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Rural nutrition interventions with indigenous plant foods – a case study of vitamin A deficiency in Malawi

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Identification, propagation, and introduction of a nutritionally rich, indigenous plant species in the existing cropping system are presented in this paper as a method of rural nutrition intervention. A case study of Moringa (*Moringa oleifera* Lam.; Moringaceae), which is a common tree in Malawi and one of the richest sources of vitamin A and vitamin C compared to the commonly consumed vegetables is presented to address the problem of vitamin A deficiency. After a brief review of the prevalence of vitamin A deficiency and the efforts to reduce its incidence in Malawi, Moringa is suggested as a potential solution to the problem. A framework for designing nutrition intervention with Moringa is described for actual implementation. It is argued that attempts to identify, document, and encourage the utilization of nutrient-rich indigenous plants could be cost-effective, and a sustainable method of improving the nutritional status of local populations.
Keywords. Indigenous plants, *Moringa oleifera*, rural nutrition, vitamin A deficiency, Malawi, Africa.

Utilisation de plantes indigènes dans l'alimentation en milieu rural – une étude de cas : la carence en vitamine A au Malawi. L'identification, la multiplication et l'introduction d'espèces végétales indigènes de haute valeur nutritionnelle dans les systèmes culturaux sont présentées comme une méthode d'intervention dans le secteur de la nutrition en milieu rural. Afin d'apporter une réponse au problème de carence en vitamine A, une étude de cas concernant le Moringa (*Moringa oleifera* Lam.; Moringaceae), un arbre du Malawi riche en vitamines A et C est développée. Après une brève revue sur l'importance de la carence en vitamine A et sur les efforts réalisés au Malawi pour réduire son incidence, l'auteur met en évidence le Moringa comme une solution potentielle au problème. Un cadre pour développer une intervention dans le secteur de la nutrition grâce au Moringa est décrit dans le but d'une application directe. L'auteur montre que les essais destinés à identifier, documenter et encourager l'utilisation de plantes indigènes caractérisées par leur haute valeur nutritionnelle constituent des voies peu coûteuses pour améliorer durablement l'état nutritionnel des populations locales.
Mots-clés. Plantes indigènes, *Moringa oleifera*, nutrition rurale, carence en vitamine A, Malawi, Afrique.

1. INTRODUCTION

Household food security and nutrition issues are at the top of the planning agenda in many countries in sub-Saharan Africa. Uncertainty in rainfall and low adoption level of improved technologies in crop production have resulted in low levels of food availability in many of these countries. In addition, low levels of income among subsistence farmers reduce the accessibility to food markets during periods of decreased crop yields. The seasonality in their production and availability of main staple foods result in food insecurity (Sahn, 1989). The introduction of food crops, such as maize and soybean, in some of these countries over the past century has to a large extent replaced the drought resistant crops, such as sorghum and millets. In some cases, this adds to the vulnerability of rural households to low and unpredictable rainfall patterns (Warren *et al.*, 1995; Marsh, 1998). In addition, this has also resulted in changes in the composition of diets with increased consumption of these newly introduced foods among the rural population over the decades (Delgado, Miller, 1988). While the introduction of exotic plant species has gradually displaced indigenous food crops in many local diets, it has also meant a loss of indigenous knowledge systems related to cultivation and utilization of these crops (FAO, 1989; Richards, 1990; Warren *et al.*, 1995). In some cases, with increased incomes from these new crops, rural subsistence households tend to depend more on, and demand more of, these new food crops, thereby increasing their dependency on market systems. As a result, these households have gradually become more vulnerable to market and price fluctuations in obtaining adequate food to meet their nutritional requirements. While this is the situation found in most rural populations in sub-Saharan Africa in attaining adequate calories from

staple food intake, the same could be said for the intake of most of the other essential nutrients including protein, vitamins, and minerals.

Adequate intake of vitamins and minerals is essential for preventing common micronutrient disorders such as vitamin A, iron and iodine deficiencies. Several diseases associated with micronutrient deficiency could be prevented if amongst other interventions, adequate information on the existence and uses of indigenous plants that provide these nutrients were made available to rural households through better designed and implemented nutrition education and agricultural interventions. The problem of vitamin A deficiency and the widespread availability of Moringa (*Moringa oleifera* Lam.; Moringaceae) in Malawi, one of the indigenous plants rich in vitamin A as well as other nutrients, is a typical case (Williamson, 1975; Ramachandran, 1980).

Vitamin A deficiency has been recognized as a serious public health problem in Malawi (Ayoade, 1988). Government efforts to reduce its incidence have made little progress. Government agencies have recognized the importance of using indigenous plant foods in trying to solve nutritional disorders such as vitamin A deficiency and have incorporated this into policies (Government of Malawi, 1990a). The overall purpose of this paper is to present a framework for implementing a policy of introducing indigenous plants as a rural nutrition intervention by governmental and non-governmental agencies in developing countries. The framework is also helpful to identify, propagate and process nutrient-rich indigenous plant species for increasing the micro-nutrient intake. A system to disseminate information on the uses of indigenous plant species through the existing system of extension is also presented.

The paper is organized as follows. First, a case study of vitamin A deficiency in Malawi is presented along with its potential solution, the use of Moringa, a local plant found throughout in Malawi. This is followed by a section on the organization and utilization of indigenous plant species in rural nutrition interventions. Concluding remarks form the last section.

2. CASE STUDY OF VITAMIN A DEFICIENCY AND MORINGA IN MALAWI

Malawi is a small land-locked country in eastern Africa with ninety percent of its population living in rural areas. Agriculture is the mainstay of the rural population with agricultural land constituting the primary natural resource for the Malawian economy. Agriculture also contributes 40% of gross domestic product and 77% of the national export revenue. The agricultural sector in Malawi is dualistic with a smallholder sector and an estate sector. Smallholder sector cultivates about 1,421,890 hectares of land of which maize occupies 1,274,400 hectares (72% of smallholder land in 1993–94) with local, composite and hybrid varieties forming respectively 91%, 2%, and 7% of maize hectarage. Maize is the major staple food crop which, because of agro-climatological factors, is only grown during (October–May) rainy season. Other major smallholder sector crops include groundnuts (12%), cotton (2%), cassava (3.56%), pulses (12%) and sorghum (1.73%) (Govindan, Babu, 1996). Some 55% of the smallholder farmers cultivate less than 1.0 hectare of land; 75% of them cultivate less than 1.5 hectares and 25% cultivate more than 1.5 hectares of land. The estate sector comprises land-holdings with more than 5.0 hectares and cultivates cash crops such as tobacco, coffee and tea. It is also a major source of employment for the landless labourers in rural areas. The development policies of Malawi have concentrated on the expansion of food and cash crop production through yield increases, improved road infrastructure and communication, increased educational facilities and small-scale industrial development.

