GROWTH AND PRODUCTION OF CASHEW NUT

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Summary

Cashew (*Anacardium occidentale* L.) is a perennial tree crop, originating from South America, and now widely grown in the tropics. Optimum cashew nut production is obtained in areas between 0 and 800 m altitude, with a temperature of 24° to 28^{o} C, and an annual rainfall of 800 to 1,600 mm with a pronounced dry period of 5 - 7 months, and soil pH ranging from 4.5 to 6.5.

Cashew is a multipurpose tree crop, from which almost all parts (roots, stem, bark, leaves, apples and nuts) are used. The nut is considered the most valuable product.

In the past, cashew was considered as a hardy crop, which needed little attention in terms of management and pest control. Current research findings indicate that this is no longer the case and that it is frequently attacked by various pests. This chapter deals with a number of aspects related to plant breeding, crop improvement and pest management, as well as agronomic practices that are equally crucial for cashew nut production and quality.

1. Introduction

Cashew (*Anacardium occidentale* L.) is an important tropical perennial tree crop, originally grown in coastal areas, but now extending also far inland. It is a major export crop in terms of foreign exchange earnings in countries like Brazil, Vietnam, India, Nigeria, Tanzania, Indonesia, Guinea-Bissau, Cote D'Ivoire, Mozambique and Benin.

Cashew nuts are common appetizers, like peanuts and pistachio nuts. They are also used in the food industry, and as an ingredient in various confectionery products. The cashew nut kernels have good nutritional values to human beings. They are a rich source of vitamins (A, D and E), fats (46.5 %) and proteins (17.8 %). Besides, they contain relatively important amounts of minerals like calcium (504.0 mg/kg), iron 90.8 mg/kg), zinc (31.3 mg/kg), copper (16.4 mg/kg), potassium (5600 mg/kg), phosphorus (4600 mg/kg), magnesium (2400 mg/kg) and sodium (22.8 mg/kg) all measured in dry weight. However, the nutrient composition in cashew nut kernels varies with cultivar and environment. Due to its high nutritional value, even small and broken pieces of cashew nut kernels find a market in confectionery products.

Almost all varieties of *A. occidentale* produce sweet juicy apples, with high soluble sugar (fructose and sucrose) content, which are consumed as fresh fruits; or used to make various apples products, such as juice and wine.

2. Origin and Distribution

Cashew (*A. occidentale* L.) is native to Latin America and has a primary center of diversity in Amazonia, and a secondary one in the Planalto of Brazil. Natural occurrence of cashew has been reported from Mexico to Peru, and in the West Indies. It was one of the first fruit trees from the New World to be widely distributed throughout the tropics by the early Portuguese and Spanish adventurers. The name cashew is from the Portuguese *caju*, which in turn comes from the Tupi-Indian word *acaju*. The incoming colonists in what is now Brazil found that the native Indians valued both the cashew nut and the so-called apple, the fleshy pedicel or stalk of the fruit (Deckers *et al*., 2001).

Cashew was discovered by Portuguese traders and explorers in Brazil in 1578. It was introduced into West and East Africa and India by the Portuguese travelers in the 16th century. By then, cashew was considered a suitable crop for soil conservation, forestation, and also wasteland development. Therefore, the initial aim of cashew introduction to those areas was not to produce nuts and apples (pseudo-fruits), but to help control soil erosion on the coast (Bradtke, 2007).

Use of cashew nuts and apples developed much later, and the international nut trade did not start until the 1920s (Rieger, 2006). Thereafter, cashew gradually gained commercial importance and spread in other places. It is now naturalized in many tropical countries, particularly in coastal areas of East Africa (Tanzania, Kenya, Mozambique, Madagascar and Uganda), West and Central Africa (Ivory Coast, Nigeria and Angola), Florida, Peru, Hawaii, Tahiti, Mauritius, Seychelles, Panama, India, Sri Lanka, Thailand, Malay Peninsula and Philippines.

