Marketing Underutilized Crops for Biodiversity:

The Case of African Garden Egg (*Solanum aethiopicum*) **in Ghana**

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Abstract

The African garden egg is one of the most important vegetables in Ghana and West Africa. This crop that is particularly diverse in Ghana is not only consumed on a daily basis by rural and urban families but also represents the main source of income for many rural households in the country. Despite its importance, there is limited knowledge and research investment on the crop. Why is this the case? The objectives of this study are to: 1) show why garden egg is an underutilized plant species; 2) analyze constraints affecting the Ghanaian marketing channel of garden egg; and 3) identify potential solutions to overcome these constraints. We conduct a farm and market chain study of garden egg using an economic conceptual framework by Gruère et al (2006). This conceptual framework was specifically developed to characterize and evaluate marketing constraints of underutilized crops. We propose some marketing strategies to better exploit the economic potential of the crop and at the same time maintain its contribution to crop biodiversity in Ghana. Specific interventions should target: 1) poor shelf life of the fruits; 2) improved post-harvest handling; 3) development of quality standards. Any public or private intervention in this direction would likely result in multiplied effects for the rural income and for future crop biodiversity.

1. Introduction

Modern crop production is based on only a few plant species (Prescott-Allen and Prescott-Allen 1990). Particularly in marginal environments of developing agricultural economies, many less well-known agricultural or non-timber forest species, continue to be grown, managed or collected, thus contributing to the livelihood of the poor and to agricultural biodiversity. Some of these species, called underutilized plant species, have the following characteristics: a) they are locally abundant in developing countries but globally rare; b) scientific information and knowledge about them is scant; and c) their current use is limited relative to their economic potential (Gruère et al. 2006). By definition, many of these underutilized plant species could benefit from marketing development as a means to support their sustained use. Generating income for the local producers and chain actors through sustained use helps foster the conservation of agricultural biodiversity.

The African eggplant, also called Garden egg (*Solanum aethiopicum*) is one of the most important vegetable crops in Ghana and West Africa (Norman; Owusu-Ansah et al. 2001; Grubben and Denton 2004). This crop is not only consumed on a daily basis by rural and urban families in Ghana but it also represents the main source of income for many rural households in the forest zone of the country (Danquah-Jones 2000; Owusu-Ansah et al. 2001). Despite its local importance, there is limited knowledge on the plant and research efforts about garden egg are limited. Garden egg is traded internationally at a limited scale, and only a very small share of the total production in Ghana is exported towards Europe. Garden egg also has interesting nutritional characteristics, and potentially useful agronomic traits, and there is an observable diversity in the type of

varieties cultivated in Ghana. At the same time, the production of garden egg is diminishing in the urban Accra region.

What constitute the public and private assets of this underutilized crop and what are the specific constraints faced by this crop? The objectives of this study are first to show why garden egg is an underutilized plant species in Ghana, and second to analyze constraints affecting the Ghanaian marketing channel of garden egg. Based on the analysis, we identify potential solutions to overcome these constraints.

To do so, we applied an economics conceptual framework on marketing of underutilized species to data collected in a study of farms and market chains for garden egg in Ghana. The information was collected at the beginning of 2006. In the two following sections we present the conceptual approach and empirical research design. We then present the main findings of the study and suggest potential avenues to improve the market chain.

2. Conceptual Approach

We use the economic conceptual framework developed by Gruère et al. (2006). Stepping up from the three tier definition presented above, Gruère et al. propose to characterize underutilized plant species according to an assessment of their economic value and the economic constraints they face. Each underutilized species is differentiated by its observed and potential value, where the observed value represents the current private and public value, and the potential is defined by a full information competitive equilibrium. The value assessment is based on four aspects. The first is the relationshiop of the observed value to its potential private and public value. The second is the gap, or asymmetric distribution of knowledge on the crop among local and outside users. The

third and fourth aspects are the spatial and temporal characterization of the use and knowledge of the crop. The authors propose to analyze market constraints affecting the crop. Market constraints include the presence or absence of output market, the presence of various market imperfections on the demand and supply side, and the potential presence of market failures (under-provision of public good). Finally, they suggest three necessary conditions for the successful commercialization of underutilized plant species for the benefit of the poor: demand expansion, increased efficiency of supply and marketing channels, and the use of a supply control mechanism.

