

Preliminary study on the cultivation potential of wild vegetables *Etilingera elatior*, *E. punicea* and *Commelina paludosa* of Sarawak

(Kajian awal tentang potensi penanaman sayur liar Sarawak *Etilingera elatior*,
E. punicea dan *Commelina paludosa*)

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Key words: wild vegetables, *Etilingera elatior*, *E. punicea*, *Commelina paludosa*, Sarawak

Abstrak

Biasanya sayur liar penting kepada masyarakat luar bandar dari segi pemakanan dan keselamatan makanan. Akan tetapi potensi penanaman sayuran ini masih belum diteliti. Pucuk muda, bunga dan buah *Etilingera elatior* dan *Etilingera punicea* serta pucuk *Commelina paludosa* biasanya dijadikan sayur oleh penduduk di Asia Tenggara. Kajian terhadap tindak balas baja dan nilai pasaran untuk menentukan potensi penanaman telah dijalankan di Sarawak, Malaysia. Bagi *C. paludosa*, tindak balas terhadap naungan juga dikaji. *Etilingera elatior* mengeluarkan hasil pucuk muda yang tinggi dengan aras baja yang rendah. Oleh itu, penanamannya akan menguntungkan jika permintaan daripada pasaran bandar boleh ditentukan. Bagi kudup bunga yang kerap dipasarkan, hasilnya tidak dinilai sepenuhnya. Cara-cara untuk meningkatkan pengeluaran bunga patut dikaji. *Etilingera punicea* didapati tidak sesuai ditanam dalam keadaan kajian yang dijalankan. Akan tetapi ia harus diuji pada jenis tanah lain kerana pucuk mudanya kerap dipasarkan. Di bawah naungan *C. paludosa* mengeluarkan hasil yang tinggi sejajar dengan peningkatan baja. Spesies ini amat sesuai ditanam di halaman rumah yang bernaungan dan berpotensi sebagai tanaman kontan yang bernilai jika diperkenalkan dalam pasaran bandar. Petani sepenuh masa mungkin mendapat manfaat daripada ketiga-tiga spesies jenis saka ini yang mungkin boleh dituai berterusan dengan tenaga buruh yang sedikit.

Abstract

Wild vegetables often play an important role in rural communities in terms of nutrition and food security but their potential for cultivation remains largely unexplored. The young shoots, flowers and fruits of *Etilingera elatior* and *Etilingera punicea*, and the shoots of *Commelina paludosa* are commonly consumed in Southeast Asia. Studies on fertiliser response and market value to determine the cultivation potential were carried out in Sarawak, Malaysia. Response to shade was also tested for *C. paludosa*. *Etilingera elatior* produces high yields of young shoots with low levels of fertiliser, and cultivation is profitable if the urban demand can be ensured. The yield of the more frequently marketed flower buds was not fully evaluated and ways to increase flower production should be investigated. *Etilingera punicea* is not suitable for cultivation under the present trial conditions, but should be tested in other soil types as the young shoots are frequently marketed. *Commelina paludosa*

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produced high yields that increase linearly with increasing fertiliser applications under shaded conditions. This species would be excellent for cultivation in shaded home gardens and could be a potentially valuable cash crop if introduced into urban markets. Subsistence farmers may benefit from all three species as they are perennial and may be harvested continuously with low labour input.

Introduction

Consumption of wild vegetables is widespread in most tropical countries and numerous studies have shown the importance of wild plants when used by indigenous communities (Salafsky et al. 1993; Etkin 1994; Leaman et al. 1996). Moreover, urban demand driven by traditional food preferences and fear of pesticide residue in cultivated vegetables are very often high, and many wild species have considerable marketing potential (Peters et al. 1989; Burgers 1993). Several studies point to the advantage of developing local species for vegetable production (de Foresta and Michon 1993; Colfer and Soedjito 1996; Christensen 1997) rather than using high yielding, but often disease prone exotic crops in resource poor communities. With increasing pressure on forest resources, certain species are also likely to disappear if not taken into cultivation.

