

OVERVIEW: IMPORTANCE OF MILLETS IN AFRICA

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Milletts are extremely important in the African SAT (semi-arid tropics), produced in 18.50 million ha by 28 countries covering 30% of the continent. This is a significant 49% of the global millet area, with a production of 11.36 million tons by 1994. There are nine species which form major sources of energy and protein for about 130 million people in SSA (Sub-Saharan Africa). Among these, only four are produced significantly in Africa; including pearl millet (the most widely grown in 76% area), finger millet (19% area), tef (9%) and fonio (4%). Millet production is distributed differentially among a large number of African countries; largest producers being in West Africa led by Nigeria (41%), Niger (16%), Burkina Faso (7%), Mali (6.4%), Senegal and Sudan (4.8% each). Finger millet is produced mainly in East and Southern Africa.

Milletts are consumed as staple food (78%), drinks and other uses (20%). Feed use is still very small (2%). As food, they are nutritionally equivalent or superior to most cereals; containing high levels of methionine, cystine, and other vital amino acids for human health. They are also unique sources of pro-vitamin A (yellow pearl millets) and micronutrients (Zn, Fe and Cu) which are especially high in finger millet.

Future trends need increasing productivity and trade (regionally and internationally) and adding value to products by improving/increasing processing and utilization in industry. More research-for-development (R4D) and networking are required to achieve these.

INTRODUCTION

Milletts are in the family of cereals grown globally with differential importance across continents and within regions of the world. They form a diverse group of small grains cultivated in diverse and adverse environments, mostly in the dry, semi-arid to sub-humid drought-prone agro ecosystems. Worldwide, there are nine species of millets with total production of 28.38 million tons, out of which 11.36 million tons (40%) are produced in Africa (Table I)¹ from six species.

Region/Country	Area (million ha)	Production (million tons)
AFRICA (28 countries)	18.50	11.36
-East and Central Africa (8 countries)	3.36	2.01
Southern Africa (10 countries)	1.20	0.75
-West Africa (10 countries)	13.94	8.60
ASIA	16.99	15.17
India	13.95	10.70
China (mostly foxtail millet)	1.90	3.67
USA (mostly proso millet)	0.15	0.18
Argentina (mostly proso millet)	0.04	0.06
World (all cultivated millet species)	38.10	28.38

Table I. Millets area and production in Africa relative to other regions of the world, 1992-94. Source: Modified from [1]

Production of millets is still at subsistence level by smallholders (0.3-5.0 ha farm size) and consumed as staple food and drink in most areas. They are crops of the present with high impact on the poor in Africa for food security, and sources of energy and protein for about 130 million people in sub-Saharan Africa (SSA). The diverse production areas cover mostly the semi-arid tropics (SAT) and sub-tropics of Africa, and include other zones in the drought-prone sub-humid areas and medium-high altitudes (Figure 1). These millets production areas coincide very well with where most of the poor live in Africa (Figure 2) spreading from Senegal to Eritrea and covering the Sahel and dry Sudano-Guinean agro-climatic zones of West Africa, and the semi-arid zones bordering the Kalahari desert in the South of Africa. They are also important in drier areas of eastern Africa and the Lake Zone. This is a significant coincidence as it does have socio-economic, food/feed, health, and environmental impact on the resource-poor peoples of Africa. It also has importance in strategies for responding to the needs and welfare of the poor including food security, nutrition and health, poverty alleviation, potential markets and dry environment enhancement.

