West Africa Seed and Planting Material

The Newsletter of the West Africa Seed Network (WASNET)

Secretariat: PO Box 9698, K.I.A. Accra, Ghana

No. 8, October 2001 ISSN 1595–2312

This is the eighth issue of West Africa Seed and Planting Material, the newsletter of the West Africa Seed Network (WASNET). WASNET addresses the needs and problems in the seed and planting material sectors in West African countries and brings together seed personnel from West Africa in a structure, which will encourage them to work together to strengthen national and regional seed industry development.

It is encouraging to see that all the WASNET country representatives have started implementing the activities, which were identified by the network General Assembly and approved by the Steering Committee. On page two of this issue, a list of the current network activities and the lead countries is provided.

Another development is that the network will probably be operating under the CORAF (West and Central African Council for Agricultural Research and Development) umbrella. The network was presented in January 2001 to the CORAF Executive Committee meeting which gave the approval.

Finally, an evaluation mission has reviewed the project and recommended that German funding for WASNET should continue up to 2006. We hope that the German Ministry for Economic Cooperation and Development (BMZ) will approve this recommendation.

The last two issues of the newsletter dealt mainly with the private seed sector and in the current issue we have a few contributions related to this important actor in the West African seed sector.

Emphasis in this issue is, however, on the root and tuber crops, cassava and yam, which are important staple foods throughout Africa. They are the major source of calories for more than 200 million people in Africa. Root and tuber crops are also major contributors to the agricultural GDP.

Cassava is one of the most important staple food crops in Africa. Much more cassava is produced today in Africa than in South America where the crop originated. In 1996, 85 millions tonnes of fresh roots were harvested from 10 million ha in Africa. This represents 52% of the total world production harvested from 62% of the total area planted worldwide. Major producing countries include, in the West African subregion, Nigeria, Ghana, Côte d'Ivoire, Bénin, and in Central Africa, the Democratic Republic of Congo, Cameroon, and Congo Brazzaville. Cassava is currently a major source of income for the largest number of households, which produce and/or process the crop in comparison with other staples. Although large-scale production systems have been set up in response to export opportunities in countries such as Ghana, it is the small-scale farmers who traditionally cultivate cassava in West and Central Africa. Yields are still relatively low in Africa as compared to yields obtained in Asia and South America. Cassava yields vary from 18.5 tonnes in Cameroon to 5.3 tonnes per hectare in Angola. Constraints include low fertility of the lands where cassava is normally grown, limited application of inputs, and relatively slow dissemination of improved cassava varieties adapted to local conditions and tastes.

Cassava shows a wide range of ecological adaptation. It yields satisfactorily even on poor acid soils. It can be grown in semiarid regions. The crop plays a vital role in alleviating famine, providing an inexpensive

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carbohydrate staple for low-income consumers. It is a food security crop in vulnerable areas such as drought, famine, and crisis regions. It produces more than twice as many calories per hectare as maize and at a considerably lower cost. Cassava leaves contain 6% of protein and are rich in vitamins, especially vitamins A and C.

Yam is indigenous to West Africa where 91% of the world output is produced. Before the introduction of other root crops, these indigenous food yams (*Dioscorea rotundata*, *D. cayenensis*, and *D. dumetorum*) were the major source of carbohydrates for the people of West and Central Africa. Nigeria alone accounts for 70% of the world's annual output of over 33 million metric tonnes. Other major producers of yams are Côte d'Ivoire (9%), Ghana (7%), and Bénin (4%).

In West and Central Africa, food yams provide more than 200 dietary calories per person daily for over 60 million people. In addition to the food security crop and its commercial importance, yams have maintained their significance in socio-cultural traditions, hence the production and consumption of yams is linked with rituals in West Africa, especially in Nigeria (the new yam festival).

The current issue will present what different countries in the region (Bénin, Burkina Faso, Ghana, Guinea, Chad, and Togo) are doing to further develop these crops.

Network activities and lead countries

- Study seed certification schemes in the region (Bénin)
- Prepare a regional catalog of seed and field standards (Burkina Faso)
- Study seed policies in the region (Gambia)
- Prepare a directory of available seed in the region (Ghana)
- Study seed laws in the region (Niger)
- Prepare regional variety catalog (Nigeria)
- Study seed import and export regulations in the region (Mali)
- Compile statistics on real needs and seed production in the region (Senegal)
- Prepare a regional directory of seed industry participants (Togo)
- Compile and publish newsletter (Secretariat)

Letters to the Editor

I have gone through your recent newsletter. It is good to see so many articles on individual seed enterprises. I think this approach can contribute to ways of moving forward.

If we are really worried about real "fly by night" operators who bring in mislabeled seed and sell from moving locations, issues about compulsory registration and certification are not relevant anyway, because these people will operate illegally. If we are worried about small seed companies getting in—and Louwaars' article points to that issue—then we do have to be careful about approved variety lists and compulsory seed certification. Any legitimate seed producer, even a small one producing unbagged seed in a local town has to develop a reputation over years, so there is no real reason for a lot of inspectors and regulators from the center to poke around to approve or not. We should not give these regulators too much blessing about how much good they are doing by getting in the way. If the government educates and trains, fine, but if they are stopping initiatives from growing into seed companies, then they are damaging the country. I am afraid that putting our blessing on complicated regulations to protect farmers from "fly by night" operators is misleading. If that is the worry, why not be clear about truth-in-labeling, and clear also that complicated regulations are irrelevant to the issue. Otherwise, we may be encouraging central regulators to suppress competition, tarring them all as "fly by night" operators, protecting the big guys, and the ones who are connected to the MOA.

But I don't want to be negative. I think the newsletter issue really pushes the agenda and discussion into extremely productive channels. More company descriptions, sub-market descriptions (e.g., x companies entered tomato seed sales in Nigeria), could really give people a flavor of the enterprise angle of a working seed industry.

David Gisselquist, E-mail: David_gisselquist@yahoo.com

It was a pleasure to receive my first copy of "West African Seed and Planting Material" issued in August 2000 (6th issue). I congratulate you for the excellent work done.

Keep up the good work. You are indeed providing sound advice to your readership particularly in the article entitled "Some legal aspects regulating the establishment of small seed companies" by Peter Witthaut. I however deplore in this issue the chronological order in which announcements are made because these are published after the closing dates for the submission of applications or articles for "courses, meetings, publications".

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Root and Tuber Crops

Procedures for the release of root and tuber crop varieties in Ghana

E. Asiedu

The rational for following a standard system in releasing crop varieties is to ensure that by releasing the proposed variety, the socioeconomic development of Ghana will be enhanced. This is achieved through strategies embodied in the release mechanism that ensures superiority of the varieties, increased adoption rate, and crop productivity. In addition, the system explorenutritive and industrial potentials of these varieties to enhance their utilization and income generating potentials without losing sight of risks of causing injuries to farmers, consumers, and the environment.

Between 1980 and 1996, the Ghana Grains Development Project (GGDP) of the Crops Research Institute (CRI) operated an independent Varietal Release Committee for maize, cowpea, and soybean, in the absence of a national varietal release system.

In June 1996, the Agricultural Research Policy Consultative Group (ARPCG), realizing the deficiencies in the releases of crop varieties, charged the technical secretariat of the National Agricultural Research Project (NARP) to draw up a proposal for the formation of the National Varietal Release Committee (NVRC) under the National Seed Committee (proposed under the seed bill of 1972 and 1973 which was revised in 1990). Subsequent to this, a committee was constituted by the then Deputy Director General of the Council for Scientific and Industrial Research (CSIR) in charge of agriculture, forestry, and fisheries. The committee was tasked to constitute the NVRC with terms of reference.

Composition and terms of reference of the NVRC

The committee's membership was selected in view of the unique and complementary roles of stakeholders in varietal development, seed production, crop promotion, utilization, and quarantine. The new committee has the Director of DCS, MOFA as the Chairman and the CRI seed scientist as the member/secretary. Other members are the Directors of CRI, SARI, DAES, WIAD, the Executive Director of GLDB, the heads of the GSID and the NSS, a representative of the universities (on rotational basis) president of SGA, a prominent plant breeder, and a farmer. Other members could be coopted by the committee when necessary. Terms of reference of the NVRC are as follows:

- To approve all plant genetic materials which shall be propagated as 'seed' materials for cultivation in Ghana.
- To ascertain that genetic and environmental attributes as described by the sponsor(s) of the variety conform to the said planting material and the variety is distinct from all others and has additional contribution to the general agriculture of Ghana.
- To prescribe such terms and conditions that should be met by varieties and planting materials such that their cultivation and consumption would not be injurious to the health of farmers and consumers, and that their propagation will not be harmful to the ecological balance of the environment.
- To ensure that all plant genetic materials with their varietal names are provided by the sponsor(s) as released varieties/cultivars in Ghana and to maintain a register of all such released planting materials.
- To ascertain that all 'seed' materials entering the country for the purpose of being released for cultivation conform to the seed laws of Ghana and have met the plant quarantine regulations of Ghana.
- To advice the Minister of Food and Agriculture on plant genetic materials which should be proscribed or withdrawn from general cultivation in Ghana due to inadmissible characteristics.

- To provide letters of approval of the proposed variety to the sponsor(s) of the variety specifying time and conditions of release.
- To meet at least twice every year or as the need arises to deliberate on its duties.

Requirements for varietal release

It is required that the sponsor(s) of crop varieties meant for release establish a breeder's 'seed' field to produce enough planting material for the next generation if the variety is accepted. This field is inspected twice at flowering and harvest.

Field inspections: During the first inspection, it is expected that the sponsor(s) present(s) breeding methodology as well as botanical and agronomic characters of the proposed variety. At the second field inspection, the sponsor(s) is/are expected to assemble all personnel involved in the development and release of the variety; such personnel include plant breeders, agronomists, protectionists, economists, food scientists, farmers, marketers, processors, and industrialists. Two years' results of varietal testing from both on-station and on-farm trials must be presented along with data on economic analysis, sensory and physicochemical analysis must be presented. The impressions of farmers, marketers, and processors must be made known by such persons at the meeting.

Breeding methodology: The breeder should outline the breeding methodology used in developing the variety.

Varietal characteristics: Morphological characters of all parts of the plant must be thoroughly described. Agronomic characters should also be described.

On-station multilocation variety trial: It is required that the said variety proposed for release must be tested widely in at least one of the major ecologies of the country or within the target ecology. Nationwide testing on-station must cover at least 5 experimental sites. Ecological specific varieties must be tested in all available research testing sites in that ecology. If such sites are not available, the chairman of the NVRC must be contacted for advise. It is advised that varieties meant for release are included in a coordinated national trial, which would reduce the expenses of the plant breeder. The results must be presented during the second inspection.

On-farm multilocation variety trial: To ensure wide adaptability and adequate farmers' participation in technology development and transfer in the target ecologies, adequate samples must be used in on-farm testing. The variety proposed for release must be compared to the existing leading variety and the farmers' variety as checks. For nationwide releases, at least 40 sites per year for two years must be considered. For ecological specific varieties 5–10 sites may be ideal. Plant breeders must take advantage of coordinated on-farm variety trials, which CRI conducts annually.

Sensory evaluation: Sensory evaluation must be conducted using representative samples of consumers, particularly in areas where the crop variety is consumed in diverse dishes. Common food dishes must be prepared for the proposed variety in comparison with the existing improved and farmers' variety to determine the superiority of the proposed variety for the purpose of its release as food.

Physicochemical analysis: Physical and chemical analysis determine the potential of the variety for market value and industrial use. Analysis of ash, starch, minerals, vitamins, etc. must be conducted.

Socioeconomic analysis: Results of socioeconomic analysis must be presented during the second inspection. This ensures that it will be more profitable for a farmer to opt for the new variety.

Perspectives of farmers, marketers, and industrialists: During the second inspection, a farmer, a marketer, and an industrialist who have participated in the on-farm testing, marketing, and processing must be invited to brief the committee on their impression of the crop variety being proposed for release. This would boost the justification for the release.

Conclusion

The release of a crop variety through a systematic procedure developed by the NVRC ensures acceptability, enhanced adoption, and utilization. It also avoids the tendency of duplication of releases of the same genetic material by different organizations under different names. The NVRC comprises stakeholders who are responsible for the development and promotion of crop varieties in the country. It is required that the variety proposed for release will be developed in a conventional way, tested widely with the involvement of farmers and other end users to ascertain its profitability and superiority, and acceptance when adopted.

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Certification of roots and tuber planting materials in Ghana

L.L. Delimini, E. Blay, and A.R. Cudjoe

A viable, profitable, and cost-effective seed industry thrives on the quality and volume of products (good seeds and planting materials) it turns out to its customers, the farmers. To achieve this, seed must be delivered to farmers at the right place, the right time, in the right quantity, and with the right quality. High quality seed and planting material hinge on the availability of genetically and physically improved crop varieties, which arise through research and varietal release. These varieties must be systematically multiplied, processed, and packaged to meet the demands of the varying sizes of the farming community.

Ghana's seed program started with cereals and legumes such as maize, cowpea, and soybean primarily because of the national and international support in research and development they had received. The support led to rapid crop improvement, development, and release of varieties.

