

Department of Geography & Geology

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A Pre-Proposal Report  
for a Proposed Upland Development Project  
in Guizhou Province, P.R.C.

Phase I, Qingzhen County

by

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The following abbreviations are used:

G.N.U.	Guizhou Normal University
G.A.U.	Guizhou Agricultural University
(G.) F.R.I.	(Guizhou) Forest Research Institute
G.A.R.C.	Guizhou Agricultural Regionalization Commission (Provincial Government)

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## Erosion Control - Qingzhen County

### 1. Objectives

1.1 To test performance and assess costs/benefits of Vetiver and other species for erosion control on terrace edges and other dry-crop lands.

1.2 To test performance and assess costs/benefits of planting appropriate spp of trees on terrace risers.

1.3 To test performance and assess costs/benefits of using tree and herbaceous cover-crops to control erosion on areas where only pockets of soil (interspersed with bare rock) remain.

1.4 To test performance and assess costs/benefits of using cover-crops followed by economic trees on substantially unvegetated eroding areas on which a more or less complete soil cover remains.

1.5 To improve quality and experience of selected academic and research personnel at GAU, GNU, GFRI and Guizhou government bodies by active involvement in on-farm R & D.

1.6 To involve key farmers in active on-farm participation in erosion-control experimentation and monitoring.

### 2. Reasons for Choosing Qingzhen County

2.1 Overall levels of erosion, though not as severe as, for example, in the north-west or north-east of the Province, are nevertheless significant. In the hill country in both the western and eastern regions of the county, current soil losses are thought to be at least 400-600 /km<sup>2</sup>/yr though Professor Xiong Suyi has mapped significant areas as 'Class 3, moderately eroded, 2500-5000 /km<sub>2</sub>/yr' (The reasons for this apparent order-of-magnitude discrepancy are not known but presumably reflect differing methods of estimation).

2.2 The area is easily-accessible from Guiyang and possesses a reasonable network of roads and jeep-tracks. Most of the county is within 50 km of Guiyang. Consequently project administration and demonstration should be facilitated.

2.3 The area is under a single county administration which, in turn, will facilitate project administration.

2.4 Qingzhen County is quite representative, economically, environmentally and in terms of population, of much of the 'middle belt' of the Province, i.e. hill country in the approximately 1200-1400 m elevation range. It has some erosion problems, locally severe, though not rated as severe or extreme at the provincial level of analysis. Though it contains some industry, its economic structure is close to the provincial norm whilst income levels are well below the provincial average.

2.5 Basic data, mainly in Chinese, are available. These include general descriptions dated 1981 and 1989. For instance, the county was the first sample area in the province for the study on agricultural regionalization from 1980-1981, following the detail work from 1982-1985.

### 3. Summary of Basic Data

#### 3.1 Location and extent

3.1.1 The County is located between lat. 26°21' and 26°59' N and 106°7' to 106°33' E. It lies just beyond the tropic with an environmental regime that can be termed 'sub-tropical, sub-montane'.

3.1.2 Area is 1492 km<sup>2</sup> (including water-bodies) of which arable is said to total about 750 km<sup>2</sup> and native grassland about 400 km<sup>2</sup>.

3.1.3 Table 1 gives basic elevation data:

Table 1            Elevation and Area

	<u>km<sup>2</sup></u>	<u>%</u>
Over 1440 m	91.7	6.5
1200-1400 m	1207.4	80.9
Under 1200 m	<u>187.6</u>	<u>12.6</u>
	1486.7	100.0

(Totals vary slightly according to documentary source).

#### 3.2 Climate

3.2.1 Mean monthly temperatures (said to be for the whole county) are given in Table 2.

Table 2 Mean Monthly Temperature (°C) - Qingzhen Town

J	F	M	A	M	J	J	A	S	O	N	D	Year
3.8	5.3	10.6	15.3	18.2	20.5	22.7	22.0	19.2	14.7	10.0	6.0	14.0

3.2.2 There is thus a considerable seasonal temperature range, on average about 18°. More significantly, the growth of most plants slows or ceases during the cold season when, on average, frosts occur on 28-35 days per year. No data appear to be available on the variability from winter to winter, or the intensity of frosts or of the duration of frosty spells. Given the considerable number of enclosed basins (dolines) it is to be expected that cold air drainage and 'ponding' of cold air would be a hindrance to plant growth locally.