3. Research Design

The study was conducted between February and April 2006 in cooperation with the Program for Biosafety Support and with the assistance of researchers from the University of Ghana, the Biotechnology and Nuclear Agricultural Research Institute (BINARI from the Ghana Atomic Energy Commission) and the Crop Research Institute (CRI).

Production areas were selected based on prior information, by agroecological zone, region, and district (market town). The regions selected were: Greater Accra, Central, Ashanti, Brong-Ahafo and Volta Region. With the help of the district Agricultural Services Officers, specific towns or areas of production were identified and weighted according to the number of producers in each area. A random sample of farmers was drawn after visiting the town and contacted the producers. A total of 156 garden egg producers were interviewed. Finally, main markets linked to these producing areas were identified by the extension officers.

Structured interviews were conducted with sampled farmers, eliciting information about costs of production, market participation, seed preferences and seed availability.

Semi-structured interviews were implemented with main actors involved in the garden egg market chain. The interviews included: a) trader profiles, b) product quality considerations, c) procurement quantities, frequency and costs, d) operating costs, and e) sales quantities, frequency and prices. For carrying out the traders' interviews we visited main regional, district and village markets close to the production areas identified. Some interviews with traders were also conducted on farms and in the villages.

4 Value assessment of garden egg

4.1. Knowledge of the plant

Unlike many other underutilized species, there is some general scientific knowledge about garden egg, its nutritional content, and some of its medicinal properties. This knowledge appears to be relatively recent and is likely not shared with Ghanaian users. Moreover, the information is often not complete or inconsistent. At the same time, efforts to improve garden egg through plant breeding have been very limited in Ghana.

The origin of garden egg (*Solanum aethiopicum* Gilo group) is in tropical Africa (Norman; Grubben and Denton 2004). Grubben and Denton explain that garden egg is the result of the domestication of one wild and one semi-domesticated Solanum species that grow in tropical Africa (*S. anguivi* and *S. distichum*). The crop is widely cultivated across most of the African continent, and more intensively in West and East Africa. Garden egg is also produced in Brazil (known as 'jilo') and occasionally in southern Italy and France (Grubben and Denton). To a certain extent, this geographical distribution suggests that the garden egg might be underutilized locally in Ghana but perhaps not in other countries with more advanced marketing chains. There are four main cultivar groups: Gilo, Kumba, Shum and Aculeatum. The first three are the most important in Africa. Gilo and Kumba

groups are produced for their fruit, while Shum is cultivated for its leaves. The most common group in Ghana is the Gilo group, which is thought to be more genetically heterogeneous due to higher crosspollination than Kumba. However, fruits with the characteristics of the Kumba group have been observed in the Ghanaian markets.

Some medicinal properties are attributed to the roots and fruits, They are described as carminative and sedative, and used to treat colic and blood pressure (Grubben and Denton 2004). The nutritional content of garden egg is comparable to that of tomato, but it has a lower content of vitamin C as shown in Table 1.

Table 1: Nutritional value (100 g of edible portion)

Content	Garden Egg		Tomato (USDA)
	Grubben et al.	Norman	
Water	90.6 g	93g	94.50 g
Energy	32 Kcal	20 Kcal	18 Kcal
Protein	1.5 g	1.1 g	1 g
Fat	0.1 g	0.1 g	0.2 g
Carbohydrate	7.2 g	4 g	3 g
Fiber	2.0 g	1 g	
Ca	28 mg	7 mg	10 mg
P	47 mg	25 mg	
Fe	1.5 mg	0.4 mg	0.4 mg
Vitamin A	-	70 IU	0.6 mg
B carotene	0.35 mg	-	
Thiamin	0.07 mg	0.09 mg	
Riboflavin	0.06 mg	0.2 mg	
Niacin	0.8 mg	0.6 mg	
Ascorbic Acid	8 mg	15 mg	25 mg

Even though garden egg is highly demanded locally and has export potential no official variety has been released for commercial cultivation. A number of local varieties are cultivated by farmers to meet the internal demand. (Owusu-Ansah et al. 2001). Seed availability is a major constraint to garden egg production. The University of Ghana, Legon and the Crop Research Institute (CRI) has been working on improved lines, but there has not been any official variety release to the market. Some specialized farmers

multiply the seeds (from advanced lines, or from selected local cultivars) that exporters of garden egg produce. The rest of the garden egg seed is recycled, produced by some specialized farmers, or bought from market women.