Very little attention has been given to the potential of domesticating wild vegetables in the tropics, and the objective of this paper is to determine the possibility of growing three wild vegetable species commonly used for subsistence and sometimes marketed in Southeast Asia. Fertiliser and shade trials at a research station and a market survey were employed in the study and related to farmer assessment of the species as reported in Mertz (1999 a, b).

Etilingera elatior (Jack.) R.M. Smith and *E. punicea* (Roxb.) R. M. Smith, both in Zingiberaceae (Plate 1 and Plate 2) were chosen for study as they are very popular vegetables in Sarawak for subsistence and marketing. They are found all over Sarawak and gathered mainly in secondary forest (DOA 1992; Christensen 1997). They are also common in other parts of Southeast Asia, particularly *E. elatior* whose flowers



Plate 1. Field trial with *Etilingera elatior*. Unfertilised plot in foreground



Plate 2. Flower buds of *Etilingera elatior* (right) and young shoots of *E. punicea* (left) sold at the market in Kuching, Sarawak



Plate 3. Harvesting *Commelina paludosa* at the field trial (left). The leaves of the young shoots are removed to obtain the edible stem tip (right)

are used in Indonesia and West Malaysia where they are regularly cultivated in home gardens (Ochse 1977; Siemonsma and Kasem Piluek 1993). Both species are tall herbs up to 5 m high (Smith 1986). All parts of the plants are strongly scented. The hearts of young shoots are boiled as vegetable, and the young flowering shoots (flower buds) of *E. elatior* are commonly used as a condiment (Burkill 1935; Wong et al. 1993).

The fruits of both species are eaten raw when ripe.

Commelina paludosa vel aff. Bl. in Commelinaceae (Plate 3) is a creeping herb common in wet areas in the highlands of Sarawak, often associated with irrigation canals for wet rice. It was chosen because of its popularity with the highland people and its high production potential. It is found in other parts of Southeast Asia in association

with *C. benghalensis* L. and *C. nudiflora* L. both of which are commonly eaten (Caldwell 1972; Lugod and Padua 1979; Siemonsma and Kasem Piluek 1993). These and other *Commelina* spp. are also collected in many African communities (Malaisse and Parent 1985; Mwajumwa et al. 1991). The stem tips of *C. paludosa* are peeled and boiled.

There are, to my knowledge, no studies on cultivation of *E. elatior* and *E. punicea* despite their relative importance in the diet of Southeast Asian populations. The Department of Agriculture, Sarawak, has established successful observation trials with both species in 1993, but no yields have been recorded (Chai, C.C., DOA pers. comm. 1996). No studies on *C. paludosa* have been reported.

Materials and methods

Fertiliser and shade trials were established at Rampangi (1° 40'N, 110° 20'E), a research station of the Department of Agriculture, Sarawak situated on the flat coastal plain 16 km north of Kuching and carried out during the period from June 1995 to July 1996. The soils are drained acid sulphate soils (haplic sulfaquents, USDA Soil Taxonomy) characterised by 22–28% clay content, a pH of 3–3.7, low levels of exchangeable plant nutrients and CEC, and high content of Al. The climate is humid tropical with annual mean rainfall of 4 600 mm (DOA 1994). July 1995 was drier than average with only 127 mm, and dry spells occurred in December 1995 and February–March 1996.

Vegetative plant material was collected from wild populations in various parts of Sarawak and was kept moist before planting directly in the field. The plants were mixed randomly with respect to origin and morphological variations.