3.2.3 The temperature regime would appear to be quite variable though no data on the subject were forthcoming. Based mainly on observations taken from 1950 to 1984, the following extremes have been recorded:

Table 3 Temperature Extremes (°C)

Maximum mean monthly temperature	29.2
Maximum daily temperature	34.5
Minimum mean monthly temperature	-2.0
Minimum daily temperature	-8.6

3.2.4 Sunshine is particularly crucial to plant growth but in respect of bright sunshine the County has the dubious record of having a mean of only 1,277 hours annually, just 27% of possible total, which is one of the lowest in China. The monthly totals are quite variable, the mean monthly maximum recorded being 243 hours compared with a mean monthly minimum of just 9.6 hours.

3.2.5 Precipitation is well-distributed through the year with 'small rains' from March to June and heavier rains from July to September. However, even in the winter months the average is above 50 mm per month. Snow does fall but rarely lies.

Table 4 Mean Monthly Rainfall (mm) Qingzhen Town (1957-1979)

J	F	M	A	M	J	J	A	S	O	N	D	Year
15.6	19.2	29.9	104.2	189.8	238.2	168.6	143.0	107.5	93.2	50.0	24.9	1184.1

3.2.6 Variability of rainfall appears to be considerable but mainly below the mean rather than above it. The wettest recorded year, 1954, had a total of 1,637 mm, just over 25% more than the norm. By contrast the driest year, 1954, received just on 700 mm, virtually half of the usual fall. In terms of monthly records, the wettest recorded month received 481 mm and the driest just 2 mm. No data are available, apparently, concerning the frequency and duration of drought nor what is defined as a drought. Given that many soils are thin and that carbonate rocks comprise just over 2/3s of the County area and the water-table thus usually lies deep, the effects of drought are likely to be considerable. Data on droughts are given in Table 5.

### 3.3 Geology, Soils and Erosion

3.3.1 Like the Guizhou Province as a whole, Qingzhen County is made up largely of carbonate rocks, mostly limestones but some dolomite. These cover 1,014 km<sup>2</sup>. The remaining rocks are largely sedimentary and include sandstones, shales and mudstones. Coal, mostly fairly high in sulphur, outcrops in many places and villagers carry away coal from these for fuel. There are, in addition a number of 'industrial-type mines serving power stations and potteries, near which there may be some problems with acid rain (though no studies have been done) and acid effluent.

Table 5 Drought Data (estimated from 33 years) in Qingzhen

Types of drought	Subtypes	Rainfall (criteria)	Times (years)	Frequency
Winter-Spring (Feb.-March)	Normal	< 60 mm in Feb.-March	22	67%
	Intense	< 33 mm in Feb.-March	9	27%
Spring (Middle- Late April)	Middle Apr.	< 33 mm per 10 days	19	58%
	Late Apr.		12	36%
Summer (June-Aug.)	Normal	< 90 mm per month		34%
	Intense	< 60 mm per month or < 100 mm per 2 months		25%

3.3.2 Soils have been mapped only at reconnaissance scale comprising yellow, yellow-brown, red and purple soils, besides anthropogenic rice soils. Soil depth is highly variable from place to place even over a few metres. On steeper and eroded slopes depth is insufficient for ploughing and the hoe is employed in cultivation.

3.3.3 Erosion levels have been estimated for the whole County and mapped on a scale of 1 : 50,000. However such mapping has not been fully supported by detailed field studies. (Professor Xiong Suyi informed me that actual measurements have been undertaken at fewer than ten points in the whole Province. Estimates of soil loss and of erosion potential are inferred from slope, vegetation, land use and lithology).