4.2. Public value of garden egg

4.2.1. Biodiversity

While contributing to interspecies biodiversity, the local cultivation of garden egg also helps maintain a large intraspecies biodiversity. The genetic diversity of garden egg is maintained by the small scale producers. While in other African countries like Ivory Coast and Senegal there is a large scale cultivation of a few cultivars (Grubben and Denton 2004), in Ghana there is no formal seed officially released and farmers often have a mix of cultivars in their fields. A large number of local varieties are available at the market. In an evaluation of the vegetable production in Ghana, Gyiele (1999) identified several types: Aworoworo, Obolo, Asurowia, Asusuapin, and Antropo. Not only are the cultivars dispersed across sites but they are also often named differently. Furthermore, the cultivars could even be the same but with different phenotypic expressions due to different biotic or abiotic factors (poor soils, salinity, drought conditions, etc.). It is true that garden egg exporters invest higher volumes of one specific type of garden egg, but the seeds used for this particular production come from farmers' fields and are not certified.

Agronomic attributes of garden egg like branching habit, time of flowering time of fruit maturity and fruit yield vary broadly across cultivars (Blay 1978). There are very few studies on inheritance of quantitative characteristics in this crop. Heritability is

important in helping the plant breeder plan and execute effective breeding strategy (Danquah-Jones 2000).

Garden egg perceivable quality attributes, such as color, shape, size and taste, also widely vary. Garden egg can be deep green, green, white, cream, or yellow. Color is also an indicator or freshness. According to the consumers interviewed in the market, yellow garden eggs are use dfor soups and the whiter ones are added to stews. There are many different sizes for garden egg. There seems to be a preference for medium to big sizes, but again that depends on the final use of the fruit of the garden egg. The shape of the fruits varies from elongated to round, and fruits can have ridges or present a smooth appearance.

Taste is also an important quality attribute sought after by consumers and quite often related to the shape. Garden egg can have blunt, sweet or bitter taste. Round types tend to be more bitter than elongated types, but this is not always the case. This is a genotype-specific characteristic but it is also suspected that certain agricultural practices could have an influence on the bitterness of the fruits. Also, cultivars that are green when immature tend to be more bitter at harvest (Blay personal communication).

Garden egg germplasm in Ghana expresses a considerable amount of diversity but little research has been done to evaluate what are the factors that determine and affect this diversity. The public value of the crop has not encouraged a larger allocation of research resources. No real strategy has been put in place to conserve the diversity of garden egg.

4.2.2. Important breeding traits

Domesticated and wild relatives of garden egg have important breeding traits that remain to be explored. In the field garden egg itself shows a higher drought and heat tolerance than tomato or conventional eggplant. This vegetable is also value locally by its high iron content (Table 1) and medicinal properties (E. Blay personal communication and Grubben and Denton 2004). Grubben and Denton (2004) also state a lower susceptibility of garden egg to pests and diseases than the exotic eggplant. In Japan, cultivars of the Acuelatum group are used as rootstock for tomato and garden egg. These important traits could be used for the breeding of garden egg but also for related crops like eggplant or tomato.

4.3. Private value of garden egg

4.3.1. Source of income

Garden egg is an income generating activity for small-holder farmers. Asenso-Okyere et al. (2000) report that about 4305 households from coastal forest and savannah ecological zones in Ghana are actively involved in the production of vegetable crops such as garden egg, leafy vegetables, tomatoes, okra, pepper and onion. The analysis of our farm survey shows that producers manage plots of less than 1 ha (Table 2). Despite their limited size, these plots represent around 60% of their total cultivated area. More than 97% of the total production in these small plots goes to the market.