The land was prepared with a power tiller 3 weeks before planting. Drainage canals 0.7 m wide were dug between plots and a base liming of Dolomite at 300 kg/ha was applied. One trial was established for *E. elatior* and one for *E. punicea*, each

consisting of 16 plots. The plot size was 16 m² (4 m x 4 m) with 16 plants per plot, a plant spacing of 1 m x 1 m, and 0.5 m between the edge of the plot and the nearest plants. Two trials were established for *C. paludosa*, one consisting of 16 shaded plots and one of 16 unshaded plots. Plot size was 7.3 m² (2.6 m x 2.8 m) with 20 plants per plot, a spacing of 0.4 m between plants and 0.6 m between rows, and 0.5 m between the edge of the plot and the nearest plants. The shaded plots were completely enclosed by black polyethylene netting providing 50% shade. The net was placed at a height of 2.5 m.

Four levels of compound fertiliser NPK-Mg+TE (12:12:17:2 + TE) at 0, 200, 400, and 600 kg/ha were applied monthly to *E. elatior* (totalling 0, 2 600, 5 200 and 7 800 kg/ha) and *E. punicea* (totalling 0, 1 800, 3 600 and 5 400 kg/ha), and once every 3 weeks to *C. paludosa* (totalling 0, 3 200, 6 400 and 9 600 kg/ha, base fertilisation of 400 kg/ha excluded). Each treatment was replicated four times and the plot layout was completely randomised. The high fertiliser levels were chosen to measure the maximum potential productivity of the species.

Irrigation was carried out manually with a hose and sprinkler whenever necessary. Each plot in a trial was given the same amount of irrigation water. Manual irrigation was chosen as the automated sprinkler systems available would give a systematic irregularity in water distribution. Weeding was carried out manually. Spraying against aphids with a synthetic pyrethrum (2.27% alphacypermethrin) was necessary for *C. paludosa* (3 October 1995 and 15 December 1995).

The number of plants was recorded on 3 August 1995 for all species. *Etilingera elatior* and *E. punicea* plants were also counted on 15 December 1995 and 5 June 1996. *Etilingera elatior* was replanted on 15 August 1995 and the *E. punicea* trial had to be restarted on 20 September 1995 due to

very poor survival. All *C. paludosa* plots were also replanted on 21 August 1995.

Plant heights were measured on 23 August 1995, 10 January 1996 and 7 June 1996 for *E. elatior*, and on 5 June 1996 for *E. punicea*. The longest shoot of each plant was measured and the average height of living plants per plot was determined.

Harvesting of *E. elatior* was carried out on 5 June 1996 and 16 July 1996. Young shoots longer than 55 cm and shorter than 105 cm were cut 5 cm above the ground and weighed. Samples of the shoots were peeled and the heart weighed to determine the weight of the edible portion. The flowering shoots were cut at the ground and the buds were cut to a standard length of 15 cm before weighing. *Etilingera punicea* was not harvested.

Commelina paludosa was harvested every 3 weeks between 26 September 1995 and 18 May 1996 with a total of 12 harvests. All young shoots longer than 20 cm were harvested by cutting 20 cm below the tip of the longest leaf. The leaves were removed from samples of the shoots, the stem peeled and the edible portion weighed.

The number of surviving plants, plant height and harvest results were subjected to an analysis of variance (ANOVA). Linear regressions were calculated using ANOVA with treatment sum of squares partitioned for regression analysis (Petersen 1994).

The vegetable markets in the five urban centres of Bintulu, Miri, Kuching, Sibul and Sri Aman were surveyed every Sunday (Miri, Saturday) for one year, starting April

1995. The markets were chosen for size and geographical location. All vendors were visited and the number, average weight and price of products originating from the vegetables were recorded. Each vendor was visited at approximately the same time of the day every week and only bundles available at that time were included in the survey. On one occasion, all vendors were asked whether the produce had been bought, cultivated, or collected from the wild.

Results

Two months after planting, only about 60% of the *E. elatior* and 20% of the *E. punicea* had germinated (Table 1). *Etilingera elatior* was replanted and subsequent plant counts after 4 and 10 months yielded survival rates of about 90% or more. The *E. punicea* trial was restarted, but the average survival rate never exceeded 70% and growth was generally very irregular. No significant correlation was found between the survival rate and fertiliser levels.

