

NUCLEAR AGRICULTURE IN THE FRENCH SPEAKING PART OF AFRICA AND MADAGASCAR

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My purpose is not to present an exhaustive account of nuclear research carried out in all fields of tropical agronomy. On the one hand, the time allowed to me is limited and, on the other hand, I would not like to try your patience. Therefore I will make a rapid review by showing how French organizations have dealt in different regions with the research fields taken into account. Then, quoting some results, I shall draw a few conclusions, not only from the knowledge acquired but, even more, from the way it has been realized.

Many years before 1960, scientific literature mentioned nuclear techniques in African tropical agronomy, particularly in the fields of radiogenetics (work on millet, for example) and of soil fertility and plant mineral nutrition by means of ^{32}P . Experiments concerning the utilization of soil moisture probes were also carried out in Madagascar and Tunisia. In general, maybe with the exception of plant improvement, these experiments as far as French scientists were concerned consisted of very limited research, more or less dispersed, following personal contacts between scientists and international organizations.

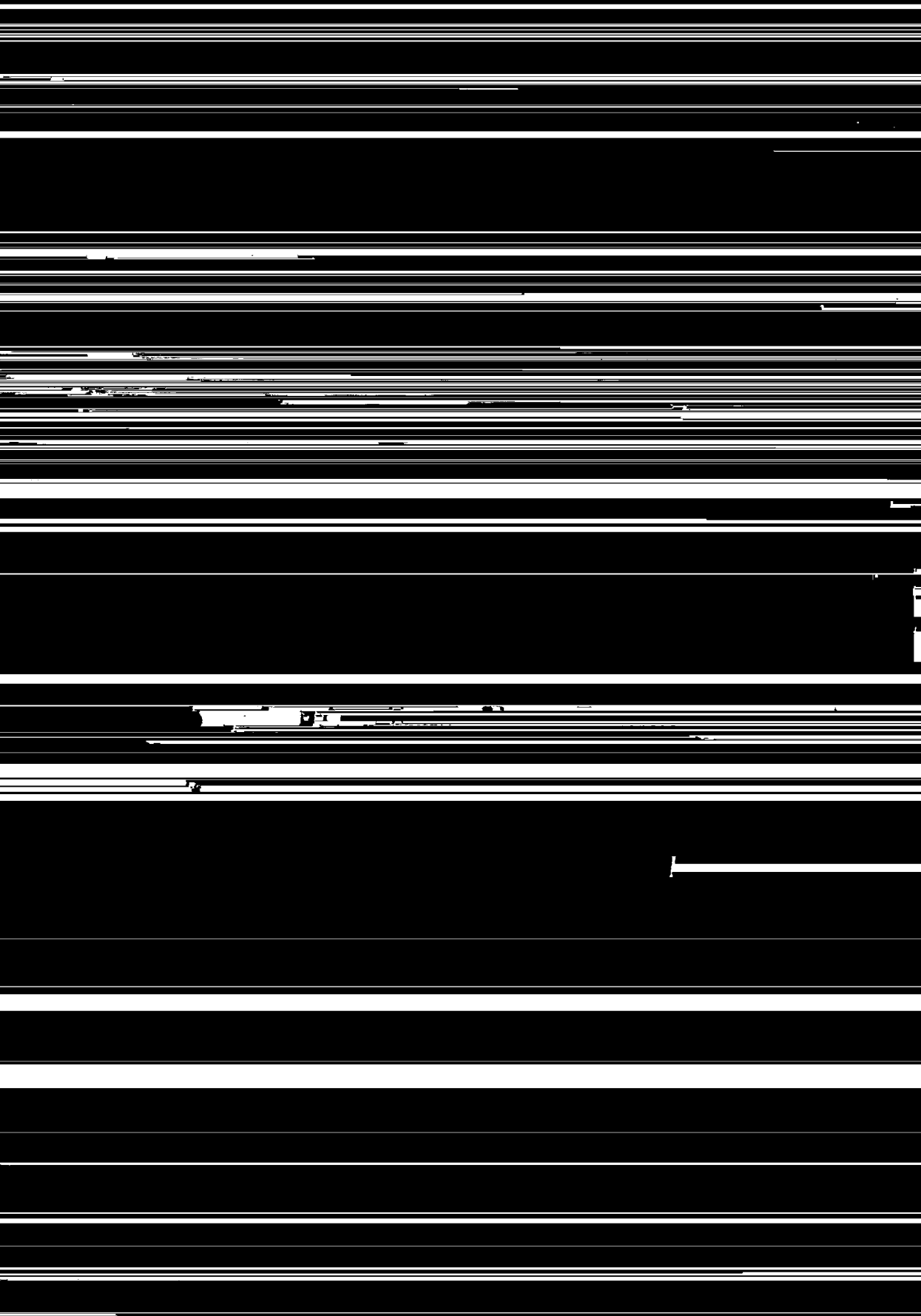
With the foundation of CEA and, especially of the agronomy department, the endeavours became more numerous, more constant and better coordinated, while in the fields of genetics and plant physiology the programmes remained partially dispersed between university departments.

