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LIMITS OF DRYING TECHNOLOGIES OF THE AGRICULTURAL PRODUCTS IN SOUTHERN REGION OF CAMEROON

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ABSTRACT

The Southern Region of Cameroon is one of the principal zones of production and marketing of the foodstuffs of local consumption and export. In spite of the efforts granted these last years in technologies and increasingly powerful techniques of conservation, post-harvests losses are always recorded in this area. To include the causes of this persistence, an investigation of the half-open type was led in the four Divisions of this area, in order to draw up a cartography of available energys resources, techniques and drying equipment of the products and the needs of the actors, making it possible to overcome the encountered difficulties. The quantitative and qualitative information analysis shows that on the scored foodstuffs intensively cultivated in the Southern Region of Cameroon, 55% are being conserved by drying techniques. The technique implemented is sun drying, by natural convection, on trays or tapoline. The use of the sun as principal source of energy, in an environment where the hygroscopy of air is higher (around 80%) with a strong annual humidity of 1700 to 4000 mm, remains the limiting factor for good conservation of agricultural productions in this area.The total information collected is then associated with the needs expressed by the principal actors to help bring out an adequat socio-economic and technical solution to their problems

KEYWORDS: Cameroon,Southern Region, Agricultural food products, Conservation, energy resources, Dryer

I. INTROODUCTION

The wet tropical zone constitutes the largest climatic unit that exists on the surface of the world and extends overlatitude 46°55', symmetrically on both sides of the equator.The countries located in this zone are mostly poor and developing countries.This zone is submited to an East-West atmospheric circulation (trade winds), conferring a humidity ranging between 1700 and 4000 mm of rain per year with high moisture winds at about 90% and little contrasted thermal variations [1].

In Cameroun, there are five agro-ecological zones [2]: the soudano sahélienne zone, the high savannas guinéennes zone, the West high plateaus zone, the tropical rain forest with monomodale humidity and the western high lands with bimodale humidity.The Southern Region of Cameroon belongs to this last zone, characterized by two raining seasons which extend from March to June and from August to November (8 months), a humidity ranging between 1700 to 4000 mm of rain per yearwith temperatures varying between 22°C to 28 °C [3].The combination of these factors makes the Southern Region of Cameroon favourable for agriculture.

Following the technological development (agricultural machines and imputs), multiple efforts were made to improve the agricultural productivity in Cameroon [4], [5]. However, in front of a production higher than the real need of the market and in the absence of self consumption and wearhouses, then much of the food is wasted after harvest [6].In order to reduce these post-harvest losses estimated at more than 40% [7], several methods of conservation of these overproductions were presented in the litarature.The Oldest and widespread method is drying [8],[7] wich is equaly applied to fruits, vegetables and meat products[9],[6], [10], [11].Among the drying methods,sun drying by natural convection is the most widely practised due to the availability of solar energy wich constitutes the principal means of conservation of the agricultural products in Africa savanas (Cameroun, Nigeria and Chad) [12], [13].However, the drawbacks of this technique of drying under climatic conditions such as those recorded in the southern Region of Cameroon, in particular long drying period and poor nutritics

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qualities of the dried products, have led the researchers to develop various other configurations equipments to dry products in tropical rain forest zones [14],[15],[16],[17],[18],[19],[20],[21], [22], [23].Within the framework the efforts made by science to improve the traditional techniques of drying, this work is about making an investigation circumscribed in the Southern Region ofCameroun, the zone most sensitive to the effects of the rain, in order to give the inventory of drying techniques and equipments in actual use in our case-study and proposals for an improvement

II. MATERIAL AND METHODS

Case study

The survey was carried out in the four Divisionss of the Area, as presented in figure 1

Division (Head-Quarter)	Area (km^2)
Dja and Lobo (Sangmélima)	19 911
Ocean Division (Kribi)	11 280
Mvila (Ebolowa)	8 697
Ntem Valley(Ambam)	7 303

Figure 1:Localization of the area

Technique of investigation

Crtography of techniques et equipements

The random sampling procedures were applied, because they are less expensive, faster, simpler to implement and make it applicable to the whole population.The choice of the units to be visited was based on two principal criteria:

- To carry out the drying or the smoking of the foodstuffs;
- To be established in the four Divisions of the Area.