Survival rate of *C. paludosa* after 2 months was relatively good in the shaded plots (Table 1), and after replanting and base fertilisation it was no longer possible to distinguish individual plants. In the unshaded plots, survival was considerably lower but it was decided to maintain the trial as reference even though mortality remained high throughout the trial and most plants in the unfertilised plots eventually died.

Seven and 12 months after planting of *E. elatior*, increasing fertiliser applications in the 0 to 400 kg/ha range led to significant

Table 1. Survival rates of *Commelina paludosa*, *Etilingera elatior* and *E. punicea* at three dates (planting dates 6–7 June 1995)

Crop	Survival rate (%)		
	3 Aug. 95	15 Dec. 95	5 June 96
<i>Commelina paludosa</i> , unshaded	43.1*	–	–
<i>Commelina paludosa</i> , shaded	72.8*	–	–
<i>Etilingera elatior</i>	62.5*	93.0	91.0
<i>Etilingera punicea</i>	20.3	60.2**	68.4

*Followed by replanting 15–21 August 1995. Further plant counts of *C. paludosa* not possible

**Trial restarted 20.9.1995, replanting on 17.1.1996

increases in plant heights (Table 2). Additional fertiliser had no effect after 7 months and even negative effects on plant heights after 12 months.

The shoot yields of *E. elatior* confirm the same trend showing a marked increase (2.5 times) between 0 and 200 kg/ha fertiliser levels, whereas the increases in yields in the 200–600 kg/ha fertiliser range are relatively small (Table 3). The yields are based on the weight of unpeeled shoots of which the edible heart constitutes 20–25%.

Flowering of *E. elatior* commenced by the end of May 1996 but occurred very irregularly. Consequently, the flower bud yields show very high variability between replications although a tendency of very low yields in unfertilised compared with

fertilised plots is visible. The edible part of the flowering shoots is the undeveloped petals and receptacle which constitute 45% of the total weight.

Conclusive production measurements of *E. punicea* were not obtained as the plant developed poorly throughout the trial. No serious pests or diseases were observed in *E. elatior* and *E. punicea*. Some leaves were attacked by undetected leaf-cutting insects in May 1996, but without significant damage to the plants.

Cumulated shoot yields of unshaded *C. paludosa* show high variability between replications. There is clearly some response to fertiliser, with considerably higher yields in fertilised plots compared with unfertilised plots, and in plots with the highest fertiliser level compared with intermediate levels. Yields in unfertilised plots fell to zero at the end of the trial as most plants were dying.

The cumulated yields in shaded plots are significantly higher than in unshaded plots at the same fertiliser levels except at 600 kg/ha, where exceptionally high yields in one of the unshaded plots render the difference non-significant. Yields of the shaded *C. paludosa* increase linearly with increasing fertiliser levels. The yields are based on the weight of shoots before removing the leaves. The edible core of the stem constitutes approximately 46% of the weight of measured yields.

Table 2. Plant heights of *Etilingera elatior* at four levels of fertiliser applications

Fertiliser level (kg/ha)	Mean plant height (cm)		
	2.5 mth	7 mth	12 mth
0	43	96	152
200	55	129	212
400	48	142	252
600	48	142	232
F-value	2.6ns	11.5**	40.5**
C.V. (%)	12.4	10.1	6.4
SE	4.3	9.1	9.6

Table 3. Average cumulated yields of *Commelina paludosa* and *Etilingera elatior* at four levels of fertiliser applications

Crop	No. of harvests	Mean yield (kg/ha) at four fertiliser levels (kg/ha)				F-value	C.V.	SE
		0	200	400	600 ⁽¹⁾			
<i>C. paludosa</i> , unshaded	12	836	18 603	14 329	39 918	7.0**	66.4	8 668
<i>C. paludosa</i> , shaded	12	10 555	40 616	60 845	69 551	31.2**	20.8	6 648
<i>E. elatior</i> , shoot yield	2	1 286	3 142	3 481	3 679	19.2**	17.3	356
<i>E. elatior</i> , flower yield	2	9	114	194	202	1.4 ns	118.8	106

