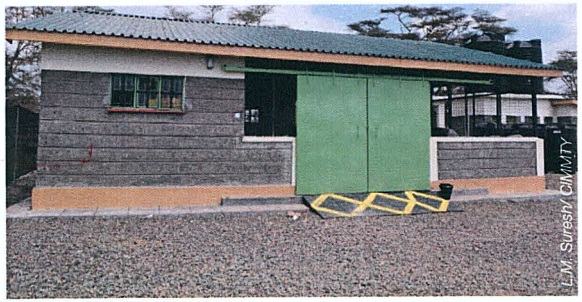


Fig 11: Pot media sterilization and filling facility

Fig. 12: Lab facility at Naivasha

Fig. 13: Greenhouse facility

Fig. 14: Net house facility

6. Capacity building and training

The MLN screening facility provides a good platform for various students, who are undertaking M.Sc. and PhD on MLN under the supervision of CIMMYT and KALRO scientists.

In addition, a number of trainings were conducted between 2014 and 2016 on disease diagnosis, inoculation technique, producing MLN free seed at all stages of seed production, breeding and phenotyping for MLN in Ethiopia, Kenya, Mozambique, Tanzania, Uganda, and Zimbabwe for over 62,800 trainees. The trainees comprised of breeders from various National Agricultural and Research Organisations, and private companies.

7. Human resources

Management

Overall MLN research station Lead : Dr. Suresh, L.M.

For further information contact: Email: l.m.suresh@cgiar.org

Cell Phone: +254702392664

Research Technician and assistants: CIMMYT Activities
Mr. Arthur Karugu
Mr. Wilson Njenga

Maize research technical staff

The MLN screening site has nine technicians who have undergone training in agriculture at certificate level.

Semi-skilled staff

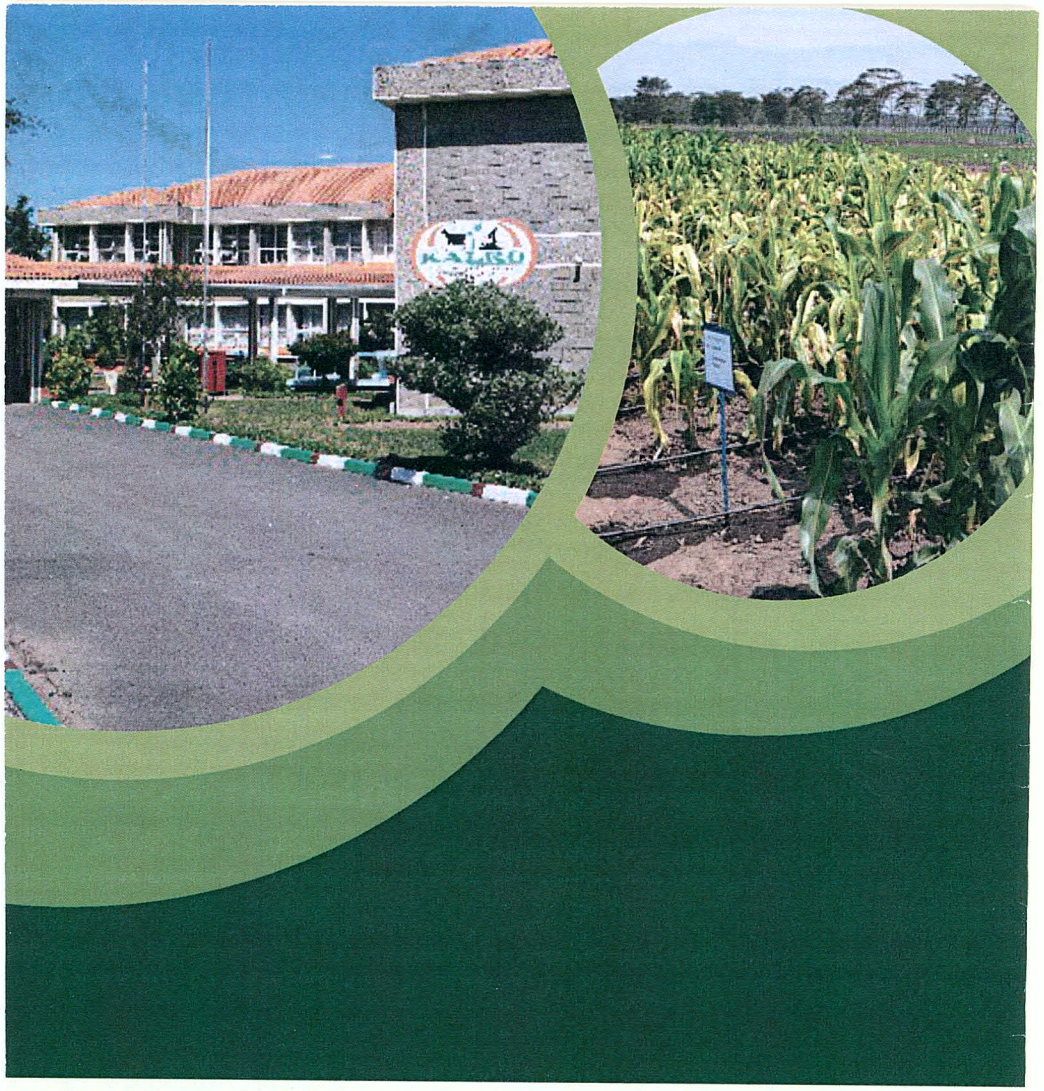
The station has six casuals contracted for normal farm and research operations.

General labor

On average Naivasha sub-Center employs 40 field staff on a daily basis and up to 60 staff monthly.

8. Challenges at the Sub-Center

- **Wild animals** such as hippos cause great damage to experimental fields, a situation that has forced CIMMYT and partners to install electric fences around the crop fields. Snakes and monkeys are also a huge threat to workers' safety.
- **Irrigation water:** there is overreliance on the borehole water supply. This is becoming difficult to sustain with the expansion of irrigated fields at the station. There is a dedicated water reservoir of 2200 cubic meters.
- Sometimes, **water scarcity and salinity** is a challenge–this worsens the symptoms and makes it difficult to evaluate MLN trials.
- **Lack of adequate equipment** including tractors, drip irrigation.



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