In total, 146 drying units were questioned.In each of the four zones, the questioned people were selected in the Head quarters.The sample for each Division is tabulated below (table 1).

Tableau 1: Distributionof the sample for the investigations.

Division (Head Quarter)	Number of questioned units
Mvila (Ebolowa)	90
Dja and Lobo (Sangmelima)	18
Ocean Divison(Kribi)	21
Ntem Valley (Ambam)	17
TOTAL	146

Tools for information collection

A questionsheet of the half-open type centered on four components was used.Within each component of the questionsheet, a chaine of questions was associated as presented in table 2.

Table 2:Questions relating to each component.

Component	Questions
Analyses of drying practice of foodstuffs	What is the nature of the structure?
	What is thelevel education of the prossessor?
	What is the type of dryer used?
	Which type ofproducts you do dry?
	Which are the periods of strong activity?
	Which means do you use to control drying?
	Who are the purchasers of the dried products?
Description of the loads of the drying operation	What cost you much during the process of drying?
Description of the needs	Are you satisfied with the equipment you use?
	What other thing do your need?
Economic and energy analyses of drying processes	What Is the energy cost of a drying cycle?
	Is your source of energye available?
	What do you do with the waste from drying process ?

Method of information processing

The collected informations were preserved quantitatively or qualitatively. A coding was done as same as in [24], corresponding questions to answerscoefficients. Coefficient 1 stands for an answered question, then 0 for an unanswered question, as presented in Table 3.

Table 3 : Simplified representation of the coding of the investigation results

Units	Resp1	Resp2
U1	X	
U2		X
U3	X	
U4		X
U5	X	

Units	Resp1	Resp2
U1	1	0
U2	0	1
U3	1	0
U4	0	1
U5	1	0
Total	*3 /5*	*2/5*
Percentage	*60%*	*40%*

For energy potentiel evaluation

The estimation of the solar and wind potential is done through the use of Reetscreen software by defining a reference year as follows:

- We considered the climatic information for 10 consecutive years (2005 to 2014);
- For each month, we calculate the average temperature for the 10 years;
- We select whatever the year, the month which it mean temperature approaches the general average over 10 years. This logic is the same as that used for the energy diagnostic software of the mecanique construction entreprise (CETIM-INERG) [25].

Then for the estimation of waste from wood processing industries, we used the informations given by [26] and [27] which are written in the tables 4 and 5 .In total, 64 units of wood transformation grouped up as indicated in the table 6 were questionned.

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Table 4: sample for forest waste evaluation

Denomination		**Nomber**
Primary Industries		1
Secondary Industries	Industrial joineries	24
	Joineries	39
Total		64

Tableau 5 : Quantity of waste generated by pramary industries[26]

Primary Industries	Type of waste	% ofinitial volume
Sawing	Barks	7 to 15
	Slabbing off-cuts and délignures	25 to 40
	Sawdurst	7 to 12
Unwinding	**Dimension Setting**	4 to 12
Cutting	Barks	10 to 11
Plywood	Cores of unwinding	4 to 5
	Residues of wet plating	24
	Residues of hard tackle	8 to 9
	Dust of sandpapering, sawdust	4 to 5
Piles tutors	Bark, Points, dimension setting	15 to 20

Tableau 6: Quantity of waste generated by secondary industries[27]

Type of transformation	Output (%)	Type of waste (%)	
		Large	Thin
Massive pieces of furniture	50-60	73	27
Seats	50-55	54	46
Industrial joineries	80	38	62
Joineries	60	68	32
Pallets	80	-	-
Parquet floors	40	-	-

The estimation of the agricultural waste is done by using information given by [28], [29] and [30] contained in the tables 7 and 8.