I shall devote here little attention to the endeavours of Euratom and to those of IAEA, even though I am quite aware of their importance.

In French speaking Africa and in Madagascar, the use of nuclear methods is still developing in the already existing framework: for example, GERDAT, which regrouped the nine Institutes or Research Centers specialized in tropical produce and ORSTOM, a French public institute whose function is among others "to undertake and to develop fundamental research directed towards vegetal and animal production outside temperate regions".

The cooperation processes between CEA, GERDAT and ORSTOM are diverse and adapted to the conditions imposed by a variety of circumstances and by the rapid evolution of local structures. There are research contracts for the adjustment or, at the opposite, for the popularization of nuclear techniques; the instruction or recycling of scientists and technicians; expert dispatching during a limited or unlimited time for operations involving technical cooperation; a logistic support in certain programmes by supplying scientific equipment and radioactive tracers; the maintenance of material etc.

From 1964 an original formula has been the introduction by CEA of nuclear methods into some countries such as Ivory Coast, Madagascar and, more recently, Niger. In Ivory Coast, the radionuclide laboratory or LRI has been set up within the existing structures of ORSTOM at Adiopodoumé. Its aim is the study of radioagronomy in the most extended meaning of the word. The Tananarive University in Madagascar with the participation of ORSTOM, has most willingly opened a laboratory, serving a double purpose: nuclear agronomy and medical research. In Niger, LRI of Niamey is



Yet, the results are more positive with groundnut (pod and grain size, and oil yield). However, it is for rice that the improvements, by induced mutations, have been and still are the most promising. From the practical point of view the most interesting modifications obtained concern the duration of the growth cycle, the plant length and height, and the grain texture. Promising mutants are now being tested in the Cameroons and in Ivory Coast by IRAT.

Irradiation of food-stuffs

Irradiation is a promising process for the preservation of products, and Africa offers immense possibilities in this field, as the preservation methods used there are still very rudimentary. Nevertheless, less work has been achieved in this field except for experiments — which have been conclusive — on the disinsectization of smoked and dried fish in Dahomey, performed in 1965 by CTFT.

Neutronagronomy

This is a dynamic field which is rapidly expanding. For a very long time a number of studies have dealt with the *in situ* measurements of soil-moisture content in tropical regions. But traditional methods have shown how difficult it is to follow the water balance, particularly as a result of its extreme variability. This very quickly drew attention to the benefit of using neutronic methods. This explains the increasing use of moisture probes.

As a first approximation there must be about 60 moisture probes of various origin in the whole of French speaking Africa and Madagascar. The experiments involving their utilization mostly took place in Ivory Coast, Madagascar, Niger, Senegal and Tunisia on very different soils: alluvial, subarid, leached ferruginous, ferrallitic and ando-soils.

Their use led to several types of studies:

- Determination of the hydrological and hydrodynamical properties of soils.
- Studies on the amount of water absorbed by crops whether fertilized or not under various kinds and rates of management.
- Determination of irrigation parameters and of the conditions for using water reserves of the soil.
- Studies on the hydrological regime of natural environments on transects, on water sheds or on particular ecological areas.