3. Botany

Cashew (*A. occidentale* L.) is part of the Anacardiaceae family, which is composed of some 60 to 74 genera and 400 to 600 species. Cashew belongs to the genus *Anacardium* and the species *occidentale*; other members in the family include: mango (*Mangifera indica*) and pistacio (*Pistacea vera*). The Anacardiaceae family is characterized by

resinous conduits in the cortex and wood**,** where resin is produced, although exudation also occurs from the leaves, flowers and fruits. The resins contain anacardic acids closely related to urushiol, which can cause dermatitis to humans. Cashew is a tropical evergreen, perennial tree with a darkish-green leathery foliage, crooked branches and very irregular crown.

3.1. Cultivars and Classification

In nature, there are two types of cashew cultivars classified as *A. occidentale* L. species, and denominated as the common or giant type and the dwarf type. Common types grow to heights ranging from 5 to 15 m, with a crown diameter of 12 to 14 m. Under conditions of wide spacing and high soil fertility, the crown span can reach 20 m. Usually, sexually propagated common cashew starts flowering between 24 and 36 months after planting.

Dwarf cashew on the other hand grows on average up to 4 m high, with crown diameter of 6 to 8 m wide. Sexually propagated dwarf cashew flowers between 6 and 18 months after planting. Other characteristics that differentiate dwarf from common cashew refer to a smaller stem or trunk diameter and a prolonged seasonal period of fructification (Bezerra *et al*, 2007).

The common types are cultivated in most cashew growing countries; the dwarf type is somewhat less popular, except in Brazil. The most suitable cashew cultivars are the ones that possess the following characteristics: high yielding ability and desirable qualities of nuts (nut weight, kernel weight and percentage kernel out-turn) and apples (high juice and sugar content and less tannins). Other appreciated characteristics are: tolerance to major cashew diseases and insect pests and adaptation to different agro-ecological conditions. Examples of such cultivars are listed in Table 1.

Variety	Type	Country	Characteristics
AC4	Common	Tanzania	High yielding, desirable nut and apple qualities, tolerant to major disease and insect pests, adapted to wide range of agro-ecological conditions.
AZA2	Common	Tanzania	High yielding, desirable nut and apple qualities, tolerant to major diseases (including, cashew leaf and nut blight) and insect pests, adapted to a wide range of agro-ecological conditions.
BRS 274	Common	Brazil	High yielding, desirable nut and apple qualities, tolerant to major disease and insect pests.
CCP-76	Dwarf	Brazil	High yielding, desirable nut and apple qualities, tolerant to major disease and insect pests.
Vengurla-2	Common	India	High yielding, desirable nut and apple qualities, tolerant to major disease and insect pests.
Sulabha (K-10-2)	Common	India	High yielding, desirable nut and apple qualities, tolerant to major disease and insect pests.

Table 1. Selected cashew varieties for commercial production.

3.2. Structure

Roots **-** Cashew is a dicotyledonous plant. It has an extensive root system which helps to tolerate a wide range of moisture levels and soil types. About 90 % of the lateral roots are concentrated in the upper 15 to 45 cm of the soil. The lateral roots of well developed cashew tree extend over an area almost twice the canopy diameter.

Trunk **-** The tree has usually a single stem which becomes rough with age. However, with different propagation methods, cultural and management practices, cashew trees can possess multiple trunks. A cashew tree propagated by air layering, grafting and stooling tends to produce many branches near the ground.

Stooling is a method for multiplying a bare rooted rootstock, in which a tree is cut or stumped close the ground to allow formation of shoots or suckers. These are then treated to form roots and detached from the rootstock for planting. Improper pruning techniques of such trees can lead to multiple trunks.

The other reason of multiple trunks in cashew is related to management practices. If sucking bugs such as *Helopeltis* are not properly controlled at the early stages of growth, they can severely damage the leader shoots or main stem of the seedlings, which consequently results to dieback. Healing of the main stem with dieback, results in a production of several water suckers, which can develop into multiple trunks if not removed.

The size of the cashew trunk increases with age, but also depends on the cultivar type and environment wherein it is grown. Common types have larger trunks than dwarf types; the trunk size increases with soil fertility and soil moisture. Other factors that influence trunk size and shape are cultural practices such as pruning and spacing. Untimely pruning leads to an awkward trunk, while closely spaced cashew trees give thin trunks.

Generally, the optimum trunk size is attained when growth conditions are optimal. Trunk circumference of a 40 years old common type cashew tree can range from 2.5 to 3.5 m at 50 cm height from ground level for a single trunk, and goes up to 4.5 m at the same height for the cashew tree with multiple trunks.