Table7 : Agricultural residues of some cultures according to the level of production [28], [29]

Culture	Type of output	Output (t/ha)	Produced report/ratio Noble/résidu	Mineral matter (%)	SHC (MJ/Kg)	Bulk Density (Kg/m^3)
Groundnut	Low meddium High	0 .2 1.0 1.9	Straw: 2.3 hull : 0.5	9,3 to 13,0 1,9 to 4,0	17.8	80
Cotton	Medium	1.0	stems : 3.5 to 5.0	4 to 17	17.2	180
Maiz	Low medium High	0.8 1.9 4.6	stems : 2 to 2.5 Raids : 0.2 to 0.25	3,8 2 to 7	17.4 17.3	 130 to 230

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Millet	Low medium High	0.4 0.7 1.7	straw : 2.0			
Rice	Low medium High	0.9 3.0 5.1	Straw : 1.75 – 4	17 to 19,2	10.2	150
Sorghum	Low medium High	0.3 1.2 3.4	stems : 2.0 – 2.5			
Coconut			Stuff : 1.6 to 4.5 hull : 0.7 to 1.1	7,0 15,0	14.8 15.0	65 640

Table 8: Agro-industrial residues[30].

Culture	Residues (%fresh produced weight)	Mineral matter (%)	Bulk Density (Kg/m^3)	SHC (MJ/Kg)
Sugar cane	Bagasse : 30	2 to 4	70 to 95	17.5
	Remains Vegetable on field 0,2 à 1 tone/ha			7.5 to 8.0
Rice	Balls : 20	18 to 22	100 à 150	13.5 to 15.5
Palm tree	Raids : 24	4.8	90 to100 (crushed)	4.4 (wet)
	Fibers : 18	3.9 to 5.4	400	9.6
	Hulls :	2.3	240	13.4
Cacao	Hulls : 100			
Cotton	Hulls : 18,9	3.4	130 to 160	16.3
Coffee	Hulls : 140 – 210	5.2 to 7.9	160 to 200	18.3

III. RESULTS AND DISCUSSION

Structure of the drying units

On the whole of the visited units practising drying, 66.4% among them are family units, 6.8 % are Limited liability companies (L.L.C), Women Associations represent 8.2 %, the retailers 11 %, the Non Governmental Organizations (N.G.O) 1.4 % and Common Initiative Groups (C.I.G) 6.2 %. Figure 2 below give the distribution of the drying units according to the users groups.

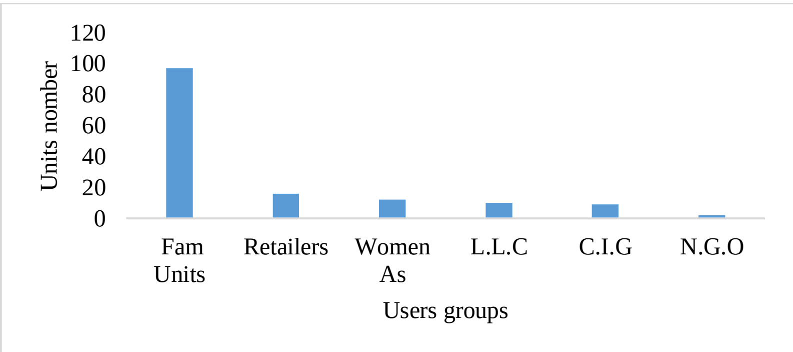

Figure 1: Distribution of the units of drying according to the users groups.

Techniques and drying equipment

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Techniques

The results of the investigation show that among the visited drying units, 82 % practice sun drying, 16 % use biomass dryers with natural convection and 2 % use electric dryers with force convection.

Drying equipment

The drying equipment found in Southern Region of Cameroon are tapolines and trays, Autobus solar dryer, wood dryer, hybrid solar-electric dryers and electric dryers.

Tapolines and trays

Sun drying on tapolines and trays is used for any type of agricultural product.It has advantage in the protection of the product from foreign bodies such as stones and pieces of wood.The disadvantage is that the product is not protected from the rains and bad weather. Figure 3 shows the sun drying of cacao, cassava and Ndo'o.