Table 2. Area cultivated and market participation of garden egg

Region	Greater Accra	Central	Ashanti	Brong-Ahafo	Volta	Average
Area (ha)	0.62	0.54	0.69	0.58	1.15	**0.69**
Area (%)	47.5	62.2	84.5	40.8	81.3	**58.9**
Percentage sold (%)	98.5	97.9	97.8	96.9	97.5	**97.6**

Gross margins from garden egg activity are presented in Table 3. Notice that these figures have been derived from the information collected from small farmer fields and converted to per hectare levels. The net benefit therefore might have an upward bias since: 1) input use is not necessarily linearly related to plot size; 2) it is difficult for farmers to account for equipment use when they produce more than one crop, and 3) farmers tend to underestimate their labor costs. The Ministry of Agriculture reports a national average of 8 Mt/ Ha under rainfed with a potential to be increase up to 18 Mt/ Ha (PPMED 2005) a value that it is in the range of our estimations.

Table 3. Garden egg gross margins across regions

Variable	Units	Greater Accra (N = 25)	Central (N = 26)	Ashanti (N = 25)	Brong-Ahafo (N = 55)	Volta (N = 25)	Total Sample (N= 156) Ave.	SD
Yield	Kg / ha	12,157.3	2,742.3	5,428.7	11,127.4	16,990.9	9,921.3	8,151.1
Price	$ / Kg	0.4	0.4	0.3	0.2	0.2	0.3	0.2
Income	$ / ha	4,389.1	1,291.9	1,815.8	1,623.6	3,161.5	2,255.9	2,353.5
Total Cost	$ / ha	1,012.9	1,197.7	944.8	781.3	1,225.5	985.2	635.5
- Inputs	$ / ha	288.9	208.7	289.2	319.3	395.5	303.4	148.9
- Equipment	$ / ha	125.3	47.1	33.4	40.8	28.2	52.2	78.5
- Labor	$ / ha	598.6	941.9	622.3	421.1	801.8	629.6	564.5
Cost / Kg	S/Kg	0.1	0.4	0.2	0.1	0.1	0.1	0.1
Gross margin	$ / ha	3,393.6	94.2	870.9	831.8	1,935.9	1,267.3	2,249.5

The gross margin values show that garden egg production can be a profitable activity but it also involves risk. The percent of farmers with a negative return on equity is a measure of downside risk. Producers' activities with a positive return on equity have a large enough net income to cover all cash costs plus an opportunity charge for unpaid producer labor and management. In average farmers interviewed faced 30% chances of having negative returns.

4.3.2. High domestic demand

Together with tomato and pepper (chillie), garden egg is among the three most consumed vegetables in Ghana. National production is estimated to be between 100,000-120,000mt.

Unfortunately, there are no statistics available on the consumption per capita of garden egg. The use of garden egg fruits in the Ghanaian kitchen is similar to tomato. But tomato and garden egg are used as complements rather than substitutes in Ghanaian cuisine. Both vegetables are the main ingredients in the stews that accompany almost every local dish or used as a soup thickeners. Garden egg fruits can also be consumed raw. Leaves and stems, that have a high demand in East Africa, are only consumed occasionally in Ghana. Processing of some cultivars is being done by Food Processing International and Nsawam Cannery Company for export purposes (Danquah-Jones 2000).

4.3.3. Export demand

Trade data is available for aubergines, which includes garden eggs and other types of eggplants. Ghana is a net exporter of garden egg but exports only represent a small share of the volume of production, between 0.7-1.5 percent of total output production. Aubergine export values and volumes as reported by the Ministry of Trade and Industries, cross-checked with UN Comtrade data, are shown in Table 4. Ghana exported between 700 and 1,500 tons of aubergines annually, for a value ranging between $300,000 and $600,000. Uganda, Ivory Coasts and Senegal are as well garden egg exporters. The main market is the European Union, and more recently the United Kingdom. Users of the garden egg in these countries tend to be consumers of African origin, African restaurants and expatriates.

Table 4. Total exports of aubergines, including mostly garden eggs.

