

## *Lablab purpureus*—A Crop Lost for Africa?

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**Abstract** In recent years, so-called ‘lost crops’ have been appraised in a number of reviews, among them *Lablab purpureus* in the context of African vegetable species. This crop cannot truly be considered ‘lost’ because worldwide more than 150 common names are applied to it. Based on a comprehensive literature review, this paper aims to put forward four theses, (i) Lablab is one of the most diverse domesticated legume species and has multiple uses. Although its largest agro-morphological diversity occurs in South Asia, its origin appears to be Africa. (ii) Crop improvement in South Asia is based on limited genetic diversity. (iii) The restricted research and development performed in Africa focuses either on improving forage or soil properties mostly through one popular cultivar, Rongai,

while the available diversity of lablab in Africa might be under threat of genetic erosion. (iv) Lablab is better adapted to drought than common beans (*Phaseolus vulgaris*) or cowpea (*Vigna unguiculata*), both of which have been preferred to lablab in African agricultural production systems. Lablab might offer comparable opportunities for African agriculture in the view of global change. Its wide potential for adaptation throughout eastern and southern Africa is shown with a GIS (geographic information systems) approach.

**Keywords** Cover crop · Dolichos · Forage · Genetic diversity · Genetic erosion · Homegarden · Hyacinth bean · Landrace · Pulse · Traditional vegetable · Underutilized crop

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## Abbreviations

AFLP	Amplified fragment length polymorphisms
BARI	Bangladesh Agricultural Research Institute
BSMRAU	Bangabandhu Sheikh Mujibur Rahman Agricultural University in Gazipur/India
CSIRO	Commonwealth Scientific and Industrial Research Organisation/Australia
EST	Expressed sequence tag
GIS	Geographic information systems
IITA	International Institute of Tropical Agriculture/ Nigeria
ILRI	International Livestock Research Institute/ Kenya
IPGRI	International Plant Genetic Resources Institute/ Italy (now, Bioversity International)
IPSA	Institute of Postgraduate Studies in Agriculture/ Bangladesh (now, BSMRAU)
RAPD	Randomly amplified polymorphic DNA
UAS	University of Agricultural Sciences Bangalore, India
USDA	United States Department of Agriculture

## Introduction

So-called ‘lost crops’ have been appraised in a number of reviews in recent years, among them *Lablab purpureus* (L.) Sweet, one of traditional African vegetables (NRC 2006). Information on neglected crops such as lablab is typically scattered over a range of journals, reports, or manuscripts, many of which will probably never be published and, therefore, remain inaccessible to most researchers. Recent compilations of information promoting the ‘conservation and use of underutilized and neglected crops’ (e.g., the series by IPGRI of the same name; Hammer et al. 2001), however, have usually excluded lablab because the species has attracted certain attention in the science literature, often far more than other neglected crops (J. Heller, pers. comm. 2003). Despite its representation in the literature, however, it can be argued that lablab truly qualifies as ‘underutilized’ given its many attributes, potential uses and adaptation.

Lablab is an ancient crop and has been documented by archaeo-botanical finds in India prior to 1500 BC (Fuller 2003) and at Qasr Ibrim in Egyptian Nubia from the 4th century AD (Clapham and Rowley-Conwy 2007). Despite its label of ‘underutilized’, however, substantial areas of lablab are sown in certain tropical regions, either as a sole crop or in mixed production systems. Its popularity may also be demonstrated by the large number of more than 150 local names reported by various authors and on databases (e.g., Westphal 1974; Kay 1979; MMPND

2005). Lablab is the third most important vegetable in the central and south-western parts of Bangladesh after eggplant (*Solanum melongena*) and taro (*Colocasia* spp.) and is reported to have a total production area in the region of approximately 48,000 ha (Rashid et al. 2007). However, the limited production data available suggest that yields are low. The species is largely cultivated as a systems’ component of homegardens or mixed cropping schemes, whose specific contribution to the overall system is usually not recorded. It has been documented as part of traditional production systems, such as those based around irrigated agriculture in the oases of Oman (Gebauer et al. 2007), homegardens in Nepal (Gautam et al. 2008), India (Kumar and Ramakrishnan 1990; Peyre et al. 2006), Bangladesh (Mir et al. 2004), Thailand (FAO 1999), and other tropical countries (Table 1).

The prime objective of this paper is to stimulate debate and focus on a crop whose striking diversity, uses and adaptation might be lost in Africa, its cradle, as it continues to be overlooked in current farming systems research and development. We also highlight the genetic diversity of the species so it might be applied to plant improvement efforts, including those in Asia, which are currently based on limited genetic diversity. The paper focuses on recent progress in plant improvement and genetic resources based on a comprehensive review of scientific literature from the mid 1990s to the present and so builds on the previous reviews of the crop by Schaaffhausen (1963), Hendricksen and Minson (1985), Shivashankar and Kulkarni (1989), and Murphy and Colucci (1999).