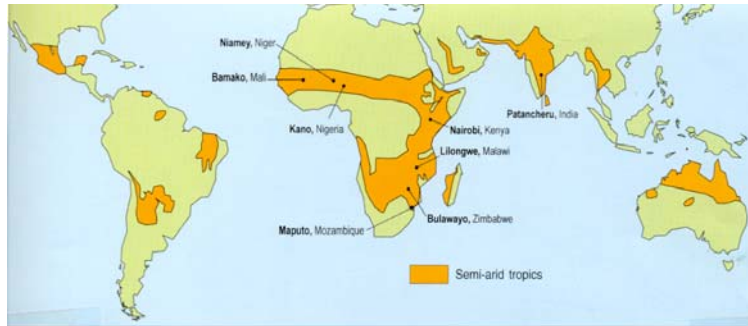


Figure 1: SAT areas of Africa and the world with ICRISAT locations

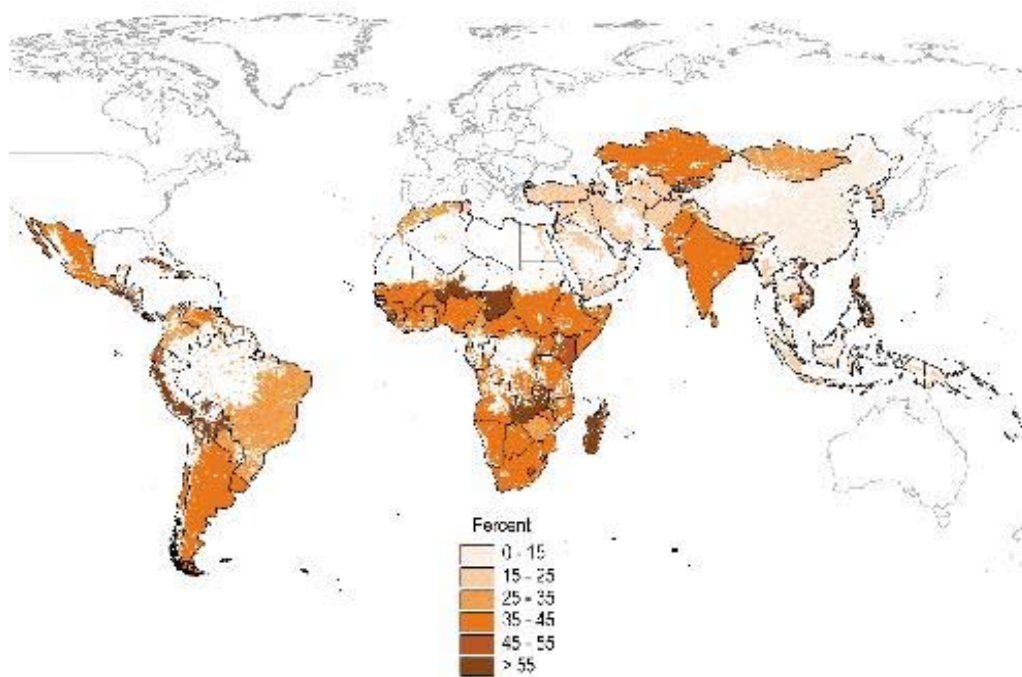


Figure 2 World Map of Poor People Habitats

This review focuses on the importance of production and production systems; processing and utilization; and commercialization with marketing of millets. It provides an outlook on research for development relating to the impact of millets, together with how to step up the crop's potentials for poverty alleviation, income generation, food and environmental enhancement and health security. It concludes with future trends in millets relative to other cereals in the continent.

PRODUCTION AND PRODUCTION SYSTEMS

In Africa, millets are extremely important in the semi-arid and sub-humid zones as staples and ethno-botanical crops. Produced in 18.50 million ha., and yielding total of 11.36 million tons mainly at subsistence level by 28 countries, the millets cover 30% in the SAT areas of the continent (Table II) 2-3, in diverse agro ecologies. Nigeria produces 40% (nearly half) of the millets grown in Africa; and West Africa has largest hectarage (13.63 m ha) accounting for 74% of total area (Table III). The cereal crop is mostly produced in mixtures (intercropped, double-cropped or relay-cropped) with other SAT (semi-arid tropical) cereals like sorghum, legumes and oilcrops like groundnuts, cowpeas, pigeonpeas and sesame, and root crops mostly cassava. There are nine species of millets cultivated worldwide; their relative importance across the continents show four to be important in Africa, and only two (not grown in Africa mainly proso millet and foxtail millet) in other areas³. The four most important millets cultivated in Africa (Table IV)³ are: Pearl millet- *Pennisetum glaucum* (L.) R.Br. (accounting for 76% of total production), finger millet – *Eleusine coracana* L. Gaertn. (19%), Teff – *Eragrostis teff* (Zucc.) Trotter (1.8%), and Fonio – *Digitaria exilis* Stapf. (acha) and *Digitaria iburua* Stapf. (black fonio) (0.8%).

