CASSAVA

Processing and Storage
Proceedings of an Interdisciplinary Workshop, Pattaya, Thailand, 17-19 April 1974

Editors: E.V. Araullo
Barry Nestel
Marilyn Campbell
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AND STORAGE

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Agronomic Potential for Cassava Production

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Abstract Cassava has advantages over many other crops in that it tolerates very poor acid soils and still gives reasonable yields, is drought-tolerant, and has no fixed harvest date giving great flexibility to farming systems. However, present cassava yields of about 10 metric tons (t)/ha are far below the known potential of 50 t/ha or more. The reasons for this are poor agronomic practices (especially weed control), use of varieties of low yield potential, and losses due to diseases and pests.

Yields can be improved with little extra input by (1) using correct agronomic practices, such as the optimum spacing, adequate weed control, and good quality planting material; (2) using varieties of known high yield potential; and (3) planting disease-free cuttings and resistant varieties.

The future yield potential of cassava was estimated to be close to 90 ton/ha per year under ideal conditions.

Résumé Le manioc présente par rapport à de nombreuses autres cultures les avantages suivants: il tolère des sols acides très pauvres tout en donnant des rendements convenables, il résiste à la sécheresse, il n’a pas de date de récolte fixe, ce qui donne lieu à une grande souplesse relativement aux systèmes de culture employés. Les rendements actuels du manioc, environ 10 tonnes/ha sont toutefois nettement inférieurs à ses possibilités connues qui atteignent 50 tonnes/ha ou davantage. Les raisons en sont les mauvaises méthodes culturales (en particulier sur le plan de la lutte contre les adventices), l’utilisation de variétés à faible rendement et enfin les pertes dues aux maladies et aux parasites.

Une amélioration même légère des moyens de production se traduit par une augmentation des rendements. Parmi ces moyens figurent: (1) l’emploi de méthodes agronomiques convenables, telles que distances de plantation optimales, lutte efficace contre les adventices, bonne qualité du matériel végétal de plantation; (2) l’emploi de variétés connues pour leurs rendements élevés; (3) plantation de boutures saines et de variétés résistantes aux maladies.

On estime que, dans des conditions idéales, le rendement potentiel du manioc devrait être proche de 90 tonnes/ha par an.

CASSAVA (Manihot esculenta Crantz) is grown at altitudes below 2000 m. Yields decrease as temperature decreases with altitude above
1000 m near the equator (Cock and Rosas, unpublished). It can be grown on very infertile soils, often as the last crop in a rotation. It will produce on extremely acid soils where few other crops will yield anything. Cassava has a great advantage over most starch-producing crops in drought tolerance. The cereal crops need water during the flowering period; if not they will often yield little or nothing. Cassava, once established, has no critical period. At the onset of a drought period, it drops its leaves and remains essentially dormant; when the rains come, it draws on its root reserves to form a new leaf canopy and later fills its roots. Hence, cassava can readily be grown in areas with rather uncertain rains that may prevent planting of other crops.

A further attribute of cassava is that it has no determined harvest period after which it spoils. Cassava, as far as is known, grows almost indefinitely, increasing its yield with time; hence, the farmer can harvest its crop when it is convenient or when it will demand a high price rather than on a set date. This adds great flexibility to a crop program based on cassava. However, if the cassava is left too long, there may be marketing problems because of oversized roots, which are usually unacceptable, increased fibre in the roots, and a decrease in the starch content (Ghosh 1968).

The total area on which cassava is grown is about 10 million ha and yields average about 10 metric tons (t)/ha per year (FAO 1971). These yield levels are far below some of the very high figures that have been quoted (de Vries et al. 1967), suggesting that its yield potential is rarely reached in practice. At CIAT, we have obtained yields of over 50 t/ha per year on a fertile soil with minimal inputs, and on a nearby farm with rather infertile soils and no irrigation, yields of over 40 t/ha per year. These results suggest that cassava's known yield potential is 40–50 t/ha even on rather infertile soils with limited inputs and without irrigation.

In spite of its great yield potential and certain attributes that make it easy to fit into a farming system, world cassava yields at 10 t/ha are far below those that might be expected. The reasons for this cannot be stated categorically, but probably include: (1) poor agronomic practices; (2) poor varietal selection; and (3) diseases and insects. In this paper I shall try to outline some of the more important of these.