The country is characterized by high level of child malnutrition, (39.1%, 7%, and 48% of children under five years of age are under weight, wasted and stunted respectively); high fertility rate (6.8), high infant mortality rates (137/1000), low urbanization (14.1%), and significant degree of international migration for work in neighbouring countries (UNICEF, 1998). The major causes of morbidity and mortality are malaria, acute tuberculosis and malnutrition.

Unreliable rainfall patterns, poor soil quality and low-intensity agricultural practices result in chronic food deficits in many parts of Malawi (Babu, Mthindi, 1994). The problem of inadequate micronutrient intake is exacerbated by very low intake of vegetables and fruits. The most common nutritional disorders in Malawi, besides the problem of protein-energy malnutrition (about 30% of children under 5 years of age are below the normal weight for their age), are vitamin A deficiency as well as micronutrient deficiencies of iodine and iron.

2.1. Vitamin A deficiency in Malawi

Vitamin A deficiency is a common and widespread nutritional disorder in many developing countries. The World Health Organization (WHO) and UNICEF have defined the prevention and control of vitamin A deficiency as one of the priorities in their nutrition programmes (WHO 1989; UNICEF, 1990). High level of vitamin A deficiency has also been identified as a major causal factor for young child morbidity and mortality (Martorell, 1989). In Malawi, vitamin A

deficiency is a public health concern. It manifests into xerophthalmia – mostly as night blindness in southern and eastern parts of the country. The World Health Organization and the International Consultative Group on Vitamin A Deficiency have declared Malawi as having serious vitamin A deficiency among its population compared to other countries in southern Africa (Escoute *et al.*, 1989).

A summary of results of surveys conducted in Malawi on the prevalence of vitamin A deficiency is given here to present the nature of the problem. Although, vitamin Adeficiency was not identified then as a causal factor, the problems associated with blindness in Mala have been reported since the early seventies (Chirambo, Benezra, 1976; Benezra, Chirambo, 1977; Budden, 1979). Asurvey conducted in 71 villages in the southern region during 1983 reported that 39 children out of 1000 children under the age of six years had active xerophthalmia (Chirambo *et al.*, 1986). According to a recent study by UNICEF and the Government of Malawi, between 0.8% to 1.0% of total population in Malawi is presumed blind, much of which could have been prevented since most of the cases are related to vitamin A deficiency (UNICEF, 1987). Escoute *et al.* (1989) using the conjunctival impression cytology method to estimate prevalence of vitamin A deficiency, found that about 22% of children aged between 22–84 months were affected in Salima and Dedza districts.

2.2. Attempts to combat vitamin A deficiency

A range of interventions has been suggested by international organizations involved in combating vitamin A deficiency in developing countries (Tielsch, Sommer, 1984; Bauernfiend, 1986). While the choice of a method of intervention in general depends on the extent of the problem, resource availability, and conditions of households to respond to the intervention, all currently available methods have a number of specific difficulties during implementation. The following are the major intervention methods being implemented in Malawi.

2.2.1. Horticultural crop production. The Government of Malawi attempted swiftly to mitigate the effects of vitamin A deficiency when the problem was identified a decade ago (Ministry of Health, 1990). Increasing the intake of vitamin A through the production and consumption of horticultural crops with high carotene contents such as beet root, carrot, papaya, and leafy vegetables such as amaranthus was suggested as a method of intervention to increase vitamin A intake in Malawi. A pilot project to increase vegetable production was initiated in 1987 with FAO technical assistance in the Lower Shire Valley in Ngabu Agricultural Development Division. Free inputs were given to the rural households to grow vegetable and fruit crops. The impact of this programme, however, has never been evaluated for improvements in intakes of vitamin A. Moreover, there were several operational difficulties in implementing the project. First, the identification of the project's beneficiaries included a majority of farmers with large holding sizes limiting the number of poor households affected by vitamin A deficiency which received help. Second, vegetables and fruits produced by the households were not fully consumed by them; they were sold in the nearby markets to generate cash incomes. Thirdly, since seeds and fertilizers had to be given at the beginning of every growing season, the project was not self-sustaining, and depended on external funds. This has resulted in a low number of farmers who have continued to cultivate vegetable and fruit after the end of the project.

2.2.2. Vitamin A supplementation. In 1985, the Ministry of Health in collaboration with the International Eye Foundation began an intervention programme through which general eye care was combined with the distribution of vitamin A capsules supplied by UNICEF. Children aged six months and over received a high dose capsule (200,000 i.u.[1]) twice a year, and lower dose capsules (100,000 i.u.) were given to children under six months. The distribution of vitamin A capsules was seen as a short term strategy to be continued with increased intake of micronutrients through regular diets in the long-run. The main thrust of this programme was in the extension and intensification of the distribution system to cover all target groups – those with cases of measles, protein-energy malnutrition, and pregnant and lactating women – through the network of Maternal and Child Health Services covering all parts of the country. Although it could be said that reasonable success has been achieved, this is not seen as a sustainable method of intervention either. This method has failed in other developing countries (Tielsh, Sommer, 1984). Experiences elsewhere, have highlighted some of the problems in implementing successful capsule distribution programmes (Cohen *et al.*, 1987). A major problem of implementation in Malawi was that the vitamin A capsules had to be imported and hence, the programme depended heavily on external donor assistance.

