

THE NUTRITIONAL SIGNIFICANCE OF ROOT AND TUBER CROP DEVELOPMENT AS STAPLES IN THE CARIBBEAN COMMUNITY

*Omwale*¹

**Institute of Social and Economic Research
University of the West Indies, Kingston, Jamaica**

SUMMARY

The competition between cereals and root crops as CARICOM staples is described. The move to substitute locally grown food for imported wheat is shown to favor root crop development in the region. Against this background, traditional nutrition-prompted objections to wheat substitution by root crops are examined.

Evidence is cited to show the essential adequacy of protein in root crops, except plantain and cassava and for all humans except perhaps some infants. The low protein in cassava and plantain, it is proposed, can be easily overcome in the process of local root crop development.

Finally, it is argued that there exists the potential to obtain cheap calories from root crops. This and the generation of economic activity among small farmers, concomitant with root crop development, are seen as possible indicators of good nutrition for the region in the future.

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¹ This paper was written while the author was Professor and Director of the Nutrition Research Institute, University of Guyana. He is now Consultant to the Food and Agriculture Organization of the United Nations and an Honorary Research Fellow at the Institute of Social and Economic Research, University of the West Indies, Kingston, Jamaica.

INTRODUCTION

There is currently a competition between cereals and root crops for the position of main staple in the Caribbean diet. Table 1 from Gurney (1) shows that cereals presently account for 28^o/o to 59^o/o of the total energy intake in the CARICOM² territories: they are almost equally important as protein sources. On the other hand, root crops³ and starchy foods, like breadfruit and plantains, contribute only 3-17^o/o of the total energy intake and even less of the protein consumption. Perhaps of more significance is the considerable importance of wheat and wheat products. This group accounts for as much as 17^o/o of the total energy intake in Guyana which has the highest *per capita* rice consumption in the region. Corn is as yet unimportant in the Caribbean community as human food, so that the main cereal challenge to wheat comes from rice, of which Guyana is the main producer.

Rice is used largely in the boiled form accompanied by legumes and/or meat and often as a stew of some sort. It therefore constitutes rather a main meal. On the other hand, wheat is made into flour and consumed in a great variety of forms that bring it into the diet at all times of day: in salted or sweet foods, in main meals, or snacks. Thus, despite the lack of any known religious significance, it approaches the description of a "cultural superfood" as defined by Jelliffe (2).

Roots and tubers are more important in the territories (and among subsistence farmers) that consume small quantities of rice; the main competition is therefore between root crops and rice with wheat filling a somewhat special niche. Thus, bread is made extensively from wheat (except by small groups like the indigenous Indians) and forms an important part of the diet, being eaten regularly at two meals every day by many people. The East Indian population of Guyana and Trinidad also rely heavily on wheat *roti* or *puri* which may be eaten 3 or 4 times per day. The roots and tubers are consumed boiled or fried in much the same situations as rice and additionally in soup. There is, however, a small quantity of pies, puddings, and sweet breads or cakes made from root crops rather than wheat flour. It should be noted that even

2 CARICOM is the Caribbean Community which is an economic community association of the English-speaking Caribbean territories.

3 Used in this paper to include tuber crops.

TABLE 1

PERCENTAGE OF TOTAL ENERGY (E) AND PROTEIN (P) INTAKES
DERIVED FROM VARIOUS SOURCES IN SELECTED CARICOM
COUNTRIES

Food group	Barbados 1971		Guyana 1971		Jamaica 1972		St. Lucia 1970		Trinidad 1970	
	E	P	E	P	E	P	E	P	E	P
Cereal products	31	30	59	49	34	38	28	33	40	43
Wheat products	19	20	17	18	22	30	24	30	26	31
Rice	10	8	41	30	6	4	3	3	14	12
Roots, tubers & starchy fruits	10	7	6	3	15	10	17	11	3	3

Source: Gurney (1).

the contributions listed in Table 1 for root crops and starchy fruits include significant quantities of the latter.

The picture is therefore one of small root crop consumption alongside with wheat and rice, but decreasing in importance particularly in favor of the latter as one goes from lower to higher income status. The typical example of Jamaica is given in Table 2.