Root and tuber crops improvement in Ghana

In the early 1990s, the root and tuber program in Ghana started receiving some support both nationally and internationally, which led to the introduction of improved varieties of some crops especially cassava. Notable among these international institutions are IITA and IFAD, which supported the Smallholder Rehabilitation and Development Program (SRDP). The SDRP in collaboration with the Crops Research Institute (CRI) initiated adaptive trials of some improved varieties of cassava in the various ecologies of Ghana which resulted in the release of three varieties. The varieties were given local names: "Afisiafi", "Gblemoduade", and "Abasafitaa". Though these varieties do not meet the traditional utilization criteria of poundability, they nevertheless satisfied processing requirements. An additional variety called "Tek bankyi" was released locally through mutation breeding from a combination of some of the introduced varieties to meet the poundability requirements of consumers.

As a follow-up to these efforts in the improvement of root and tuber production, a bi-continental project—the Ecologically Sustainable Cassava Plant Protection Project (ESCaPP)—to address cassava plant health problems embodying Brazil and four West African countries (Nigeria, Cameroon, Bénin, and Ghana) was initiated in IITA. This multi-disciplinary and multi-institutional project delved into sustainable plant health and through its efforts staff of the Ministry of Food and Agriculture were trained in recognition of pests and diseases for certification purposes.

The GTZ/IITA/CRI project funded by GTZ has also supported efforts in multiplication of root and tuber crops in selected mandate areas in the subregion including Ghana. In line with its objective of incorporating certification of planting materials in the seed supply system, the GTZ supported the formulation of certification standards for the West African subregion. The GTZ/IITA/CRI project assists countries in providing healthy roots and tuber planting materials on request.

Root and tuber certification scheme

In order to ensure the availability of good quality planting material to the farmer, it was necessary to develop standards and protocols for certifying root and tuber crops followed by a multiplication and distribution system comprising three stages outlined below:

Stage 1: Materials from breeders are multiplied. These multiplication fields are manned by personnel from MOFA and GLDB under optimal agronomic conditions to produce clean and healthy foundation planting materials.

State 2: Transfer of these materials to certified farms managed by contract growers for further multiplication under less stringent agronomic conditions.

Stage 3: Resulting certified materials are then distributed to farmers for direct use at the farm level.

Establishment of planting material teams

As a first step towards meeting the quality assurance needs of planting materials in the country, Planting Material Inspection Teams (PMITs) were set up by the Plant Protection and Regulatory Services Directorate (PPRSD). These inspection teams take cognizance of the ecologies and the common types of crops produced in the country, i.e. the northern sector which comprises Northern, Upper East, and West regions; the middle belt comprising Ashanti and Brong Ahafo regions; and the southern sector comprising Greater Accra, Eastern, Volta, Central, and Western regions. Field inspections are staggered to coincide with time of planting, vegetative growth, and time of coppicing. The teams consist of specialists from the PPRSD, CRI, and the University of Cape Coast. Team members are made up of entomologists, pathologists, seed technologists, and agronomists. Minimum acceptable standards are set for each of the disciplines.

The role of each specialist is to ensure that these standards are met as follows:

- Entomologists: ensure minimum acceptable levels of cassava green mite, mealy bug infestation, etc.
- Pathologist: ensures minimum acceptable levels of infestation of diseases of cassava mosaic virus, bacteria blight, anthracnose, *Cercospora* spp. etc.
- Seed technologist: ensures adequate isolation distances, previous cropping practices, farm location, etc.
- Agronomist: ensures plant population, soil fertility, general crop husbandry, etc.

The PMITs are expected to inspect all primary sites (Stage 1) and secondary (Stage 2) multiplication sites to detect disease and pest infestation levels and agronomy to assure that all planting materials in theses stages are healthy and are of good quality for distribution to farmers. At the tertiary stage (Stage 3), only samples of farms are inspected for certification.

Future perspective

The present emphasis of planting materials inspection is on cassava ostensibly because of the depth of research and crop improvement and release of varieties, which make available varietal characteristics to inspectors. However, with time and as varieties are released and characterized, other crops such as yam, cocoyam, and frafra potato would be incorporated into the certification system. The present inspection and certification scheme needs to be strengthened through training to increase capacity of all inspectors and collaborators.

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Propagation of root and tuber crops by tissue culture in Ghana

M-D. Quain

Root and tuber crops (*Dioscorea* spp., *Manihot esculenta*, *Ipomoea batatas*, *Xanthosoma sagittifolium*, and *Solennostermon rotundifolius*) in sub-Saharan Africa play a major role in the diet and economy. They account for over 50% of the total staples produced and are also the backbone of the economy in the region. In West Africa, root crops provide 33% of the total food energy and 15% of the protein intake of West Africans. Some root and tuber crops are important sources of vitamins, minerals, and essential amino acids such as lysine. Additionally, cassava, cocoyam, and sweetpotato leaves are important sources of protein in many parts of West and Central Africa. In Ghana, root crops contribute 46% of the agricultural GDP. Generally, root and tuber crops have not received much research attention.

Major constraints limiting the production of root and tuber crops are low yield and susceptibility to diseases. Due to free movement of people, goods, food, and planting material of root and tuber crops move easily from one place to another within the West African subregion. Little or no attention is paid to quarantine measures. Therefore, while distributing planting material, pest and diseases also move from place to place.

Since planting materials have to move from one place to the other, measures must be taken to ensure the distribution of clean planting materials so as to prevent dissemination of pest and diseases. Tissue culture, which is a tool in biotechnology, holds the key to the problem of disease-free planting material. The tissue culture laboratory of the Crops Research Institute (CRI) of the Council for Scientific and Industrial Research (CSIR) appealed to the West African Seed Development Unit (WASDU) for help in the expansion of the existing tissue culture facility. The assistance provided by WASDU helped the laboratory to increase its incubation capacity from 5000 to 45 000. A standard screen house was also provided for the hardening off of developed plantlets.

The set objective was to use the tissue culture facility to produce clean disease-free planting material and to rapidly multiply clean planting material for distribution in the subregion. Another objective was to receive certified clean tissue culture planting material, which have preferred characteristics from other tissue culture laboratories for rapid multiplication and distribution to interested researchers in the subregion.

The methodology has been to use the standard tissue culture procedures (meristem cultures) for the production of clean disease-free planting materials. Certified clean materials are micropropagated to obtain required quantities. Well-developed plantlets are established in the screen house

for the production of seed yam, corms of cocoyam, as well as cuttings of sweetpotato and cassava. The expertise of pathologists (virologist and microbiologist) are engaged to ensure that the planting materials stay clean for distribution to scientists and extension officers.

The laboratory has been involved in training students, technical staff, and extension officers in tissue culture manipulations as well as postflask management of plantlets. Besides producing clean planting materials of the root and tuber crops which is in line with WASDU's objectives for the West African subregion, the laboratory is also involved in the national Root and Tuber Improvement Program (RTIP) for the production of clean planting material of our local root and tuber crops. It also plays a key role in the national Musa project for which clean clonal material with tolerance to the banana streak virus (BSV) are being produced in vitro.

The tissue culture research work is impeded by:

- Irregular supply of electric power; a standby generator involves financial and mechanical problems.
- Irregular supply of water; funds are being sought for to provide a reservoir for the laboratory.
- Nonavailability of government funding for research; ready sources of funds for research work are not available.
- Nonavailability of laboratory consumables.

Conclusion

The tissue culture technology is well developed with working protocols for root and tuber crops in the sub-region. However, this potential is highly under utilized due to irregular supply of basic amenities, inadequate number of trained personnel, and morale boosters for personnel. If the associated constraints are addressed, the promising potentials of tissue culture and biotechnology to the root and tuber sector are enormous.

It is hoped that in the near future, the application of tissue culture in root and tuber crops fully utilize other biotechnology tools such as somatic embryogenesis and hybridisation, cryopreservation, and molecular genetics to improve the crops to their desired state.

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Cassava in Benin

N.G. Maroya

Background information on Benin and the agricultural sector

The Republic of Benin stretches over some 112600 km^2 and is divided into the following six departments: Atacora, Atlantique, Borgou, Mono, Ouémé, and Zou. These departments are subdivided in urban districts and sub-prefectures and communes. A new decentralisation legislation yet to be implemented will double the number of departments to include: Alibori, Atacora, Atlantique, Borgou, Collines, Couffo, Donga, Littoral, Mono, Ouémé, Plateau, and Zou.

In 1999, the population was estimated at about 6 million with an annual rate of increase of 3.2%. Population is unevenly distributed. The southern part accounts for 65% of the population occupying 15% of the total area. The rural population represents 60% of the total population.

Agriculture is the major activity. Production is based on natural resources, which are relatively abundant. The country's terrain is generally flat, with the exception of the Atacora mountain chain in the northwestern part. With the exception of some areas in the north, rainfall exceeds 800 mm on average in most parts of the country and peaks at 1300 to 1400 mm in the south.

The major food crops grown are maize, groundnut, cowpea, rice, millet, sorghum, cassava, and yam. Among these, cassava and yam account for most of the production and commercial surpluses that are sold to other countries in the subregion. However, these crops are affected by constraints which hinder their development and which include plant genetic constraints, the low productivity of production systems, high cost of inputs, damage caused by diseases and pests, and more specifically, declining soil fertility.

Cassava (*Manihot esculenta* Crantz), first introduced in Africa by the Portuguese in the 16th century, is one of the major sources of energy in the human diet in the tropics. It produces 8.2 million calories per hectare as against 3.3 million for maize.Cassava contributes more than 50% in meeting calorific needs in 26 tropical countries.

In Bénin, it was under King Guézo (Kingdom of Abomey) that cassava was most cultivated in the wake of the major drought (1847–1850) which affected all other crops. The

predominance of cassava in Bénin can also be accounted for by the fact that it has been, along with maize, the staple food in the northern and central regions. To date, apart from this social role, cassava has become a cash crop (both at domestic, regional, and even international levels) in Bénin. In the past, cassava production was meant for local consumption but today, processing is industrial and its various products (gari, flour, chips, tapioca, starch, alcohol, and pastry products, etc.) are marketed country wide. Moreover, cassava accounts for 2.8% of the GDP and 8.3% of the agricultural GDP as compared to cotton (the major export crop) which represents 3.7% and 11% of GDP and agricultural GDP respectively.

Cropping areas and production trends

Bénin is zoned in natural agroecological regions with various potentials exploited through specific production systems which are characterised into eight agroecological zones. Each zone has specific climate, physical (vegetation, terrain, and soil) and social characteristics. They are:

The far northern zone (Zone 1)	9057 km²
The northern cotton growing zone (Zone 2)	20930 km²
The Borgou southern food crop zone (Zone 3)	27786 km²
The Atacora western zone (Zone 4)	16936 km²
The central cotton growing zone (Zone 5)	31722 km²
The 'zone des terres de barre' (Zone 6)	6373 km²
The depression zone (Zone 7)	2564 km²
The fisheries zone (Zone 8)	3151 km²

Production statistics confirm cassava as one of the food crops in Bénin. Areas under cultivation have increased from 103 216 ha in 1986 to 185 784 ha in 1997 or an 80% increase within ten years. Over the same period, production rose from 72 4261 tonnes to 1 91 436 tonnes or a 165% rate of increase.

This increase in acreage is a sign of the growing interest of producers in that crop. Despite a considerable geographical spread of cassava cultivation, strong disparities still exist within the major production zones. Yields vary considerably, ranging between 7 and 18 t/ha in sole cropping. Improved varieties developed by INRAB (BEN86052 and (RB89509) yield up to 20–22 t/ha without fertilizer in a rotation system which preserves soil fertility. Yields can be as high as 30 t/ha with fertilizer application.

There are three major cassava producing regions:

A marginal production region

This region produced, between 1993–1994 and 1998–1999, 8.42% of the total production in 9.44% of the country's total area. That region of 70 365 sq. km covers zones 1, 2, 3, and 4 excluding a sub-prefecture in the Atacora department and two others in the Borgou sub-prefecture. The relatively low production levels recorded in this region can be correlated with the food habits of populations who predominantly consume yam and sorghum/millet.

A medium production area

This area covers zones 7 and 8 with a total surface area of 6 025 km² and contributes 22.45% of total national cassava production (average 1993–1999) over 21.46% of cassava production. The region includes 20 sub-prefectures in the departments of Atlantique, Mono, Ouémé, and Zou.

A major production area

This area spreads over 38 554 km², and contributes on average more than 69.13% of national production over an area almost similar to cassava growing areas. It covers areas 5 and 6 representing "la terre de barre" and the central cotton growing area. It includes 33 sub-prefectures located in all 6 departments (almost the entire Zou region). Production levels are high and national surpluses are obtained in this area.

Tables 1 and 2 show surface areas as well as levels of production in each of the eight agroecological zones over the cropping seasons 1993–1999.

The cassava-based production systems in Benin

Cassava cultivation in Bénin is done manually by all social groups notably women for the production of raw materials for processing. Several cropping systems are implemented with a croping cycle of 8 to 18 months and sometimes longer depending on the varieties used. Land preparation is done without ploughing or on ridges in the southern part of the country or on both ridges and small mounds in central Bénin, and on mounds (small and large) in central, north-central, and northern Bénin. Intercropping with annual crops (maize, sorghum, cowpea, or groundnut) is practised in some regions. In some cases, cassava is intercropped with palm oil in the south and with palm wine trees in the south east. Standard intercropping practices commonly found are: (a) cassava–maize (south and central Bénin); (b) cassava–sorghum or millet (north); cassava–groundnut or cowpea; (d) cassava–vegetables (at household level).