2.2.3. Agricultural extension. Agricultural extension services could provide a major vehicle for nutrition education. The female extension cadres of the Ministry of Agriculture, the so-called Farm Home Assistants (FHAs), have the main responsibility for the nutrition education programme which is oriented largely to female farmers. Efforts have been made to involve

[1] i.u. = international units

male farmers in nutrition education programmes by extending the messages through the male extension staff. The Government of Malawi published a guideline book on nutrition education (Government of Malawi, 1990b) to be used by the extension staff and subject matter specialists in the rural areas. Vitamin A related messages are included in the guidelines. A specific manual for prevention and control of vitamin A has also been prepared (Ayoade, 1990). However, in practice, the male agricultural extension staff rarely use nutrition messages in their regular extension programmes in Malawi.

2.3. Indigenous Moringa as a solution

The Food and Nutrition Unit in the Ministry of Agriculture recently identified nutrient-rich, Moringa (*Moringa oleifera*), a local tree popularly known as drumstick which is commonly grown in several parts of Malawi as a potential solution to vitamin A deficiency. A native of eastern India, Moringa is found throughout the semi-arid tropics. It is widely grown as a multipurpose vegetable in south Asian and south-east Asian countries (Ramachandran, 1980) and elsewhere. Moringa trees are also commonly grown as live fence posts or hedges. Almost all parts of the tree are economically useful (Briscoe, 1990). Young fruits, leaves and flowers are cooked as vegetables in many parts of Malawi (Williamson, 1975). However, in places where it is consumed, its use has been restricted to the seasons of the year when the main staple food becomes scarce and it has remained in these areas as one of the 'crisis'or 'emergency'foods.

In general, edible leaves from vegetable plants are a rich source of beta-carotene which is a precursor for vitamin A. **Table 1** compares the nutrient content of important plant foods commonly consumed by rural Malawian households to Moringa. Only plant foods which reputedly have a high content of vitamin A, as indicated by the nutrition manuals used in Malawi, are compared to Moringa (Ayodade, 1990). Compared to all other leafy vegetables that are commonly used in Malawian diets, Moringa has the highest content of vitamin A and vitamin C. It also contains equally good amounts of protein, phosphorous, and calcium. The contribution of vitamin A to rural diets from Moringa could be extremely high if consumed regularly. While all plant foods shown in **table 1** are sold in the local markets, Moringa is available abundantly, in many parts of Malawi, during the dry season and during periods of food shortages in local markets. It should however be noted that in comparing the nutrient contents of various crops, average values are used. In practice, these values may differ depending on the methods of analysis, stages in which the leaves are picked and the conditions of cultivation.

It is useful to compare the cost of nutrients from various sources with that of Moringa to see the economic benefits in recommending Moringa as a candidate for nutrition intervention with indigenous plants. In order to study the preferences and consumption of Moringa, a field survey was conducted among 150 households in the Salima district of Malawi (Babu, Chale, 1994). Data on the prices of various vegetables in the local markets were also collected. The cost comparison of three major nutrients from different food sources is given in **table 2**. The cost ratios for vitamin A show that Moringa is the cheapest source of vitamin A of all commonly used foods in Malawi. The cost of vitamin A from beans is about 150 times higher than that of

Table 1. Nutrient contents of common relish foods in Malawi compared to Moringa[(1)] (per 100 g edible portion) — *Contenus nutritionnels d'aliments communément observés au Malawi comparés au Moringa (par 100 g de partie comestible)*.

Nutrients	**Beans** (*Phaseolus* spp.)	**Cowpea leaves** (*Vigna unguiculata*) (L.) Walp.)	**Turnip leaves** (*Brassica rapa* L.)	**Cassava leaves** (*Manihot esculenta* Crantz)	**Amaranthus leaves** (*Amaranthus* spp.)	**Pumpkin leaves** (*Cucurbita moschata* Duchesne ex Poir.)	**Moringa leaves** (*Moringa oleifera Lam*.)
Energy (Kcal)	320	45	35	90	45	25	95
Protein (g)	22	4.7	2.9	7.0	4.6	4.0	6.7
Phosphorous (mg)	95	63	130	120	100	135	70
Vitamin A (i.u.)[(2)]	85	389	708	1667	1278	556	3767
Vitamin C (mg)	25	56	62	310	50	80	220
Calcium (mg)	22	225	160	300	410	475	440

The common relish foods in Malawi are selected from a coding exercise of possible relish foods in Malawi conducted for Food Security and Nutrition Monitoring Survey (Babu and Mthindi, 1994) in the Ministry of Agriculture.

(1) Source for Moringa is Gopalan *et al.* (1981), and source for all other foods is West *et al.* (1985); (2) The β carotene from different foods have been converted to vitamin Afollowing Beiri and Mckenne (1981) for easy comparison and is measured in international units (i.u.).

Table 2. Cost comparison of nutrients from different sources (MK(1)/100g) — *Comparaison des coûts de nutriments provenant de différentes sources (Mk/100 g).*

	Vitamin A		Vitamin C		Calcium	
	Cost/1000 i.u.	Cost ratio(2)	Cost/100 mg	Cost ratio	Cost/100 mg	Cost ratio
Moringa leaves (*Moringa oleifera*)	0.08	1:1	0.13	1:1	0.07	1:1
Cowpea leaves (*Vigna unguiculata*)	1.28	1:16	0.89	1:7	0.22	1:3
Turnip leaves (*Brassica rapa*)	0.70	1:9	0.81	1:6	0.31	1:5
Cassava leaves (*Manihot esculenta*)	0.30	1:54	0.16	1:1.2	0.17	1:2
Amaranthus leaves (*Amaranthus spp.*)	0.63	1:8	1.60	1:12	0.20	1:3
Pumpkin leaves (*Cucurbita moschata*)	1.44	1:18	1.00	1:8	0.14	1:2
Beans (*Phaseolus spp.*)	12.04	1:150	4.00	1:31	4.55	1:65
Egg (hen)	1.19	1:15	–	–	1.78	1:25
Milk	5.65	1:74	80.00	1:615	0.55	1:8
Beef liver	0.71	1:9	13.33	1:103	25.00	1:36

(1) 1 MK (Malawi Kwacha) = 0.02 USD; (2) Cost ratio compared to Moringa; the estimated price of Moringa is calculated as price of Moringa = price of other source compared × (nutrient content of Moringa/nutrient content of other source compared).