This paper also brings together and builds on the insights of diversity and domestication of the species provided in a number of previous studies over the last 8 years (Pengelly and Maass 2001; Maass et al. 2005; Tefera 2006; Maass and Usongo 2007; and Venkatesha et al. 2007), and it offers new insights into the species’ eco-geography based on passport data from 643 herbarium specimens and germ-plasm accessions collected from Africa (Ramme, 2002).

## Four Theses

### (i) *One of the most diverse domesticated legumes*

Lablab has been noted for decades as being one of the most agro-morphologically diverse (e.g., Piper and Morse 1915, Rivals 1953; Pengelly and Maass 2001; Mohan and Aghora 2006; Islam 2008) and versatile tropical legume species through its roles as pulse (also used as ‘dhal’), vegetable (green bean, pod, leaf), forage/green manure, herbal medicine, and even ornamental (Adebisi and Bosch 2004; NRC 2006) and, more recently, Morris (2009) reviewed its bio-functional properties for use as pharmaceutical or nutraceutical. In Indonesia, seeds serve as raw

**Table 1** *Lablab purpureus* documented as a homegarden plant in different regions and countries of the world

Country, Location	Region <sup>a</sup>	Use	Local name [common name]	Reference
Fiji, Naura	OCE	Food (parts of plant other than fruit)	[Hyacinth bean]	Brazil (1990)
Papua New Guinea	OCE	Food (parts of plant other than fruit)	[Hyacinth bean]	Brazil (1990)
Indonesia	SEA	Vegetable, medicinal, other	Kara-kara, Komak, Kacang-kara, Kacang-bado, Kacang-biduk, Kekara <sup>b</sup>	Levang and de Foresta (1991)
Java	SEA	Food (parts of plant other than fruit)	[Hyacinth bean]	Fernandes and Nair (1986); Brazil (1990)
		Vegetable	Kara Andong, Kara Uceng [Hyacinth bean]	Krol (1992)
W. Java	SEA		Kara [Hyacinth bean; bonavista bean]	Abdoellah and Marten (1986)
Sulawesi	SEA	Vegetable	Kacang komak	Kehlenbeck (2007)
Philippines	SEA	Food (parts of plant other than fruit)	[Hyacinth bean]	Fernandes and Nair (1986); Brazil (1990)
Thailand	SEA		Thua paep	FAO (1999)
Vietnam	SEA	Food (fruit)	Dâu ván	Hoang et al. (2008)
Bangladesh, Gazipur	SA		[Country bean]	Mir et al. (2004)
Chittagong				Momen et al. (2006)
Sylhet		Vegetable		Uddin and Mukul (2007)
India, NE	SA			Kumar and Ramakrishnan (1990)
S + W Tripura			Sim	Sankaran et al. (2007)
W Bengal		Vegetable		Mitra and Pathak (2009)
Uttaranchal			Sem	Kala (2005)
Kerala			Aviram [Indian butter bean]	Peyre et al. (2006)
Nepal	SA	Vegetable	Hiude simi	Subedi et al. (2006)
Nepal, western	SA	Vegetable	Hiunde simi	Sunwar et al. (2006)
Sri Lanka	SA	Vegetable		Hochegger (1998)
Yemen	WA			Ceccolini (2002)
Ethiopia	SSA	Vegetable	Amora-guaya, Gerenga, Lubia bean, O-cala	Westphal (1974)

<sup>a</sup> OCE Oceania; SA South Asia; SEA South East Asia; SSA Sub-Sahara Africa; WA West Asia

<sup>b</sup> various more local names listed

materials for ‘tempeh’, a traditional fermented food typically made from soybeans (Subagio and Morita 2008). The same authors also demonstrated that protein isolate from lablab beans has high potential as a practical food additive for improving cake quality. The degree of agro-morphological diversity in the species in even a narrow geographical range is demonstrated in Nepalese homegardens where lablab is not only one of the most frequently cultivated crops but is attributed 7 and 12 named varieties in the lowland ‘terai’ zone (c. 100 m asl.) and mid-hill zone (800–1,200 m asl.), respectively (Sunwar et al. 2006). The Nepalese farmers differentiated among varieties using morphological characters such as pod shape, size and colour in conjunction with their particular seasonal adaptation. Similarly, remarkable morphological variation has also been reported throughout the entire hill region of north eastern India (Yadav et al. 2003; Sankaran et al. 2007).

Lablab also has considerable physiological diversity. Mugwira and Haque (1993) identified a range of adaptation to nutrient stresses such as acidity and low available phosphorus on two acid soils of Ethiopia. Karachi (1997) was able to show highly differential adaptation to semi-arid conditions and suitability for forage use in 17 landraces obtained from Kenyan farmers.

The versatility of its uses has resulted in comprehensive germplasm collections being assembled, with an overall total of more than 3,000 accessions worldwide (Table 2). However, this total number of accessions has many duplicates and an estimate of number of unique accessions conserved cannot be derived because of the scarcity of passport and/or characterization data.