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Figure 2 : Sun drying of a) Cacao ; b) Cassava ; C) Ndo'o

Autobus solar dryer

Autubus solar dryer is a platform of drying built out with local materials (bamboo, woven plait).The trays in plait bamboo slide on rails made up of bamboo fixed on each side under the roof (figure4).One notes a tendency to modernization: we moved fromraffia roofs to the sheet roof.When it rains, these trays are pushed under the roof.This type of dryer is mostly used for cocoa drying.Its advantage is that the products are protected from rains and its disadvantage is that the products are not protected from the insects.

Figure 3: autobus solar dryer at : a) Ebolowa et b) Sangmelima

Wood dryer

The wood dryers are used for meat products (fish, meat) and sometimes for the tubers (Cassava).The advantage is that the time of drying is reduced and the product is protected from the insects during drying.The disadvantage is the risk of contamination of the product by smoke.

Figure 4: Wood dryer

hybrid solar- electric dryers

The hyride solar - electricity driers are used for cocoa drying in particular.They are locaally constructed (figure 6).The electric power is used to ensure only the force convection air.The advantage of these dryers is that they have a great capacity of drying and the time of drying is reduced.

Figure 5: Hybride solar-electricdryer

Electric dryers

The only entirely electric dryer is met in the public Vocational training Center of sangmelima.It has a capacity of drying of one tone per load and can be used for drying all agricultural products.The advantage of this type of dryer is in addition to its great capacity of drying and the reduction of time, protect of the product against dust. Its disadvantge is the high cost of electric energy and the unballastings and frequent cuts.

Figure7 : Electic dryer found in the Vocational Training Center of Sangmelima

Table 9 summarizes the techniques and equipment of séchge met in L area as well as the types of products concerned.

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Table 9: Techniques and equipment used for drying in the Southern Region ofCameroon

Technique	Percentage	Equipment	Type of foodstuffs
Sun drying	82 %	Tapolines (95%) Trays (5%)	Vegetables Graines Tubers
Dryers with natural convection	16 %	Wood dryer	Meat products Tubers
Dryers with forced convection	2 %	Electric dryers	Cacao

It is shown in this table that very few units uses electricity as source of energy undoubtedly because of the energy cost of these devices but also because of the weak accessibility to the electric power.Wood is used for meat products (fish, meat) and to a lesser extent for the tubers (Cassava).It is also noted that nearly 98% of the dryers are natural convection dryers.

Many researchers proposes the use of hybrid dryers in particular solar-biomass dryers to solve the problems involved in sun drying in the wet tropical zone.The investigation carried out shows the absence of such a device in the Southern Region of Cameroon.

Motivation of the transformers for the purchase of a dryer

For 53.6 % of the heads of units, the selection criterion of the type of dryer is its price. This justifies the major practice of the sun drying whose principal advantage is the lower cost of the equipment. For 30. 4 % of them, it is the adaptation to the type of dried product, 6.5 % privilege energy used, 5.1 % the capacity of drying and the remainder (4.3%) the financing (Figure 8).