Country	Total area (km ²)m	SAT area (km ²)m	SAT area (%)
Angola	1.252	0.289	23
Benin	0.117	0.035	30
Botswana	0.580	0.200	34
Burkina Faso	0.271	0.214	78
Cameroon	0.466	0.048	10
Central African Republic	0.621	0.030	5
Chad	1.168	0.362	31

Eritrea	0.122	0.027	22
Ethiopia	1.132	0.186	16
Gambia, the	0.011	0.011	100
Ghana	0.240	0.010	4
Kenya	0.584	0.100	17
Madagascar	0.595	0.131	22
Malawi	0.119	0.018	15
Mali	1.257	0.377	30
Mauritania	1.042	0.064	6
Mozambique	0.789	0.360	46
Namibia	0.826	0.181	22
Niger	1.186	0.151	13
Nigeria	0.912	0.352	39
Senegal	0.197	0.166	84
Somalia	0.639	0.041	6
Sudan	2.490	0.742	30
Swaziland	0.017	0.002	10
Tanzania	0.945	0.308	33
Uganda	0.243	0.038	16
Zambia	0.755	0.259	34
Zimbabwe	0.391	0.262	67
Africa average (n=28)	-	-	30

*SAT definition: Length of growing period (LGP) 75-180 days; excludes arid lands (<75 LGP) and often-droughted areas (>180 LGP).

Table II. Countries in Africa with semi-arid tropical (SAT)* environments

Source: Modified from [2]

These four species of millets are spread out in their cultivation across several countries in the three sub-regions of Africa. Pearl millet is grown in all 28 countries. Finger millet is cultivated mostly in Eastern, Southern and Central Africa in Uganda, Western Kenya, Sudan and Eritrea; Zimbabwe, Zambia, Malawi and Madagascar; Rwanda, and Burundi. Fonio is only cultivated in West Africa mostly in Mali, Burkina Faso, Guinea Canakry and Nigeria. Teff is grown only in the dry mid-highlands of Ethiopia.

Region/Country	Area (million ha)	Production (million tons)
West Africa	13.63	8.70
Nigeria	5.10	4.53
Niger	4.87	1.86
Burkina Faso	1.23	0.78
Mali	1.14	0.69
East Africa	2.45	0.77
Sudan	1.92 (2.50)	0.54 (0.63)
Tanzania	0.22	0.16
Southern Africa	0.39	0.09
South Africa	0.21	0.04
Zimbabwe	0.18	0.05

Table III. African countries and regions with largest areas for millets production. Source: Modified from [1]

One most significant importance of the millets, which present them as focus for major agricultural research and development efforts, is their widespread adaptation in marginal production and niche areas. They provide farmers with the best available opportunity for reliable harvest, food and nutrition in environments with erratic and scanty rainfall, and low soil fertility levels⁴.

PROCESSING AND UTILIZATION

Millets (together with sorghum) provide 75% of total caloric intake for the poor people living in the SAT and sub-humid drought-prone areas. Millets alone provide 13.40 kg/yr per capita food use.

Across Africa several indigenous foods and drinks are made from flour/meal and malt of the millets. They are nutritionally equivalent or superior to other cereals. They generally contain high protein (upto 9.5 g/100g for teff and fonio), ash, calcium (upto 344 mg/100g for finger millet), phosphorus and potassium (upto 250 mg/100 g and 314 mg/100 g respectively for finger millet), iron and zinc levels³. The high levels of methionine and good digestibility make the millets valuable food for humans and other monogastric animals. The nutritional, chemical and biological properties of millets have been critically reviewed recently³.