3.3.4 Soil loss measurements have apparently been made in the Sha Er area flanking the gorges of the Yazi River where annual losses of 50t/ha/yr are indicated, a serious matter in this limestone terrain with very shallow soils. No measurements have been made on the widespread cone-karst in the County on much of which the vegetation has been reduced to scattered scrub, grass and Pteridium fern by intensive cutting for fuel and/or fodder. (Such areas apparently recover reasonably well if closed to collectors for at least 5 years). However, a comparison of 1980 aerial photography with that of 1960 suggests that bare areas are increasing at about 3000-5000 mu (200-330 ha) annually.

3.3.5 Given that few actual measurements have been done, only a qualitative assessment of erosion in the County can be given. As elsewhere, erosion risk on wet-rice land is negligible to low. Occasional examples of wet terrace failure, followed by rebuilding, were observed. The question here is not erosion control but investigation of the possibility of terrace-edge plantings of trees to increase cash income.

3.3.6 The major areas of agriculturally-induced erosion are those in dry cultivation, most of which is on sloping terraces and the rest on open fields. It is estimated that about 33,400 ha (half a million mu) are in dry cultivation, rain-fed rice in summer with rape-seed, some wheat and a little broad-beans in winter. No terrace-edge bunds were observed and crop ridges, not uncommonly, may be aligned directly up-and down-slope. The following Table sets out areas and slope angle of dry-crop land in the County.

Table 6 Areas under Dry Crops by Slope Class

<u>Slope Class (degrees)</u>	<u>Area (mu)</u>	<u>Area (ha)</u>
less than 10	155 000	10 330
10 - 25	280 000	18 660
25 - 35	68 000	4 550
over 35	<u>6 700</u>	<u>445</u>
	509 700	33 985

Source: Mr Cai Har Wei, County Agricultural Commission

Current policy is that lands with slopes greater than 25° should be retired from cropping and put into pasture or forest. Because of the conflict between population pressure and limited land (diverse man/land ratio), the policy is being carried out only in a few of the areas.

### 3.4 Land Use and Production

3.4.1 The overall pattern of land use in the County is set out in Table 7.

Table 7 Land Use (1984)

	<u>Area (mu)</u>	<u>Area (ha)</u>
Rice-fields	170 340	11 356
Supplementary arable land	446 000	29 733
Dry crops	506 100	33 740
Fruit orchards	10 100	673
Government tea plantation	5 800	387
Community tea plantation	2 500	167
Grassland (unimproved)	220 300	14 687
Wasteland	307 000	20 467
Forest - trees	203 800	13 587
- scrub	129 000	8 600
- sparse woods	32 100	2 140
- planted	11 680	779
	376 580	25 106
Waterbodies	117 800	7 853
Urban/industrial	54 700	3 647
Transportation	20 100	1 340
	<u>2 237 320</u>	<u>149 156</u>

3.4.2 Land-use trends are not known with any certainty there being no provision for updating the inventory. Since 1986 between 25 and 35 000 mu (1660-2330 ha) of wasteland have been planted with trees every year. However, from 1980 to 1986 the proportion of the County in forest and scrub fell from 16.2% to 14.2% (Mr Cai Har Wei). As mentioned earlier, bare areas are thought to be increasing at around 3-5 000 mu (200-300 ha) yearly.

3.4.3 Most agricultural land in the County is double-cropped, even the dry-crop areas, the usual rotation being rice (irrigated or rain-fed)/rape-seed, with some wheat and a little broad-beans and winter vegetables. The overall crop intensity index is 187 meaning that 87% of the cropland, including that used for dry crops, on average, is double-cropped. In achieving such a high intensity considerable reliance is placed upon compost and dung which represents a long-continued nutrient transfer from uncropped to cropped land.

3.4.4 Some 60-70% of the rice-land is said to be irrigated and yields, for such a cloudy and comparatively cool region are reasonably high at an average of just over three tons per hectare per crop (1984 data). On dry-crop land, however, yields are substantially lower and unquestionably more variable from season to season though no data were forthcoming. Rain-fed rice, grown on sloping terraces, yields about 1.5 tons per hectare, wheat about 1.5 to 2.25 tons and rape-seed about 1.5 tons.



