NATIONAL INSTITUTE OF RESEARCH - DEVELOPMENT FOR MACHINES AND INSTALLATIONS DESIGNED FOR AGRICULTURE AND FOOD INDUSTRY – INMA BUCHAREST

Achievements in the use of renewable energy for agricultural applications

INTRODUCTION

INMA is one of the oldest and most prestigious research institutes in Romania in the field of processes, technologies and technical equipment elaboration, with an RD experience of over 95 years.

The main objective of the activities that carried out by INMA Bucharest focuses on increasing the research capacity of the institute in the direction of intelligent specialization for the creation of technologies and intelligent technical equipment converging with the concept of Agriculture 4.0 and access to the concept of "Excellence in process research" in agriculture, forestry and food industry.

The institute focuses its efforts to become a center of excellence in the field of digitization of agriculture, so that technologies specific to IoT, artificial intelligence, robotics and more are implemented in agricultural processes in order to optimize them and achieve intelligent farm management of the future.

Also, INMA Bucharest continues the development of technologies and technical equipment specific to the field of intelligent specialization Bioeconomy, by adapting the priority scientific directions to current realities. The new technologies developed by the institute for agriculture, forestry and the food industry are adapted to the climate changes that have begun to affect our country.

As specialized institution, INMA has initiated, in research projects, the development of equipment designed to optimize certain operations within organic farming technologies, specific for use on small and medium areas.

In order to carry out the ***works of establishment, maintenance and harvesting of organic crops***, on small areas, INMA has developed a Prototype of ELECTRIC TRACTOR. It is intended for technologies for performing agricultural works using environmentally-friendly equipment, consisting of the following main subassemblies: drivetrain, cab, ground loop, lighting and light-signalling system and electric propulsion system. The battery of the electric tractor prototype can be charged from the national grid of 220 *V AC*, with a maximum charging current of 32 *A*. The particulate matter emitted by the tractor is zero both in operation and when stationary. Its working autonomy, in continuous operation, is of maximum 5 *hours* and the period of full charge of the battery is of 3 *hours*.

ELECTRIC TRACTOR Prototype – TE

MAIN TECHNICAL SPECIFICATIONS:

- Electric motor type:	three phase asynchronous, 15 kW power rating;
- Battery pack type:	Li-ion 96-144Vdc, 17 kWh;
- Maximum length:	3330 mm;
- Maximum width:	1530 mm;
- Maximum height (cab):	2530 mm;
- Wheelbase:	2020 mm;
- Track:	1280 mm front, 1250 mm rear;
- Ground clearance:	260 mm (front);
- Total mass:	1970 kg;
- Maximum speed:	28 km/h.

Innovative technical system (intelligent equipment) horticultural analysis, prediction and biodynamic action - SIH-0

In order to achieve the ultra-localized application of phytosanitary substances on cultivated plants, microvalves were installed for each nozzle-port support of the dosing system ramp. The solenoid valve coil works ON/OFF at 12 Vdc. The system thus created allows the individual control of each nozzle separately by means of electromagnetic microvalves commanded by a central computer, based on an algorithm to identify cultivated vegetables using real-time images taken from an RGB video camera, processed using a neural network. After identifying the cultivated plants, the microvalves located above them are ordered so that the substances are applied only to the respective plants.

Technical and functional specifications

- Rear wheel track:	1320 mm;
- Wheelbase:	2600 mm;
- Electric drive motor:	12 kW;
- Li-ion battery:	96 Vcc;
- Solution tank capacity:	400 l;
- Pump motor:	3 kW;
- Maximum flow rate of the pump:	86 l/min;
- Maximum working pressure:	20 bar;
- Boom legth:	8 m;
- No. Boom sections:	3;
- No. Nozzle holders:	31;
- Pressure and flow regulator:	3-way;
- Clean water tank capacity:	10 l;
- Solution indicator:	through transparency;
- Platform structure:	galvanized steel.