Cassava is cultivated by individual farmers and by groups. Plot size varies depending on farmers' conditions of living. They range from small holdings (less than 0.5–3 ha) to large plots (5–10 ha and more). Each farmer grows several crops. Cassava sole cropping is practised generally at the end of the rotation and leads to a fallow period. Cassava cultivation in Bénin is characterized by non-application of purchased inputs (fertilizers, pesticides, etc.) because it is subsistence production

Table 1. Evolution of areas (ha) under cassava cultivation per agroecological zone (cropping seasons 1993–1994 to 1998–1999).

Year	1993–1994	1994–1995	1995–1996	1996–1997	1997–1998	1998–1999	Average	%
Zone 1	3	29	64	106	117	195	86	0.05
Zone 2	1 849	1 746	2 170	2 535	2 139	2 561	2 167	1.31
Zone 3	7 515	9 505	9 047	9 053	9 901	10472	9 249	5.59
Zone 4	3 425	4 560	3 910	4296	3 808	4 673	4 112	2.49
Zone 5	43 734	38 030	46 597	50 024	53 598	57 137	48 187	29.14
Zone 6	46 403	68 552	59 014	69 695	77 488	75 356	66 085	39.96
Zone 7	10 085	15 877	12 298	16 213	18 982	16 655	15 018	9.08
Zone 8	18611	28297	21 472	21987	15 326	17 187	20 480	12.38
Total	131 625	166 596	154 572	173 909	181 359	184 236	165 383	100.0

Source: Annual statistics MDR/DPP.

Table 2. Evolution of cassava production (tonnes) per agroecological zone (cropping seasons 1993–1994 to 1998–1999).

Year	1993–1994	1994–1995	1995–1996	1996–1997	1997–1998	1998–1999	Average	%
Zone 1	18	145	397	549	545	780	406	0.03
Zone 2	11 736	11 857	14 489	16 179	12 635	14 784	13 613	0.89
Zone 3	66 368	72 221	73 389	78 731	88 812	81 464	76 831	5.04
Zone 4	33 178	36 083	40 147	41 735	32 835	40 720	37 450	2.46
Zone 5	397 493	328 703	396 886	555 302	519281	590 401	464 678	30.49
Zone 6	339 344	481 266	469 100	602 574	821 097	820 182	588 927	38.64
Zone 7	112 446	163 527	114 729	190 882	255 702	245 745	180 505	11.84
Zone 8	149 639	214 106	158 676	156 529	130 207	161 438	161 766	10.61
Total	1 110 222	1 307 908	1 267 813	1 642 481	1 861 114	1 955 514	1 524 175	100.0

Source: Statistical year book MDR/DPP.

done by small-scale farmers without any coordination in the processing and promotion of exports. Moreover, there are no specific fertilizer formulations for cassava.

Farmers cropping systems characterized by a low cassava density intercropped with shorter duration crops do not help to quantify the performance of cassava clones. However, there is a significant yield increase at the national level compared to the situation in the 80s (Figure 1). The yield decline recorded in 1987 is attributable to an epiphytic bacterial disease which led to a reduction in areas grown and therefore to a significant yield decrease.

Varieties grown and promotion activities

The criteria used to differentiate cassava varieties are variable but the most easily identifiable are morphological traits. This is an important factor for cassava producers and especially women processors for whom the dry matter content, yield, and quality of by-products are predominant characteristics. Indeed, before fixing the price of a mature cassava plot, women sample a few plants to confirm these characteristics. To meet these criteria, some research work is conducted when developing new varieties.

Research collaboration on cassava with IITA has led to the identification of clones such as TMS 30572; TMS 30555; TMS 30001; and TMS 4(2)1425 with high yields and adequate levels of resistance to diseases. However, these were not accepted by farmers because of their morphology (prolific branching) which does not allow intercropping. Other breeding work conducted with IITA in order to break these barriers are currently being evaluated at the

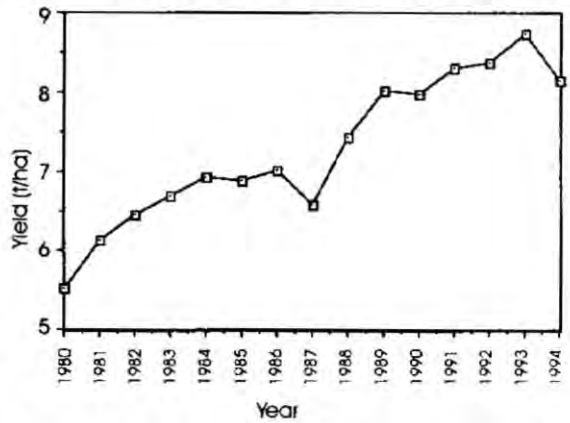

Figure 1. Yield trends of cassava in Bénin.

southern agricultural research center at Niaouli. In this process, 86052 which gave promising and stable results through regional trials was selected. Research activities which led to the development of this clone released since 1992 were supported by CARDER, the National Directorate of Agriculture, and Sassakawa Global 2000.

The multiplication of the planting material for these improved varieties by seed farmers was initiated but was only implemented by some projects such as the Bénin-Japan Project for the rehabilitation of cassava cultivation or the NGO Global 2000. The coverage rate was estimated at 20% but cuttings are not checked for their plant health status. No certification standard is used.

Constraints to cassava cultivation in Benin

Declining soil fertility is a major constraint at national level and more specifically in the south. This situation is linked on the one hand to the degradation of the vegetal cover and on the other to the non-use of organic and mineral fertilizers except for cotton. This is exacerbated by the successive planting of crops which depletes soil nutrients. The high population density and low availability of land in the south has led to intensive exploitation of the soils, reduced fallow periods, and increased intercropping. In the north, (Borgou, Atacora, and northern Zou), slash-and-burn shifting cultivation along with short duration fallow periods (less than ten years) is a threat to the ecological balance of the area, compounds soil erosion, and will soon lead to a reduction of cultivated areas. Other constraints often reported by farmers are pest problems and damage caused by parasites and rodents.

Status of cassava research in Benin

Research activities are conducted at the Niaouli Agricultural Research Center (CRA-SB Niaouli) in the south. Multidisciplinary research development teams based in the south (at Niaouli and covering zones 6, 7, and 8) and in the center (Bohicon and Savè) in the Zou department and in the north (Ina, Natitingou, and Kandi) in the Borgou and Atacora departments support research activities. Research on cassava started at the Institut des Recherches Agronomiques Tropicales (IRAT) around 1962, with collections from introductions from Madagascar, Brazil, and IRAT-Paris. This genetic base was continuously updated with new introductions and surveys conducted in the southern part of the country. This has made it possible to include a large number of local clones grown by farmers. An important collection of clones from IITA was introduced in order to increase the genetic diversity. Several other activities were also conducted at different stages of program implementation and led to some varietal breakthroughs which helped to develop new clones in Bénin.

The following specific achievements were made in the area of cultural techniques:

Preparation of cuttings: It has been confirmed that the best cuttings are those obtained from stems aged 12 months. These are cut into 20–30 cm long cuttings so as to have a round tip to plant while the aerial part is skewed. Each stem produces on average five cuttings.

The cutting mode: Several techniques of cutting were tested. The best results were obtained with oblique cutting (45° from the soil); 2/3 of the cutting length is in the soil while the aerial part is slightly skewed towards the soil facing sunset. This position prevents rotting and facilitates cutting recovery.

The cutting period: A series of trials conducted in the southern part indicate that the best period is at the beginning of the rainy season. Cuttings made in March gave the best tuber yields while those made in September or October had a poor performance.

As far as soil fertility is concerned, the best results in soil regeneration were obtained with tree leguminous crops such as *Senna seamea*, *Gliricidia sepium*, *Leucaena leucocephala*, and *Acacia magium*.

All these results were transferred through on-farm trials by research-development teams and through the training of specialized technicians within Regional Action Centers for Rural Development (CARDER). The latter will then reach farmers through extension workers using demonstration, training, and application plots.

Conclusion and prospects

Research results obtained over the last years are quite interesting and have contributed considerably to improving national agricultural production, specifically cassava production. However, farmers' expectations are yet to be fully met and much is to be done so that the promising planting material is made available to the great majority of farmers and food security becomes a reality. The new cassava project initiated by government with a national budget of one billion CFA for 2000 raises many hopes. Similarly, the Root and Tuber Crops Development Programme (PDRT) currently funded by the International Fund for Agricultural Development (IFAD) for a seven-year period will help to strengthen participatory research capacities and regionalisation of activities while encompassing the concerns of rural populations for a sustainable development of our agriculture.

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Root and tuber crops in Burkina Faso

R.A. Dabire and J. Belem

Burkina Faso is a major cereal producing country. However, other crops such as roots and tubers are also cultivated. According to experts, cereal production will considerably decline in the next ten years. To prevent likely major food crisis, international institutions such as FAO and IITA suggest the introduction and development of root and tuber crops such as cassava, yam, and potato, especially in developing countries in West Africa. What is the current status of such crops in Burkina Faso?

This report reviews the situation of root and tuber crops production specifically cassava, yam, and potato in Burkina Faso, a cereal-growing country working towards food security and self sufficiency.

Burkina Faso is an inland country within the Sudan-Sahel zone in West Africa and stretches over 274 000 km^2. It is located between latitudes 9° 20′ and 15° 05′ North and longitudes 50° 20′ West and 20° 03′ East. It shares borders in the north and in the west with Mali, in the south with Côte d'Ivoire, Ghana, Togo, and Bénin and in the east with Niger.

The climate is characterized by two distinct seasons: a humid season from June to the end of September and a dry season from mid-October to mid-April. There are three climatic zones:

- The Sahelian zone with an average rainfall of less then 600 mm/year with an extended dry season lasting 7–8 months (mid-September–June);
- The Sudan-Sahelian zone with an annual rainfall of 600–900 mm and a dry season which also lasts 7–8 months;
- The Sudan zone which includes two areas: one area with an annual rainfall of 900–1100 mm punctuated by 5–6 months dry season and a second area with an annual rainfall exceeding 1100 mm and a dry period not exceeding 5 months.

The population is estimated at 10 million with a 3% growth rate. It is predominantly rural (93.6%). Agriculture is the major activity. Crops are generally grown on moderately fertile soils poor in organic matter and deficient in phosphorous and nitrogen. Nutrition wise, some 75% of calorie intake is provided by cereals, out of which 60% are supplied by sorghum–millet. Agriculture is characterized by small household plots (3–6 hectares) with 3–6 active members. It is subsistence agriculture with sorghum, millet, and maize grown over 88% of areas cultivated annually, while cash crops are grown on only 12% of cultivated areas. Cereal production occurs under upland conditions and is subject to climatic hazards (drought, erratic rainfall, etc.) and to the continuous degradation of the environment and the soils. This dependence on cereals as the staple food means importing relatively important quantities depending on the rainfall situation of the previous year. Under such circumstances, agriculture can hardly meet the food needs of the population let alone guarantee food security. Yet, other sources of energy from yam, sweetpotato and cassava are available. Emphasis on these crops is justified by their agronomic and nutritional value. Cassava is a perfect example as it has a wide adaptation capacity to the major soil and climatic conditions in Burkina Faso and grows in poor soils and does not require much fertilizer. Moreover, cassava can withstand several months of severe drought and yet be harvested during the humid season when food shortage is prevalent. Therefore, even in a situation of poor rainfall, minimal harvesting can be achieved. Some cassava or yam-based processed products can be stored over long periods and serve as calorie supplements.

Background: trends in areas, production, consumption, and marketing

Generally, Burkina Faso is not a potential root and tuber crops exporting country. Production is not organized and is still at household level for domestic consumption, on small family plots not exceeding 1 ha. Two categories of root and tuber crops are grown depending on cropping systems:

Upland crops grown in the rainy season (Table 1): yam, sweetpotato, cassava, ginger, fabiramas, and sweet peas.

Irrigated dry season crops made up basically of potato (Table 2).

As far as marketing is concerned, the distribution channel is highly informal and the market is predominantly domestic. Yam and sweetpotato are supplied through urban centers in Ouagadougou and Bobo-Dioulasso. Some quantities were imported in January and June from neighboring countries such as Côte d'Ivoire, Bénin, Ghana, and Togo. For yam, a cultural event called "la fête des ignames" (the yam festival) is celebrated every year in the Sissili province during which an important quantity is sold and various yam-based meals exhibited.

The potato sector is relatively best organised with l'Union des Coopératives Agricoles et Maraîchères au Burkina (UCOBAM), the Société des Fruits et Légumes (Fex Faso), la Fédération des Unions des Groupements Naam (FUGN)

Table 1. Areas, yields and production of yam, sweetpotato, and cassava.

Year	1988			1989			1990			1991			1992		
	Area (ha)	Yield (kg/ha)	Production (tonnes)	Area (ha)	Yield (kg/ha)	Production (tonnes)	Area (ha)	Yield (kg/ha)	Production (kg/ha)	Area (ha)	Yield (kg/ha)	Production (tonnes)	Area (ha)	Yield (kg/ha)	Production (tonnes)
Yam	8246	7017	78339	4510	8637	51112	5500	11727	33500	6300	11279	36500	1755	36620	14700
Sweet-potato	6117	5331	30456	2174	2399	6228	17900	268	4343	11400	1637	16758	1812	3436	7331
Cassava	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

–: data not available.
Sources: Office of Agricultural statistics of the Ministry of Agriculture and Animal Resources.