Moringa. Even among leafy vegetables, the cost of nutrients is the lowest when they are consumed in the form of Moringa. Similar benefits are shown for cost comparisons of vitamin C and calcium from Moringa.

Besides being a high value plant in terms of nutrition, the seeds of Moringa have been useful for purifying water in rural areas where potable water is not available, and thereby reducing the incidence of diarrhoeal diseases (Mayer, Stelz, 1993). Moringa has also been effectively introduced in agroforestry systems in south India where it is grown for its fruits and leaves which are commercialised (Babu, Rajasekaran, 1990). Given that Moringa grows in all parts of Malawi, it could form a successful component of agroforestry systems at least in areas where vitamin A deficiency poses a serious problem.

The organization and planning of rural nutrition interventions with indigenous plant foods is presented in the next section.

3. DESIGNING RURAL NUTRITION INTERVENTIONS WITH INDIGENOUS PLANTS

Methods of food-related nutrition interventions in rural areas can be classified into five major groups, namely, food subsidies, growing commercial crops, development of home gardens, supplementary feeding, and food rations (Goldman, Overholt, 1981; Kennedy, Pinstrup-Andersen, 1983). While components of Indigenous Knowledge Systems (IKS), which include a system of collecting, documenting, and using indigenous knowledge for development interventions (Warren *et al.*, 1995), could be incorporated in each of the above methods, IKS on nutritious plant species by itself is presented here as a method of nutrition intervention. Several international and non-governmental organizations have shown interest in documenting and utilizing indigenous knowledge systems of farmers in implementing agricultural and rural development projects (Warren *et al.*, 1988) and in natural resource management (Rajasekaran *et al.*, 1990). A great deal of emphasis had also been given to identify local plants that are rich in one or more nutrients and use them in local diets to increase food security and nutrition (Ogle, Grivetti, 1983; Malaisse, Parent, 1985; FAO, 1989; Hussain, 1998). However, such attempts will only be effective if they are institutionalized by incorporating them in government or private extension systems. This will ensure documentation of indigenous knowledge and dissemination of information relating

to indigenous plant food utilization to regions where these plants could be grown. This requires the coordination of appropriate institutions involved in this activity. This will enhance the use of indigenous plants to solve nutritional problems as part of implementing rural development projects.

This section describes a conceptual framework and an organizational procedure for designing nutritional interventions using indigenous plants. This is based on the case of Moringa presented above and a field survey of the institutions involved in food and nutrition-related programmes. This is also intended to provide guidelines to institutions involved in food and nutrition-related activities, such as the ministries of agriculture and health as well as other non-governmental agencies in Malawi to help them develop a system of designing nutritional interventions using indigenous plant foods. The conceptual framework, adopted from Babu and Mthindi (1994), for relating food security of rural households and indigenous knowledge systems in nutrition and health is given in **figure 1**.

The availability of land and labour along with the improved technology and the use of modern inputs such as hybrid seeds and chemical fertilizers determine the quantity of food and/or cash crop production in an agriculturally based rural community. The availability of markets for crop produce, the level of prices for outputs and the ratio between self-consumption and market-oriented production determine the income from crop production of these households. The non-farm income is determined by the nature and availability of employment and wages in the rural areas.

Household food security, while largely dependent on household income, is also determined by the food acquisition behaviour of households. Most of the rural Malawian households are net buyers of food. About 80% of them run out of food produced from their land six months after harvest (Babu, Mthindi, 1994). For the rest of the period they depend on the casual employment on larger farms for food and cash income. Increased food availability and income of households do not automatically guarantee improved nutritional