Region/Country	Total millets ('000 tons)	Pearl millet (%)	Finger millet (%)	Proso millet (%)	Foxtail millet (%)	Teff (%)	Fonio millet (%)	Other millets (%)
North Africa	554	98	2	0	0	0	0	0
Western Africa	8986	95	0	0	0	0	4	1
Central Africa	447	87	13	0	0	0	0	0
Eastern Africa	1547	35	50	0	0	9	0	6
Southern Africa	404	65	30	0	0	0	0	5
Africa	11938	76	19	0	0	2	1	3

Table IV. Relative importance of millet species cultivated in Africa. Source: modified from [3]

About 80% of the world's millet is used as food, with the remaining being used for stockfeed (2%), beers (local and industrial), other uses (15%) and bird seed (Table V)¹. Foods prepared from millets are several and differ from country to country and occasionally from region to region. In West Africa, the main food dishes from pearl millet vary by country. The stiff or thick porridges (Tuwo or Tô) are the most popular, commonly consumed in all the Sahelian countries across the region. The steam-cooked product 'Couscous' is more commonly consumed in the Francophone countries including Senegal, Mali, Guinea, Burkina Faso, Niger and Chad. The thin porridge 'bouillie' is also popular in these countries. Three countries among others have unique foods from pearl millet specific to them. In Nigeria and Niger the thin porridge 'Fourra' is very popular while 'Sougouf', 'Sankhal' and 'Araw' are very popular in Senegal.

Animal feed as forage, grain and residue is still insignificant, with about 7% (< 2 million tons) of total production going into stockfeed. Malting and brewing local beers using millets is significant in Uganda, Zimbabwe, Zambia and Namibia. Non-

alcoholic local beverages are commonly made from millets in West Africa. The stalks of the long season, late maturing pearl millet types (called Maiwa in Nigeria) are used in roofing, fencing and as firewood. Table V shows millet utilization by type, region and selected countries^{1,3}.

Millets have good grain qualities suitable for processing. Processing of the grain for many end uses involves primary (wetting, dehulling and milling) and secondary (fermentation, malting, extrusion, glaking, popping and roasting) operations. Being a staple and consumed at household levels, processing must be considered at both traditional and industrial levels, involving small, medium and large-scale entrepreneurs.

Region/country	Direct food (‘000 tons)	Feed(‘000 tons)	Other uses ¹ (‘000 tons)	Total (‘000 tons)	Per caput food use (kg/yr)
Africa	8673	187	2328	11188	13.40
Burkina Faso	683	2	126	811	68.53
Chad	217	0	41	258	33.73
Ethiopia	108	0	153	260	1.97
Mali	658	3	119	781	74.63
Niger	1440	17	259	1716	162.45
Nigeria	3315	100	1155	4570	31.50
Senegal	505	5	83	593	61.61
Sudan	364	20	76	460	14.14
Tanzania	177	2	53	233	6.41
Uganda	517	20	95	633	25.93

1. For bird seed, manufacturing purpose and waste/spent grain in brewing.

Table V. Millet utilization by type, region, and selected countries, 1992-1994 average

Dehulling, which is not favorable to millets due to their small grain sizes and which causes high dehulling losses, is followed by milling. All the millets can be milled by hand grinding (household level) or machine milling (cottage, small-to-medium scale service and large scale industrial). The milling process affects the nutritional status of

millet and prepared products. Generally, flour products from mechanically milled processes are acceptable and have improved shelf life, whereas the traditionally milled products retain more nutrients³. There is need to balance these process outcomes to have longer shelf life with adequate nutritional status. This should be achievable through product development and testing research. Pearl millet is relatively more amenable to milling process as it has relatively largest grains of the millets. However, modified mini mills for millets processing would minimize milling losses if used.