Table 2. Area, production, and average potato yield (1990–1991 cropping season) in research sites.

	Sahel	Centre	North-west	West	East	Total
Area (ha)	2.47	20.15	64.33	9.02	0.73	96.70
Yield (t/ha)	19	17.40	36.30	26.40	15.40	26.80
Production (tonnes)	47	351	2335	238	11	2982

Table 3. Status of root and tuber crops in various production systems.

Crop	Importance of crop	Place in sole cropping	Place in intercropping	Remarks
Millet	1	11	2	Assoc > Pure
Sorghum	2	10	4	Assoc > Pure
Groundnut	3	2	7	Pure> Assoc
Maize	4	1	9	Pure> Assoc
Cowpea	5	13	1	Assoc > Pure
Cotton	6	4	12	Assoc > Pure
Red sorghum	7	9	7	Pure = Assoc
Rice	8	3	–	Pure
Bambara groundnut	9	5	10	Assoc > Pure
Sesame	10	6	6	Pure = Assoc
Sorghum	11	–	3	Assoc
Sweetpotato	12	7	15	Assoc > Pure
Cassava	13	8	11	Assoc > Pure
Yam	14	14	12	Pure = Assoc
Roselle	15	23	5	Assoc > Pure
Okro	16	15	–	Pure
Upland rice	17	–	–	–
Fonio	18	21	–	Pure
Vegetable	19	16	–	Pure
Water melon	20	17	–	Pure
Banana	21	–	12	Assoc
Local aubergine	22	18	–	Pure
Gourd	23	20	–	Pure
Tobacco	24	21	–	Pure
Melon	0	18	–	Pure
Soybean	0	12	–	Pure
Cocoyam	25	24	–	Pure

and the Union Régionale des Coopératives Agricoles de Bobo-Dioulasso (URCABO) which collect and market the production. Cassava has gained greater importance with the introduction of new varieties from IITA. Several stakeholders, farmers, and traders are interested in this crop and wish to start production. However, problems related to production, processing, and marketing might arise in future and should therefore be considered.

Production systems and major constraints

A study conducted in Burkina Faso by INERA in 1998 listed major crops grown in the country and underlined the importance of tuber crops such as yam and cassava in the current production systems. Generally, cereal crops are predominant and as shown in Table 3, cassava is ranked 13th in order of importance while yam is 14th and sweetpotato 12th out of the 25 crops listed.

Cassava is grown as a sole crop in traditional areas and intercropped with yam, banana, and roselle in new production zones. Moreover, no chemical treatment or fertilizer is used. Major constraints reported by farmers on yam are animal damage, termites, lack of high yielding and short duration planting material, insects and diseases, poor understanding of cultural techniques, and inadequacy of processing equipment.

As far as yam is concerned, apart from soil depletion, deforestation (due to stalking and shifting cultivation), lack of adapted and high yielding varieties, and parasite proliferation are other constraints to be tackled.

Finally, potato is basically grown as a sole crop and the major constraints are inavailability of seeds, storage problems, and lack of adapted and high yielding varieties.

Traditional models or approaches for the production of planting material

There are hardly any traditional methods of producing planting material in Burkina Faso. Planting material is taken directly from the previous harvest, which compounds diseases and insect pest proliferation.

The status of research and modern approaches or models for the production of planting material

Apart from soil and climatic constraints, the following should also be noted:

- Plant production constraints, the most important being difficulties in seed and quality planting material supply, varietal problems (varieties not adapted to the market situation, low level of diversification), and parasite pressure.
- Socioeconomic constraints including difficult access to credit, lack of, or inadequate storage and processing facilities, and lack of professionalism.
- Technical constraints including poor control over storage and processing techniques and lack of processing equipment.

For all these crops, processing and storage techniques are either not fully controlled or available. Cassava is produced in the southern, southwestern, and eastern parts of the country with an annual rainfall exceeding 700 mm/year. Constraints reported are:

- Varietal problems: all varieties grown are local, low yielding, and susceptible to diseases and pests. They are not adequate for processing.
- Non availability of planting material: with new introductions from IITA, several farmers wish to start cassava production but do not have planting material.
- Processing problems: the lack of processing techniques and material is a constraint for the development of cassava which is a perishable product.
- Improvement of cultural practices: organic matters and mineral fertilizers should be applied and cassava should be intercropped with other crops such as leguminous crops to avoid soil depletion.

The agroecological research zones

Burkina Faso is zoned into five research areas on the basis of climatic, soil, and socioeconomic criteria. Table 4 shows the potential and limitations in yam, sweetpotato, and potato production within the five agricultural research zones.

Table 4. Yam, sweetpotato, and potato production potential in various research zones.

	Research zones			
Crop	Sahel	Northwest	Center	West East
Yam		(p)	+++	++++ (p)
Sweetpotato		+ (p)	+++	+++ (p)
Potato	+ (p)	+++	++	++ (p)

+ low production; ++ medium production; +++ high production; (p) potential of the crop.

Some research achievements and perspectives

Research on root and tuber crops is scanty and consists of studies on introductions and collections of species such as yam, cassava and sweetpotato. Several achievements were made since the adoption by government of the Agricultural Research Strategic Plan in 1995:

Potato: Out of 12 varieties introduced and assessed at Karangasso-Sambla (Southwest), the following 4 varieties were selected: Var 9, Var 18, Var 31, Var 56. The major constraints were soft or dry tuber rot in the field or in storage caused by the following pathogens: *Fusarium solani*, *Rhizoctonia solani*, *Sclerotium rolfsii*, and *Erwinia* sp. Insect pests are *Zonocerus variegatus*, *Aphis* sp.

- Solving seed problems through extending the production into the humid season
- Selection of varieties with a good storage capacity and resistance to pathogens responsible for rotting and to insect attacks

Yam: Some local ecotypes were collected. Similarly, major yam viral diseases in Burkina Faso were characterised by the INERA virology laboratory and data collected is used in a Phd thesis being prepared. Recent work initiated by INERA in collaboration with IITA on 60 IITA improved varieties introduced and assessed in Burkina Faso have led to the identification, with farmers participation, of varieties with a good emergence ability, resistance to pests and diseases, and high yield. However, one of the major constraints to yam production is field attack by a white coccid. Research work to be conducted will focus on:

- The development of cultural and fertilization techniques to make the crop more sustainable (rotation trials, yam/maize/leguminous crops)
- Agroforestory trials with *Gliricidia sepium* which has a nitrogen fixing ability
- Mastering and teaching farmers techniques of rapid multiplication of planting material
- The multiplication of high yielding improved varieties selected by farmers and their distribution to the farming community

Cassava: Some 43 genotypes were identified and partly characterised throughout the country. Tubers are consumed in various forms (10) but leaves are generally not used. All local varieties are susceptible to viral diseases and produce low yields. Six varieties derived from the uniform yield trials are in the final selection phase on-farm. These are: 92/0325, 92/0067, 91/02312, 92/0427, 4(2)1425, 94/0270.

Improved varieties give the best yields when planted early (in June) compared to varieties planted late in September. Future research work will focus on the:

- continuation of the breeding process on-farm
- multiplication of varieties selected by farmers
- control and training of farmers in planting material rapid multiplication techniques
- mastery and enhancement of processing techniques

Finally, for all these tuber crops, the modern model of planting material production is the one developed by IITA which requires the training of scientists and technicians responsible for transferring these technologies to farmers. This will help to solve the acute problem of availability of planting material in a country where demand is high and cultivation areas are steadily on the increase.

Conclusion

Food security and self-sufficiency is the major focus of agricultural research in Burkina Faso. Although a cereal growing country, the Agricultural Research Strategic Plan encompasses root and tuber crops which are given priority. Erratic rainfall as well as agronomic requirements and high production costs of farmers growing traditional crops have led the latter to resort to root and tuber crops such as cassava and yam. Financial and technical support from IITA and WASDU to INERA aims at promoting such crops. This will contribute to reaching food security and self sufficiency for African populations in general and for Burkina Faso in particular.

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Cassava in Guinea

E-S. Bah

Guinea stretches 245 857 km² in the western part of West Africa at 10° North of the equator. From the last census conducted in 1999, its population was estimated at 7.5 million. The country has various specific physical characteristics in terms of land, climate, soils, and hydrography. There are four distinct natural regions.

Middle Guinea in the North covers 22% of the total country area. This region supplies water resources to the whole of West Africa and includes mountains and lateritic plateaux culminating at 1515 m. Agriculture is hardly practised but livestock flourishes.

Maritime Guinea stretches over 18% of the total country area. It includes a 50–90 km wide coastal plain which is swampy and highly salty, made up of mangroves. There is a predominant 6–8 months rainy season with important peaks as high as 5000 mm per year.

Upper Guinea covers 40% of the total country area. This savannah region is made up of vast plains watered by large rivers. This region is subject to bush fires and deforestation caused by the slash-and-burn practice. The Sudan climate is hot and dry with harmattan winds blowing in March. Two seasons of equal duration are found: the dry season from November to April and the rainy season from May to October.

The forest zone stretches over 20% of the total country area and is located at the extreme southern part of the country. The landscape is made up of mountains and thick forests with an average altitude of 500–600 m. It covers a sequence of small plains and hills overlooking the Simandou and Nimba mountains (the latter culminating at 1752 m). It rains almost throughout the year (8–10 months) hence the good performance of agriculture and forestry.

Status of cassava production

Cassava is an important component within the production systems in Guinea. It accounts for 11% of cultivated areas and 16% of calorie intake for the average Guineanas against 26% of calorie intake and 49% of areas under local rice.

In Guinea, cassava production is still modest and was estimated at 775 600 tonnes produced on 122 550 ha in 1998. Production increased rapidly between 1992 and 1998 and cultivated areas have more than doubled with a 109% increase. However, large variations are noted between production zones. According to data from the National Agricultural Statistic Department, 64% of total production was obtained in upper and forest Guinea which are the major production zones. Yields are extremely variable ranging from 4 t/ha of fresh cassava on-farm to over 8 t/ha in the forest area. National average is estimated at 6.3 t/ha (SNSA 1998).

Cassava is used differently in agricultural holdings. In 1998, it accounted for 9% of cultivated areas in the N'Zérékoré region (forest area) as against 16% in the Boké region (coastal Guinea). The share of cassava producers in relation to total production was estimated at 34% in 1998. Being a typical food crop, farmers' strategies vary depending on whether production is used solely for domestic consumption or for commercial purposes.

Cassava consumption in Guinea

Cassava is a substitution food throughout the country except in Upper Guinea where it equals rice in importance. Previous studies seem to indicate that consumption levels are 35% in Upper Guinea, 25% in Middle Guinea, 30% in Maritime Guinea, and 10% in the coastal areas.

More than 55% of populations interviewed during the study on the cassava sector in Guinea conducted in 1999 indicate that cassava is the second staple food, regardless of their social status or their geographical origin. The study revealed an annual per capita consumption of 38 kg of dry cassava, although this varies from one region to another. Highest per capita consumption is recorded in the forest and upper parts with 49 and 52 kg of dry cassava and 5–6 kg of cassava leaves, respectively.

In the middle and coastal areas, dry cassava consumption is more than half compared to other regions: 15 and 20 kg per capita per year in dry cassava and 4–5 kg in cassava leaves. The study shows that cassava is the first substitution product of rice.

Production systems and constraints

There are three major cassava production systems in Guinea, depending on the growing environment.

External plots are more or less far from human settlements. Cassava is grown on slopes (84%) or on plains (11%). Cassava is hardly planted on steep slopes. This practice is more common in Upper Guinea (1/3), in Forest Guinea (1/3) and more often in Middle Guinea (1/4) and rarely in Coastal Guinea (less than 1/10). It is grown on these plots in a sole cropping situation (2/3) and 1/3 in intercropping with maize, rice, groundnut, and okra. It is planted on mounds, ridges, or flat on the ground especially in the loose soils in forest areas. Rotation practices vary from one

region to another. In Upper Guinea, cassava may come first whereas in forest areas, it may be planted before the land is ploughed. Such technique is practised less but produces larger chip yields.

About 82% of farmers working in these plots process their harvest into chips (3.5 tonnes chips/ha). Two planting dates are used. About ¾ of farmers plant in the beginning of the rainy season (April–July) while the rest plant at the end of the rainy season (October–November). Whatever the planting date, 95% of farmers will harvest in the dry season between November and April. Only 5% of farmers harvest in the rainy season during the hunger period (July–August).

Inland valleys are the major production areas of leaves and fresh tubers. Plots are small sized (0.3 ha on average). Under lowland conditions, cassava is grown as a sole crop (90%) or intercropped. Two planting dates are used in non flooded lowlands, that is, at the beginning or the end of the rainy season. Ploughing is not practised. Soil fertility is partially renewed by runoff waters. Leaf production is basically sold in peri-urban areas. Yield under lowland conditions are estimated at 2.5 tonnes of chips/ha.

Major constraints to cassava production

Major constraints in Guinea are wandering animals, labor shortage, disease and pest incidence, storage, inadequate supply of improved varieties.

Damage caused by animals ranging free is the major constraint mentioned by 40% of cassava producers interviewed. This forces farmers who did not fence their plots off to harvest as soon as animals are let loose (early November).