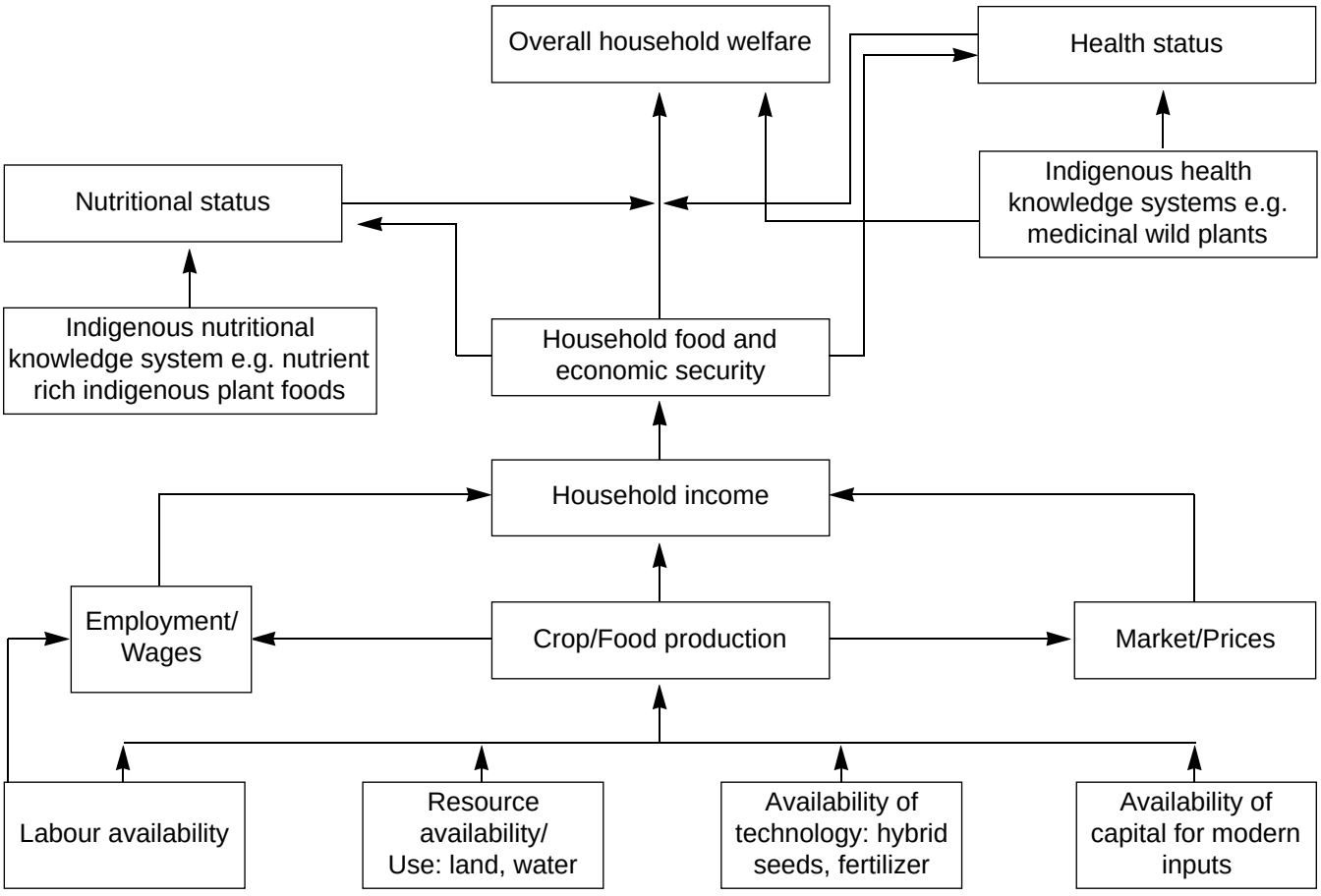

Figure 1. Conceptual framework relating to rural household food security and indigenous knowledge systems in health and nutrition (adapted from Babu and Mthindi, 1994) — *Cadre conceptuel en relation avec la sécurité alimentaire au niveau des communautés rurales et des systèmes de connaissance indigène en santé et nutrition (d'après Babu et Mthindi, 1994).*

and health status. For example, due to the prevailing cropping and food eating patterns, some essential vitamins may not enter the food system. This may result in nutritional deficiency in one or more nutrients among a group of households in a region or sub-regions of a country. The prevalence of vitamin A deficiency in the Lower Shire Valley of southern Malawi is a typical case (Ayoade, 1988). It is in this stage that the identification and utilization of indigenous plant species will be beneficial to supplement essential nutrients and contribute to better health, in the case of medicinal plants.

A model of the process of utilizing indigenous plant foods in rural nutrition intervention is given along with specific activities and the coordinating units and the personnel responsible in **figure 2**. Although originally designed for introducing Moringa, this model was developed at the request of the Malawi Ministry of Agriculture as a general framework for guiding various stages of implementing the rural nutrition intervention with indigenous plant foods. In developing this framework, several consultative meetings were held with various institutions involved in the food and nutrition issues in Malawi. This framework was necessary to identify various steps and players involved in the process of implementing interventions. This was also necessary to develop consensus among those involved and to ensure their commitment for follow up activities.

3.1. Problem identification

In general, specific nutritional problems are identified through two major sources of information in developing countries. The most common are the national nutrition surveys which identify various