**Agronomic Practices**

Cassava is reported to be aggressive toward weeds and insect pests (Hendershott et al. 1972) but adequate weed control can markedly improve yields. In trials at CIAT, yields were reduced to less than 2 t/ha when no weed control was used (Doll 1974). In the same trial, plots weeded twice by hand yielded about 20% less than plots kept weed-free all the time. Hand weeding twice was considered to be sufficient by Hendershott et al. (1972).

It is also reported that cassava depletes soil, especially with respect to potassium, due to its high nutrient requirement (Dijk 1951). This is not surprising. Any crop that yields well, particularly on poor soils, will deplete the nutrient reserves in that soil. However, Birkinshaw (1926) reports up to 15 cassava crops being harvested continuously. De Geus (1967) states that to obtain high yields on poor soils, particularly lateritic soils, use of fertilizers is essential. In Latin America, farmers frequently say that excessive nitrogen actually decreases yield due to excessive top growth. In our trials using up to 300 k/ha of N, we have not observed any negative nitrogen response. Reports on favorable response to fertilizers are numerous (Blin 1905; Doop 1937; Malavolta et al. 1952, 1953; Normanha 1951; Chadha 1958; Albuquerque 1958; Jacoby 1965; Jacob and Uexkull 1966; De Geus 1967; Silva a Freire 1968; Normanha et al. 1968; Samuels 1970; Chew 1970; Kumar et al. 1971; Almeida 1971). However, due to the low value of cassava and high price of fertilizers in some regions it is not considered to be of economic interest to the farmer (Normanha 1951). The response to the different elements is extremely varied depending on soil type; however, it is obvious that yields can be increased by judicious use of fertilizers. In Colombia, less than one-quarter of the farmers use fertilizer, and those who do apply only small quantities (P. Andersen, personal communication), and it
is likely that this situation does not only occur there.

The length and quality of planting material markedly influences yield. The stakes should be from the basal part of mature plants for optimum yields (Huertas 1940; Jeyaseelan 1951; Krochmal 1969; Enyi 1970), and in general, longer cuttings give higher yields (Jeyaseelan 1951; Fernando and Jaysundera 1942; Brandao 1959; Rodriguez et al. 1963). However, Loría (1962) found no significant yield differences between 40-, 60-, and 80-cm stakes, suggesting that above 40 cm there is little yield increase by using longer stakes.

The results from studies on planting position — vertical, inclined, or horizontal — and planting on the flat or on ridges do not show any consistent trends. It is possible that different systems are needed for different soil and climatic conditions. Recently, it has been reported that planting on ridges in a very wet area prevented root rots and effectively increased yield (C. Lozano, personal communication).

The results from spacing trials are also equivocal (Verteuil 1917; Fernando and Jaysundera 1942; Machado 1951; Rodriguez et al. 1966; Enyi 1972). Normanha et al. (1950) suggested that optimum plant population varied with soil conditions and more recently large variations in optimum distance have been shown for different harvesting times and different varieties (Cock, Gutierrez, and Wholey, unpublished). Large yield increases can be expected by using the optimum plant population. In our trials, yields of M Colombia 1438 decreased from about 45 t/ha at 6000 plants/ha to about 30 t/ha at 20,000 plants/ha, whereas those of M Colombia 22 increased from about 42 t/ha to 55 t/ha over the same range (Cock, Gutierrez, and Wholey, unpublished). More work is needed in specific localities, but undoubtedly yields can be increased by planting at the optimum density.

**VARIETAL SELECTION**

There is ample evidence that different varieties grown under similar conditions have very different yielding ability (Galang 1931; Lambourne 1937; Anon. 1957; Arraudeau 1969; Sarmiento 1969; CIAT 1972, 1973) and that these variations are large enough to be highly important to the grower. In a recent trial at CIAT with a very low level of disease and pest incidence, yields of varieties varied from 16 to 46 t/ha per year. Thus, simple selection opens the way in some instances to very large yield increases.

**DISEASES AND PESTS**

The two most important cassava diseases in the world appear to be African cassava mosaic and bacterial blight. The cassava bacterial blight (CBB) causes extremely severe losses. C. Lozano (personal communication) has shown that it can reduce yields from 47 t/ha to 25 t/ha in susceptible clones. The extent of the disease is not clearly defined. However, it is widespread in Latin America and Africa. Recently, a request for information on its control from Taiwan suggested that it may also be a problem there. The disease can survive for long periods in planting pieces from infected plantations and these can form a focus of infection in a new plantation. The disease will spread rapidly through a plantation by rain-splash once a focus for infection is present. Disease-free planting material can be produced (Lozano and Wholey 1973), even from infected stocks, and from these disease-free plantations can be established to give higher yields (CIAT 1973). Resistant lines are also available, but they have, in general, low yielding ability. In time, high-yielding resistant types will be produced.