Malting and fermentation processes result in malted and brewed products which are non-alcoholic and alcoholic depending on the desired needs. Malted pearl millet and finger millet are used in the brewing of traditional opaque African beer in southern and eastern Africa. Finger millet makes the best quality malt used in both brewing industry and making of digestible nutritious foods. Pearl millet has been shown to have similar diastatic power similar to sorghum and makes just as good beer brewing with good quality malts⁵. He also showed the potential of pearl millet, like sorghum in the brewing of clear lager beer. Teff and fonio are mostly for food (porridges and flat breads); they possess low malting potential, per se, because of very high malting losses³. Fermentation of sprouted (germinated) millets results in significant increases in protein and starch digestibility^{6,7}. Fermented thick porridges are popular in Niger, Sudan and Southern Africa, while fermented thin porridges are commonly consumed in West Africa especially Nigeria and Ghana (ogi, koko, akamu, kunu) and East Africa mostly in Kenya and Uganda (uji) where souring (with lemon) is used instead of fermentation. In Nigeria and Ghana, stiff or thick porridges (tuwo) are not fermented, as done in francophone West African countries.

NUTRITIONAL AND TECHNOLOGICAL PROPERTIES

Millets are high energy, nutritious foods recommended for the health and well-being of infants, lactating mothers, elderly and convalescents. However, the foods produced from them traditionally and industrially, at present, have short keeping qualities due to the presence of high fat content in the millet flours. This constraint to extended utilization and properties of millet foods is being responded to through research and development in improved processing. Their good nutritional values including high levels of quality protein, ash, calcium, iron and zinc, which make millet nutritionally superior than most cereals, are now being enhanced through biofortification and micronutrient research. Tables VI-VIII⁸⁻¹⁰ show the major nutrients, minerals, and essential amino acids of the four important millets in Africa, relative to two other cereals wheat and sorghum, where available. Details of the nutritional, biological and technological properties of the four African millets are presented in a previous detailed review on millets³.

Major nutrients (g100g ⁻¹)	Millets				Other cereals	
	Pearl millet	Finger millet	Teff	Fonio	Wheat	Sorghum
Protein	11.0	7.3	9.6	9.0	7.8	7.9
Carbohydrate	70.0	74.0	73.0	75.0	71.0	73.0
Fat	4.8	1.3	2.0	1.8	1.1	2.8
Crude fiber	2.3	3.6	3.0	3.3	2.0	2.3
Ash	1.9	2.6	2.9	3.4	1.6	1.6
Food energy (KJ)	1483	1403	1411	1541	1105	1142

Table VI. Major nutrients of the four important millets in Africa relative to other selected cereals.

Mineral (mg100g ⁻¹)	Millets				Other cereals	
	Pearl millet	Finger millet	Teff	Fonio	Wheat	Sorghum
Calcium	37	344	159	44	30	27
Copper	9.8	0.5	0.7	-	1.1	2.4
Iron	114	9.9	5.8	8.5	4.0	6.6
Manganese	190	140	170	-	120	180
Magnesium	0.8	1.9	6.4	-	3.6	2.9
Phosphorus	339	250	378	177	400	520
Potassium	418	314	401	-	330	440
Sodium	15	49	47	-	16	14
Zinc	2.0	1.5	20.0	-	3.5	4.4
Chloride	43	84	13	-	-	-

Table VII. Mineral composition of the four important millets in Africa.

Amino acids (g16g ⁻¹ N)	Pearl millet	Finger millet	Tef	Fonio
Cystine	1.6-1.8	1.7	1.9	2.2-2.5
Isoleucine	3.9-4.6	4.0	3.2	4.0-4.3
Leucine	9.5-12.4	7.8	6.0	10.5-11.8
Lysine	2.8-3.2	2.5	2.3	1.9-2.5
Methionine	1.8-2.6	2.9	2.1	3.0-4.5
Phenylalamine	4.1	4.1	4.0	5.7-6.8
Threomine	3.3-4.1	3.1	2.8	3.3-3.7
Tryptophan	1.4-1.5	1.3	1.2	1.6
Tyrosine	3.0	4.1	1.7	3.5
Valine	4.9-6.0	6.4	4.1	5.2-5.5

Table VIII. Essential amino acids in important millets of Africa.