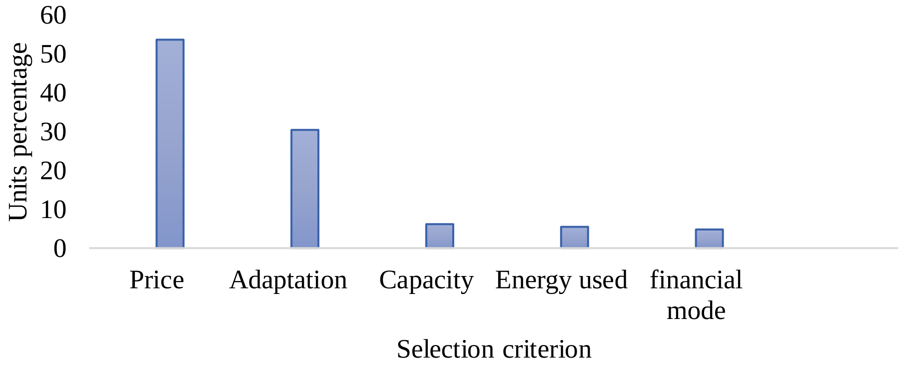

Figure 8: Distribution of drying units per principal choice criterion of a drier

Productions and shares dedicated to drying

Table 10 gives a distribution of the agricultural productions of the region as well as the potential share intended for drying (40% of the productions). They are also mentioned the harvest period, as well as the corresponding seasons.

Table 10: Data showing agricultural productions of the Southern Region and shares dedicated to drying

N°	Product	Production in Tones	potential share intended for drying	Harvest Period	Season
1	Maiz	68555	27422	May- Jul Nov- Jan	Raining Dry
2	Rice	1728	691.2	Oct-Nov	Raining
3	Cassava	630573	252229.2	May- Jul Nov- Jan	Raining Dry

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4	Macabo	155534	62213.6	Nov-Jan	Half Raining Half dry
5	Sweet potato	11999	4799.6	Sept-Oct	Raining
6	Gnam	6150	2460	Sept-Nov	Rainig
7	Potato	552	220.8	Jun-Nov	Raining
8	Groundnut	33322	13328.8	Jun- Aug Dec- Feb	Dry Dry
9	Bean	49	19.16	Nov-dec	Dry
10	Soya	72	28.8	Nov-Dec	Dry
11	Pineapple	902	360.8	March-apr	Raining
12	Water melon	46	18.4	Jul-Aug	Raining
13	Soft banana	110576	44230.4	Jan-Feb	Dry
14	Tomato	6281	2512.4	Jul-Aug March-April	Raining
15	Pepper	725	290	Aug-oct	Raining
16	Okro	6991	2796.4	May- Jul Nov- Jan	Dry Dry
17	Ognon	310	124	March-Apr	Raining
18	Plantain	568234	227293.6	Jan-Feb	Dry
19	Marrow seeds	37925	15170	Aug- Dec	Half Raining Half Dry
20	Gingember	52	20.8	Jul-Aug	Raining
21	Palm oil	12981	5192.4	Jul-Aug	Raining
22	Sesame	2343	932.2	Sept-Oct	Raining
23	Cocoa	nd		Sept-Jan	Half Raining Half dry

Nature of the dried products

The dried products are mainly cocoaas shown in figure 9with about 34.2 %, followed by Cassava dried by 13 % of the total units, Ndo' o (almonds of wild mango) by 12.3 %, fish by 11.6 %, pistachio by 8.2 % of them, corn by 6.8 %, Okro (Hibiscus esculentus) dried by 5.5% of the units, the bush meat by 3.4 %, hazel nuts and groundnut by 1.4% each one and finally Okok by 2% of the units.All the surveyed units carry out a drying in discontinuous mode.Whereas the cocoa, the ndo' o and the fishare to 75 %, 61 % and 14% respectively bought by the exporters. All the other food products are dedicated for local consumption.