THE MOVE TO REPLACE WHEAT AS A CARICOM STAPLE

The great popularity of wheat in the CARICOM diet has an enormous foreign exchange cost because of the obligatory import of this commodity. Table 3 shows that the cost increased from between 48% and 130% in various CARICOM territories during the decade 1963-73. Efforts are therefore being made to develop locally grown substitutes for this imported cereal. Most attention, of course, is being directed towards the making of flour, the principal form in which wheat is marketed for consumption. The initial drives have been concerned with composite flours⁴ with a view to eventually reducing the wheat component to zero.

⁴ For a good review of this subject, see Rao and Chatelanat (3).

TABLE 2
RELATIVE IMPORTANCE OF COMPETING STAPLES AS ENERGY
AND PROTEIN SOURCES IN THE DIET OF VARIOUS SOCIAL
CLASSES IN JAMAICA

Foods	Ranking of main energy (E) and protein (P) sources for four expenditure groups							
	Lowest 25%		Second quartile		Third quartile		Highest 25%	
	E	P	E	P	E	P	E	P
Bread	6	3	5	2	5	4	4	3
Wheat flour	2	1	1	1	3	3	5	7
Rice	3	2	4	5	1	2	1	4
Yam	—	5	—	10	—	10	—	10

Source: Gurney (1).

Guyana, which is the region's major rice producer, considers this commodity an important foreign exchange earner so that it is low on the list of contemplated wheat flour substitutes. Expansion of corn production is geared towards substitution for imported animal feeds; therefore, the root crops and starchy fruits are the main contenders for replacement of wheat flour.

Conclusive experimental and pilot scale work has been done by Sammy (6) in Trinidad on sweet potatoes, yams (*Dioscorea*) and breadfruit flours. The Jamaica Industrial Development Corporations' Institute of Food Technology has also done tests on banana and breadfruit flours while work on cassava flour is in progress in Guyana. These trials have shown that bread of acceptable quality by the consumer can be made from all of these composite flours. With sweet potato, up to 20% substitution for wheat was undetected. Minor problems of staleness are encountered with the cassava blends, but methods exist for minimizing these.

Sammy (7) calculated that a 10% substitution would result in an initial saving of some US \$4.3 million of foreign exchange presently committed to wheat imports by the CARICOM countries. This is an ample incentive for a substitution program. There will be an eventual requirement for new baking technology and equipment. However, in a phased substitution, savings and time would permit such a change without difficulty. The production of roots rather than the purchase of new equipment is likely

TABLE 3

**IMPORTS OF WHEAT AND WHEAT FLOUR, IN WHEAT
EQUIVALENTS, IN SELECTED CARICOM COUNTRIES**

Country	Quantity (tons)		Increase over 10 year period*		
	1963	1973	Quantity (tons)	Value (US \$)	Value (% increase)
Barbados	17,157	20,880*	3,723	716,000	53
Belize	8,598	10,418*	1,820	420,000	61
Guyana	38,539	54,167	15,628	3,740,000	115
Jamaica	129,544	209,684	80,140	12,913,000	137
Trinidad	86,572	97,558	10,986	3,727,000	48

Sources: Rao and Chatelanat (3), and *Food and Agricultural Organization of the United Nations (4,5).

to be the limiting factor in the program.⁵ There is thus every likelihood that, in addition to Guyana where it is already a stated policy, the other territories will move increasingly towards wheat substitution; in that event the root crops appear to be early contenders for the role of indigenous staple substitute.

**THE TRADITIONAL NUTRITIONIST'S VIEW OF WHEAT
SUBSTITUTION**

Although no dissent is expressed over the need to replace wheat imports, nutritionists often voice concern about the protein content and retail cost of possible substitutes. In this regard they usually emphasize two points: a) wheat flour has an average of about 11% protein; substitutes like rice only contain 7-8% protein while root crops like cassava have even less (2%). Thus, in their view, there is a danger of aggravating the existing protein deficiencies by unfortified wheat substitution; b) the retail cost of

⁵ For example, Guyana that produced 14,000 tons of cassava in 1973, required some 23,000 tons for a 10% substitution of 1975 wheat imports.

nutrients from wheat flour and other cereals like corn are often less than that from alternatives like root crops (8). There is therefore some concern that, consequently, higher flour prices might lead to a reduction in its purchase and consumption, to the nutritional disadvantage of the poor who are already at risk.