Enclosed are two tables (Appendices 1 and 2) showing for the year 1974, the different programmes on the use of moisture probes in Ivory Coast and Madagascar.

For the present time important studies may also be pointed out. They have been carried out by IRAT on the terraces of the river Niger, in order to determine the kinetics of seepage and water redistribution. Similar work is conducted by ORSTOM in Tunisia in the watershed of the Qued Sidi ben

permeability. They brought out different behaviours according to the plant cover, particularly between *Graminaceae*, which rapidly use the superficial water reserves of the soil, and leguminous plants which progressively utilize small quantities of water from greater depths. These different experiments have been carried out on a whole range of tropical plants: citrus fruits, pine-apples, groundnuts, cacao trees, coffee shrubs, sugar cane, cotton plants, *Graminaceae* and leguminous fodder plants, maize, cassava, millet, rice etc.

These experiments have also specified the role played by the different natural covers in the processes of erosion and lateral flow and the consequences resulting from their transformation by man. On this subject one can cite: methodological, as well as practical studies, conducted on watersheds in Madagascar and Ivory Coast; studies on the contact zone between forest and savanna in tropical Africa, and the desiccation and desertification of the Sahel regions.

Nuclear tracers

I shall devote a much shorter time to this subject, as the use of radio-tracers has become a familiar technique, in a number of fields of agronomy. Therefore, I shall mention without any definite order a whole series of studies dealing with plant physiology, so as to give you an idea of the diversity of the problems:

- Physiology of hevea-latex by IRCA.
- Sulfur, phosphorus and carbon metabolism in the groundnut and millet by IRAT and ORSTOM.
- Photosynthesis in the banana tree and in the papaya by IFAC.
- Root-hair absorption by the cacao tree by IFCC.
- Activity of the oil palm root system in the Cameroons and Ivory Coast by IRHO.
- Pollination problems on Malagasy coffee shrubs by IFCC and ORSTOM etc.

In *agricultural hydrology*, research work involving tracers is practically

defining the influence of organic matter form upon the crop yield and the use of nitrogenous fertilizers on millet, groundnut, maize and rice cultures. These studies are now extended by a scheduled action of GERDAT in order

experimentation site some laboratories for conventional nitrogen analysis. However, the accuracy of soil nitrogen serial analysis is insufficient for isotopic analysis. It is then necessary to put into practice an ad hoc organization with its own staff, which in Africa is not always an easy problem to solve.

Finally I believe we did not fully profit by past experience. For example, I notice that some experiments carried out in pots or in lysimeters were successful whereas in the field they were not conclusive: this difference is sometimes caused by lateral contamination. Indeed, there is often a lack of preciseness when considering the set-up of experimental conventions. On the other hand the accuracy of nuclear methods is relevant with the overall knowledge the agronomist is expecting to draw from his experiments, and are techniques well adapted to the scale of the problems to be solved?

I would like to draw your attention towards these points which perhaps may look elementary but which too often induce misunderstandings and therefore may slow down the development of radioagronomy.