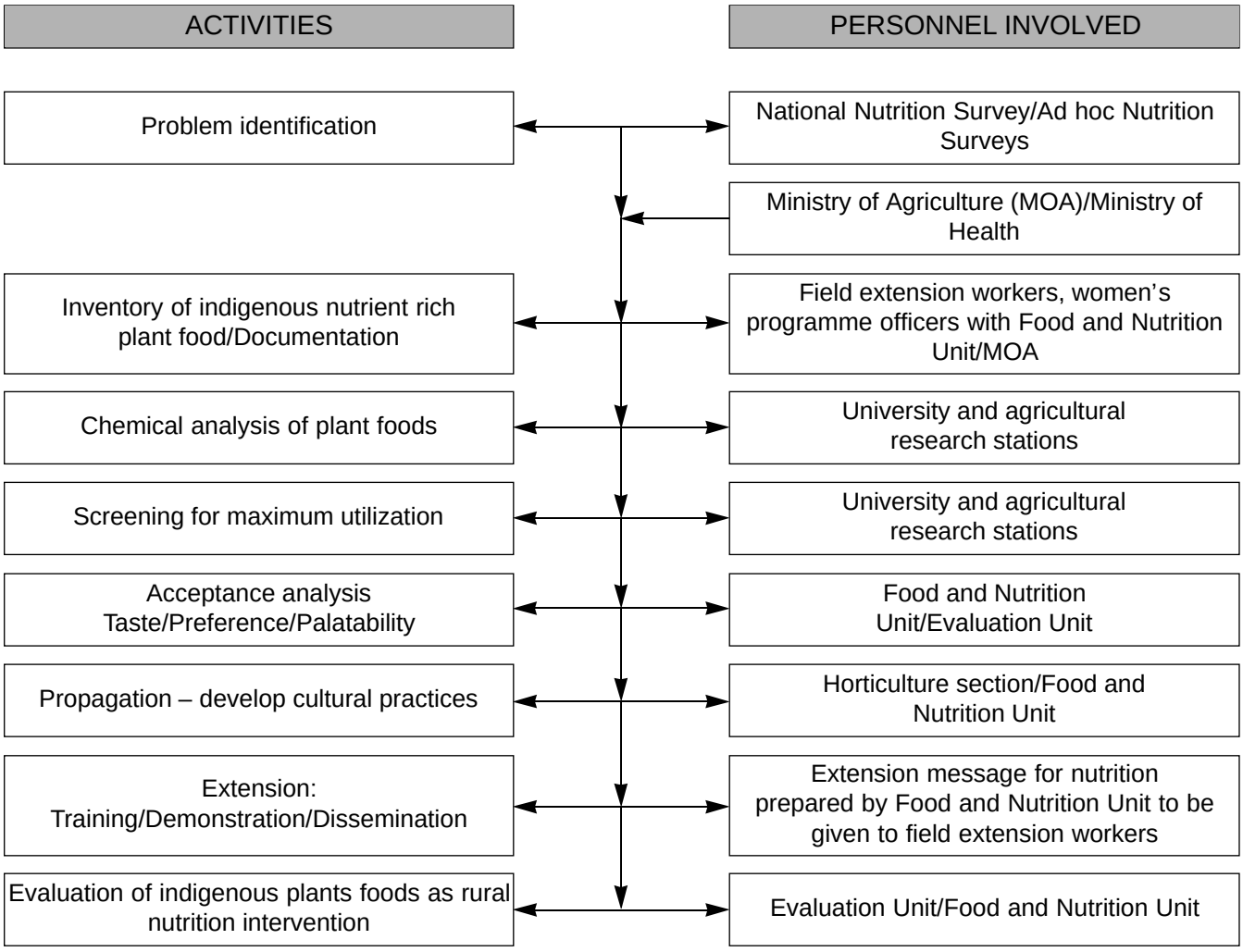

Figure 2. A model of the process of utilizing indigenous plant foods in rural nutrition intervention — *Un modèle de la démarche destinée à l'utilisation des aliments provenant des plantes indigènes lors d'intervention rurale dans le secteur de la nutrition*.

nutritional problems in different parts of the country. Ad hoc nutritional surveys can also be conducted based on reports from local hospitals so that the nature and the extent of the problem can be quantified. These surveys are carried out usually by the Ministry of Agriculture or the Ministry of Health with the support of national statistical organizations. In the case of deficiency disorders, once the problem is identified in a particular area, it has to be traced for deficiencies of one or more nutrients. One of the sectoral ministries such as Ministry of Agriculture or the Ministry of Health takes the lead and alerts other sectoral ministries and organizations to identify solutions to the problem. This process is made easier in countries where multi-sectoral nutrition committees chaired by the President or the Prime Minister's office takes the lead role (Quinn, 1994). In the case of introducing Moringa as a nutritional intervention, Malawi Ministry of Agriculture assumed the responsibility of organizing and leading other organizations involved in the process. In what follows, the stages and the activities of the Ministry of Agriculture in Malawi towards introducing Moringa are used to illustrate the process of implementing rural nutrition interventions.

3.2. Making an inventory

Having identified the problem and evaluated potential existing alternatives for intervention, there was a consensus among various institutions involved to identify indigenous sources of vitamin A and promote them as a solution. However, this required an inventory of indigenous plants consumed by households in different parts of the country. This would allow the planners to choose cost-effective and most acceptable sources of vitamin A for further development and dissemination. Fortunately, a partial inventory of useful indigenous plants was already available for Malawi although they had to be further analysed and screened for their nutrient content. For example Williamson (1975) provided a list of 200 wild plants available in Malawi with a design of their botanical characteristic ties and use in Malawian diets. Msonthi (1989) developed a geographical distribution of edible wild fruits that are growing in various parts of Malawi. Saka *et al.* (1989) have analyzed chemical composition of selected edible wild fruits commonly available in Malawi. They found that cassava, turnip, amaranthus and Moringa have highest levels of vitamin A with 1630, 788, 1330 and 3710 i.u. per 100 g edible portion respectively.

In places where such information is not readily available the existing agricultural extension system can be used for information gathering. The village level extension worker would be useful in developing the inventory by working with the rural households who are familiar with the plant foods that are eaten in a particular area. The timing of making the inventory is also important. The indigenous wild foods are usually consumed during the lean season when the food availability is low. These foods are also called "crisis foods" or "famine foods" or "emergency foods". They have been recognized and used for generations by ancestors in the area. However, they may not be taken regularly in present day diets due to changes in the consumption patterns.

3.3. Analysis and screening

Once this inventory is prepared, the next step is to carry out a chemical analysis of these food plants for essential nutrients and vitamins. This can be carried out in the laboratories of the universities and agricultural research stations. The chemical analysis of the indigenous plant foods help food technologists, nutritionists, and other agricultural scientists to choose the food which will have the maximum nutrient content. Such an analysis with information on methods and procedures, including sample selection and parts of some useful plants analyzed is available for Malawi. For example, Mtumuni and Cusack (1991) analyzed nutrient contents of various foods that could be used for food supplementation. Their analysis showed that Moringa had the highest vitamin A levels with 3650 i.u. per 100 g edible portion.

3.4. Acceptance analysis

The importance of taste in food acceptance has recently been recognized to play a crucial role in determining the success of food and nutrition intervention programmes (Babu, Rajasekaran, 1991). It is well-known that the quality of food taken is the major factor determining its nutritional impact (Kennedy, Alderman, 1987). Variations exist in the quality of food intake among sub-groups of the population (Horton, 1985). It has also been suggested that increasing incomes could be a direct way of improving nutrition as the quality and variety of foods increase with income (Pitt, 1985).

These considerations point to the need for assessing the acceptance of indigenous plant foods. An acceptance analysis should be conducted in order to determine the impact of tastes and preferences on the dietary intake pattern of different groups of households. Information based on the analysis could then be effectively used in targeting households for nutritional interventions using indigenous plant foods. This approach would improve the success of the acceptance of indigenous plant foods that have been introduced. An acceptance analysis conducted in Malawi indicated that Moringa is accepted as a green-

leaf vegetable, particularly when other vegetables are not available or expensive to purchase (Babu, Chale, 1994). For example, four different recipes of Moringa were tested for their acceptance along with boiled pumpkin leaves as an alternative. A sample of 50 rural households was invited to choose between five relish foods made from Moringa with that of pumpkin leaves. The foods included Moringa boiled with salt; Moringa boiled with salt and chillies; Moringa boiled and fried with salt and chillies; Moringa boiled with beans; and Moringa boiled with meat. Moringa fared well with the commonly used pumpkin leaves with about 63% of the participants preferring it over pumpkin leaves. Among the Moringa recipes, Moringa boiled with beans was the most preferred choice followed by Moringa boiled and fried with salt and chillies. About 70% of the participants said they would learn the recipes and still use Moringa in their regular diets.