Extending areas under cassava cultivation may entail labor problems especially for fencing, preparation of mounds and ridges, weeding, and peeling of cassava.

The major pests causing extensive damage to cassava in Guinea are the African cassava mosaic virus, termites, locusts, mealybugs, storage insects, and green mites.

Almost 4/5 of cassava cultivated are local varieties which are low yielding due to global infection by the cassava mosaic virus and high susceptibility to attacks from mealybugs and green mites.

Research on cassava in Guinea

The institutional environment is conducive to the development of cassava cultivation and processing. Promotion activities are conducted by the Agricultural Research Institute (IRAG).

IRAG has regional research centers based in the four natural regions of the country each with a research mandate based on the major crops grown in that area.

Research on maize grown throughout the country is spearheaded by the Foulaya Agricultural Research Center (CRAF) which has scientists in other research centers who are responsible for monitoring cassava research activities conducted in their agroecological zone.

Initially, cassava research was the responsibility of the Tuber Crop Department. However, after the restructuring of IRAG in 1995, the cassava, yam and potato programs were created and supervised by program leaders, research assistants, and technicians.

Activities are conducted on-station, in trial sites, and on-farm on the basis of a design developed to that effect.

National strategies aim at developing national programs in collaboration with partners in development (agricultural projects, NGOs, farmer groups, etc.). This approach is achieved through regional or central advisory committees.

A medium-term plan (MTP) has been developed and includes research priorities for 1999–2002.

Production of planting material

There is no standard model for the production of cassava planting material. However, some varieties were identified and evaluated on-farm by breeding programs in collaboration with NGOs, a national Rural Promotion and Agricultural Extension Department (SNPRV), development projects, and some international institutions (IITA/GTZ).

Results obtained from on-farm trials were used to recommend some varieties for dissemination at farmers' level through NGOs and development projects with the support of extension services.

The major constraint to this approach is the non availability of improved planting material which is not always available in sufficient quantities during the planting period because of deterioration during transportation.

Several cassava clones were disseminated between 1990–1999. These include: TMS–30572, TMS–30555, TMS–30337, TMS–4(2)1425, TMS–30395, TMS–60142, TMS–91934, and TMS–73397. However, constraints with these varieties lie in the long duration period (12 months) compared to local varieties (7 months) and in the poor quality of the 'toh' they produce.

The cassava program pursued its breeding work with the support of IITA through several projects (RRPMC, OFDA, ICT, OFAR, IITA/GTZ, etc.) to develop varieties meeting the needs of Guinean farmers. Some varieties ready for dissemination are currently being multiplied on-station. They include: 92 B/0033, Tokoumbo, 90/0258, TME 1, TME 225, 91/0730, Alile locale, LAPAI, and 80/40.

The giant cassava

Within the cassava on-farm research activities, the Touguikhouré village in Kindia received from the Foulaya Agricultural Center, three improved varieties: F-98/9, F-98/4, and Faranah which were tested under farmers' conditions. The results obtained were simply miraculous because villagers reported that it was the first time that 2.20 m-long tubers were seen in the village. Future research will confirm wheather this is a natural characteristic or a varietal trait that could be optimised.

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Root and tuber crops in Chad

M.K. Laomaïkein

Chad stretches over 1 284 000 km^2 in the transition area between the Sahara and Sudan zones. It is a vast plain ranging from 8 to 13 latitude North and 4 au 24 longitude East.

From the north to the south, soils are gross mineral subarid, tropical ferrugineous, hydromorphic, and ferralitic Vertisoils. Soil characteristics are influenced by a hot and dry climate as well as the quality of deposits. Their fertility and productivity in terms of root and tuber crops increase depending on weather conditions and the agroecological situation of each region. The country is divided into three major agroecological zones following the natural conditions described above. The three zones are:

The arid Saharan zone: North of the country, covering more than half of the land area, the zone is characterised by low rainfall peaking at 200 mm in the south. The rainy season decreases in intensity as one moves towards high altitude zones. Limited agricultural activities are conducted in this area. Date trees and potato are grown in the oasis.

The Sahelian zone: Located between 200 mm and 700 mm rainfall limits is a typical livestock area. Agriculture is traditionally irrigated. Cassava is cultivated around Ouaddis and in the Sahel–Sudan zone.

The Sudan zone: Has a rainfall ranging from 750 mm to more than 1500 mm/year. This is the agricultural area where root and tuber crops are fast expanding. Cultivated areas are vast but underexploited. Out of 39 million hectares representing 30% of the national territory, only 792 000 hectares are under root and tuber crops. The region is subdivided in five agricultural provinces (Logone Occidental, Logone Oriental, Moyen Chari, Tandjilé, and Mayo-Kebbi). Root and tuber crops are predominantly grown in these regions.

The cultivation of root and tuber crops, especially cassava, yam, sweetpotato, etc., is expanding in the Sudan zone.

A staple food in the savanna area of Chad, yam (*Dioscorea* spp.) and cassava (*Manihot esculenta*) are like "intruders" in the Sudan savannas. They are crops of recent introduction, especially cassava which is present in almost all areas.

In the Sudan area, yams (*D. bulbifera, D. dumetorum,* and *D. sagilitifolia*) were introduced and adopted among local cereals as a hunger period crop but they have now become residual crops after the introduction of cotton.

Cassava has been widely spread since 1943, at the end of the 19th century. In the Sudan provinces, it was disseminated during the 19th century and is the staple food of the populations of the five provinces mentioned earlier. Unlike yam and other root and tuber crops, cassava dissemination in the Sudan agricultural area occurred at a later stage but very rapidly, and the process was closely related to the ecological and socioeconomic changes in the wake of the civil war.

For a long time, yam and tuber crops were given little importance in research activities conducted in Chad. In 1994 an agreement of cooperation was signed between IITA and DRTA (Directorate of Agricultural Research and Technology of the Ministry of Agriculture) which later became ITRAD (Chadian Institute of Agricultural Research for Development) for the launching of a research program on root and tuber crops. Neglect of these crops is accounted for, among other reasons, by the fact that these are inferior and less profitable plants compared to cash crops. However, their share in agricultural production and consumption in the Sudan zone is significant as it reaches the same level in coastal countries.

Through collaboration with IITA, cassava stakes and yam tissue culture plants were introduced in Chad and some seedlings adapted to the geo-agro-bioecological conditions of the Sudan zone were identified at the Deli agronomic station. New selections of cassava and yam clones were also made.

Results obtained after a few years with these new clones tested on-farm provided valuable practical knowledge on cassava cultivation. Farmers' opinion on improved varieties was collected. Clones are intermediate and long duration types which can be consumed in several ways (fresh, boiled, fried, or processed). They are: Rabé or RT 94/D70; Madjira

or RT 94/D01, and other high yielding potential clones which must be processed before they are consumed (Toudjiel or RT 94/D023 and Djadjinda or RT 95/D056).

Status of cultivated areas and production

Data collected by the Office National du Développement Rural (ONDR-DSN, 1970–1999) show a global significant increase. Indeed, areas under cassava have increased 9–10 fold between the 1970s and early 1990s. A rapid growth rate was recorded after the civil war and from 1994, areas cultivated had reached 100 000 ha because of the severe drought which caused famine in the country. Statistics per district or province show the increase in areas in the various zones. Globally, increase in cultivated areas since the beginning of the 1990s was more important than that of areas under cereals in the Sudan zone. At the extreme southern part of the country, bordering the Central African Republic, where conflicts between cattle rearers and farmers are often raging, there is a slight decrease in cultivated areas. Moreover, decision makers place great focus and importance on root and tuber crops as these can be catalysts for food security and can generate income for smallholders and help to control poverty.

Areas under cassava cultivation have recorded a spectacular increase followed by yam in the Sudan zone. This is explained by the very fragile food security and misery created by the introduction of cotton. Root and tuber crop production is mostly used for domestic consumption.

Consumption

No investigation has been conducted on consumption aspects yet. However, roots and tubers are generally considered as subsistence crops which can provide food all year round. They contribute significantly in feeding agricultural households.

The analysis of food requirement projections until 2010 indicates that demand is higher than supply. Indeed, demand could even be higher with population increase recorded during the oil boom. The exacerbated food situation will definitely impact negatively on the agricultural policy.

Information collected at farmers level indicate that food security is the main target of farmers growing cassava, yam, and other root and tuber crops in the Sudan zone. Per capita consumption is 490 kg/year in rural areas and 230 kg in urban areas which indicate that root and tuber crops are the staple food for the majority of the population in those areas and urban households spend 35% of their income to purchase such commodities.

These crops are consumed in various forms depending on the area. The major modes of consumption recorded in the various geographical production zones are:

- fresh tubers, raw, boiled, fried or roasted in hot ashes
- cassava paste 'mourou gali' obtained from fermented flour and porridge used for weaning infants
- cookies or 'chikouangue' (beu or goudjikanga)

Yam: stewed, boiled, or fried

Sweetpotato: raw, boiled, fried, ash roasted, stewed

Potato: fried, boiled, stewed

Cocoyam: 'Coleus dazo' and others are consumed in the same form as other crops.

Recently, with the support of IITA, grinding and peeling machines as well as a range of new cassava-based products (and processing techniques) were introduced, hence the appearance of new products in the diet of populations and in markets. These are: gari, tapioca, starch, fermented and non fermented flour for making cookies, 'kossei', and other traditional meals.

Yam and cassava are for domestic consumption and are also sold in the surrounding markets and urban centers. They therefore become food crops as well as income-generating products because income from their sale can be used to purchase agricultural equipment.

In peri-urban areas, cassava is cultivated for commercial purposes and yam is largely grown to supply urban markets. The major growing centers are all located by the border with Cameroon and the Central African Republic around the Logone Oriental and Moyen Chari provinces. At the domestic level, cassava and yam are sold in the major cities such as Moundou and Sarh.

In the Sudan zone, major marketing centers are Koumra and Moïssala but root and tubers are not the main goods traded.

Production systems and major constraints

The development of root and tuber crops in southern Chad goes along with cotton growing and the cultivation of other food crops. Apart from cotton, the production system in the Sudan zone is based on roots, tubers, and cereals. In order of importance, cassava comes first followed by yam.

According to producers, the improvement of transportation and marketing conditions would go a long way to make root and tuber crops (cassava and yam) to compete with cotton as they contribute to food security and generate income for some families as other crops such as cereals and oilseed crops.

Cassava and yam are often intercropped with cotton. The low level of profitability of cotton growing is such that farmers are becoming less interested in it. Diversification noted in the area is another indication of such lack of interest. Farmers now request improved high yielding cassava, yam, sweetpotato and potato planting material.

There are very few food crops with as little yield fluctuation as cassava. The enthusiasm shown by farmers in the five southern provinces is due to this crop's excellent adaptation capacity to climatic changes. It grows on hardly fertile soils and yet produces significant yields. Moreover, labor is minimal and cassava does not require bird watching as in cereal crops. Propagation is through cuttings and is less dependent on seasonal fluctuations. Cassava can be stored underground and used anytime it is required. Yam cultivation requires fertile soils, which is a limiting factor to the extension of this crop in production systems. In some regions, cassava is cultivated mainly for commercial purposes.

There are many major constraints to the production of root and tuber crops in the Sudan zone. These are, among others, related to the cropping system because plots are small-sized and scattered in the bush far from villages, a situation which can cause serious conflicts between cattle rearers and farmers.

Root and tuber crops are predominantly grown and processed by women. Marketing channels are often not well organised.

In the densely populated Sudan zone, soils are poor due to several reasons: the high rate of population increase, lack of fertilizers, non restitution of crop residues into the soil, hazardous practices (bush fires, trampling by cattle), and inadequate regeneration of the fertility of the soils which are rarely supplied with organic nutrients.

Rainfall distribution in production areas is erratic and the country has experienced in the last year a drastic decline in rainfall.

Constraints relating to the cropping systems are:

- Low yield of local varieties (2–5 t/ha)
- Inadequacy of technological packages and use of rudimentary cultural techniques
- Lack of improved high yielding varieties
- Lack of adequate conservation of genetic resources

Other specific constraints include:

- Lack of planting material (seeds)
- Traditional utilization of harvest products
- Poor storage of processed products

Some socioeconomic constraints also affect the development of these crops. These include:

- Lack of agricultural credit (to purchase processing equipment)
- Inadequate storage and conservation facilities (leading to postharvest losses and poor marketing)
- Lack of means of transportation (carts) for the small processing equipment (scrapper-grinders)

These constraints are considered as major obstacles to the socioeconomic development of farmers because otherwise they could have created income-generating activities.

Root and tuber crops (cassava, yam, etc.) are the predominant components of agricultural production systems in the Sudan zone.

Approaches in plant material production

In general, planting starts in March–May for yam and June–September for cassava. However, most cassava planting is done in August. Because of poor knowledge of agricultural practices, farmers plant large yam tubers and whole cassava roots. Yet, IITA has recommended that the best size for a cassava cutting is 15–25 cm and 300–500 g for a yam tuber fragment with some "eyes" already germinated or not.

The lack of planting material, damage often caused by termites, and the lack of experience in planting techniques are the major constraints to the production of cassava planting material. So far, the development of new, improved yam and cassava clones adapted to the agroecological conditions of the country is conducted by IITA. However, the strong demand from farmers has led to this activity being conducted at the Békao and Déli farms and the planting material produced is distributed to farmers through the WASDU and IITA-funded project.