(1) Fertiliser application once every 3 weeks for *C. paludosa* and once a month for *E. elatior*

*significant at 5% level ($F_{0.05} = 3.49$)

**significant at 1% level ($F_{0.01} = 5.95$)

ns = non-significant

C.V. = coefficient of variance

SE = standard error between two treatments

Other than the relatively light attack of aphids, no serious pests or diseases were observed in the shaded and unshaded *C. paludosa*. Weed growth was quite severe in the shaded trials but became manageable as the plants developed a fuller ground cover.

The following market data are based on 1996 prices when RM1 was equivalent to US\$0.4. The most frequently marketed products of *E. elatior* are the flower buds with an average price of RM3.6/kg and of *E. punicea* the unpeeled shoots (RM1.4/kg). The unpeeled shoots of *E. elatior* (RM1.5/kg) are less common and the fruits of both species are only found occasionally. *Commelina paludosa* was not recorded in the markets.

The survey of 21 vendors in Bintulu, Miri and Kuching in April 1996 selling various products of *E. elatior* revealed that nine (43%) of the vendors were growing or maintaining small wild gardens of *E. elatior*, generally with no inputs other than land and limited labour for weeding. Only two (14%) of 14 vendors selling *E. punicea* had cultivated the plant themselves.

Discussion and conclusions

The relatively poor survival rate of all species at the beginning of the trial was probably caused by an intolerance to excessive heat and, despite regular irrigation, recurrent drying of the soil experienced during the dry months of June-July 1995. The liming rate of 300 kg/ha may also have been too low.

The reasons for the continued poor growth and frequent rotting of unspouted rhizomes of *E. punicea* were not determined, but as it occurs naturally mainly in hilly and riverine areas of interior Sarawak, the soil conditions in Rampangi may be unsuitable either in terms of low pH and Al toxicity or poor drainage. Moreover, shading may be necessary for sprouting of rhizomes and these may also be more sensitive to transplantation than *E. elatior*.

The plant height measurements of *E. elatior* suggest good response at the lowest level of fertiliser (200 kg/ha/month) compared with unfertilised plots and that high doses are unnecessary. This is confirmed by the harvest data which could not be obtained over a longer period because of the slow establishment of plants. However, with shoot yields of the second harvest 2.7 to 4.5 times higher than the first harvest, there is considerable potential for yield improvements with time.

The natural occurrence of *C. paludosa* in partly shaded, wet locations explains the poor survival of unshaded plants. However, soil fertility may be an equally important factor as the survival in the unfertilised plots of the unshaded trial was significantly lower than in fertilised plots (significant at 5% level, $F = 5.15^*$, $F_{0.05} = 3.49$). Because of the high variability in the unshaded *C. paludosa* trial, it is difficult to establish firm conclusions. Yields may be rather high, notably with high dosages of fertiliser but generally the cultivation of this species without shade under the present trial conditions must be considered unsure.

Shaded *C. paludosa*, on the other hand, produces high yields. Fluctuations between individual harvests and a tendency for yields at high fertiliser levels to decline during the harvesting period (*Figure 1*) indicate some harvesting stress. The fluctuations observed among the first four harvests follow the same trend at all fertiliser levels with more than 50% reductions in yields between the first and second harvests. The only plausible explanation seems to be that all harvests with low yields were immediately preceded by weeding which may have caused light physical damage to young shoots. In terms of yield stability, the fertiliser level at 200 kg/ha seems most appropriate.