Despite its large agro-morphological diversity in South Asia, its origin, however, appears to be African (Verdcourt 1970, 1979; Maass et al. 2005; Maass and Usongo 2007), which is the only continent where wild plants of the species

**Table 2** Summarized stock of *Lablab purpureus* germplasm collections (>10 accessions) maintained in different countries and regions of the world

Country, Region <sup>a</sup>	Accessions reported (no.)	Information source
South America	134	BI (2008)
North America (USDA)	52	GRIN (2009)
Europe	82	BI (2008); IPK (2009); VIR (2009)
Oceania (incl. CSIRO/Australia)	104	BI (2008)
China	410	BI (2008)
Philippines	209	Engle and Altoveros (2000)
Taiwan (AVRDC)	423	AVRDC (2009)
South-East Asia (other countries)	82	BI (2008); NIAS (2009)
Bangladesh	551	Islam (2008)
India	221	BI (2008)
South Asia (other countries)	93	BI (2008)
Ethiopia (incl. ILRI)	223	BI (2008)
Kenya	403	BI (2008)
Sub-Saharan Africa (other countries; incl. IITA)	67	BI (2008)
Total	3,054	

<sup>a</sup> AVRDC The World Vegetable Center, Taiwan; CSIRO Commonwealth Scientific and Industrial Research Organisation, Australia; IITA International Institute of Tropical Agriculture, Nigeria; ILRI International Livestock Research Institute, Ethiopia; USDA United States Department of Agriculture, USA

have been recorded to occur naturally. Fuller (2003) suggested its introduction to South Asia occurred from west to east so that archaeo-botanical finds have been dated, for example, from 2000 to 1700 BC at Hallur, India's earliest Iron Age site in the state of Karnataka, to 1200–300 BC at the Veerapuram excavation site in the state of Andhra Pradesh.

(ii) *Crop improvement in South Asia, Australia and the USA based on limited genetic diversity*

Although, lablab is widespread in many Asian countries, it is not among the mainstream crops and its role in diets continues to decline in many societies. For example, lablab is disappearing from southern Japan and, while the entire reasons for this may be quite complex, it is undoubtedly related to declining relationship between traditional crops and communities, and the failure of younger generations to continue the tradition of growing heirloom varieties (D.A. Vaughan, pers. comm.). Conversely, lablab is a highly popular crop in South Asia (e.g., Haque et al. 2003; Rahman et al. 2002), where it is especially cultivated under drought-prone conditions. Genetic studies and plant improvement were conducted at Tamil Nadu Agricultural University in Coimbatore, India since the 1930s (e.g., Rangaswami Ayyangar and Krishnan Nambiar 1935) resulting in a number of cultivars being developed. At the University of Agricultural Sciences (UAS) Bangalore, India, several improved cultivars have been developed by selecting for desirable traits in segregating populations (M. Byre Gowda, pers. comm.). The most widely distributed Australian cultivars, however, resulted from research towards forage improvement (Whitbread and Pengelly 2004). This program also endeavored to combine traits of the successful, wide-spread forage cv. Rongai with an

African wild, perennial germplasm accession, which led to the release of cv. Endurance (Liu 1998). While the Australian improvement program has been discontinued, a lablab forage cultivar, cv. Rio Verde, has recently been released in Texas, USA (Smith et al. 2008).

The current most active lablab improvement programs for food, however, probably exist in India (e.g., Mahadevu and Byre Gowda 2005; Girish and Gowda 2009) and Bangladesh (e.g., Alam and Newaz 2005; Arifin et al. 2005). More than 30 improved lablab varieties have been produced at various Indian institutions since breeding began (Gopalakrishnan 2007). In Coimbatore, India, the photo-insensitive, ultra-short-duration vegetable lablab, CoLT 22/1, commences flowering at 40–42 days after sowing, and enables the harvesting of green vegetable pods as early as 48 days after sowing so enabling use throughout the year (Veerabadhiran et al. 2001). Byre Gowda (pers. comm.) from UAS Bangalore, India, recently succeeded in breeding the high-yielding, photo-insensitive cultivar HA-4.

There are also major plant breeding programs at Bangladesh Agricultural University in Mymensingh (e.g., Alam and Newaz 2005; Nahar and Newaz 2005) and at Bangabandhu Sheikh Mujibur Rahman Agricultural University in Gazipur, India (BSMRAU; formerly, IPSA, Institute of Postgraduate Studies in Agriculture) (Arifin et al. 2005). Two photo-insensitive lines have recently been bred and released as year-round cultivars, cvs. IPSA Seam-1 and IPSA Seam-2 (Rokhsana et al. 2006). These can be grown during both the hot/dry and humid/cooler seasons with flowering in both cultivars commencing between 45 and 60 days after sowing. This compares positively with the traditional photo-sensitive landraces

that flower 2–6 months after sowing and are only grown during the hot/dry winter season. Lablab plant improvement programs are also underway in China (e.g., Tian et al. 2005; Xi and Tang 2006); however, information has proven difficult to access.