Thanks to the support provided by SECADEV (a Catholic relief project for development) and World Vision International, the four IITA-bred clones selected by farmers were disseminated on-farm. These NGOs and PCVZS (cotton and food crop project in the savannah zone) have strongly supported the root and tuber crop breeding program.

Clones (Rabé or RT 94/D70 and Madjira or RT 94/D01) are medium- and late-maturing varieties used differently (fresh, boiled, fried, and processed) while Toudjiel or RT 94/D023 and Djadjinda or RT 95/D056 (bitter varieties) must necessarily be processed. These improved varieties are disseminated after three years of multilocational trials. They are largely cultivated and adapted by farmers who request large quantities of healthy improved cultivars.

The promotion of planting material

Roots and tubers are important food crops in Chad although they rank second as a staple food. Unlike cereals and cash crops, root and tuber crops have not been the main focus of research. Cultural practices are still traditional and the majority of farmers plant yam in holes. The size of planting material is 0.5–1 kg which is why few yams are planted. Whole cassava tubers are equally planted. This practice leads to poor plant recovery, rotting, and/or drying up of seedlings leading to poor yields.

Productivity of root and tuber crops is low because farmers, both men and women, are not aware of improved production technologies, do not have access to improved planting material and plant low yielding local cultivars. Yet it is possible to increase production up to exporting surpluses. This can be achieved through the training of farmers and the staff of public, private, formal, and informal institutions on the use of improved technological packages for the production of planting material. The introduction of new improved varieties has been of great interest to farmers but they are difficult to produce in large quantities. The planting material currently available is produced and multiplied by ITRAD and distributed freely to farmers through its program and through NGOs (SECADEV and World Vision International).

Other important aspects related to root and tuber crops in Chad

Women play a central role in the production and processing of root and tuber plants. Postharvest operations are often a drudgery and incomes are insignificant. This is an indication of considerable potential for the promotion of women who are often negleted. Promoting postharvest activities can generate market opportunities for farmers and contribute to improving their living conditions.

Despite its importance in the diet of millions of inhabitants in Chad, the new technical and socioeconomic production aspects are yet to be fully integrated. Several farmers show interest in root and tuber crops, which points to the need to develop adequate planting materials and improved cultivars. Potato is also gaining grounds in some areas, hence the need to develop and introduce high yielding varieties.

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Cassava production in Togo

K.A. Somana, K.M. Sedzro, and K.E. Akakpo

A West African country, Togo shares borders with Burkina Faso in the north, the Republic of Benin in the east, Ghana in the west, and the Gulf of Guinea in the south. It stretches over 56 600 km² with a population estimated at 4.5 million inhabitants in 1999. The climate is the tropical Sudan type in the north and Guinean type in the south. The country is zoned into five economic regions.

The Savannah region: This region is located at the extreme Northern part between 0° and 1′ longitude east and 10° and 11′ latitude north. It covers a total area of 8533 km² or 15% of the total land area. It is within the contrasted climatic zone characterized by an arid dry season which is not favorable to agricultural activities.

Plains and plateaux have relatively poor and degraded soils with a savanna vegetation. The natural environment has been severely degraded by human activities. Soils are overexploited and the plant cover is degraded through overgrazing or the cutting of firewood.

Agriculture is basically subsistence and is a major activity for 96% of the population in that region.

The major food crops are sorghum, millet, beans, maize, Bambara groundnut, and yam. Cassava is the least cultivated crop in this region and is not a component of the cropping system as it is grown basically around human settlements. Three-year rotations are practised with cotton–cereals–cereals–cotton. Average plot size is less than two hectares for an average 14 persons/household.

The Kara region: It spreads between parallels 9° and 10°10′ latitude north and meridians 0° 15′and 1° 30′ longitude east. It stretches over 11 629 km², or 20.50% of the total area. The Sudan–Guinea climate includes a rainy season followed by a long dry season crop. Major crops grown are sorghum, millet, rice, fonio, yam, groundnut, and cowpea. Cassava is grown in the southern and western parts, often intercropped with maize, cowpea, or yam.

The Central region: This region lies between parallels 8° and 9° 15′ latitude north and meridians 0° 15′ and 1°35′ longitude east. It has a subhumid tropical climate with two distinct seasons: a rainy season from April to October and a dry season from November to March. Average temperatures vary between 20 and 32°C. Climatic conditions are globally adequate for agricultural activities. Soils are suitable for several crops both food and industrial. Agriculture is the main activity in the region. Crops grown include sorghum, millet, maize, yam, cassava, and groundnut. Root

and tuber crops and more specifically yam and cassava are important components in plant production.

The following intercropping is practised: cassava–cowpea, cassava–maize, cassava–yam.

The Plateaux region: It is bordered in the north by the Central region and in the south by the Maritime region. The population is predominantly agricultural (about 80%) with a large percentage of young people. Agriculture is the major catalyst for industrial, artisan, and commercial activities carried out in the region.

The terrain is relatively mountainous with limited mountains (17% of the total area) peaking to only 986 m (the Agou peak).

With a contrasted terrain, the Plateaux region has a climate ranging from the sub-equatorial midaltitude climate (cold) to the equatorial and humid tropical climate (the Precambrian peneplain climate). It stretches over 16 800 km^2 (29% of the national land area).

The Plateaux region is one of most humid areas in the country with even rainfall distribution all year round under normal conditions, that is, 7–8 months rainy season with 1000–1800 mm/year and 4–5 months of dry season. The region has vast stretches of arable land although unevenly distributed (12450 km^2 of arable areas). The major food crops are, in order of importance: maize, cassava, sorghum, yam, rice, and cowpea. This region ranks 2nd in terms of cassava production.

The Maritime region: It covers the extreme south of the country between 1° 50′ longitude east and 6° and 6° 50′ latitude north. It stretches over 6395 km^2 or 11.2% of the total country area being thus the smallest of the five economic regions of the country. The rural population is estimated at 30% while the urban population is 62.7% of the total national population.

The Maritime region has a Guinea-equatorial climate with four seasons: two rainy seasons and two dry seasons. However, rainfall distribution is not uniform in all prefectures as it fluctuates, from north to south, between 1200 mm and 800 mm and from 90 to 60 days.

This region is affected by rapid deforestation due to the collection of firewood and the making of charcoal. The area is gradually turning into a savanna zone.

Food crops grown are maize, cassava, yam, rice, beans, and groundnut. The southeastern part (43% of the Maritime region) is densely populated with high agricultural densities and shortened fallow periods. Cassava cultivation is highly developed and accounts for over 50% of total production. Intercropping is always practised while sole cropping is hardly developed. Crop rotations often include maize and cassava.

Production trends, copping systems and major constraints

Production

Cassava is one of the main food crops in Togo. It ranks first both in annual tonnage and areas cultivated. National annual production fluctuates between 350 000 and 600 000 tonnes. Cassava is grown in all the regions but is predominant in the Maritime and Plateaux regions where 40–50% and 20–30% of annual production are obtained, respectively. The Central region comes third while the Kara region contributes less than 10%. Cassava is not a common crop in the savannah region which produces less than 0.5% of the total national output. Gari is the main processed product. According to estimates, over 60% of the national annual production is processed into gari (Table 1) while the rest is consumed as fresh cassava. Processing is still artisan and basically done by women.

Cropping systems

In Togo, cassava is often intercropped with cereals (maize, sorghum, millet) other root and tuber crops (yam and sweetpotato) or with leguminous crops (cowpeas and groundnut). Depending on the production density, cassava is either cultivated as a sole crop or as a main or secondary crop. Thus, 84% of the total production in 1990 was obtained with the secondary crop as against 10% with the main crop and 6% with the sole crop. Cassava cultivation is sedentary, which is the major cause of soil degradation in the major production areas.

The major constraints to cassava production in Togo are:

- use of local, traditional, infected, or low yielding varieties
- disease and pest incidence which limits production
- difficult access to arable lands
- declining soil fertility leading to soil depletion
- lack of good planting material
- artisan, low productivity, and strenuous processing techniques
- poor marketing which constraints promotion of the production

Background of cassava research in Togo

Agricultural research started in Togo after 1940 with the setting up of branches of French research institutes. After independence in 1960, collaboration with such institutes continued through new institutions like IRAT

(Tropical Agricultural Research Institute) in 1961 which was the first to work on maize with the introduction of higher yielding varieties. Difficulties encountered in getting adequate supply for the Ganavé plant (based in the Maritime region, Préfecture des Lacs) led to the creation of the first Togolese Research Structure on maize in 1975. In 1997 it became the National Tuber Plant Institute (INPT) responsible for the promotion of cassava research and processing. The Institute has developed and introduced cassava varieties with good starch content for making gari and chips. It also works on other root and tuber crops such as yam, sweetpotato, and potato. The Institute was working in collaboration with the Directorate of Agricultural Research (DRA) in charge of food crops other than root and tubers. DRA was merged with INPT and become National Food Crops Institute (INCV) which became one of the seven institutes making up the new National Directorate.

INPT like INCV, in collaboration with IITA, have all worked on several aspects or areas for the development of cassava cultivation in Togo. Their work focused on:

- varietal improvement
- processing
- agronomy (dissemination of high yielding varieties, restitution of cassava fertilizing elements, etc.)
- crop protection, etc.

The National Food Crops Institute (INCV) has also collaborated with the French institute ORSTOM (now called IRD) in the following areas:

- Crop protection: study of cassava soft and dry rots, bacteriology, and cassava sanitation through tissue culture
- Agronomy: study of cassava planting date, improvement of yields on-farm and on-station, fertilization, and adaptability
- Agroeconomics/sociology: cassava processing, timing of gari production, and study of the evolution of market prices

The creation of ITRA in 1998 went along with the setting up of a National Cassava Research Program which continues research activities started by INCV and covers the areas mentioned above.

These activities contribute to the selection of high yielding varieties suitable for several agroecological production zones with eating qualities almost similar to those of local varieties. Most of the research is still continuing and integrates dissemination to farmers thanks to support provided by WASDU. Moreover, work on the impact of cassava-based cropping systems on soil fertility are conducted at the Davié station. With the assistance of IITA, some significant advances have also been obtained in the use of cassava for bread making.

Production of planting material in Togo

Traditional cassava growers obtain planting material in three ways:

- from the previous year's harvest
- from neighbors
- from markets (this new source of supply is developing)

A few modern growers get quality planting material from research or extension services. These producers informally disseminate the material in other farmers' plots. There are no structures in charge of producing and disseminating planting material. Multiplication and distribution tests initiated with the WASDU projects are the first attempts to organize production and marketing of planting material in Togo.

Approach for the promotion of planting material in Togo

Increase in cassava production requires the use of quality planting material. The availability and dissemination of high yielding varieties in all production areas are equally important factors. Therefore, the multiplication of planting material of promising varieties should be given priority. The material selected on-station must be multiplied and distributed to farmers producing planting material who will be trained in multiplication techniques including rapid multiplication. This will lead to the availability of planting material in sufficient quantity which will be distributed to farmers as a substitute for their old and low yielding varieties.

Consumption

The major part of cassava production (some 60%) is processed into gari.

In 1982, the significant increase in cultivated areas within production areas (Table 2) was not matched with yield increase (Figure 2). Indeed, the lowest yields were recorded in that year which is due, among other reasons, to the following:

- erratic rainfall
- pest outbreaks

Production varied a lot with positive or negative peaks from one year to another in the major production areas. It should be noted however that production levels have kept

Table 1. Estimation of the population, production per capita, and cassava consumption in Togo.

Year	Total population (thousand inhabitants)	Annual production/ inhabitants (kg) *	Annual consumption of processed products/ per capita (kg)	Total annual consumption of cassava processed products (tonnes)
1990	3 492	170	33.9	118 378.8
1991	3 595	142	33.9	121 870.5
1992	3 701	122	33.9	125 463.9
1993	3 808	103	33.9	129 091.2
1994	3 928	135	33.9	133 159.2
1995	4 052	149	33.9	137 362.8
1996	4 179	131	33.9	141 668.1
1997	4 269	139	33.9	144 719.1
1998	4 406	131	33.9	149 363.4
1999	4 516	154	33.9	159 092.4

Source: Department of General Statistics; * DESA.

Table 2. Evolution of areas (ha), yields (t/ha), and production (t) of cassava in the various economic regions of Togo over the last 20 years.

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Maritime	Area	49 600	43 220	38 090	29 556	54 654	62 192	42 221	44 983	50 122	60 495
	Yield	8.615	7.811	9.566	8.597	9.603	6.449	7.725	8.992	7.923	6.385
	Production	351 926	295 323	212 696	172 207	312 254	341 168	219 646	294 195	235 333	279 969
Plateaux	Area	12 400	12 880	10 023	17 668	15 996	13 652	25 986	20 090	19 573	28 446
	Yield	7.824	8.311	7.399	9.822	7.515	7.478	8.529	12.965	10.756	9.918
	Production	101 986	107 502	78 373	145 197	111 834	99 957	190 721	146 348	169 248	223 089
Centrale	Area	10 500	6250	9242	5705	13 769	12 156	14 102	15 156	12 540	9743
	Yield	12.344	12.456	12.019	6.389	6.442	11.69	9.039	12.175	11.075	13.406
	Production	119 004	71 176	106 447	34 989	58 502	118 680	96 266	87 411	117 646	118 428
Kara	Area	4600	3230	7966	4221	5984	13 780	11 964	12 644	9860	15 073
	Yield	8.549	14.104	12.836	9.0	8.285	4.689	6.995	8.751	7.318	10.42
	Production	19 951	36 527	54 578	37 982	48 937	42 407	39 639	65 013	54 617	71 975
Savanes	Area	–	–	–	–	–	–	2095	3043	1098	777
	Yield	–	–	–	–	–	–	2.238	7.288	4.011	0.689
	Production	–	–	–	–	–	–	2044	2823	2537	535
Togo	Area	77 100	65 560	65 310	56 800	90 403	101 780	96 350	95 616	93 193	114 534
	Yield	8.915	9.686	9.438	9.094	8.101	8.384	8.308	8.256	9.737	10.381
	Production	592 867	510 528	452 093	389 448	531 526	602 212	548 316	595 790	579 381	693 998

Source: DESA (Department of Surveys and Agricultural Statistics).