A much longer harvest period would have been desirable as all plants are perennial, but this was not possible in this study. However, a careful extrapolation of the harvest data of *E. elatior* to reach a conservative estimate of annual yields is

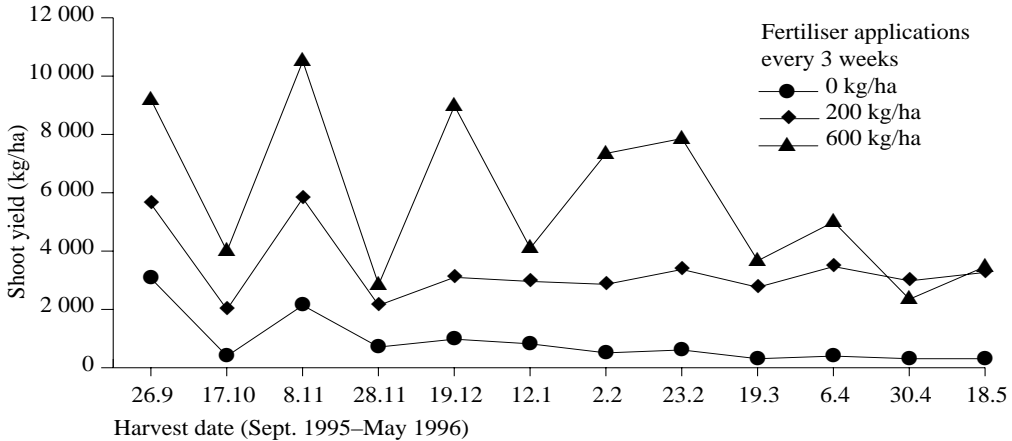


Figure 1. Shoot yields of *Commelina paludosa* at different harvesting dates and fertilizer levels. Yields at the fertilizer level of 400 kg/ha are omitted for clarity as they follow the tendency of the 600 kg/ha level and are only slightly lower.

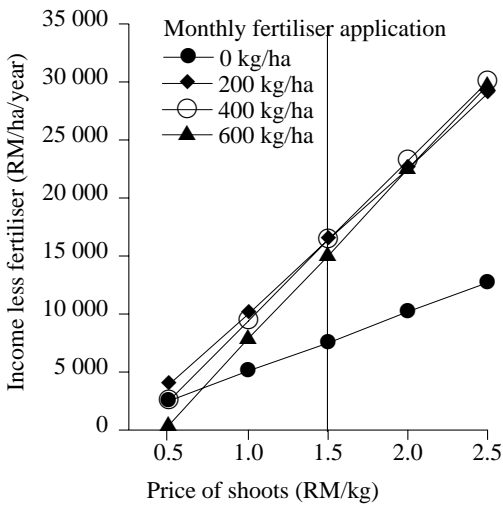


Figure 2. Annual income after subtraction of fertilizer costs from shoot production of *Etilingera elatior* at different shoot price and fertilizer levels. Only fertilizer costs occurring during the harvesting period are included (price of fertilizer in Kuching 1995 = RM0.94/kg or US\$0.38/kg).

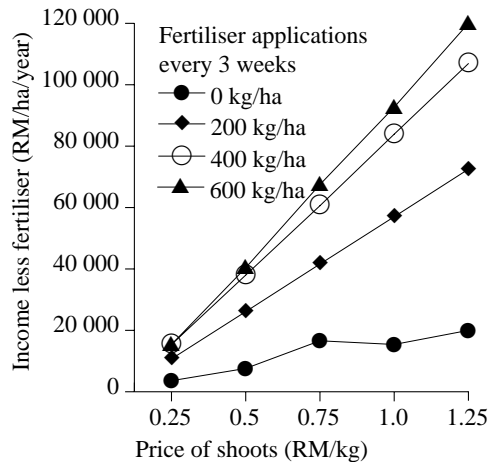


Figure 3. Annual income after subtraction of fertilizer costs from shaded *Commelina paludosa* shoots at different fertilizer and hypothetical shoot price levels. Only fertilizer costs occurring during the harvesting period are included (price of fertilizer in Kuching 1995 = RM0.94/kg or US\$0.38/kg)

obtained by multiplying the cumulated yields by four, i.e. assuming that the measured yields obtained from two harvests during 1.5 months can be repeated at least every 3 months. Multiplying with various market price levels and subtracting the costs of fertilizer at various fertilizer levels produces the potential annual income from

shoot production (Figure 2). Depreciated costs of establishment (value of land, land preparation, planting material, base liming and fertilisation), running costs (mainly labour for weeding, fertilizer application and harvesting), and marketing costs (transport and rental of market stalls) were not

included in the calculations and must be subtracted from the income levels.