The afore-mentioned plant breeding successes illustrate most Asian activities targeting vegetable or pulse improvement, where the most important goals appear to be the development of short-duration, determinate, bushy types that are insensitive to photoperiod, fairly homogeneous and pest-resistant (e.g., Ramasamy et al. 1990; Peng et al. 2001; Sultana et al. 2001; Rahman et al. 2002; Adebisi and Bosch 2004). To support these and other plant improvement objectives, genetic maps containing molecular and morphological markers have been constructed from different mapping populations (Konduri et al. 2000; Yuan et al. 2009) or improved by comparative mapping with mungbean (*Vigna radiata*) (Humphry et al. 2002). As a consequence of the historical interest in the crop and the focus on plant improvement, relatively large collections of landraces and other genetic stocks have been assembled in a number of institutions (Table 2). Several of these collections have provided the basis for various molecular studies of diversity (Table 3) that have helped to understand the genetic patterns of diversity of this crop.

Despite the impressive agro-morphological variation available, particularly in southern Asia, it appears that lablab in that region is genetically less diverse than material from Africa. Sultana et al. (2000) revealed that the 20 landraces from Bangladesh studied by RAPD markers were genetically similar and more related to most of the approximately 60 accessions received from CSIRO, Australia of other Asian origins than to those from diverse origins in Africa. Similarly, Venkatesha et al. (2007) showed that 62 southern Indian landraces analyzed either by AFLP or EST markers only exhibited narrow genetic diversity. When these Indian landraces were compared to the very significant genetic variation within the core collection proposed by Pengelly and Maass (2001), the limited genetic diversity available in the landraces collected from southern India became even more apparent (Fig. 1). In a molecular diversity assessment applying AFLP markers (Fig. 2), Tefera (2006) showed, on the other hand, that East African landraces were fairly distinct from the proposed core collection that was chosen to represent both agro-morphological variation and a broad range of geographical origins (Pengelly and Maass 2001). Accordingly, these newly collected East African landraces could even genetically expand the proposed core collection. The recognition of limited genetic diversity available in Indian indigenous landraces and in Indian plant improvement programs has led Mahadevu and Byre Gowda (2005) to initiate the addition of ‘exotic’ germplasm sourced from

the USDA-held collection to their breeding program at UAS Bangalore.

### (iii) *Limited research and development in Africa*

In contrast to South Asia, wild, undomesticated lablab has been found to occur naturally in several African countries (Verdcourt 1970, 1979), and both the wild types and domesticated African landraces have been shown to be genetically diverse (e.g., Liu 1996; Maass et al. 2005; Tefera 2006). Lablab has been a traditional crop in eastern Africa (Westphal 1974; Maundu et al. 1999) although its use has dramatically decreased in recent years (Maundu et al. 1999; Ngailo et al. 2003). In an assessment of traditional knowledge about land use along a humidity gradient in Arumeru district of Tanzania, Ngailo et al. (2003) found that, in the sub-humid villages, lablab, as a field crop, was cultivated on about 10% of the land during the 1930s, but its use had decreased to almost nothing by 2000 (Fig. 3). Despite this decline, however, lablab appears to persist as a garden crop (rather than a field crop) in eastern and southern Africa; and recent market surveys from eastern Africa suggest that there is a high demand (and subsequently a good price) for lablab in Kenya (Ngailo et al. 2003).

There is almost no ongoing lablab research in Africa, except for programs focusing on improving soil properties by using green-manure/forage crops, such as in maize-based systems of Kenya (Mureithi et al. 2003; Cheruiyot et al. 2007; Lelei et al. 2009), Malawi (Sakala et al. 2004) and Nigeria (e.g., Ibewiro et al. 2000; Amodu et al. 2004; Gbaraneh et al. 2004; Rahman and Ogungbile 2006), or sorghum- and millet-based systems in the semi-arid tropics of Mali (Kouyaté et al. 2000). Almost all of these African initiatives have included and continue to include one popular late-maturing forage cultivar, cv. Rongai (Makembe and Ndlovu 1996; Fischler and Wortmann 1999; Haque and Lupwayi 2000; Wortmann et al. 2000; Shehu et al. 2001; Mureithi et al. 2003; Amodu et al. 2004; Nworgu and Ajayi 2005; Nyambati et al. 2006; Abeke et al. 2007; Ojiem et al. 2007; Abeke et al. 2008; Mubiru and Coyne 2009) and, as a result, the potential role of the species as a pulse or vegetable in Africa is likely to be severely underestimated. Only recent work at ILRI in Ethiopia and CSIRO in Australia (Pengelly and Maass 2001) and, subsequently, in southern Africa (Whitbread and Pengelly 2004) explored a much larger range of accessions for feed and food and identified germplasm, which was well adapted to drier climates and crop use. Similarly, Ewansiha et al. (2007) at IITA in Nigeria evaluated almost 50 germplasm accessions largely acquired from USDA for the dual purpose of feed and food. They identified accessions with good grain and forage yields of high potential for use in the cereal-legume livestock systems in the moist savannah zone of West Africa.