COMMERCIALIZATION AND TRADE

Commercialization

The greatest constraint in the realization of importance of millets is in their handling and limited use by the producers, processors and consumers. The harvesting, threshing, and processing for food are mainly done by women at the household level. Processing and brewing for malts and drinks are however done at both communal (taking 70% share) and medium- large scale industrial levels by breweries (taking

10% share mostly in southern Africa). The brewing process and activities form the bulk of commercialization in millets and account for 80% of the informal trading of the crop. The remaining 20% are in form of thin and thick porridges (in west, east and southern Africa) and flat breads (mainly in Ethiopia using teff, and Sudan using pearl millet). The reverse is however true for food use at household levels to satisfy food security. In most instances, for these foods, drinks and local beer, millets composited with other cereals, like sorghum and maize, are used.

For millets, commercialization and trade need to be put in proper perspective for better and appropriate response to their enhancement and upscaling through value addition.

Commercially, there is a slow and emerging trend in the industrial use of millets at the national and regional levels. Because of its nature and ecology of production areas, the mainly cultural and household processing and consumption pattern is yielding to more and more cottage, medium and large scale practices. Pearl millet, for instance, ranks first as the major staple in human consumption in the West African SAT. A survey conducted by the West and Central African Millet Research Network (WCAMRN) on 522 consumers in four countries revealed that millet is the most preferred staple in the SAT of the region¹¹. It is consumed at breakfast, lunch and supper, and its product demand is very high; 62-84% eating it in form of thin (bouillie and furra) and thick (tuwo/tô); porridges upto 80% consuming it as couscous in Senegal. Similar levels can be found for teff in Ethiopia, as flat bread (injera).

In southern Africa, commercialization of millets products is more advanced than in West Africa. In eastern, central and southern Africa traditional beer brewing from finger millet and pearl millet has long been a large-scale commercial enterprise; used in the form of malt and unmalted adjunct. In Zimbabwe, small quantities of pearl millet and finger millet are used in commercial opaque beer brewing. In Kenya, finished millets products in form of 'Uji Mixes' are processed in large and small scale private firms; and demand for these products are high. Table IX shows the commercially available composite flour food products from finger millet, pearl millet and red/brown sorghum in Kenya and Uganda local markets and peri-urban super market outlets.

Name	Company	Uses	Packaging	Ingredients
Baby porridge	Proctor & Allan Box 18218 Nairobi	Porridge for young babies and children	1-2kg	Maize, sorghum, soya and finger millet
Ken-Uji Sour	Mt. Kenya Food Products Ltd Box 42 Nkubu	Porridge	1kg	Finger millet, Wheat, Sorghum, Pearl millet and Lemon extract
Nana Porridge	Super Foods Box 1578 Eldoret	Porridge	0.5kg	Finger millet, Cassava, Groundnuts, Soya and Greengrams
KIDS Flour	JOA Spices Ltd. Box 123 Eldoret	Porridge for children	0.5kg	Finger millet, Sorghum, Soya, Maize, Fish powder, Greengrams, Groundnuts
Liwah Porridge	Liwah Industries Box 7834 Eldoret	Porridge for Children	0.5-2kg	Finger millet, Sorghum, Soya, Cassava, Groundnuts, Milk powder, fine maize flour
Elna	Arid Products Enterprises Box 19791 Nairobi	Porridge	1kg	Sorghum, Finger millet, Soya, Wheat and Lemon extract
Jelly Porridge	Favourke Farm Products Kitengela Box 57629 Nairobi	Porridge	1kg	Finger millet, Cassava
Uji kwa watu wote	Money Saver Millers Box 434 Busia	Porridge	0.5-1.0kg	Maize, Sorghum, Pearl millet, Soya, Groundnuts