3.5. Developing cropping practices

A common problem in the introduction of new plant foods into a community besides the issue of acceptance is the timely availability of propagation materials. In the case of Moringa, it can be cultivated both as a perennial as well as an annual. The cultivation of annual varieties reduces the time between the planting and harvesting. Ensuring the local availability of planting materials is important in the case of annual varieties. This will enable better adoption of the newly introduced crops. Equally important is developing cropping practices for the new crops introduced. In Malawi, the Horticultural Division in the Ministry of Agriculture is responsible for developing technical messages for Moringa. This Division also coordinates with its regional and local units to propagate the identified crop species including Moringa and provide planting material to the communities. For example, in one of the agricultural divisions planting materials in the form of stumps from high quality Moringa were gathered and distributed to those who were in need of the planting materials. The recommendation was to plant the trees in the bunds of the field to form a fence around the garden during the period just before the starting of the rainy season (October/November). Moringa stumps continue to be the most popular planting material for perennial Moringa production in Malawi since one of the key objectives is to plant Moringa on the bunds as live fencing around the crop fields.

3.6. Extension and training

Most of the efforts of the agricultural extension systems in developing countries are focussed on increasing food production. Therefore, most of the technical messages delivered by extension are production-oriented. Given that traditional crops are grown year after year with the same agronomic practices, there are few new messages to be disseminated to the farmers. In the off-season extension agents are relatively free to undertake additional activities such as nutrition education. One way of engaging extension workers in development-related activities is by utilizing and delivering messages on indigenous plants. Feedback information from the field can also be sent to research units through the same channel. It is also important to document and disseminate the information on the success of indigenous food plants in nutrition interventions. International agencies, such as FAO, have already started their role by documenting the presence and the use of edible wild plants in local communities in several developing countries (FAO, 1989). One specific project in Ngabu district that addressed the problem of vitamin A deficiency included a training component. The training was aimed at introducing commonly grown and wild plants that had high levels of vitamin A including Moringa and demonstrated their propagation, cultivation and utilization. The field extension officers were the trainers who in turn demonstrated the use of these plants to farmers during their extension visits.

3.7. Evaluation

The introduction of indigenous plant foods could be tried out as a pilot project in a small area to determine its success. Indigenous foods introduced should be evaluated for improvements of the nutritional status of the population in relation to particular nutritional problems for which they are recommended. The evaluation of indigenous plant foods' introduction for its effectiveness as a method of rural nutritional intervention may provide useful insights and lessons. The evaluation studies should be carried out by the evaluation sections of the local agricultural divisions with the help of subject matter specialists for food and nutrition although capacity for such activities are severely lacking in many countries. One such evaluation is documented elsewhere (Babu, Chale, 1994). The results of the evaluations should be used in modifying and redesigning intervention programs. They are also useful in identifying operational, administrative, and technical problems in implementation. Thus, the cyclical process of identifying new indigenous plants and their evaluation for their effectiveness in improving nutritional status should be an integral part of on-going work of the institutions involved in rural nutrition activities.

4. CONCLUDING REMARKS

The introduction of Moringa to combat vitamin A deficiency in Malawi is presented to illustrate the process of utilizing indigenous plant foods for rural nutrition intervention. Moringa is shown to be superior in providing vitamin A compared to all commonly eaten vegetables in Malawi. The usefulness of indigenous knowledge on local foods can not be ignored in designing rural nutrition interventions. In addition, this approach provides a more sustainable way of improving the nutritional status of the population. In most cases, educating the rural households on the nutritive value of indigenous foods may help them to utilize these foods in their diets on a regular basis. Nutrient-rich indigenous plants could also play an important role in designing farming systems research and agroforestry projects. Further research would involve evaluating the introduction of indigenous foods for its benefits towards changes in the consumption patterns and nutritional improvements of the beneficiaries. The process of implementing a rural nutrition intervention using indigenous plant has been documented using the example of Malawi. Understanding the role of various institutions in the process of identifying, designing and implementing rural nutrition interventions can hardly be overemphasised.

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Bibliography

Ayoade RB. (1988). Prevention and control of Vitamin A deficiency in Malawi. *In* V. Quinn (ed). *Proceedings of Third Africa Food and Nutrition Congress on Nutrition and Food Security*. Harare **2**, p. 146–158.

Ayoade RB. (1990). *Field assistant's manual for preventing and control of Vitamin A deficiency using carotene rich foods in Malawi*. Lilangwe: Food and Nutrition Unit, Ministry of Agriculture, 90 p.

Babu SC., Chale B. (1994). *Indigenous vegetables for rural nutrition: An evaluation of Moringa in Salima*. BUNDA/IFPRI Working Paper No. 6. Lilongwe: Bunda College of Agriculture.

Babu SC., Mthindi GB. (1994). Household food security and nutrition monitoring: The Malawi approach to development planning and policy interventions. *Food Policy* **19** (3), p. 272–284.

Babu SC., Rajasekaran B. (1990). Agroforestry, attitude towards risk and nutritional availability – A case study of South India farming systems. *Agrofor. Syst.* **15**, p. 1–15.

Babu SC., Rajasekaran B. (1991). Biotechnology for rural nutrition: An economic evaluation of algal protein supplements in south India. *Food Policy* **16**, p. 405–414.

Bauernfiend JC. (1986). *Vitamin A deficiency and its control*. New-York: Academic Press, 530 p.

Beiri JG., Mckenne MC. (1981). Expressing dietary values for fat soluble vitamins: Change in concepts and technology. *Am. J. Clin. Nutr.* **34**, p. 289–295.

Benezra D., Chirambo MC. (1977). Incidence and causes of blindness among the under five age group in Malawi. *Br. J. Ophthalmol.* **61**, p. 154–157.

Briscoe J. (1990). Spotlight on species *Moringa oleifera*, ILIEA(Institute of the Low Input External Agriculture). *Newsletter* **4**, p. 11–13.

Budden FH. (1979). *Blindness in Malawi*. WHO (World Health Organization), Lilongwe.

Chirambo MC., Benezra D. (1976). Causes of blindness among students in a developing country. *Br. J. Ophthalmol.* **60**, p. 665–668.

Chirambo MC., Benezra D., Escoute A. (1986). Blindness and visual impairment in Southern Malawi. *Bull. World Health Organ.* **64**, p. 567–572.