AN ESSENTIALLY DIFFERENT NUTRITION PERSPECTIVE

New approaches to food and nutrition planning, however, involve more than a superficial look at present average consumption and cost of nutrients. They require a disaggregated view of nutrition that identifies the specific characteristics of narrowly-defined groups who are at risk of malnutrition and whose development must be undertaken (9). It is proposed therefore that decisions on wheat substitution must be made on the basis of information concerning several issues: a) how important is wheat in the diet of those at risk of malnutrition? b) is the malnutrition problem a pure protein deficiency? c) would substitution of wheat flour by root crops lead to pure protein deficiency in the diet of flour users? d) what are the real current social costs of producing nutrients from root crops as compared to cereals and what potential exists for cost reductions? e) what, therefore, would be the net social benefit of substituting locally-produced root crops for presently imported wheat?

Wheat and the Nutritionally at Risk

Table 2 shows that wheat is quite important in the diet of poor Jamaicans since it supplies them more energy than rice to which it eventually gives way as one progresses up the income scale. As a protein source it is also more important than yam and rice. This picture is not atypical of the rest of CARICOM. Therefore, we can be certain that wheat substitution policies may affect the region's poor. Unfortunately, no information is available on consumption patterns of infants and young children of the poor who are especially at risk of malnutrition. With this fact in mind, we therefore concentrate largely on the effects that substitution would have on the older population.

The Nature of the Nutrition Problem

When the Caribbean nutrition problem is carefully defined, no evidence exists to indicate the existence of pure protein deficiency. Rather, the food consumption surveys done by the Caribbean Food and Nutrition Institute indicate the problem to be generally one of insufficient food intakes. In other words, increased consumption of the same diet in order to satisfy energy needs would also satisfy protein requirements. This is not surprising in view of current knowledge of protein requirements and the composition of staples. Wheeler (10) in a study of two healthy breast-fed infants reported a value of about 4.8 for the NDpE⁰/o of the mother's milk.⁶ This is consistent with the calculations of Payne (11) who defined the *safe level* of protein in the diet of all young children to be just about satisfied by an NDpE⁰/o of 5 in the presence of adequate dietary energy. The figure is, of course, less for healthy adults. It should be emphasized that one is considering safe levels which therefore permit a margin for many whose requirements, though unknown, will be less than that of the most demanding individual. As Table 4 shows, apart from plantain and cassava, a wide variety of staples used in the Caribbean are, on their own, sufficiently protein concentrated to support healthy humans. The two former food items, with breadfruit and some protein-poor sweet potato varieties are commonly eaten with small quantities of legumes and/or animal protein. The indigenous Amerindians of Guyana, for example, are traditionally a hunting and fishing people in addition to being cassava consumers.

The Protein Quality of Composite Flours

Apart from these issues, Table 5 shows that substitution of 10⁰/o cassava flour for wheat flour would probably only reduce the protein/energy balance from 5.6⁰/o to about 4.9⁰/o NDpE. The higher rate of 20⁰/o substitution resulting in 4.5 NDpE⁰/o could still on its own support life, except perhaps for some infants. Clearly, since the substitutes like yam, eddoe and sweet potato are superior to cassava in terms of protein content,

⁶ NDpE⁰/o is the net (utilizable) dietary protein expressed in energy equivalents and as a percentage of total energy in the diet.

TABLE 4

AVAILABLE DATA ON NET DIETARY PROTEIN ENERGY RATIOS
(NDPE^{o/o}) OF COMPETING STAPLES IN THE CARIBBEAN

Staple	Crude protein energy (^{o/o} of total)	Utilizable protein percent of energy calculated as crude protein calories percent multiplied by	
		NPU (child)	Protein score
Wheat	12	5.2	5.6
Rice	8	6.1	6.5
Corn	9	4.8	5.4
Yam	8	—	6.0
Plantain	4	—	2.3
Cassava	2	—	1.5

Source: After Payne (11).

they represent even safer propositions. In any event, it should be remembered that the diet of even those at risk contains very small but useful quantities of supplementary proteins like legumes, green leafy vegetables, milk or meat. Energy would therefore still remain the limiting factor in the diet of poor people who consume composite flour including moderate quantities of root crops. Larger quantities of complete substitution could clearly afford supplementation with legumes or fish meal as so often proposed by nutritionists and food scientists.