Obuji Flour	Massellah Food Products Box 44550 Nairobi	Porridge	0.5kg	Sorghum, Finger millet, Soya, Cassava, Groundnuts, Greengrams, Milk powder Sorghum
Cerevita Instant sorghum porridge	Nestle Foods Kenya Ltd Box 30265, Nairobi	Porridge	1.0	
Famila Ujimix (sour porridge)	Unga Ltd. Box 30386, Nairobi	Porridge	1.0	Finger millet, maize flour, souring agent
Famila pure wimbi porridge mix	Unga Ltd. Box 30386, Nairobi	Porridge	1.0	Finger millet, calcium
Special	Jambo millers Box 783, Nakuru	Porridge	1.0	Millet, sorghum, pearl millet, greengrams, groundnuts Millet
Jambo uji flour	Jambo millers Box 783, Nakuru	Porridge	1.0	
Maizena-Nutra plus	CPC Kenya Ltd. Box 41045, Nairobi	Porridge	0.5	Maize, soya, millet, sorghum, citric acid, vitamins, minerals
Nutritious soya millet	Tarsus Box 2021, Mbale-Uganda	Porridge	1.0	Millet, soya bean
Pure millet flour	Tarsus Box 2021, Mbale-Uganda	Porridge	1.0	Finger millet
Soya millet	Ambeeire Agencies # 4127, Bukasa Rd. Box 1753, Kampala- Uganda	Porridge	0.5	Finger millet and soyabean

Casmil flour	Maganjo grain millers Box 6738, Kampala- Uganda	Porridge/Ugali	1.0	Cassava, millet
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Table IX. Commercially available composite flour food products from finger millet, pearl millet, and sorghum with other components in the Kenyan and Ugandan markets

Trade

International trade in millets is estimated to range between 200,000 – 300,000 tons, representing approximately 0.1% of world trade in cereals or 1.0% of world millet production¹. Africa has no participation in this official trade figures. However, what is important in Africa is internal national and regional trading of millets. Substantial quantities of millets are traded within African countries and subregions. Grains move from surplus to deficit areas, along and across boundaries. Two broad types of grain marketing are identified in West Africa¹¹. These include the long distance from grain involving more than one country in the Western Africa sub-market (Senegal, Mali, Niger and Nigeria); and short distance trading which is usually an internal country grain marketing system. Grain trade in this sub-sector is estimated at 15-20% of domestically produced grains, with the rest consumed locally in the areas in which they are produced.

At the regional level, in the Sahelian countries of West Africa, countries that generate surplus millet (mainly pearl millet) are net exporters. Because of the informal nature of trading in this sub-region, trading volumes are usually not well recorded. However, based on surplus/deficit from production data in good rainfall years, Mali and Burkina Faso are potential millet grain exporters to Mauritania, Senegal, Guinea and Niger, by large-scale traders, producers and wholesalers¹². Another significant net exporter of millet in West Africa is Nigeria, through cross-border trading principally to Niger and also Chad, Cameroon, Ghana and Burkina Faso. A survey of such cross-border grain trade shows Niger as net importer, with 11% of total grains imported (100,000 tons) from Nigeria being pearl millet. This quantity could increase significantly following droughts, an indication of Nigeria's significance in pearl millet trading in the West African sub-region.

OUTLOOK AND FOCUS OF RESEARCH-FOR-DEVELOPMENT

There are important researchable and development issues that confound or influence the importance and status of millets, and their potential in commercialization and trade. Generally research has focused on the most important species, pearl millet,

which originated in West Africa and evolved through the harsh environments of the West African SAT. Adaptation and improvement of local varieties and local variety derived materials have been the forms of research. Finger millet (next most important species) research has focused on processing and end-use in thin and thick porridges as composite flour, in eastern and central Africa; and for malting and brewing in southern Africa.

Considering the projected millet production, demand and trade by 2005 within and across the African SAT regions¹, there is need to develop demand enhancing and demand expansion strategies in the short-, medium-, and long-term, to foster the development and promotion of the millets. In the short term (uptil 2005), growth of millet production is projected from 27 million tons in 1992-94 to 31 million tons in developing countries of Africa¹. This growth will be achieved through increased productivity and production. The outlook on demands for food and livestock feed are major and can be encouraging. Millets will continue to be used as staple in the SAT primarily for human foods, as a major source of calories, and a vital food security component. As feed, it is expected that increase of 60% by 2005 will depend on development in large African producing countries like Nigeria and Sudan. This scenario coupled with increasing production and productivity through use of new research developments in pearl millet hybrids, would enhance demand and encourage production. Demand would also be enhanced through knowledge and use of grain technological and nutritional qualities of the millets by industries in both developing and developed world. The potentials for the production of pearl millet topcross hybrids to increase productivity are being researched in West and East Africa by ICRISAT. Productivity increase of millets would surely entice processing industries and markets for value-adding and economic returns.