Cohen N., Rahman H., Mitra M., Spirague J., Islam S., Leenhivis de Regt E., Jalil MA. (1987). Impact of massive doses of Vitamin A on nutritional blindness in Bangladesh. *Am. J. Clin. Nutr.* **45**, p. 970–976.

Delgado CL., Miller CPJ. (1988). Changing food patterns in West Africa: Implications for policy research. *Food Policy* **10** (1), p. 55–62.

Escoute A., ChiramboMC., LuzeeanR., Amedee-ManesmeO. (1989). *Vitamin A deficiency in Malawi-Salima/Dedza East prevalence survey*. Lilongwe: Ministry of Health.

FAO (1989). *Edible plants of Uganda – the value of wild and cultivated*. Rome: Food and Agricultural Organization.

Goldman R., Overholt C. (1981). *Nutrition intervention in developing countries, study I: Agriculture production, technology change and nutritional goals*. Cambridge, Mass., USA: Oelgeschlager, Gunn & Hain, p. 111–121.

Gopalan C., Ramasastri BV., Balasubramaniam SC. (1981). *Nutritive values of Indian foods*. Hyderabad, India: National Institute of Nutrition, ICMR (Indian Council of Medical Research).

Government of Malawi (1990a). F*ood and nutrition policy and strategy statement*. Supplement to Development policies. Lilongwe: Office of the President and Cabinet.

Government of Malawi (1990b). *Nutrition facts for Malawian families*. Lilongwe: Office of the President and Cabinet.

Govindan K., Babu SC. (1996). *Supply response under market liberalization: A case study of Malawian agriculture*. Outreach Division Discussion Paper No. 4. Washington, DC., USA: International Food Policy Research Institute.

Horton S. (1985). The determinants of nutrient intake – results from western India. *J. Dev. Econ.* **19**, p. 147–162.

Hussain A. (1998). Preventing and controlling micronutrient malnutrition through food-based actions in South Asian countries. *Food Nutr. Agric.* **22**, p. 63–68.

Kennedy ET., Alderman H. (1987). *Comparative analysis of nutritional effectiveness of food subsides and other food related interventions*. Occasional Paper no.7 Washington, DC: International Food Policy Research Institute.

Kennedy ET., Pinstrup-Andersen P. (1983). *Nutrition-related policies and programs: Past performances and research needs*. Washington, DC: International Food Policy Research Institute,

Malaisse F., Parent G. (1985). Edible and wild vegetable products in the Zambesian woodland area: A nutritional and ecological approach. *Ecol. Food Nutr.* **18**, p. 43–82.

Marsh R. (1998). Building on traditional gardening to improve household food security. *Food Nutr. Agric.* **22**, p. 4–14.

Martorell R. (1989). Vitamin A deficiency and child health and survival. *Food Nutr. Bull.* **11** (3), p. 3–4.

Mayer FA., Stelz E. (1993). Moringa provides food and low-cost water purification. *Agrofor. Today* **5** (1), p. 16–18.

Ministry of Health (1990). *National project for prevention of vitamin A deficiency*. Project document of the Ministry of Health, Lilongwe, July 1990.

Msonthi JD. (1989). *Report on the distribution of edible wild fruits growing in Malawi*. Paper presented at the seminar on: The Role of Culture in the Development-Process of Malawi, 11–13 November 1989.

Mtumuni B., Cusack J. (1991). *Nutritive values of indigenous foods in Malawi*. Lilongwe: BUNDA College of Agriculture.

Ogle BM., Grivetti LE. (1983). Legacy of the Chameleon. Edible wild plants in the Kingdom of Swaziland, Southern Africa. A cultural, ecological, nutritional study. *Ecol. Food Nutr.* **16**, p. 193–208.

Pitt MN. (1985). Food preference and nutrition in rural Bangladesh. *Rev. Econ. Stat.* **67**, p. 726–732.

Quinn V. (1994). A history of the politics of food and nutrition in Malawi – the context of food and nutritional surveillance. *Food Policy* **19** (3), p. 255–271.

Rajasekaran B., Warren MD., Babu SC. (1990). Indigenous national resource management systems for sustainable agricultural development – A global perspective. *Int. J. Dev.* **3** (1), p. 1–14.

Ramachandran C. (1980). Drumstick (*Moringa oleifera*): A multipurpose Indian vegetable. *Econ. Bot.* **34**, p. 276–283.

Richards P. (1990). Indigenous agricultural revolution. London: Hutchinson.

Sahn D. (1989). *Seasonal variability in Third World Agriculture*. Baltimore, USA: John Hopkins University Press.

Saka JDK., Msonthi JD, Sambo E. (1989). *Chemical Composition of some edible wild fruits of Malawi*. Paper presented at the seminar on: The Role of culture in the development process of Malawi. 11–13 November 1989.

Tielsch S., Sommer A.(1984). Epidemiology of vitamin A deficiency and xerophthalmia. *Annu. Rev. Nutr.* **4**, 183.

UNICEF (1987). *Conceptual framework for child nutrition interventions in Malawi*. UNICEF Malawi.

UNICEF (1990). *Strategy for improved nutrition of children and women in developing countries*. A UNICEF Policy Review, UNICEF New York.

UNICEF (1998). *The state of the world's children, 1998*. New York: Oxford University Press.

Warren DM., Tutilola SO., Slikkerveer J. (1988). *Indigenous knowledge systems: Implications for agriculture and international development*. Studies on technology and social change **11**. Ames Iowa State University, USA.

Warren DM., Slikkerveer LJ., Brokensha D. (1995). *The cultural dimension of development: Indigenous knowledge systems*. London: Intermediate Technology Publications, p. 103–105.

West CE., Pepping F., Temalilwa CR. (1985). *The composition of foods commonly eaten in East Africa*. Wageningen, The Netherlands: Wageningen Agricultural University.

WHO (1989). *World Health Organisation – Priorities for 1990s*. Geneva, Switzerland: WHO.

Williamson J. (1975). *Useful plants of Malawi* (revised and extended ed.). Zomba, Malawi: University of Malawi.

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