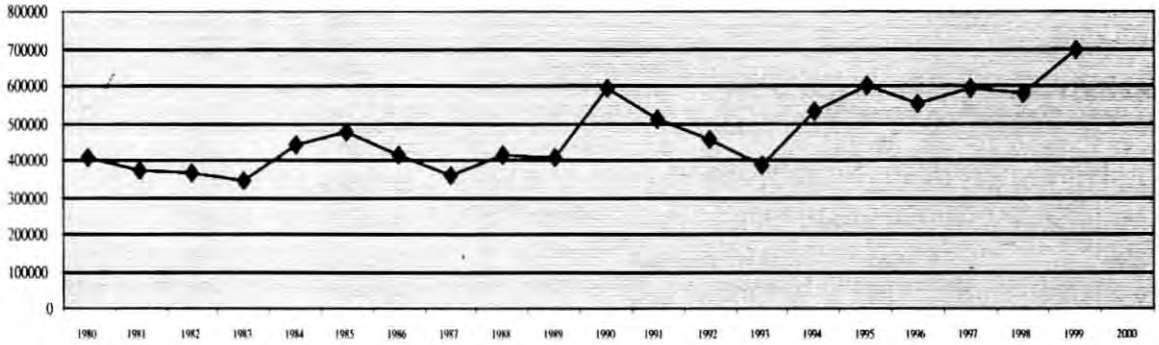

Figure 1. Trends in cassava production in Togo in the past 20 years.

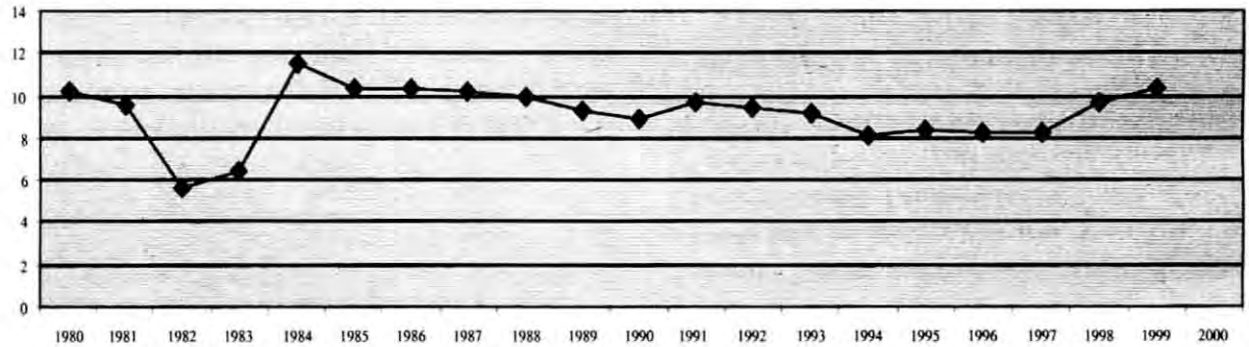

Figure 2. Trends in cassava yield (1980–2000).

on increasing in the Kara region due to renewed interest by farmers.

Over the last years, production variation has been low with a relative increase and the highest level was recorded in 1999 (Figure 1). Apart from the threefold increase in cultivated areas in 1982, which was not followed by an increase in production, the production curve follows the same trend as that of cropped areas.

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Yam cultivation in Guinea

S. Kourouma

The Republic of Guinea is a West African country with a total area of 245 857 km^2. It is bordered by the Atlantic ocean in the south west, by Senegal and Mali in the north, by Guinea Bissau in the north west, in the south by Liberia and Sierra Leone and in the east by Côte d'Ivoire. The whole country stretches over the humid topical zone where the 10th paraliel of the northern hemisphere meets the 10th meridian longitude West. Guinea is divided in 4 major natural regions: Upper Guinea, Middle Guinea, Lower Guinea, and the Forest region.

Yam is grown throughout the country with a predominance in the upper region which contributes ¾ of national production. Yam is grown in all the prefectures of this region: Kankan, Kouroussa, Kérouané, Siguiri, Dabola, Mandiana Dinguiraye, and Faranah.

Background of yam production and research in Guinea

Yam has been grown in Guinea for centuries with a predominance of *Dioscorea rotundata* and a limited number of *D. alata*.

Reports from the elders mentioned that yam cultivation started well before the advent of the Wassoulou Empire (1840–1898). Apparently, varieties currently cultivated were domesticated from wild species of *D. abissinica* called "Djambi" in the Malinke dialect and of *D. prahencilis* "kara" and the corresponding species of Sofèrè is Djanbi-Sofèrè which is an Abissinica type and also of Koubgè Djambi Koubgè, etc.

Yam research in Guinea started in 1988 at the Bordo Kankan Agricultural Research Center with the inventory and the collection of 13 local varieties in the Kankan sub-prefectures with assistance from the French Cooperation Fund (FAC).

In 1993, a collection of 9 wild varieties of yam was made in collaboration with the Yam Research Coordination Unit (CIRAD, IRSDA, IITA). In the same year, local and exotic varieties were assessed for their agronomic traits.

Since 1994, introductions and evaluations of *D. rotundata* improved varieties from IITA, Ibadan (Nigeria) were conducted at the Bordo Kankan Station. In 1997, IRAG and IITA compiled a collection of 13 wild species and 5 cultivated varieties of *D. rotundata* in all the regions.

Some *D. rotundata* species were afterwards characterized for their morphological traits. This work will be followed by enzymatic characterization.

Evolution of areas and production

Statistics departments do not have data available on the evolution of areas. However, in 1996 and 1998, cultivated areas were, respectively, 35 000 ha and 47 500 ha (National Agricultural Statistics Department).

Yam production gives the following trends:

- 1991: 102 000 tonnes produced by the Rural development Project in Upper Guinea (PDRHG)
- 1995: 150 000 tonnes (PDRHG)
- 1997: 400 000 tonnes (National Agricultural Statistics Department)

Total national production was estimated at 570 000 tonnes (Lettre de politique de développement agricole 2 L.P.D.A 2)

Yam-based production systems

Yam in Guinea is basically cultivated manually with *D. rotundata* species and a limited number of *D. alata* and *D. esculenta*.

It is grown in a four-year rotation system following a natural fallow period of ten years or even more.

Crop sequence in this respect is as follows: yam–rice–yam-intercropping (maize, cassava, okra, sesame, etc.). Yam comes as the first crop in the cropping season and is also grown after three years of rotation.

In the first case, it is intercropped, and sole cropped in the second case.

Yam is grown on mounds generally made at the end of the rainy season (September) when the soils are humid and at the beginning of the rainy season (in May).

Planting density is highly variable, ranging between 5000 and 8000 mounds per hectare; this variation depends on farmer practices and on soil types as farmers consider mound size as a yield factor.

Planting occurs in March and April on the mounds made at the end of the rainy season (September), and in May and June on the mounds made right after he first rains. The weight of seed yams varies between 300 and 500 g. Crop sanitation is through weed control, no fertilizer application and no stalking.

Yam mosaic and stunting have been reported on *D. rotundata* and *D. alata* although with low incidence rates. *Criocerus livida* and *Aspidiolla hartii* attacks were also reported by farmers.

Harvesting is manual using either a hoe or small implements. The first harvest is after six months of plant development (in August) while the second is in November and December.

Major constraints

Erosion of genetic resources

The fact that yam is becoming a cash crop at farmer level has impacted on the mode of traditional production. A long time ago, farmers used to include in their collection a wide range of varieties. However, today, yam seed trade includes a narrow range of varieties with a predominance of early maturing, drought and disease tolerance, and high yielding cultivars, which translates into high genetic erosion.

Poor knowledge of the planting material

There is a whole range of varieties inadequately registered, hence, a confusion in the local names used.

Lack of planting material

This is the major constraint as it does not increase cultivated areas and impedes farmers' activities. Producers have to use ¼ of their production as seeds, a practice which reduces their incomes and increases production costs.

Declining soil fertility

This is another important constraint and entails shifting cultivation. Massive migrations of farmers seeking more productive land are recorded from the north to the southern areas in Upper Guinea. As yam is a time-consuming crop which comes first and third in the rotation process, farmers are sometimes forced to abandon their plots for a fallow period of at least ten years.

Postharvest losses

Yam is a perishable product and generally when the storage period exceeds four months, losses are high due to pest and disease attacks and to the breaking of the dormancy.

Lack of credit for farmers

Yam production requires some initial investment as farmers need seeds and adequate labor for large-scale production.

Planting material production approach and models

Planting material is obtained using various approaches:

- Second harvest of tubers: After the first harvest which occurs after five to six months, tubers from the second crop are used as planting material for the next season.
- Under a sole cropping situation, that is after 8–9 months, small tubers weighing 300–500 g are used directly as planting material.
- Whole tubers are segmented and covered with plant debris to trigger germination. These germinated fragments are used as planting material.

Constraints to this model are:

- reduced levels of production
- inadequate levels of planting material produced
- loss of planting material during germination

Yam varieties already released or in the process of being released

From 1997 to 1998, the yam program of the Bordo Kankan Research Station (CRAB) has introduced on-farm improved varieties from IITA Ibadan (Nigeria) and Ghana which gave promising results on-station. Farmers from Djamanda, Tinti-Oulen, and Sana were distributed improved varieties of the TDr series (TDr 131, TDr 745, and TDr 608).

During the same year (1997), a Belgian NGO called ACT (Agence de Coopération Technique) based in the Lower Guinea area (Kindia) purchased local varieties (Soférè, Kougbè) for yam farmers in the Upper Guinea region and these varieties were tested and disseminated in the Kindia-Mamou-Télémilé triangle mainly in the villages of Bangouya, Madina, and Kollet which is a conducive area for yam cultivation.

From 1998 to 1999, with the collaboration of IRAG/IITA/GTZ within the WASDU Project, the Bordo Kankan Research Programme introduced improved varieties TDr 131, TDr 179, and TDr 608 in other localities such as Sabadou-Baranama, Missamana, Kalan-Kalan, and Gbangban.

From 1999 to 2000, the same improved varieties were introduced in the localities of Tinti-Oulen, Tinti-Oulenkorö, Sirassoledou, and Djénè-Madina.

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The Private Seed Sector

The Yogo agricultural farm in Burkina Faso

O.J. Yogo

In the wake of the gradual withdrawal of the state from the seeds and agricultural inputs sector, the involvement of the private sector was much required. Some 300 producers are active in the seed sector in Burkina Faso. They work in cooperatives, individually or in collaboration with nongovernmental organisations.

Research conducted by our company includes varietal selection and foundation seeds production while the Plant Production Division is responsible for the control and the certification of seeds.

The Yogo agricultural farm is a seed production unit set up five years ago (1995–1996) which currently produces certified seeds on its own plots. Production activities are supervised and controlled by the Plant Production Division (DPV) through the National Seed Department.

The farm currently employs 8 full-time workers and uses casual labor as required. During the 2001/2002 season, we have developed over 40 hectares to produce seeds of the following crops: maize, sesame, soybean, cowpea, and groundnut.

Quantities produced were: maize (25 t), sesame (2 t), soybean (1 t), cowpea (1 t), groundnut (1 t).

We intend, starting from next season, to produce seeds of vegetable crops and probably market some agricultural

inputs. In that respect, we will be developing some 100 hectares as early as the 2001/2002 cropping season.

Our company will also establish business linkages with other African and even European seed farms.

Our short-term objective is to achieve an integration between agriculture and livestock with a view to reducing production costs and gradually move towards biological production through the use of organic manure.

The major constraints to the emergence of a viable seed sector include:

- the low rate of seed users (less than 10%)
- difficult access to credit
- poor organisation of the sector
- lack of professionalism from stakeholders

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TROPICASEM, Cameroon

Tropicasem Cameroon is a subsidiary of the Technisem-Tropicasem Group, which is the only international company specialising in the production and marketing of vegetable seeds for warm regions. Like its counterpart in Mali, Côte d'Ivoire, Bénin, Nigeria, The Gambia, and Burkina Faso, Tropicasem Cameroon is acting as a commercial subsidiary for Cameroon. It employs about 50 workers, all Cameroonians, acting as agronomists, agricultural technicians, marketing, and commercial experts.