The Nutrient-Cost Potential of Root Crops

Cost of production data is extremely difficult to obtain in the CARICOM countries. This is largely because yield reports are questionable on account of widespread intercropping on small food crop farms. There is also considerable variation in the use of inputs so that averages are somewhat difficult to construct and interpret. Furthermore, nutrient cost at retail level is subject to wide fluctuations due to price variations and differences in subsidy and quantities imported from time to time and from place to place. Table 6, for example, shows that whereas corn meal was the

TABLE 5

PROBABLE PROTEIN/ENERGY RATIOS IN CASSAVA SUBSTITUTED FLOUR

Composite	Per 100 g					Score	FE ^o /o	NDpE ^o /o
	Wt (g)	Energy (KC)	Protein (g)	Sulphur AA (mg)	Lysine (mg)			
Cassava	10	34	0.15	4.15	6.22	$\frac{202.78 \times 100}{9.60 \times 43}$	10.6	4.9
Wheat	90	328	9.45	378.95	196.56			
Blend 1	100	362	9.60	383.10	202.78			
Cassava	20	68	0.30	8.30	12.44	$\frac{187.16 \times 100}{8.70 \times 43}$	9.5	4.5
Wheat	80	291	4.40	336.84	174.72			
Blend 2	100	365	8.70	345.14	187.16			

Source: Calculations based on protein score deduced from FAO recommended amino acid profile.

TABLE 6

**RELATIVE COSTS OF ENERGY FROM COMPETING STAPLES IN THE
CARICOM. COMPARISONS BETWEEN JAMAICA (1974) AND
ST. LUCIA (1975) AND BETWEEN CRUDE RETAIL COSTING
AND SOCIAL COSTING**

Product	Ranking in descending order of cheapness of energy by		
	Retail price in Jamaica (1974)*	Retail price in St. Lucia (1975)**	Adjusted social cost in St. Lucia (1975)**
Rice	4	1	1
Green banana	3	4	2
Corn meal	1	2	3
Tania	—	5	4
Wheat flour	2	3	5
Breadfruit	—	6	6
Dasheen	—	6	7
Sweet potato	5	6	8
Ripe banana	6	6	9
Bread	—	6	10

Sources: * Gurney (8) and ** McIntosh (12).

cheapest energy source in Jamaica during 1974, rice calories were cheaper in St. Lucia in 1975. Again, when use is made of the method proposed by McIntosh (12) to account for "national" or social costs of imports and subsidy etc., results are quite different. Such adjusted costs make green bananas cheaper than corn meal and tania (*Xanthosoma sp.*) superior to wheat flour as compared to crude retail costing.

More important for planning and development are costs of production and the potential for increasing productivity of root crops as compared to cereals. Table 7 shows that in Guyana rice and corn are currently better calorie yielders than cassava for each dollar invested on a per diem basis of unit land use. Clearly, however, the potential for cassava improvement far exceeds that of the two cereals. For a start, the average per hectare yields of corn and rice in Guyana compare more favorably with world averages than does that of cassava. Again the highest recorded

TABLE 7

PRODUCTIVITIES AND COST OF PRODUCING ENERGY FROM SOME ALTERNATIVE SYSTEMS

Crop	Yield (T/ha)	Growth period (days)	o/o Edible	Edible production (T/ha/d x 10 ⁻³)	KC/kg	Edible production (KC/ha/d x 10 ³)	Cost (G/S ha)	Production
Rice (Guyana average)	1.48	100	70	10.36	3,520	36.46	n. a.	n. a.
Rice (Guyana special)	3.22	100	70	22.54	3,520	79.67	299	266
Rice (World average)	2.00	150	70	9.33	3,520	32.85	n. a.	n. a.
Rice (IRRI variety)*	16.40	—	—	71.23	3,520	250.73	—	—
Corn (Guyana av.)	1.70	135	100	12.59	3,630	45.70	n. a.	n. a.
Corn (Guyana special)	3.00	120	100	25.00	3,630	90.75	350	259
Corn (World average)	2.10	135	100	15.56	3,630	56.00	n. a.	n. a.
Corn (INEAC variety)*	5.50	—	—	54.79	3,630	192.86	—	—
Cassava (Guyana average)	5.61	330	83	14.11	1,530	21.59	n. a.	n. a.
Cassava (Guyana special)	6.01	330	83	15.12	1,530	23.13	714	32
Cassava (World average)	9.10	330	83	22.89	1,530	35.00	n. a.	n. a.
Cassava (APL variety)*	77.00	—	—	194.79	1,530	298.03	—	—

Sources: Calculations based on Ministry of Agriculture, Guyana (14), Robert R. Nathan Associates Inc. (15), and De Vries, Ferwada and Flach (16).