Research-for-development (R4D) should focus on strategies to enhance and expand demand, in the short-, medium- and long-term. Recommended strategies would include:

1. Increasing production and productivity: to improve competitiveness and close up deficit gaps; and ensuring food and nutrition security.
2. Promoting millets for commercialization and markets through:
 - improvement of processing and utilization methods and technologies¹³, including fermentation, malting, steaming, micro milling, compositing and product development.
 - diversifying end-use products to include ready made, non-conventional and better-packaged, more presentable conventional foods.
 - Expanding the use of pearl millets in livestock feed industry
 - Expanding the use of millets in malting, brewing and by-products industries
 - Expanding the options for millets use in novel food products, novel traits, biofortified food products (using their unique qualities with high

levels of Copper, Iron, Zinc, Magnesium and Manganese nutritional convenience and health snack foods.

- Evaluating, developing and emphasizing grain and food product qualities and standards for industry and end uses
- Developing sustainable regional trade in millets raw and finished products¹⁴ through improving market channels and trading volume with maintenance of quality and standards

3. Increasing and diversifying millets utilization through

- Technology, knowledge, and information dissemination, transfer and exchange¹³ including equipments and facilities, and markets
- strengthening and creating new linkages and human resources development through training, education and networking within and across sub-regions
- expanding awareness to improve status of millets by generating healthy government policy environment
- better utilization and involvement of professional expertise, and interdisciplinarity
- closer interactions between public and private sectors including producers, consumers, processors, intermediaries mainly traders and middlemen, and distributors

CONCLUSIONS

Millets are still the staple food for millions of poor people in drought-prone Africa. Being high-energy nutritious grains make them useful components of dietary and nutritional balance in foods. However, the continued and future importance of millets as food in Africa are in

- food and nutrition security due to them having good amounts of untapped potential for yield increases through hybrid development and production, superior yield gains under drought and resource-poor environments
- good grain qualities suitable for processing, and unique nutritive values with significant amounts of essential amino acids (lysine and methionine) minerals (especially micronutrients including calcium, zinc, iron and phosphorus) and vitamin A (in form of beta-carotene in yellow endosperm pearl millet); the quantities, qualities and bio availability of which need more improvement as reviewed in the grain properties and utilization potential of millets³.

In order to enhance and extend demand of millets for market orientation, there is need for strategic shift to commercial production. There is need to foster better market organization along and across borders of the Sahel, and into more productive Sudan Savanna and Veld areas. A change from a fragmented to an integrated food systems approach along the commodity chain, would help linking productivity gains to

increased demand. This approach would also stem high grain price variability and reduce millets sensitivity to price fluctuations. Strengthening linkages between and among producers, processors, traders, institutions and markets would enhance growth of millets' commercialization and trade along the commodity chain. Increasing biofortification research and development with millets is one strategy for fostering export trade among and between developing world (mainly Africa) and the developed world.

On the research-for-development front to increase production and productivity, more efforts should be put on:

- developing and producing pearl millet hybrids (topcross and population cross) with sustainable seed systems, for both the Sahel and Sudan Savanna/Veld agro-ecosystems to extend to more productive agroecologies
- farmer-friendly IPM packages for the control and management of economically important weed, insect and disease pests focused on pearl millet and finger millet as priority
- effective and efficient striga control and management in West Africa and Sudan
- enhancing intergrated resource management for soil-water-crop livestock systems in millet-based production systems of the Sahel and Sudan/Veld Savannas
- continuing with more vigour the processing (primary, secondary and tertiary) and utilization methodologies; equipment and facilities development, fabrication and modification; and grain quality assessment with product quality and standards
- fostering interaction and networking for millets R4D and information access within and across regions and sub-regions

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