**Table 3** Overview of molecular studies performed on *Lablab purpureus* in chronological order

Germplasm sources and main objectives <sup>a</sup>	Method applied <sup>b</sup>	Reference
CSIRO: 40 accessions for germplasm characterization	RAPD	Liu (1996)
Mapping population from cross of two CSIRO accessions	RFLP, RAPD	Konduri et al. (2000)
Bangladesh/Japan germplasm + CSIRO (c. 60 accessions) for germplasm characterization	RAPD	Sultana et al. (2000)
Mapping population for comparative mapping with mungbean ( <i>Vigna radiata</i> )	RFLP	Humphry et al. (2002)
USDA: >30 germplasm accessions	SSR	Wang et al. (2004)
CSIRO: 103 accessions for germplasm characterization	AFLP	Maass et al. (2005)
11 varieties from Hunan province	RAPD	Tian et al. (2005)
12 landraces from southern India for characterization	RAPD	Gnanesh et al. (2006)
Mostly core collection (28 accessions) + Tanzanian landraces for germplasm characterization	AFLP	Tefera (2006)
[information inaccessible due to language of publication]	RAPD	Xi and Tang (2006)
62 landraces collected from southern India, compared to some core collection accessions	AFLP, SSR	Venkatesha et al. (2007)
USDA: 47 accessions for germplasm characterization and phylogenetic analysis	SSR	Wang et al. (2007)
40 accessions from India	AFLP	Patil et al. (2009)
10 insect-tolerant or -susceptible landraces from India	RAPD	Sujithra et al. (2009)
Mapping population from cross of two Chinese accessions	RAPD	Yuan et al. (2009)
Germplasm collection from AVRDC + Bangladesh c. 200 accessions for germplasm characterization	AFLP, SSR	Tariqul Islam (BARI, Bangladesh) PhD thesis in process
Germplasm from Genebank of Kenya for germplasm characterization	AFLP, SSR	Allan Shivachi (Moi Univ., Eldoret, Kenya) MSc thesis in process

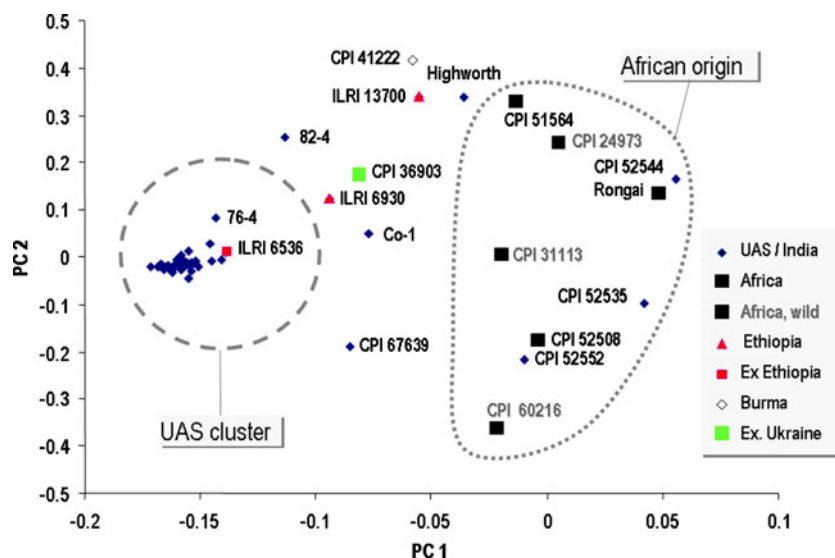
<sup>a</sup> AVRDC The World Vegetable Center/Taiwan; BARI Bangladesh Agricultural Research Institute; CSIRO Commonwealth Scientific and Industrial Research Organisation/Australia; USDA United States Department of Agriculture

<sup>b</sup> AFLP amplified fragment length polymorphism; RAPD randomly amplified polymorphic DNA; RFLP restriction fragment length polymorphism; SSR simple sequence repeats