High capacity agricultural drone for performing phytosanitary treatments in field crops

The functional agridrone model for carrying out phytosanitary treatments in field crops is a Y-type hexarotor drone powered by two batteries, equipped with 6 8700 W motors, whose rotation speed is controlled by 6 electronic speed controllers (ESC) of 120 A nominal (150 A maximum). Th drone has a 66 liter tank from which an electric pump at 12 Vdc, powered by 2 separate 12 Vdc batteries pumps phytosanitary substances with a pressure of up to 7.5 bar to a circular spray boom on which 6 nozzle holders equipped with calibrated spray nozzles are mounted. The drone is equipped with a Pixhawk 4 Orange cube autopilot with Here 3 GNSS GPS module for precise positioning in the field and can be programmed to operate the electric pump to spray agricultural crops only on predefined areas based on the mission profile entered by the operator.

Technical and functional specifications

- Motors:	brushless, double propeller, 8700W;
- Batteries:	14S1P Lipo, 17000 mAh;
- Autopilot:	Pixhawk 4;
- Radio controller:	12 channel, T12;
- Camera:	multispectral, MAPIR Survey 3W OCN;
- Frame:	Y at 120^{o} made of aluminum;
- Substance tank capacity:	66 l;
- Pump max pressure:	7.5 bar;
- Pump flow rate:	8.8 l/m;
- Spraying boom:	circular with 6 nozzles.

System for the protection of field crops according to "agriculture 4.0" intended for the SMART farms

The system includes the following main subassemblies:

- drone (agricultural drone) DJI Agras T16;
- platform trailer for general use;- solution basin for refilling the drone's liquid tank;
- battery charging station equipped with an electricity production system with photovoltaic panels.

The DJI Agras T16 unmanned aerial vehicle (agricultural drone) within the system has a high fixed point stability system to take off and land vertically at a fixed point on a general purpose trailer that is equipped with a solution tank for refilling the drone's liquid tank and a charging station for the drone's batteries using an electricity generation system with photovoltaic panels to ensure energy independence.

Intelligent mobile platform – EIIC

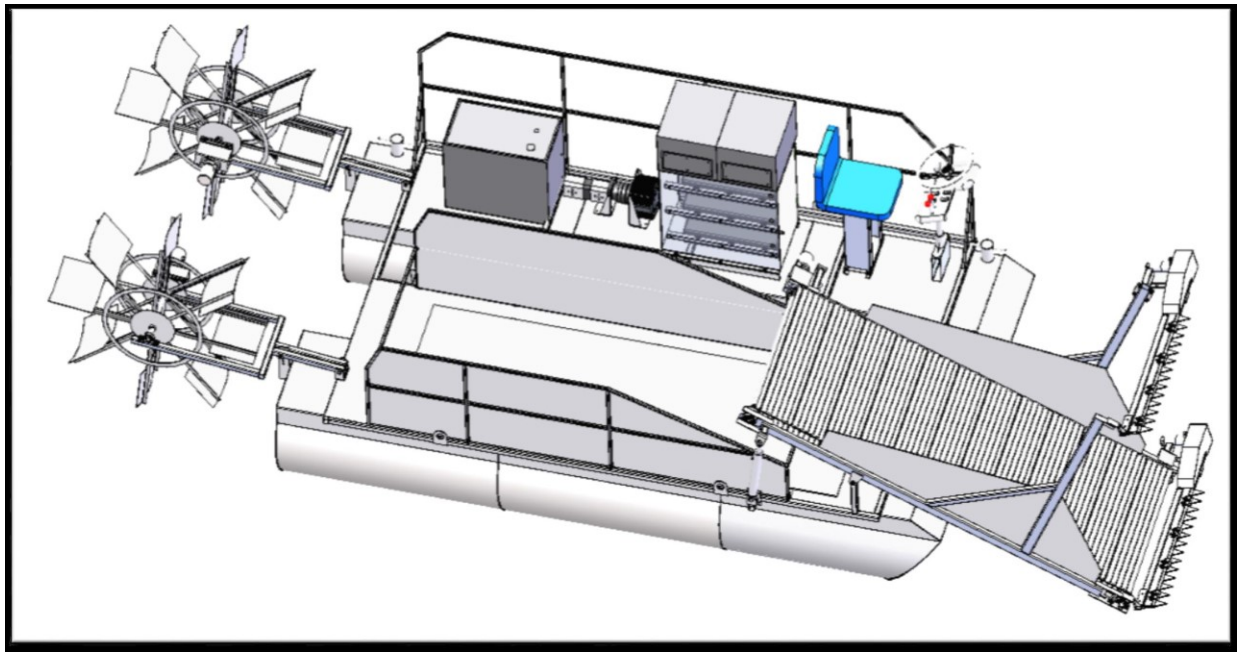
In the automatic mode, the equipment placed on the rail (running track) moves controlled by the PLC and constantly checks the value of the signals received from the limit sensors so that at the end it stops and returns to the initial position (equivalent to reaching the start sensor). From the moment of receiving the start command, the electric pump of the equipment will also be started, it will work until reaching the end of the course, on the way back it will be stopped. In parallel, the proximity sensors will sense the presence/absence of plants on the height corresponding to them and will accordingly command the opening/closing of the electro valves that control the spraying nozzles, distributing the phytosanitary substances on the surface of the plant leaves.