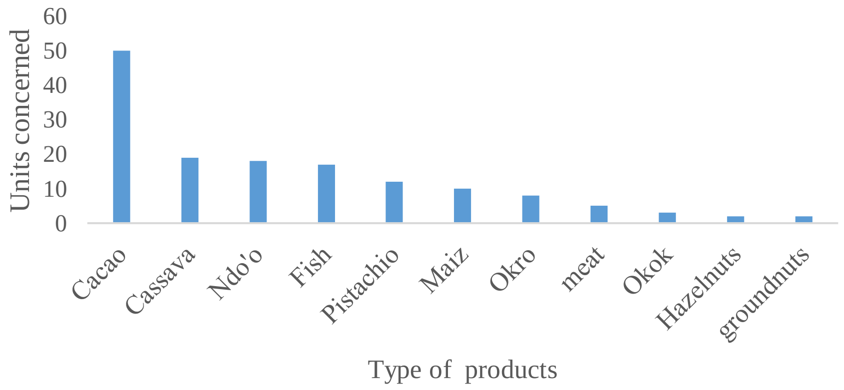

Figure 9: Distribution of the units per type of dried product

Also, products such as tomato, cabbages, potato although cultivated in the area, are not dried. This lack of interest for these food products would be dependent on the passion of the actors to treat food products which brings more money to them, but also on the difficulties of implementation and their lack of know-how, this is also due to the considarable watry nature of these food products.Among all these food products, tomato have the highest water content of 96 % making it difficult for the drying process.

Availability of energy sources

L'électricité

Electricity is distributed only by eneo.The rate of access to this energy is about 23% but only in the urban areas (Head quarter of Divisions) and in the villages located on an axis connecting two cities.It is regarded as expensive and is used only for lighting.The table 11 presents the grid of tariffication practised in Cameroon.

Table 11:Electricity tariffication grid practised in Cameroon

	Nomber of KWh/mois	Unit price FCFA	TVA
Social instalment (for domestic use)	Cons.< 110	50	0
	111 < Cons.>400	79	19.25 %
	401 < Cons. > 800	94	19.25 %
	801 < Cons.	99	19.25 %
Social instalment (other uses)	Cons.< 110	84	0
	111 < Cons.>400	92	19.25 %
	401 < Cons.	99	19.25 %

Kerosene

Kerosene is a source of well-known energy in rural areas and is used in many villages thanks to the bush lamp, the principal means of lighting.

Gas

The distribution of gas does not reach the rural areas.The rate of access to this energy is 46% in the urban zones and only 3,3% in the rural areas which are however areas of high food production.This gas is conditioned out of bottle of 6 kg, 12.5 kg 32 kg and 35 kg and is sold to 3200, 6500, 16800 and 18200 FCFA in 2017

Solar energy

The annual average of total horizontal radiation level is 4.5 kWh/m2 / day.A recourse to Reetscreen international software enabled us to obtain the weather conditions of Ebolowa, head quarter of the Region.The reference year and the weather conditions relating to it is given in table 12.This table shows that the Southern Regionof Cameroon is very wet with an annual average of relative moisture of 92% and annual average temperature of 23.5C. With a sunning duration ranging between six (6) hours to eight (8) hours, the valorization of this resource as principal source for drying is made difficult.

Table 12 : Reference year and the weather conditions related

Month	Reference year	Month avarage temperature	General average temperature	Average Relative Moisture	Average irradiation	Average wind speed
		°C	°C	%	KWh/m^2/j	m/s
January	2013	23.76	23.79	93	4.83	0.71
February	2012	24.05	24.07	90	4.76	1.03
March	2009	24.28	24.19	95	5.27	0.76
April	2009	24.26	24.27	95	5.03	0.78
Mai	2012	24.11	24.04	94	4.95	0.74
Jun	2008	23.32	23.29	94	4.37	0.83
Jully	2007	22.66	22.69	87	4.17	1.71
August	2009	22.60	22.63	94	4.12	0.90
September	2005	22.66	22.80	85	4.39	1.89
October	2009	23.00	23.06	96	4.36	0.77
November	2009	23.64	23.55	95	4.63	0.74
December	2007	23.56	23.55	85	5.17	1.53

Figure 9represents the monthly change of the solar irradiation.Marchwith an irradiation of 5.27 KWh/m2 / day is the sunniest month and the least sunny month is August with an irradiation of 4.12 KWh/m2 / day.