Appendix 1

RADIONUCLIDE LABORATORY OF TANANARIVE - MADAGASCAR

Title of the study	Institution	Responsible scientist	Financing	Situation
Neutron probe Study of the influence of starting cultivation in a field on its water balance	ORSTOM	D. Ibiza (Hydrology)	DGRST	Ambatolampy
Study of the influence of starting a cultivation in a sloping field on its water balance	CTFT	Benoit de Coignac	DGRST	Manankajo
Influence of the water regime of soils on the utilization of nitrogen fertilizers	IRAM/CNRA	Arrivets	LRI/CNRA	Ampangabe
Water need and irrigation control of rotating crops: cotton, maize and Cape peas	IRCT/IRAT/CNRA	Cretenet	LRI/IRCT	Tulear
Variation of water profiles under various vegetative covers in the low Mandrare valley	ORSTOM	Danloux	ORSTOM/LRI	Amboasary
Water consumption of cotton-plants in the irrigated area of Samangoky. Study of the evolution of the level and saltiness of the underground water-level	LRI/IRCT	Marini/Kaiser	IAEA	Tanandava
Control of irrigations of the Samangoky area with a neutron probe. Adjusting of the neutron probe.	LRI/IRCT	Marini/Kaiser	IAEA	Tanandava
Determination of the hydrodynamical properties of the main soils in the area of Samangoky	LRI	Marini/Villemin	IAEA	Tanandava
Determination of the physical hydrodynamical properties of the soils at the experimental station of Sodemo	LRI/Sodemo	Marini/Baran	Sodemo	Morondava
Study of the water consumption of sugar-cane and tobacco in irrigated cultures	LRI/Sodemo	Marini/Baran	Sodemo	Morondava
Determination of the physical hydrodynamical properties of the main types of soils of the Citrus-cultivating State Farm of Bezezika (1,000 ha). Control of the water-level and of the irrigations	LRI	Marini/Villemin	Bezezika	near Morondava
Set-up and adjustment of the neutron probe	LRI	Roulot/Marini	LRI	LRI-Tananarive
Standardization of the soils at the trial points of Morondava, Tulear, Tanandava and Bezezika	LRI	Marini/Villemin	LRI	LRI

Appendix 2

RADIONUCLIDE LABORATORY OF ADIOPODOUME - IVORY COAST

Title of the study	Institution	Scientist	Situation	Type of work	State of progress
Study of the savanna in low Ivory Coast	ORSTOM Geography	Winckell	Dabou	Standardization of routine measurements	In progress
Compared ETRM of <i>Panicum</i> and <i>Paspalum</i>	ORSTOM Bioclimatology	Cardon	Adiopodoumé	Routine measurements	Interrupted
Water consumption of pine-apple	IFAC	Combres	Anguededou	Calibration and positioning of measuring tubes	In progress
Irrigation experiment under cacao-trees	IFCC	Jadin	Bingerville	Standardization	In progress
Water consumption of sugar-cane	IRAT	Langellier	Ferkessedougou	Standardization, density	Starting
Water consumption of rice	IRAT	Kalms	Bouake	Standardization	Starting
Hydrological study of the sloping bed of Sakassou	ORSTOM Hydrology	Lafforgue Camus	Sakassou	Setting up the experiments Standardization-Density-Kinetics	Starting
Water balance under banana-plantations	ORSTOM Pedology	Roose	Azaguie	Standardization Kinetics	Ended
Laboratory standardization of soils using the neutron absorption method	ORSTOM LRI	Bois	Adiopodoumé	Routine measurements	In progress

Appendix 3

UTILIZATION OF RADIOTRACERS - LRI ADIOPODOUME - IVORY COAST

Title of the study	Institution	Responsible scientist	Situation	Type of work	Nuclides	State of progress
Biology of a rice-parasiting nematod	ORSTOM Nematology	Reversat	Adiopodoumé	Autoradiography	³⁵ S	Ending
Biology of the queen-termite	CNRS	Bordereau	Dijon Adiopodoumé	Liquid scintillation	³ H	Ended
Permeability of the latex cells	ORSTOM Physiology	Hanover	Adiopodoumé	Liquid scintillation	¹⁴ C	In progress
Protein malnutrition and immunological deficiency	Foundation NESTLE	Shopfer	Adiopodoumé	Liquid scintillation Autoradiography	¹⁴ C ¹²⁵ I ¹³¹ I	In progress
Study of the phytoplankton of the ocean	CRO	Dufour	Abidjan	Liquid scintillation	¹⁴ C	In progress
Study of the zooplankton of the ocean	CRO	Leborgne	Abidjan	Liquid scintillation	¹⁴ C	In progress
Paraprimary production of the ocean	CRO	Herbland	Abidjan	Liquid scintillation	¹⁴ C	In progress
Pollination of the cacao-tree	IFCC	Lucas	Bingerville	GM couting	³² P	In progress
Labelling of tsetse flies	ORSTOM Medical entomology	Challier	Bobo Dioulasso	Labelling and detection in the field	⁵⁹ Fe	Interrupted
Physiology of <i>Hevea</i>	Faculty	Lambert Coupe	Abidjan	Routine counting	³² P ¹⁴ C	In progress