MAIN TECHNICAL SPECIFICATIONS:

- Length:	900 mm;
- Height:	1310 mm;
- Width:	620 mm;
- Number of nozzles:	9;
- Spraying levels:	6;
- Spraying control:	automated, using a PLC.

Experimental model of an electric self-propelled floating technical system for harvesting biomass – ERBA

- the equipment is intended for harvesting lake biomass, especially reed;
- it is designed and made to function ecologically, in a non-polluting manner;
- provides an important link in the management of aquatic biomass;
- the harvested product can be used in various economic sectors (green energy, construction materials, etc.);
- contributes to the maintenance and clearance of navigation channels affected by the excessive development of aquatic biomass;
- can be used in lakes, canals, ponds, the Danube Delta.



Experimental modular urban farm demonstrator – M.H.T.U.F.

The system is a research instrument within the new technologies of growing vegetables in artificial environments, isolated from the external environment, benefiting from a microclimate (temperature, humidity, speed of air currents, CO_2 concentration and intensity of artificial light radiation) monitored and controlled by means of intelligent systems Actuator. The demonstrator is composed of the following main elements: thermally insulated premises, vertical plant growth system, air cooling, ventilation and humidification system, System for enriching the atmosphere with CO_2, fertirigation system, system for the control and monitoring of environment factors. The modular urban farm is an autonomous powered using a PV system.

Main technical specifications:

- premises volume:	26 m^3;
- Refrigerating aggregate installed power:	2.9 kW;
- Humidifier flow rate:	1.2 l/h;
- CO_2 tank capacity:	2 kg;
- Air evacuation flow rate:	825 m^3/h;
- Water filtering capacity:	15000 l;
- Surface pump power:	450 W;
- Pump max. flow rate:	45 l/min;
- Maximum pumping height:	38 m;
- Adjustable flow rate drip nozzle:	0-70 l/h.

Innovative irrigation system by harnessing the humidity in the air

The experimental model of the innovative irrigation system by harnessing the moisture in the air is intended for SMART farms, especially those in areas threatened by desertification, to obtain an additional amount of water for crop irrigation, as well as for economic agents who are interested in developing their technical equipment for irrigation in order to increase profit. The field of use of the experimental model is the irrigation of crops in the open field or in protected environments (greenhouses, solariums), by exploiting the humidity in the air, at a minimum installed energy power. The system is fully autonomous being powered by a PV system.

Interior unit

Exterior unit