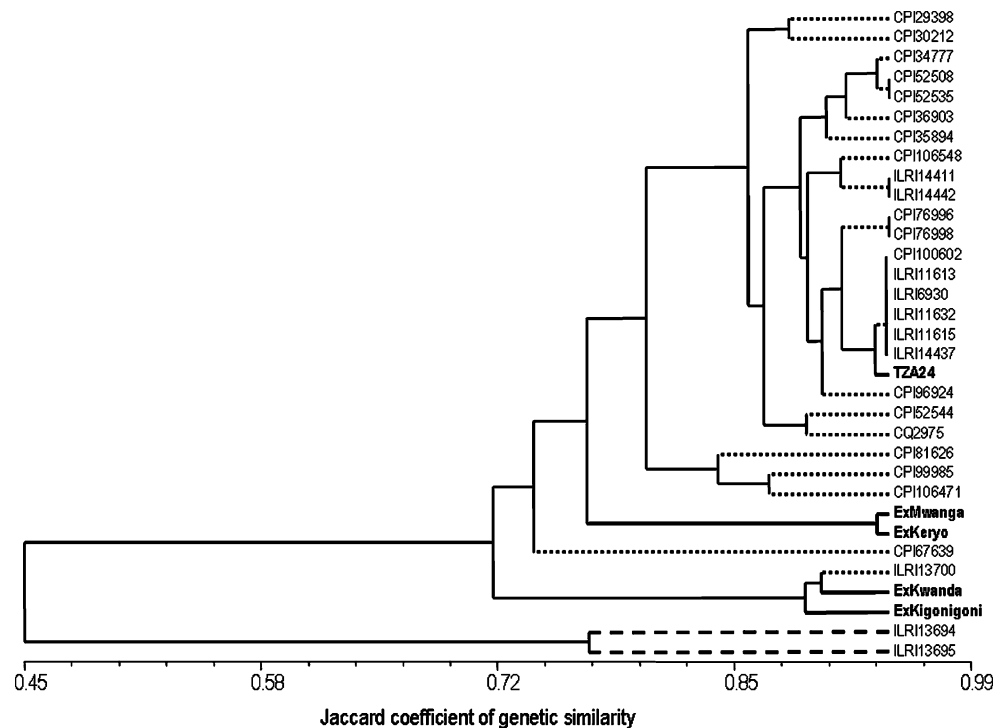
A small number of studies (Fischler and Wortmann 1999; Mureithi et al. 2003; Nyende and Delve 2004; Odunze et al. 2004; Tefera 2006) have attempted to address with farmers the issue of acceptability of lablab, its varieties and potential uses. These are key initiatives if lablab use is to be expanded

as it is, or has become, an unknown species and crop to most farmers and rural communities. When performing a participatory evaluation among various lablab accessions with a variety of panelists, Tefera (2006) found that many were neither accustomed to production nor to consumption

**Fig. 1** Principal component analysis from 151 AFLP markers of 53 *Lablab purpureus* accessions indicating narrow genetic diversity of southern Indian landraces (UAS cluster) maintained at UAS Bangalore as opposed to members from a core collection proposed by Pengelly and Maass (2001) (Modified from Venkatesha et al. 2007)



**Fig. 2** Dendrogram of the diversity among 33 *Lablab purpureus* accessions assessed by AFLPs (Amplified Fragment Length Polymorphism), applying UPGMA (Unweighted Pair Group Arithmetic Means Algorithm), and hierarchical cluster analysis. Core collection accessions proposed by Pengelly and Maass (2001) in dotted lines, two ILRI-accessions of subsp. *uncinatus* in dashed lines; eastern African landraces in bold lines; TZA = Tanzania. (Modified from Tefera 2006)



of the crop although they appreciated the quality of some accessions and the substantial difference in pod characteristics existing among them. During an organoleptic taste assessment, some of the panelists even questioned if the pods of certain accessions came from snap bean (*Phaseolus vulgaris*) varieties (Tefera 2006).

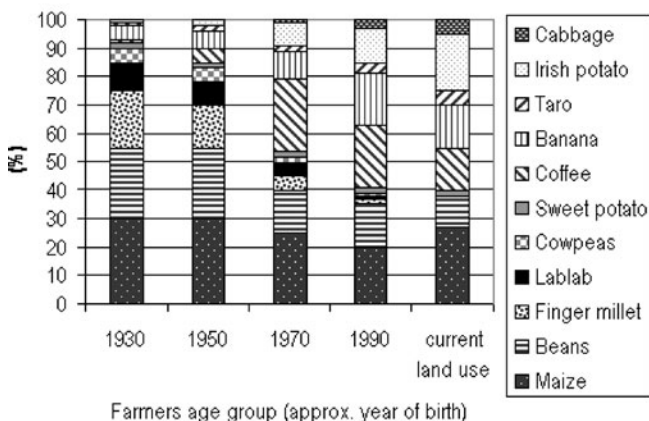
With the exception of the study by Tefera (2006) in Tanzania and M.G. Kinyua's (pers. comm.) recent inception of a plant improvement program at Moi University, Kenya, there are no reports of ongoing research on improving lablab as a food for Africa.

The traditional diversity of lablab in Africa is undoubtedly under threat of genetic erosion. Given its unique and important genetic resource for any potential improvement program, be it in Asia or Africa, a substantial conservation program needs urgently to be undertaken.

(iv) *Outstanding adaptation to drought*

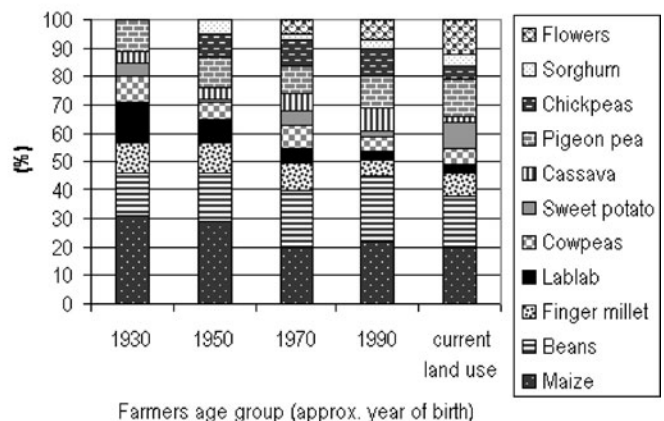
Lablab is especially adapted to drought (e.g., Maundu et al. 1999) and has been reported to have better drought tolerance than common beans (*Phaseolus vulgaris*) or cowpea (*Vigna unguiculata*) (Piper and Morse 1915). When Keller et al. (2006) surveyed diversity of indigenous vegetables in eastern