* Highest recorded yields, cited by Wilson (13).

yields according to Wilson (13) indicate a bright future for cassava. The same is true for other root crops which can even be further improved by breeding to an extent unavailable for cereals (16). In Western Central Africa, Johnston (17) determined that the cheapest calories are already produced by cassava, followed by sweet potato, corn, eddoes, sorghum, millet, rice and yams, in that order.

Recent small plot, new variety trials in Guyana have already given cassava yields some 5-7 times greater than those of traditional varieties. The cost of some inputs will no doubt increase because of the new technology associated with some of these varieties but, certainly, research will lead to greater efficiencies and the nutrient cost will fall considerably. The net benefits of wheat substitution by root crops will therefore be very likely great, and can have considerable significance for nutrition improvement in the Caribbean. The necessary development of root crop production and productivity should, and indeed must, involve the small farming families who are currently growing these crops and are also at risk of malnutrition. For these groups, the rural landless and secondarily the urban unemployed, there could be new and increased income, cash and non-cash, but all likely contributing to improve their current nutritional status.

CONCLUSIONS

In evaluating the potential contribution root crops can make to wheat substitution due attention should be paid to the historical development of the Caribbean diet. Clearly the present importance of wheat in the CARICOM is due in a great measure to the colonial relationship which evolved between the region and Europe (18). In that circumstance there could have been no encouragement for the development of an indigenous staple like the cassava of the Amerindians. On the other hand, a new awareness of the importance of self reliance can foster the emergence of appropriate local staples with relevant technology and adequate forward and backward socioeconomic linkages. It is precisely such a development that could improve nutrition in the region if, as is proposed, it creates new jobs and new opportunities for the poorest and the most deprived: to feed themselves adequate quantities of foods.

In the process one would need to exercise special care to

ensure that the mode of production and distribution of composite flours does not result in disadvantageous diet changes among farmers. The welfare of small cassava farmers e.g., must be improved sufficiently for them to purchase enough of the centrally marketed flour rather than replace other food crops with cassava and consume proportionately larger quantities of the latter. Entry into the cash economy must also be accompanied by sufficient improvement in the financial status of subsistence farmers to accommodate "buying-up" and the high income elasticities of demand for consumer durables; otherwise, there may be some reduction in the quantities of food consumed by members of these at-risk households (19). With these cautions, it is clear that root crop development in the CARICOM could be one basis for improving nutritional status in the region rather than necessarily endangering it as has been suggested by some.

RESUMEN

LA IMPORTANCIA NUTRICIONAL DEL DESARROLLO DE LOS TUBERCULOS COMO ALIMENTO PRINCIPAL EN LA COMUNIDAD DEL CARIBE (CARICOM)

Se describe la rivalidad entre granos y tubérculos como el alimento principal de CARICOM. El movimiento de sustituir alimentos cultivados localmente por el trigo importado demuestra la preferencia que hay por el desarrollo de tubérculos en la región. Dentro de este marco, se examinan las objeciones que, fundadas en la nutrición tradicional, hay en cuanto a la sustitución de trigo por tubérculos.

Se cita evidencia demostrativa de que esencialmente, los tubérculos en general, a excepción del plátano y yuca (*Musa sp.* y *Manihot sp.*, respectivamente), contienen proteína adecuada para consumo humano, salvo, quizás, algunos niños. Se propone que la escasa proteína de la yuca y del plátano es fácilmente controlable durante el proceso del desarrollo de tubérculos locales.

Finalmente, se argumenta que existe la posibilidad de obtener calorías baratas de los tubérculos. Esto y la generación de actividad económica que existe entre los agricultores que poseen granjas pequeñas, juntamente con el desarrollo de tubérculos, se consideran como posibles indicadores de lograr una buena alimentación para la región en el futuro.

yields according to Wilson (13) indicate a bright future for cassava. The same is true for other root crops which can even be further improved by breeding to an extent unavailable for cereals (16). In Western Central Africa, Johnston (17) determined that the cheapest calories are already produced by cassava, followed by sweet potato, corn, eddoes, sorghum, millet, rice and yams, in that order.

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