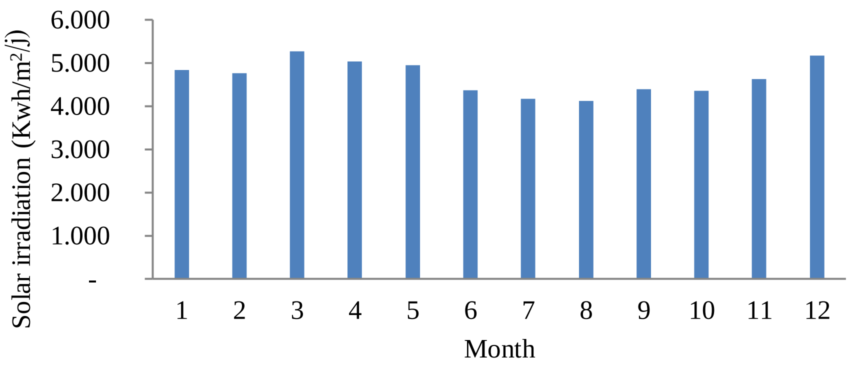

Figure 9: Monthly average of the solar irradiation change in Ebolowa

Wind

In figure 10 obtained from table 12, it is noted that the wind speed does not reach 2m/s during every month of the year. The valorization of this potential requires very complex and expensive installations out of range of the drying actorswho are mostly family units.

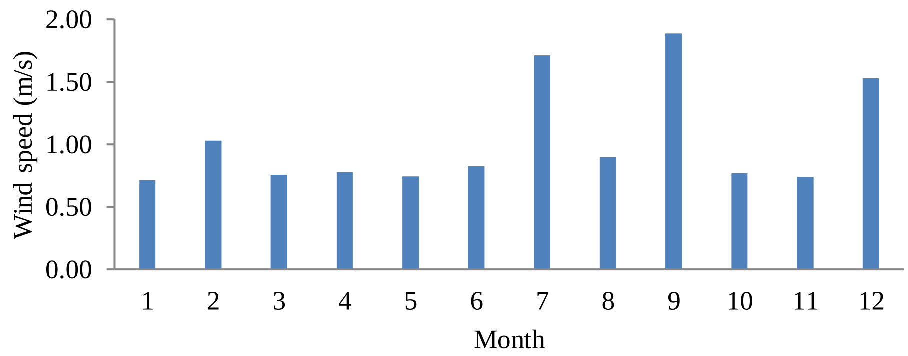

Figure 10: Monthly average of wind speed

Biomass

The vegetable coverage in the Southern Regionof Cameroon consists of two great forest formations:the wet dense forest with two alternatives (ombrophilous of low altitude of the littoral and sempervirente congolaise or Dja) and the wet dense forest with one alternative (marshy forest) what confers significant wood-energy resources to the region.Wood-energy, in rural area as in urban environment, remains the first energy vector in the Region.

The other types of biomass come from the residues of wood transformation, the agricultural residues, agroalimentary industries and domestic waste

Résidues of wood transformation

The residues of wood transformation are at priori of a particular interest because of their concentration on the site and of their availability related to steady operation of production of these industries, which can support a permanent activity of valorization.These residues come from first transformationindustries (table5) and secondary transformation industries (table 6).

Table5: Residues of primary wood transformation industries

Type of residues	Résidues in m3		Résidues in tonne	
barks	4187.092	8973.234	2094	4487
Slabbing off-cuts and delignures	14955.39	23928.62 4	7478	11964
Setting dimension of the	2392.862	7178.587	1196	3589
Sawdust	4187.509	7178.587	2094	3589
Total			12862	23629

The table shows that the potential gross available of the industry of first transformation thus varies from 12862 to 23629 tons.Part of the residues is converted at energy ends and free or brulé, distributed the sold remainder and thrown and could be developed for drying.

Table 6: Residues of secondarary wood transformation industries

Type of transformation	Nomber	Transformation capacity (m^3/an)	Output (%)	Residues (m^3)	Residues (tones)
Industrial joineries	24	22 308	80	4461.6	2231
Joineries	39	3 546	60	1418.4	709
Total				5880	2940

The table shows that the rough potential of residues available is 2940 tones per year.Because of their presence in the urban centres, the residues produced by joineries are used by the households for cooking and can also be used for energy valorization for drying purposes.

Finalywood processing industriespotential varies between 15802 to 26569 tones per year.