At the current average market price of RM1.4, the sale of unpeeled shoot production may provide an annual income of more than RM15 000/ha with monthly fertiliser applications of 200 kg/ha. Higher fertiliser dosages are unnecessary, even at high price levels. On top of this comes the sale of flower buds and the added value of selling peeled shoots. Cultivation of *E. elatior* could be a very profitable enterprise provided there is a sufficiently large market for the products.

The market survey indicate, however, that shoots of *E. elatior* are not sold as regularly as the flower bud, which the plant produces in far lower quantity than the shoot. Possible ecologic or agronomic solutions for enhancing flower bud production should therefore be investigated. The economic importance of *E. elatior* is confirmed by the fact that farmers already cultivate the plant as a cash crop and that it was well received in on-farm trials, notably in a more inaccessible area where it is not so easily accessed in the wild (Mertz 1999a, b). There is substantial scope for developing more intensive cultivation of this species both for subsistence and commercial purposes.

No economic analysis was possible for *E. punicea*, but as its shoots are sold much more widely than *E. elatior*, production is likely to be profitable if cultivation takes place under suitable conditions. The species is, however, fairly abundant in the wild and clear benefits of cultivation would have to be demonstrated for farmers to domesticate this plant.

Commelina paludosa is occasionally found in rural markets in Sarawak but otherwise this species is not marketed to any significant extent. However, given its popularity in the highland communities and the general popularity of leaf and shoot products in markets, I will attempt a conservative estimate of the value of *C. paludosa* if it were to be marketed.

Shaded *C. paludosa* produces a relatively bulky harvest and up to 60% of the shoots is not used. This implies a relatively low market price and in *Figure 3* the potential annual income levels after reduction of fertiliser costs and at market prices of RM0.25–1.25/kg are shown. The *Figure* is based on extrapolation of cumulated yields obtained during the harvesting period, and it is assumed that the yield levels can be maintained.

Even at very low prices, the annual income potential of *C. paludosa* is substantial with as much as RM40 000 at an average market price of RM0.5/kg and with a fertiliser level of 400 kg/ha. The problem remains whether a market can be created and whether production can be maintained at a sufficiently high level. An alternative market for *C. paludosa* may be for livestock feed as other *Commelina* spp. are known for their excellent palatability mainly for ruminants (Ibrahim et al. 1988; Gaullier 1990; Siemonsma and Kasem Piluek 1993).

Commelina paludosa was introduced to two Iban communities in Sarawak which received the crop well as it grew vigorously in swampy areas. While commercial production may not be appropriate at present, the crop has good potential for cultivation in home gardens. Small perennial plots near streams or in swampy areas would be ideal for *C. paludosa* where, with small amounts of fertiliser, it could provide a continuous supply of vegetables to households. Although the plant is mainly known in the Highlands, introduction in the lowlands seems feasible if monitored with respect to acceptability in the diet and potential occurrence as weed, notably in wet rice systems (Mertz 1999a, b).

The species studied as well as other related wild vegetables are all used in other parts of Southeast Asia, where they constitute an important contribution to the diet of rural communities and urban populations. The domestication, cultivation, development and marketing of these crops may therefore be envisaged in other

countries where, as in Malaysia, there is an increasing awareness of food quality and environmentally sound production methods. Moreover, subsistence farmers with scarce labour supply may benefit from the perennial growth of most wild vegetables and maintain permanent groves that require little maintenance in terms of land preparation and weeding.

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