**Sub-humid: Ng'iresi and Olgilai villages**



**a**

**Semi-arid: Moshono and Kiserian villages**



**b**

**Fig. 3** In four villages of Arumeru district, Tanzania, 30 farmers of different approximate age groups were interviewed about land use changes along a transect from (a) sub-humid to (b) semi-arid; this was

compared to records and a current assessment. (Derived from Ngailo et al. 2003)

Tanzania, lablab was mostly recorded from the dryer regions and was cultivated in 9 from 10 villages surveyed in the Kongwa district (Keller 2004). Ngailo et al. (2003) also showed that farmers in northern Tanzania perceived the portion of their land cropped with lablab to remain almost the same in two semi-arid villages over a period of about 70 years, while it decreased drastically in two sub-humid villages over the same period (Fig. 3). According to data compiled by Cook et al. (2005), forage lablab is best adapted to annual rainfall regimes of 650–3,000 mm although it can be used as a forage in regions with rainfall of <500 mm provided seedlings can be established. However, lablab does drop leaves during prolonged dry periods. Cook et al. (2005) also maintained that lablab is able to extract soil water from at least 2 m depth, even in heavy-textured soils. Muchow (1985) showed lablab cv. Highworth to be among the more drought-tolerant crops, when comparing its grain yield with those of soybean (*Glycine max*) and different *Vigna* species in semi-arid southern Australia. This was confirmed by a study of the relative shoot drought tolerance of major crops grown in the semi-arid tropics, where survival at the seedling stage was compared (Singh and Matsui 2002). Only seedlings of some cowpea accessions and lablab survived in reasonable percentages, even 19 days after terminating watering.

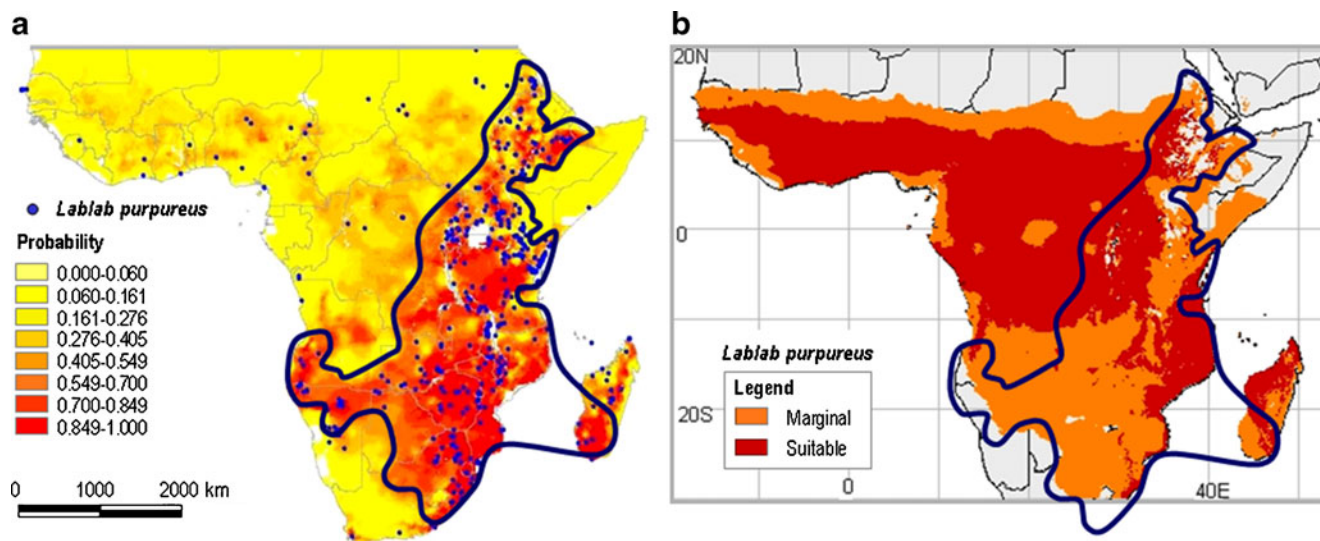
Drought is an important production constraint in the West African savannah zone, where drought stress in both the seedling and terminal growth stages results in low grain and fodder yields. Nworgu and Ajayi (2005) showed that lablab was the most drought-tolerant species in a comparison of various tropical forage legumes evaluated in South-Western Nigeria. Despite occasional reports of only moderate

drought tolerance, such as that by Abdel-Wahab et al. (2002) who concluded from nodulation experiments on different soil types in Egypt that the one lablab accession studied was only tolerant to moderate levels of drought, there is overwhelming evidence that there is both strong drought tolerance and considerable diversity in drought tolerance within the species. For example, Ewansiha and Singh (2006) reported significant variation in drought tolerance of seedlings in lablab and cowpea, with the number of days to 100% plant death in lablab and cowpea seedlings ranging from 19 to 31 and 21 to 30, respectively.