Agricultural residues

The cultures for food or industrial purpose leave a residue on the fields, generally developped bythe farmer, either to improve or maintain the productivity of the soil, or to feed animal.For each category, the evaluation of the potential is carried out based on the utilisation factor, when it is known.

Table 7: Agricultural Résidus

Type of residues	Noble product (tones)	Ratio produced noble/résidu	Residues (tones)
Maiz stems	68555	2	34277.5
Raids of Maiz	68555	0.2	342775
Rice straws	1728	1.75	987.4
Stems of Cassava	630573	2.70	233545.5
Groundnut straws	33322	2.3	14487.8
Raids of palm tree	12981	24	540.9
Cocoa hull	ND	1.25	-
Total			626 614.1

Estimation shows that more than 626 614 tones per year of agricultural residues are left in plantations of the Southern Region of Cameroon.In this case their energy valorization can be considered and the production of biomass will be reduced to the collection and conditioning according to requirements' of the user.

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Domestic waste

According to the Hygiene and Sanitarioncompany of Cameroon (Hysacam), the town of Ebolowa produces 30 000 tones of domestic waste per year of which 100 tones are tested for production of fertilizer and are distributed freely to the population and the remainder (29 900 tones) can be developed for drying purposes .

Problems and needs of the processors

The actors attest that the charge which is most expensive to them during the process of drying is the labour about 75%, followed by energy 25%.The high percentage in favour of the labour is justified by the proportion of the units practising sun drying which takes much time in the process.

The problems encountered by the processors practising sun drying are about 63.3%, the interruption of the process by rains and the insufficiency of solar energy. Then for 16.7 % of them, the problem is at the level of drying areas assun drying requires much space of storage.Those limitations of sun drying are evoked in the literature wich may lead to a poor quality of the dried products [19],[23].With regard to the users of the electric power, the precariousness of the energy infrastructures (frequent cuts, variation of the tension of the network) constitutes the principal drawback.Lastly, the problem of access to financing is announced by the actors who buys their raw material.

In expressed needs, 48% of the units practising sun drying wish an increase in the capacity of drying and request drying enclosures.But it is noticed that the actors rather prefere solar energy and electricity, although all of them wish to use waste for energy production.The requirement in financing expressed by certain processors is explained by the desire to increase the capacity of supplied raw material, need especially expressed by the retailers.

The needs expressed by all the actors in general go towards the reduction of drying time, the increase ofdrying capacity and the continuity of drying process in order to improve output, quality of dried products and especially to reduce losses during the process of drying.

All the actors wish to improve their productions are then motivated by the purchase of an adapted dryer, with mean criteria of purchase and by order of importance, the cost of the dryer (53.6%), the adaptation to the type of the product to be dried (30.4%), energy used (6.5%), the capacity of the dryer (5.1 %) and the financing (4.3%). The high percentage in favour of the cost justifies the large practice of sun drying, whose principal advantage is the low cost of the equipment.

IV. CONCLUSION

The problems of drying in the Southern Region of Cameroon were presented in order of needs and means.The investigation showed that these problems are related to the dryingtechniques.Three drying techniques of the agro-alimentary products are currently used in the area:

— Sun drying where the products are directly exposed to the sun on tapoline or trays over 82%.It is used for fruits, vegetables, seeds and tubers;

— Drying with wood where the product is spread out over a netting under which wood is burnt,which transmits its heat by natural convection to the product with over 16%.This type of drying is used more for meat and fish products.

— Drying with the electricity which is more used for cacao takes about 2% only.

The mostly used technique is sun drying which involves a long drying period caused by the low duration of sunning, the moisture of the air which is about 92% and the interruption by rains. The processors wishes to have a drying enclosure able to fulfill the following functions :

- Ensure the continuity of drying process ;
- Reduce the drying period ;
- Use solar energy preferably;
- Protect the product agains the rain, birds and insects.

A hybrid solar-biomass dryer that we recomend would be adequat. The biomass is selected because of its availability and its low cost in the area.

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