Exports	1996	1997	1998	1999	2000	2001	2002	2003	2004
Value	$370,971	$390,064	$503,805	$578,281	$398,634	$400,681	$589,550	$343,539	$651,074
Quantities (kg)	999,466	981,908	1,145,404	1,264,961	850,634	947,064	1,559,282	711,506	415,136

Source: Ministry of Trade and Industry of Ghana.

5 Market Chain

Unlike other underutilized species, garden egg has a relatively well developed marketing channel that links rural communities to regional, national and international destinations. At the same time, the marketing systems present significant constraints. We will first present the price determinants of garden egg in Ghana and then analyze the marketing channel.

5.1. Price Determinants

Consumers tend to prefer whiter, elongated, medium-sized garden eggs. Size and color affect prices but there are different uses for the different variations. In the case of shape, even though there is preference for elongated garden egg, traders argue that there is no price differential between round or elongated types. Garden prices are affected also by the seasonality of the crop, low shelf life, and fruit damages due to pest, diseases and post harvest handling. Seasonality is the main factor affecting the price of garden egg. Garden eggs prices fluctuate significantly along the year (GIDA et al. 2004), increasing from November and reaching a peak during April – May. This is the harvesting period of farmers who were able to produce during the dry season (at least in the southern parts of the country). Farmers that have irrigation facilities and produce during the dry season obtain higher market prices. Often, however, farmers prefer to use irrigated lands for

other cash crops, like tomato in the north or other exotic vegetables in the rest of the country that might represent a higher income.

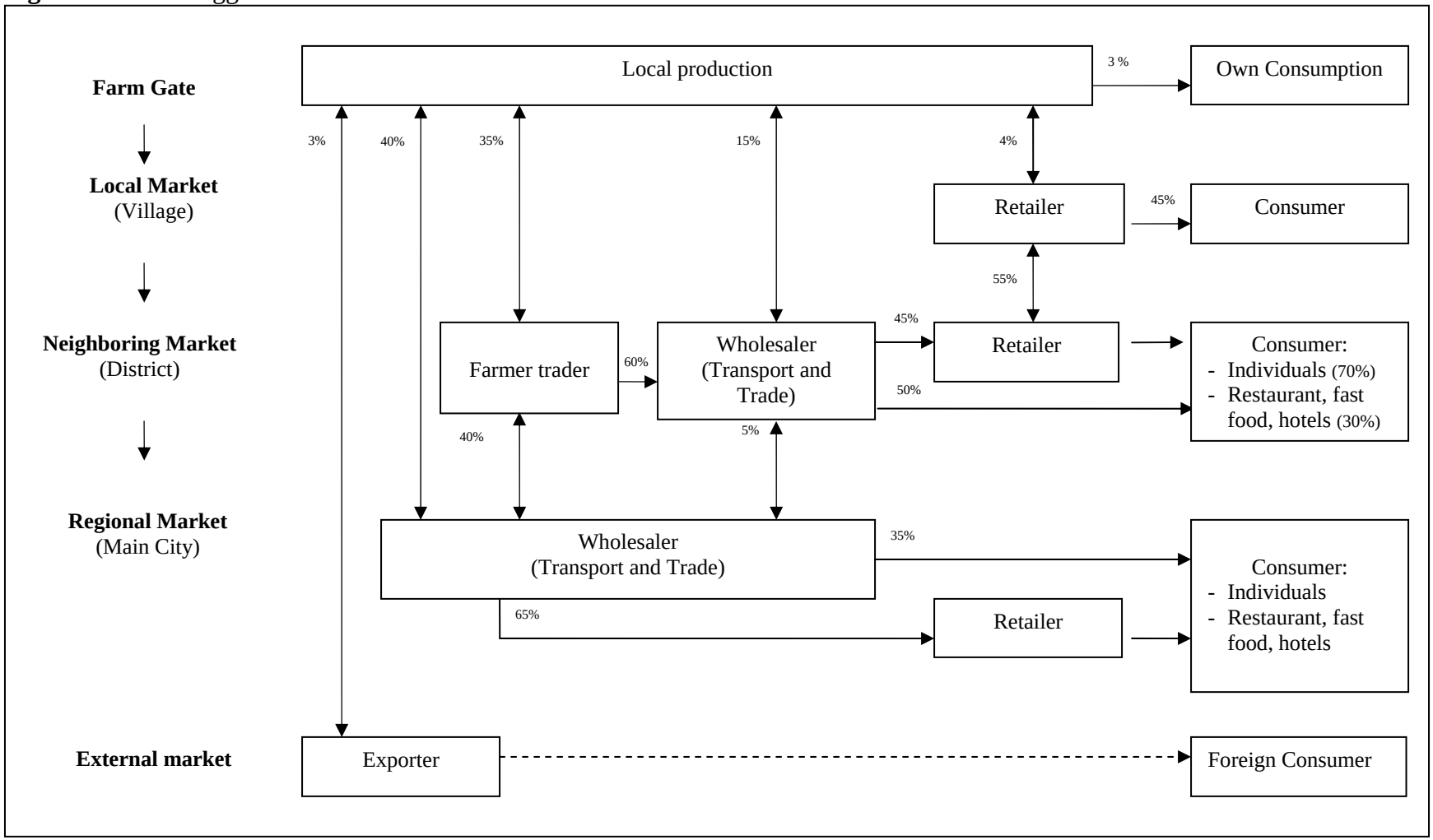
The average shelf life of a garden egg is 3 to 7 days, depending on harvesting frequency and conditions. This limited shelf life affects the internal price and limits exports, not to mention losses due to spoilage. Several days after harvesting, garden eggs change color from white or cream to yellow and/or intense orange. At the same time, the water content of the vegetable declines dramatically, thus affecting the appearance and texture of the produce. Even though local consumers look for fresh, whiter garden eggs, there is a market for more ripened fruits. The retail price drops by at least by 50% compared to the original value, however. According to the market women we interviewed, spoilage losses could be as high as 25%.