Canopy **-** Cashew trees normally exhibit a canopy of spreading habit. In older trees, the development of the canopy spread may be greater than the height, with a symmetrical spread and lower limbs bending to touch the ground,

The canopy habit varies with cultivars, and can be differentiated in terms of compactness. Some cashew cultivars have a compact canopy (Figure 1a), while others have a loose canopy (Figure 1b). Compact canopies have many bearing sites as compared with loose ones. Therefore, most cashew trees with compact canopies are relatively high yielders. In addition, when applying agro-chemicals on compact canopies there is a minimum wastage of the chemicals as a result of missing the target spraying shoots. Cashew cultivars with compact canopy are more preferred than the ones with loose canopy.

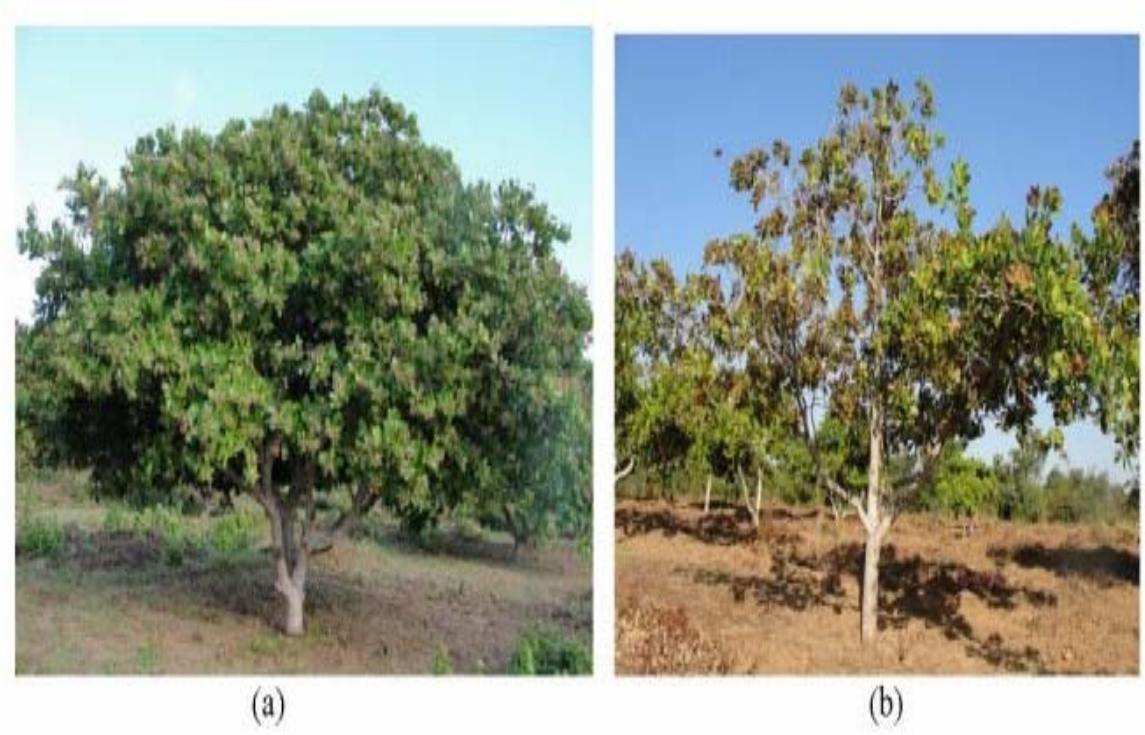

Figure 1. (a) Cashew tree with compact canopy (9 years old); (b) Cashew tree with loose canopy (9 years old).

It is considered that a well pruned cashew tree shows an umbrella-shaped canopy. Nevertheless, apart from the art of pruning, the canopy shape is also influenced by the genetic composition of the particular cultivar. While some cultivars have a natural habit of bending down their lower branches others tend to raise them up.