Our units in Cameroon and Côte d'Ivoire have each a research station where varietal selection trials are conducted on a daily basis and results tested on-farm. Tropicasem Cameroon collaborates with re-sellers based in agricultural areas. Tropicasem also collaborates with pilot vegetable growers who contribute in disseminating new varieties adapted to tropical conditions as well as to market needs. Promising varieties are promoted through field days. Like any commercial establishment, Tropicasem faces competition and fiscal problems. Our main aim is to meet the needs of farmers through a regular supply of high quality seeds.

Tropicasem is a member of ACOSAC (The Central African Seed Trade Association) and even a member of AFSTA. TROPICASEM, B.P. 5655 Douala. Tel: +237 475241; Fax: +237 475246; E-mail: acosac@camnet.cm

True potato seed (TPS)

B. Zaden

TPS, a revolutionary product to grow potatoes from botanical seeds, has the following advantages as compared to the conventional method (planting tubers):

- seed is free from diseases (virus) and has good field tolerance to late blight (Phytophthora);
- no logistic problems;
- costs saving.

TPS can either be directly sown, transplanted from a seed bed, or planted as small seedling-tubers after the dormancy has been broken. Generally, 100 g of seed is used for one hectare and approximately 750 kg/ha for mini tubers.

With regard to onions, Bejo Zaden is introducing the following new varieties: (a) Lucifer F1, an early high productive Red Bombay hybrid, (b) Flare F1, a late and long storable Red Bombay hybrid. Samples are available on request by contacting:

Bejo Zaden, PO Box 50, 1749 ZH Warmenhuizen, The Netherlands. Fax: +31 226 393504; E-mail: c.keppel@bejo.nl

Courses, Meetings, Publications

Courses, Workshops

International Course on Plant Breeding and Seed and Technology. Duration 10 weeks, May–July 2002, International Agricultural Center (IAC), Wageningen University, Wageningen, The Netherlands. The overall objective is to provide participants with the knowledge and skills to identify, plan, and implement plant breeding and seed programs. The course program is built around a number of modules: (a) Introduction to molecular genetics and information technology, (b) Biotechnology and biosafety, (c) Genetic distinction and molecular markers, (d) Seed enterprise development, (e)

Master class on seed technology, (f) Breeding for resistance, (g) Management of seed programs, (h) Integrated quality management, (i) Plant variety protection, (j) Socioeconomic perspectives of plant breeding and seed production, (k) Genetic conservation and agro-biodiversity, (l) Selection of crop varieties, (m) Seed technology II: agronomy, storage, and marketing. Fellowships are available for nationals of developing countries from the Netherlands Fellowship Programme (NFP). For the participation in individual modules no NFP fellowships are available. Applicants for a NFP fellowship should submit their application to the Netherlands Diplomatic Representative (Embassy/Consulate) in their home country. Application deadline is January 1, 2002.

Information: International Agricultural Center (IAC), PO Box 88, 6700 AB Wageningen, The Netherlands. Tel: +31 317 490111; Fax: +31 317 418552; E-mail: training@iac.agro.nl

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Seventh International Workshop on Seeds, 12–16 May 2002, Salamanca, Spain. The meeting will provide a forum to highlight the advances of the past three years and to focus on the future of seed biology. The scientific program will be composed of invited plenary presentations, short oral presentations and posters on the following topics: Seed Development (Embryogenesis, Synthesis and accumulation of storage compounds, Hormonal regulation, Late maturation events), Seed Germination and Dormancy (Imbibition and early germination events, Biochemical and molecular basis of germination and dormancy, Hormonal regulation, Induction and breaking of dormancy, Modeling germination and dormancy), Desiccation and other Stress Tolerance and Conservation (Acquisition and loss of desiccation tolerance, Mechanisms of seed deterioration, longevity and viability, Germplasm preservation), Seed Ecology (Ecology of germination, Dispersal strategies, Seed survival and seed banks) and Seed Biotechnology (Seed quality improvement including priming and invigoration, Genetic modification, Seed technology including artificial seeds). The approximate fees for the workshop will be: ISSS members 300 USD; Non members 350 USD; Accompanying person 200 USD. Registration form available on line (www.geocities.com/workshop on_seeds/) by fax or e-mail from:

Congress Secretariat, Halcón Viajes Congresos, Serranos 35, 37008 Salamanca, Spain. Tel: +34 923210728; Fax: +34 923210749; E-mail: congresos@air-europa.com

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Report of the workshop 'Developpement de la filière semencière au Sahel dans une perpective d'intégration régional: Quel rôle pour le secteur privé'. The Institute du Sahel (INSAH), the research institution of CILSS (Comite Permanent Inter-Etats de Lutte contre la Secheresse au Sahel), organized a 'seed workshop' in Dakar, Senegal from 12–14 March 2001. INSAH had commissioned seed sector studies in a number of member countries (Burkina Faso, Cape Verde, Gambia, Guinea Bissau, Mali, Mauritania, Niger, Senegal and Chad) and the objectives of the workshop were: (a) to discuss these reports, (b) to look at regional integration and harmonization of the seed sector, and (c) at the role of the private sector could play in this regional integration. Seed sector studies (Mali, Niger, Burkina Faso, Gambia, Mauritania and Chad) and the recommendations of the workshop are available from:

Mariam Sow, Coordinatrice Securite Alimentaire, Programme Majeur Agrosoc, Institut du Sahel, BP 1530, Bamako, Mali; Tel: +223.220918; Fax: +223-233479; E-mail: msow@pria.insah.ml

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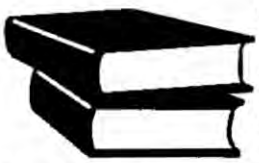
Publications, books



Guide Practique de Production de Semences de Riz par les Paysans by A.M. Beye et R.G. Guei. 2000. Bouake, ADRAO; Man, BAD-Ouest; et Abidjan, ANADER. Contact ADRAO/WARDA, 01 B.P. 2551, Bouake, Cote d'Ivoire; Tel: +225-31 634514; Fax: +255-31634714; E-mail: warda@cgiar.org

L'Autoproduction améliorée; Une nouvelle Approche de Production de Semences Communautaire de Riz by Amadou Moustapha Beye. 2000. Bouake, ADRAO; Man, BAD-Ouest; et Abidjan, ANADER. Contact: ADRAO/WARDA, 01 B.P. 2551, Bouake, Cote d'Ivoire. Tel: +225 31 634514; Fax: +255 31634714; E-mail: warda@cgiar.org

The World Cassava Economy, Facts, Trends and Outlook. FAO/IFAD, 2000. This publication provides the facts and figures and latest developments regarding cassava. ISBN 925104399x. Price: US$ 12. From: FAO Sales and Marketing Group, Viale delle Termi di Caracalla, 00100 Rome, Italy. Fax: +39 6 57053360; E-mail: publications-sales@fao.org

The June 2000 issue (No. 42) of the Biotechnology and Development Monitor is all about Farmers and Seed. Interesting to read. The Biotechnology and Development Monitor is available free of charge from: The University of Amsterdam, Department of Political Science, Oudezijds Achterburgwal 237, 1012 DL Amsterdan, The Netherlands. Fax: +31 20 5252086; E-mail: monitor@pscw.uva.nl

Policies for African seed enterprise development, Robert Tripp and David Rorhbach (2001), Food Policy 26 (2001) 147-161.

Seed System, Higher Productivity and Commercialization: Prospects for Sorghum and Millets in Tanzania. 1999. SADC/ICRISAT Sorghum and Millet Improvemnet Program, Bulawayo, Zimbabwe. Available (at postage costs) from ICRISAT, P.O. Box 776, Bulawayo, Zimbabwe. Fax: +263 983 8318; E-mail: icrisatzw@cgiar.org

Seed System for the New Millennium: An Action Plan for Tanzania. 1999. SADC/ICRISAT Sorghum and Millet Improvemnet Program, Bulawayo, Zimbabwe. Available (at postage costs) from ICRISAT, P.O. Box 776, Bulawayo, Zimbabwe. Fax: +263 983 8318; E-mail: icrisatzw@cgiar.org

Seed Health Testing Methods Reference Manual published by The International Seed Health Initiative for Vegetables (ISHI-Veg) on the FIS website. An inventory of existing test methods have been make and new ones developed. Based upon historical use, peer review and research in private and public institutions, methods for 21 host-pathogen combinations have been selected. The manual serves as a focal point and guide for the ISHI-Veg development of reference methods. The manual and the seed health testing methods are not static; they will be expanded and updated continuously. ISHI-Veg is an initiative of the vegetable seed industry in The Netherlands, France, United States, Israel and Japan, in close cooperation with the FIS Vegetable Seed Section. Further information: FIS Secretariat, Chemin du Reposoir 7, 1260 Nyon, Switzerland. Tel: +41 22 36544 20; Fax: +41 22 36544 21; E-mail: fis@worldseed.org; FIS website: http://www.worldseed.org

Public-private Interface and Information Flow in the Rice Seed System of Andhra Pradesh (India) by Suresh Pal, Robert Tripp and A. Janaiah (2000), Policy Paper 12, National Center for Agricultural Economics and Policy Research, New Delhi, India (ncap@iasri.delhi.nic.in). The commercial seed sector has been slow to develop in sub-Saharan Africa. The paper examines the major impediments and identifies areas in which seed policies can be strengthened. Seed enterprise development has been hampered by regulatory frameworks that favor parastatal enterprises and that inhibit commercial innovation. In addition, government and donor projects provide large amounts of free or subsidized seed that further discourages seed enterprise development. In addition to regulatory reform and the curtailment of many seed distribution projects, there are other policy changes that need to be implemented. National agricultural research institutes need to invest more resources in promoting their varieties and helping to stimulate commercial seed production. Greater emphasis is required on regional strategies for public plant breeding and private seed marketing. National policies need to strengthen input marketing capacity and infrastructure. Finally, donors, governments and NGOs should shift from trying to encourage village-level commercial seed production and instead strengthen farmers' capacity to assess new varieties and to be effective consumers of commercial inputs. (2001 Elsevier Science Ltd. All rights reserved).

Climate Change and Global Crop Productivity by K.R. Reddy and H.F. Hodges (2000), CABI Publishing, Wallingford, Oxon OX10 8DE, UK. Current and predicted worldwide climatic changes have raised concerns about potential crop yields and production systems. Such concerns include the ability to accommodate these uncertain effects in order to ensure an adequate food supply for an increasing population. This book is the first comprehensive examination of potential effects climate change will have on crop production systems. It also reviews the effects such systems have on climate change itself. There are individual chapters on the main cereal crops, soybean, cotton, vegetables, roots and tubers, as well as on grasslands, trees and rangelands. Environmental factors influence a number of plant physiological processes uniquely. These chapters discuss the mechanisms of species responses to temperature, carbon dioxide, radiation, water and nutrients. Playing an important role in fostering dialogue among the scientific community, including policy makers, and in furthering integrated responses to global climatic change, this book is written by leading international authorities from the USA, Europe, Japan, Australia and New Zealand. It is indispensable for advanced students and researchers in crop science, including breeding and technology, environmental plant physiology, ecology and climatology. 21 chapters, 472 pages.

Seed Calculator

Plant Research International a introduit le progiciel Seed-Calculator à l'intention des laboratoires et des entreprises qui testent les semences. SeedCalculator est un outil convivial pour procéder rapidement à des analyses normalisées de tests de germination. Version texte et documentation complète disponibles sur le site : http://www.plant.wageningen-ur.nl/products.

Information: Plant Research International, P.O. Box 16, 6800 AA Wageningen, Pays-Bas ; Tél : +31-317 477019 ; E-mail : sales@plant.wag-ur.nl

Seed Trade News International

Seed Trade News est un magazine mensuel de Ball Publishing, Batavia, Illinois, USA. Il est gratuit pour les lecteurs avertis. Je pense que les lecteurs avertis ici sont des gens qui travaillent dans l'industrie semencière. Seed Trade News Magazine, P.O. Box 9, Batavia, IL 60510 Etats-Unis, E-mail : cvisser@ballpublishing.nl

Site Internet: www.seedtradenews.com

Publications/manuels didactiques préparés par le projet semencier IITA/GTZ

Starting and managing a successful seed enterprise by F.A. Oresajo, B.R. Gregg and A.J.G. van Gastel, WASDU Publication No 11, 2001.

Financial management for seed managers by F.A. Oresajo, B.R. Gregg and A.J.G. van Gastel, WASDU Publication No 9, 2001.

The WASDU SeedSaver Drying-Packaging System by B.R. Gregg, A.J.G. van Gastel, I. Djokoto and E.A. Asiedu, WASDU Publication No 7, 2001 (In preparation)

L'igname et la pomme de terre en Afrique de l'Ouest par A.W. Ebert et K. Djinagou Igue, WASDU Publication No 6, 2000.

Seed operations—cost and income analyses sheets by B.R. Gregg and A.J.G. van Gastel, WASDU Publication No 5, 2000.

Seed production manual for the informal sector by B.R. Gregg and A.J.G. van Gastel, WASDU Publication No 4, 2000.

Preparing a realistic business plan for successful seed companies by B.R. Gregg, A.J.G. van Gastel, A.W. Ebert, L.L. Delimini and E.A. Asiedu, WASDU Publication 3, 1999

Good Seed, extension and farmers by B.R. Gregg, A.J.G. van Gastel, E. Asiedu, F.K. Donkoh and R.W. White, WASDU Publication No 2, 1999.

Managing seed marketing by B.R. Gregg and A.J.G. van Gastel, WASDU Publication No 1, 1997.

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