## Prospects

### Mapping the Potential of Lablab in Africa

The probability of occurrence and potential use of lablab throughout eastern and southern Africa can be estimated by using passport data from a range of germplasm accessions and herbarium specimens as input into the FloraMap® program (Jones and Gladkov 1999; Jones et al. 2002), and by subsequently calculating and mapping the distribution probability based on climatic similarities. The resulting map (Fig. 4a) is in contrast to that generated by a database on tropical forages and derived primarily from known adaptation of widespread forage cultivars, such as cvs. Rongai or Highworth (Fig. 4b; Cook et al. 2005). While the tropical forages mapping suggests that large parts of eastern Africa are only marginally suited to the species, the analysis using passport data indicated that many accessions were collected from precisely some of those regions defined as “marginally



**Fig. 4** Maps of ecogeographic surveys of *Lablab purpureus*, predicting (a) high probability of occurrence of the species, based on 643 herbarium specimens and germplasm accessions by applying FloraMap®

(Modified from Ramme 2002); or (b) high and marginal suitability of the crop from the Tropical Forages database (Cook et al. 2005). The line includes the high probability area generated by FloraMap



suited” (Fig. 4a). Such divergent outcomes from GIS analyses can be expected when different ecotypes of a species are included (Jones and Gladkov 1999), as is the case here. The integrity of the divergence between the adaptation maps based on different ecotypes is supported by on-the-ground adaptation studies in southern Africa, where cvs. Rongai and Highworth were deemed to be unsuitable due to long vegetative phases that made them prone to early frosts or drought and impeded seed production (Maass et al. 2003; Whitbread and Pengelly 2004). Overall, the two maps demonstrate the wide potential range of adaptation for this species in Africa, depending both on specific genotypes (cultivars) and its purpose of use(s).

Few germplasm or herbarium collections originated from West and Central Africa. However, it would be expected that the species be adapted over a large proportion of that region given its rainfall and latitude. Widespread adaptation in West and Central Africa is supported by the forage accession analyses’ prediction of adaptation in the region (Fig. 4b).

#### Future Opportunities

The provocative title on whether or not *L. purpureus* is a crop lost for Africa aims to stimulate consideration of this versatile, variable and adaptable crop resource and avoid its loss. While the current initiatives to develop this underutilized plant for food and feed in Africa continue to be founded on a very narrow genetic base, and often on plant types selected for forage rather than pulses or vegetables, there is every reason for concern that known and existing biodiversity, which may be more suited to Africa and its range of climates, is being overlooked.

Adebisi and Bosch (2004) summarized that lablab has considerable promise as a crop species because its grain yields can be higher than those of cowpea and its spectrum of adaptability to differing ecological conditions is wider than for any other leguminous plant. However, not enough is known about adaptation to drought across the species (Ewansiha and Singh 2006). Even less information exists about the physiological mechanisms of that adaptation. The history, success and failure of lablab evaluation in various African environments, either as a crop or forage, have clearly been based on narrow genetic diversity and a few commercial cultivars, some of which were initially selected for their forage value only. Basing decisions on the potential value of the crop in Africa on results from this limited genetic base will undoubtedly lead to the risk that the species as a whole may be discarded (Maass et al. 2003). A wider range of diversity exists and is available from the world’s genebanks, including African indigenous materials. And this wider range of germplasm needs to be evaluated in future work. This may not only provide new

insights into the potential role of lablab, in semi-arid regions in particular, but such an approach may also aid in ensuring that indigenous germplasm is conserved.

Due to its drought tolerance, lablab might offer comparable opportunities for African agriculture in the view of global change. The IPCC (2007) report indicates that many semi-arid areas, including southern Africa, will suffer a decrease in water resources due to climate change. Thornton et al. (2002) mapped the possible changes in production systems over sub-Saharan Africa and came to the conclusion that some of the existing cropping systems may decrease in area.

The mutual benefit and potential collaborations arising from the exchange of materials and knowledge between African and Asian researchers will hopefully have been stimulated during the First International Lablab Meeting near Arusha, Tanzania, in March 2008. Improved, high-yielding cultivars from drought-prone areas in India could contribute to African food security in regions with similar climates. Genetically distant African landraces may offer to the South Asian breeding programs new sources for pest and disease resistance together with other important traits. Collecting special purpose germplasm from semi-arid regions, such as in Namibia, where the wild *L. purpureus* subsp. *uncinatus* var. *rhomboideus* has been recorded (Verdcourt 1970) and which has never been included in any screening program, may add needed traits for future breeding programs.

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