Leaves **-** Leaves are thick, prominently veined, and oval to spatula-shaped, with blunt tips at maturity and entire margins. In the early stages of growth, cashew seedlings propagated by seed do not produce leaves with blunt tips, but normally produce sharp-pointed tips. Majority of these sexually propagated cashew seedlings continue to produce pointed leaves for almost a year. The normal blunt leaves are produced at plant maturity. In contrast, vegetatively propagated cashew seedlings produce blunt leaves right from their youngest age, provided that the scions were harvested from mature plants.

Mature cashew leaves are generally green, but the color intensity depends on the genotype. Young emergent cashew plants could have leaf colors ranging from light green to pink, orange red, red and maroon. Moreover, different cashew cultivars can physically be distinguished by flush color. During flushing, especially prior to flowering, the crowns of cashew trees with a different flush color look quite different, despite they have been treated equally (Figure 2). For example, while the crown of cashew cultivar AC22 looks brown, that of cultivar AC10/220 appears green. Leaf color can be one of the distinctive characteristics among cashew cultivars.

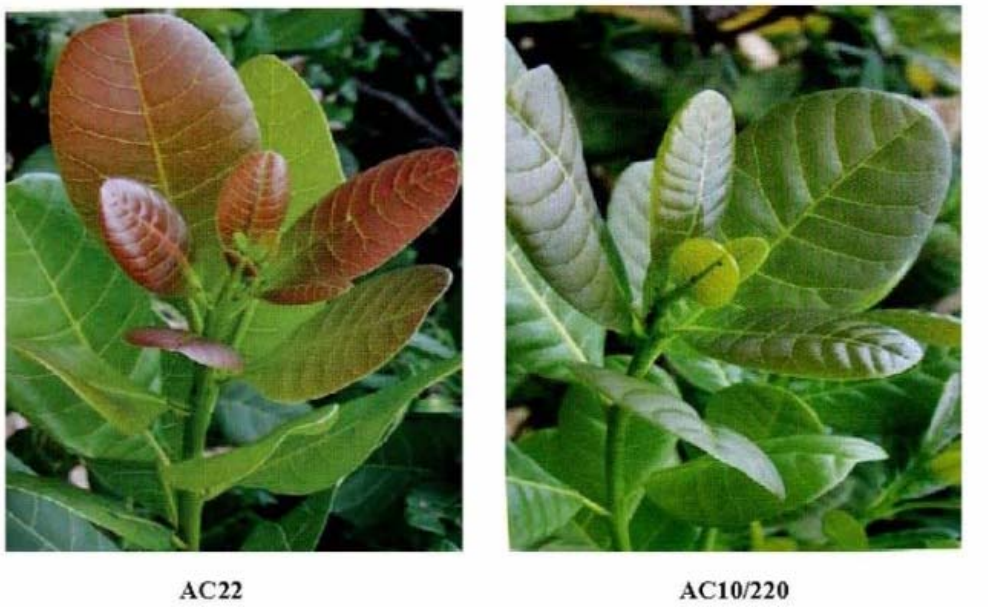

Figure 2. Flush of two cashew cultivars as they appear at the same growth stage.

Flowers **-** Unlike other monoecious plants such as maize (*Zea mays*), which have both female and male flowers only, the cashew tree has three types of flowers: hermaphrodite (bisexual), male and sterile flowers (Figures 3a, 3b and 3c respectively). The flowers are born in clusters, which together form a panicle. Female flowers are only found in a bisexual form (Figure 3a). The sterile flower is abnormal; it possesses neither stigma nor anthers with pollen (Figure 3c). The color, shape and mean size of the panicles vary with the cultivars.