Although cassava is of Latin American origin, African cassava mosaic has not been reported in Latin America, but has been found in most areas of Africa and India. Reported losses due to this disease have been between 20 and 90% (Lozano and Booth 1974). The disease is spread by a white fly (Bemisia tabaci), as well as other species (Chant 1958), that feed on cassava. The disease may also be spread by planting infected cuttings, and as the vector is pantropic the disease is a potential menace to all cassava-producing areas. It also appears, as with cassava bacteria blight,
that higher yields can be established by planting clean cuttings (Opsomer 1938; Briant and Johns 1940). Another effective method of control appears to be genetic resistance, and several highly resistant clones have been isolated (Doughty 1958; Jennings 1960; Sam Raj 1966; Beck 1971; Childs 1957).

Apart from these two diseases, there are many of lesser importance, e.g. *Cercospora* spp. and *Oidium* spp., and others of local importance, e.g. *Phyllosticta* spp. in the colder cassava growing areas and *Coleotrichum* spp. in Africa. These diseases may be of great importance in certain environmental situations, and resistant varieties should be sought. A new disease has recently been reported in Colombia that causes a superelongation of the stem. This disease, caused by a lower ascomycete, is potentially extremely dangerous as it causes severe yield losses when cassava is grown under humid climatic conditions (Lozano and Booth 1974). Fortunately, resistant varieties with reasonable agronomic characters are known to exist (C. Lozano, personal communication).

Outside Latin America, cassava pests are not generally considered to be important. In Latin America, thrips are extremely widespread and during dry periods cause damage to the apex, reducing leaf area. Yield losses due to the pest are not known. I suspect that they may be quite severe. A large percentage of the known germ plasm has high levels of resistance to the pest and should be used where it is a problem. Thrips have also been reported in Zanzibar (Briant and Johns 1940).

Other pests are problems in specific areas. The shootfly (*Silba pendula*) and spidermites (recently introduced to Africa) do attack plants, but no estimates of damage are known. Highly resistant lines have not been found, but there are differences in susceptibility and less susceptible lines should be used where these pests are problematic. The hornworm (*Errinys ello*) occurs in sporadic severe attacks, and these can be controlled by insecticide application.

By using improved agronomic practices, selecting better varieties, and planting clean cuttings, it is certain that yields of cassava can be improved to near their known present potential. However, when introducing new varieties, great care should be taken not to introduce new diseases and insect pests, as this could largely negate the desired objective.

**Future Yield Potential**

It is of interest to speculate on the possible yields of cassava, in the future, under good agronomic practices with varieties that have good insect and disease resistance. Cassava, when growing at its maximum rate under moderate conditions of solar radiation, will produce total dry matter at the rate of 1.2 t/ha per week. Most current cassava varieties do this for only a short part of their growth cycle when they have sufficient leaf area to intercept most of the incoming solar radiation. After about 6 mo growth, leaf area of most cassava varieties tends to decline because of increased leaf drop. However, varieties do exist that maintain a high leaf area and high growth rate during their full growth cycle. Apparently, the leaf fall is not associated with movement of carbohydrates and nutrients to the roots, suggesting that varieties can be obtained that maintain their leaf area and also fill their roots.

Varieties have also been found that distribute up to 70% of their total final harvestable dry matter to their roots. Unfortunately, these varieties do not maintain their leaf area. With a hypothetical cassava of the future, if we allow 6 wk for crop establishment and assume a total dry matter production of 1.2 t/ha per wk for 46 wk, of which 0.2 t/ha per wk is lost in leaf fall, it would be possible to obtain a variety that produced 46 t/ha per yr of total harvestable dry matter. Assuming that 70% of this dry matter can be distributed to the roots it appears possible to produce a variety that could yield 32 t/ha per yr of dry roots or at 65% moisture content a variety that would yield over 90 t/ha of fresh roots per yr.

So far at CIAT we have obtained in small plots yields of 66 t/ha per yr with a variety that had very high total harvestable dry matter production (more than 40 t/ha per yr) but a rather lower harvest index than assumed in
the section above. It seems feasible to think in the future in terms of varieties with yield potential approaching 90 t/ha per yr.

References