Stem, fruit and flower borers are the main pests that attack garden egg. The damages caused can reduce yields and affect the quality of the produce. For the local market, these damages affect the price significantly but the product can still be sold.

5.2. Market Channels and Actors

Among the farmers interviewed, the share of garden egg sold was higher than 90%. This result is evidence that the crop is an extremely important source of income for those who produce it. There are a number of market possibilities for the produce. Figure 1 summarizes the main market channels of garden egg observed across regions. It is important to recognize that Figure 1 is a simplification of a more complex system where volumes trade, actors, functions, sources of provision and customers vary broadly.

Figure 1: Garden Egg Market Chain – Market Shares



The main actors in garden egg trading are: farmers, wholesaler, retailers and exporters (Table 5). Production constraints faced by farmers are multiple. At the field level, there are a number of pest and diseases that attack this vegetable crop, reducing the total output and the final quality of the product. Production of garden eggs is especially labor-intensive intense during the harvesting period. Garden egg has to be harvested two times per week. Otherwise the fruits mature in the plant, develop seeds, and change color, resulting in a severe penalty on the market value. Under optimal conditions, the crop should be harvested in the early morning hours when the heat and the sun are not so strong. Post harvest activities are also crucial for maintaining the quality of the fruits. Garden egg fruits are very sensitive to handling and easily develop bruises through inappropriate post-harvest practices. Bruises decrease the value of the fruits and serve as points of entrances for pest and diseases. Garden egg is traded in sacks of approximately 27 kg. Sacks vary greatly in content and that do not protect the produce from the impacts of handling and transportation. Finally, the glut of production occurs in rainy season when market prices are the lowest during the year.

Trading of garden egg is almost exclusively managed by women who are generally called ‘market women’ independently of the function they perform. Many times they perform more than one function. Depending on the volume managed and the level of control they have in the specific market, they may be known as “market queens”. The control of market queens on garden egg volumes traded and prices is limited. Garden egg demand seemd to be covered with the internal production and its production is dispersed all over the country. Therefore, there is no real need for a strong organization to assemble

and transport garden egg from remote areas to main consumption centers (Ghana, Kumasi, Cape Coast) as is the case of other crops, such as tomato.

Table 5. Main actors in garden egg market chain.