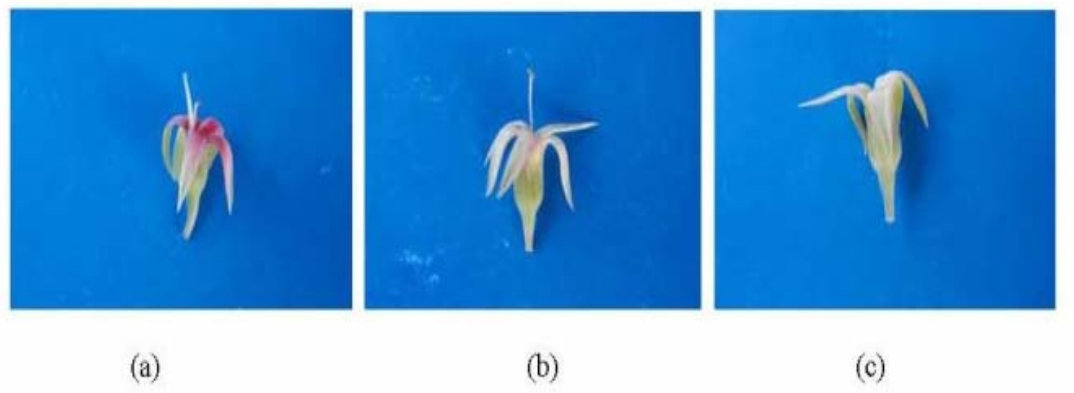

Figure 3 (a). Cashew bisexual flower. (b). Cashew male flower. (c). Cashew sterile flower.

Cashew apples and nuts **-** Botanically, the cashew apple is not a true fruit; it is more properly called receptacle, which is a modified peduncle, generally referred to as a false or pseudo fruit. The true botanical fruit is the kidney shaped nut. The nut has all features that justify it to be botanically referred to as a fruit. Important structures that are clearly seen during the early stages of the fruit development include petals or sepal remains

between the stalk (apple) and the nut (fruit); the corolla attachment point and a stylar (Figure 4a and 4b).

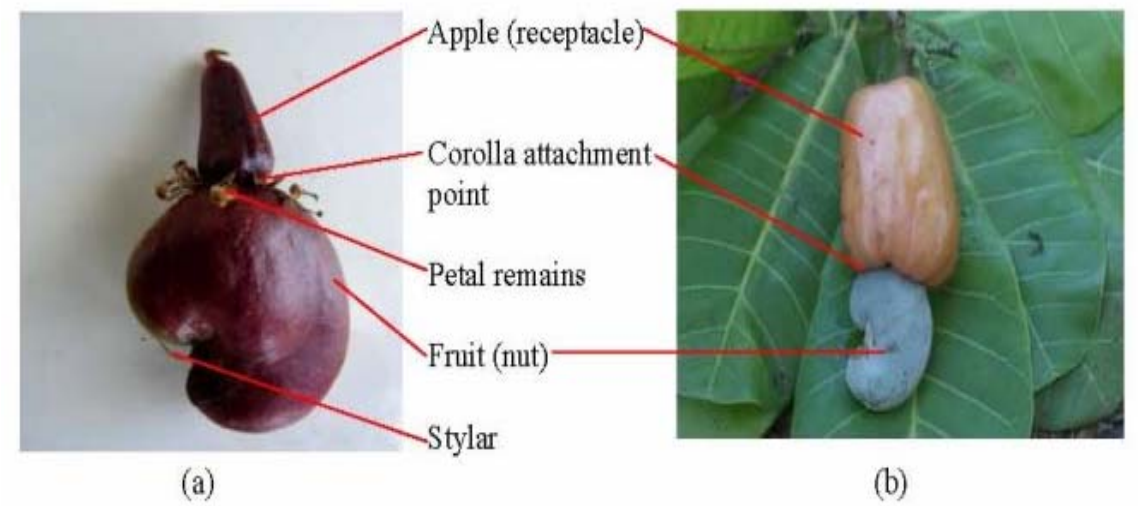

Figure 4 (a). Immature cashew apple and nut; (b). Mature apple and nut.

Apple color and shape vary with the cultivar. They can be yellowish, greenish-yellow or red. The fruits are borne single or in small clusters. Depending on the cultivar and the environment, the fruits can mature in 60 - 90 days. The weight of apples is about ten times the weight of nuts. The average weight of nuts varies between 3 and 15 g.

The cashew nut has two shells: a hard exterior shell and a testa. The testa is a thin brown skin (a fine, brown seed coat), inside the hard shell. It is wrapped around a slightly curved fleshy kernel. The testa protects the kernel from penetration by atmospheric oxygen, so preventing it from becoming rancid (oxidative rancidity) as it contains antioxidants. The testa is removed during the processing. Depending on the cultivar, the nut shell is about 5 mm thick. The nutshell is composed of an inner and outer wall, separated by a honeycomb tissue infused with caustic oil liquid known as cashew nut shell liquid (CNSL).

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Biographical Sketches

Fortunus Kapinga is a Senior Agricultural Research Officer, and Head of Cashew Breeding Department at Naliendele Agricultural Research Institute, Mtwara, Tanzania. He holds a B.Sc. in Agriculture General (2004, Sokoine University of Agriculture, Tanzania) and a M.Sc. (Crop Science), specialized in Crop Improvement (2009, Sokoine University of Agriculture, Tanzania). He has been working in the department for more than 18 years.

Mr Kapinga was one of the pioneer technicians participated in the first establishment of cashew polyclonal seed and scion gardens in Tanzania, which are now the main and reliable sources of improved cashew planting materials in country. Apart from other duties, he has been working as a Manger of Cashew Development Centres (CDC), in which the polyclonal seed and scion gardens were established. His major responsibility was to supervise and maintain production of high quality improved planting materials. Also, he has been conducting training programs to extension officers and farmers on improved cashew production techniques, including the aspects of cashew nursery establishment and asexual propagation to maintain attributes of the improved cashew, field management, and crop protection.
His research activities are mainly focusing on breeding high yielding varieties with desirable nut qualities, tolerant to major disease and insect pests, and adapted both to a wide range of agro-ecological and acceptable market conditions. Kapinga has long experience in characterization of cashew cultivars for distinctiveness, uniformity and stability test. In collaboration with other scientists he has developed and released sixteen improved cashew clones. He is co-author of several publications on cashew.

Dr. Louis Kasuga holds a B.Sc. degree in Agriculture (1988 Sokoine University of Agriculture, Tanzania), a M.Sc. (Tropical Agriculture Development from Reading University, UK) and a Ph.D. in Agricultural Botany (2003 Reading University, UK). Dr Kasuga is a Principal Agronomist and Head of Agronomy Section at Naliendele Agricultural Research Institute, Mtwara, Tanzania. He is Country Coordinator for the Regional Cashew Improvement Network for Eastern and Southern Africa, covering Ethiopia, Kenya, Malawi, Madagascar, Mozambique, Tanzania and Uganda. Before, he worked in two international projects dealing with the promotion of cashew industry in Tanzania, and participated in developing a number of technologies to help small-scale farmers to increase and improve cashew production.
Dr Kasuga participated in establishing and developing the multidisciplinary knowledge-based model of research and extension outreach known as Integrated Cashew Management Program. His research has mainly focused on the formation and working with farmer groups. He has extensive experience in conducting on-farm and on-station trials, and in developing packages for rehabilitation of abandoned or neglected cashew orchards.
Dr Kasuga is editor of a book on integrated cashew management in Tanzania. He has over 15 publications and has been doing international consultancy work for NGOs and private companies in various countries in East Africa.

Elly Kafiriti holds a B.Sc. degree in Agriculture (1982, Kansas State University), a M.Sc. in Agronomy (1986, Southampton University, UK**)** and a Ph.D. in Biological Sciences (2004 Leuven Catholic University, Belgium)**.** He is currently Principal Agronomist with the Oilseeds Research Program at Naliendele Agricultural Research Institute, Ministry of Agriculture Food Security and Co-operatives in Tanzania, and Director for Research and Development in the Southern Zone of Tanzania. In the past, he

served as the National Lead Scientist for the Oilseeds Research Program. He is a regular member of the Monitoring and Evaluation Team, which reviews the technological progress in the Tanzanian Department of Research and Development. Also, he is a member of the Cashew Research Steering Committee that reviews and approves cashew research activities, and the budgets to implement them.

Dr. Kafiriti is a research manager for more than 15 years; and a part time lecturer in botany with the Open University of Tanzania since 2000. His research work has been mainly on sesame and groundnut agronomy with a focus on developing appropriate technologies for increased production. A significant part of his research time has dwelt on participatory research with rice farmers in irrigated fields, identifying suitable rice varieties, determining appropriate and economic rice nitrogen fertilizer rates, land suitability for irrigated rice; and validating the benefits of bunds in rain fed lowland rice production.

He is the author or co-author of more than 20 peer reviewed papers published in national and international journals, a number of pamphlets, fliers, booklets and video films; and of a chapter in Crop Production in Tropical Africa.