Actor	Description
Farmer – Trader	A farmer that goes to the market to sell his produce and sometimes the produce of other farmers
Wholesalers (permanent or mobile wholesalers)	Two different types: - Mobile wholesalers from regional or neighboring markets, travel around the different producing areas (farm gate). They act as collectors but often keep smaller quantities for retailing. - Permanent wholesalers are fixed in one market and either send other people to gather produce for them or buy from farmers that come to the market. They sell to other smaller market women or directly to consumers.
Retailers	Market women that can have a fixed place in the market or not. They either buy from wholesalers. They can sell to other retailers but their main customers are restaurants, fast food places and directly to individual consumers
Exporters	An exporter could be a farmer that produce garden egg to exports, a farmers association or an out-grower that sells to a registered exporter association

Garden egg can be traded in the market where the farmer lives (*village markets*). The volumes traded in this market are relatively small (4%). Approximately 35% of the volume produced is traded directly by the farmer, who assumes the transportation costs and goes to the next big market (*neighboring markets*) to get a higher price. This decision is determined by the volume traded and distance to the market (Fafchamps and Hill 2004). The highest share is traded by wholesalers. These wholesalers travel around different producing areas, gathering enough volume to trade in neighboring or other larger markets (*regional markets*). Approximately 40% of the total volume produced is traded by wholesalers from regional markets and 15% by wholesalers in neighboring

markets. On average, 3% of the production of surveyed farmers was destined for export.[1] Farmers can export directly or function as as out-growers for registered exporter associations like the Vegetables Producers and Exporters Association of Ghana (VEPEAG). These associations are concentrated mainly in Greater Accra and Volta regions.

Once at the neighboring market, farmers have the option to sell to mobile wholesalers from regional markets (40%) who often offer higher prices or to wholesaler and market women from this market (60%). Wholesalers in the neighboring markets can either sell to consumers (50%) or to retailers from their own market and other neighboring markets (45%), and eventually to wholesalers and smaller traders from regional markets. This part of the chain is similar in the regional markets where mobile wholesalers sell to directly to consumers (35%) or permanent market women and retailers (65%). Quite often, a number of market women act as intermediaries in between wholesalers and retailers, thus multiplying the steps to finally reach the consumer.

There are two main constraints to exports. One is related to the standardization of the different quality grades. The Vegetable Producers and Exporter Association of Ghana (VEPEAG) have developed basic standards to meet the export demands, but there is still a need to improve the standards and make them uniform across exporters. The second constraint is the short shelf life of garden eggs that is enhanced by inappropriate post harvest handling and pest and diseases affecting the external appearance.

[1] This represents a much higher share than the 0.7-1.5% obtained with national trade and production data suggesting a possible bias on one or the other estimate.

6. Conclusion and policy suggestions

In this paper we analyze the economic value and marketing channel of the African garden egg in Ghana. We applied a conceptual framework to conduct an empirical marketing chain analysis of the garden egg in Ghana, based on structured and semi-structured interviews in the main area of production and markets at the beginning of 2006. We find that garden egg provides an example of underutilized crop. In Ghana, garden egg is locally abundant, lacks significant knowledge and research investment, and has significant public and private value that has not been realized. .

Our findings also suggest that some targeted marketing development strategies might be followed to better exploit the economic potential of the crop and at the same time maintain its contribution to local crop biodiversity in Ghana. First, we find that the poor shelf life of the fruits affect export possibilities as well as local market potential. Market women complain that they have to throw away large portions of their stocks when they are not able to sell it within one week. Pest and disease at the production level contribute to the low shelf life as well as observed low yields in many regions. Second, we find that more generally, the market would benefit from improved post-harvest handling. This vegetable is sensitive to poor practices at harvest and after harvest that decrease its shelf life even more. Third, the lack of quality standards for the local and external market creates problem for price transmission and limits export opportunities.

Each of these identified constraints can in turn trigger a specific policy response that would benefit the market chain actors. A quality standard could be developed and disseminated among producer groups. Crop improvement and selection efforts should focus on identified pests and shelf life. Post-harvest handling issues would require a

concerted effort of market chain actors and an improvement of storage and transportation conditions. Any public or private intervention in this direction would likely result in multiplied effects for the rural income and for future crop biodiversity.

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