### 3.5 Population

3.5.1 In 1984 the population of Qingzhen County was about 380 000 to give a crude density of 255 persons per km<sup>2</sup>. In the period 1949-1984 the average annual increase rate was 2.7%, though by 1980-84 the rate had fallen to 1.5% per year. However, most of the people born earlier are still alive and many are in the reproductive age-groups so that in the absence of significant out-migration, further increases may be expected.

3.5.2 Of the 1984 total population, 310 000 persons or 84% are reckoned to be agricultural. (It is not known to what degree such may be partly employed in off-farm work or partly dependent upon support payments). With a crop-land area of about 500 km<sup>2</sup> this gives an 'agricultural' density of 620 persons per square kilometre, comparable with densities in some of the poorest upland areas of Java. (Note, however, that figure does not include grassland, which, however provides unit/area incomes at least an order of magnitude lower than crop-land). It is little wonder that per person incomes are quite low: from all sources (c. 1988) ¥353 per year but from agricultural alone, only ¥200 per year.

3.5.3 Han Chinese are in the majority in the County. Some 25 minority groups are represented with a total of about 70 000 representing 19% of the total county population.

## 4. Project Outline

### 4.1 Interventions (Fulfilment of objectives 1-3)

4.1.1 Field assessment shows that three micro-environments in the dry-crop areas occur in close association:- sloping terraces, where vegetative erosion control measures can realistically be applied only in a very narrow strip at the lower edge of each terrace (otherwise crops and production may be depressed)

- terrace risers, currently mostly unused but in some need of stabilization

- areas, mainly above terraces, in which only pockets of soil remain, interspersed with bare rock, mostly limestone. Areas containing these three micro-environments are very extensive, especially in the Sha Er area where annual soil losses are estimated at around 50 /ha/yr.

4.1.2 It is proposed that interventions be developed and trialled for each of these three micro-environments together since they occur together spatially and in many locations treatments of one micro-environment alone are likely to be ineffective since each is a sediment source and a simultaneous reduction should be aimed for. (A possible exception may be terrace risers which are partly vegetated with volunteer species, mainly grasses, but trees are proposed basically to improve terrace-riser stability, to provide some potential cash income and to supply village timber).

4.1.3 It is proposed that planting of quick-spreading legumes be trialled for areas which are bare of vegetation but where soil cover remains substantially complete. Such areas include road and railway cuttings and embankments, some of which are reinforced by stone or concrete revetments at high cost. Alternatively Vetiver can be trialled and compared with other interventions in terms of costs and benefits. The area over which such an intervention could be trialled is not known and may, in fact be under the jurisdiction of highway and railway authorities in some cases. However, there remain many kilometres of county roads along which trials could be made.

4.1.4 Other areas bare of vegetation but with a substantially complete soil cover include mine tailings and similarly-disturbed areas. On these a two-stage approach is suggested: initial control of sediment movement using quick-spreading legumes and/or Vetiver, followed by the planting of appropriate economic trees. It is particularly emphasised that the currently-used intervention on such terrain, involving planting *Pinus massoniana* seedlings, some only 10 cm high, is not likely to be effective since substantial bare, eroding surfaces may remain for many years until a closed canopy is formed and the surface is sufficiently stable for volunteer species to establish themselves. The area occupied by such terrain is not known but is thought not to be large. However, sediment yields are probably high to very high and their potential for downslope damage by accelerated sedimentation is likely to be considerable.

4.1.5 The development, trialling and economic (cost/benefit) analysis of these interventions will fulfil all the initial objectives. It remains to set out, briefly, how objectives 5 and 6, specifically, may be achieved.

## 4.2 Development of Personnel and Institutions

4.2.1 In many developing countries it is increasingly being realized that rural development in general and upland development in particular is both highly complex and likely to be quite site-specific in the application of particular interventions. No one scientist and no one discipline can cope with such complexity. The development of a conducting on-farm research in association with practising farmers is thus essential (at the moment, for example, farm extension work at G.A.U. seemingly reaches farmers 'second-hand' via the instruction of county-level extension workers. On-farm experimentation, in which farmers are actively associated with university and high-level government researchers, apparently does not exist though it has been characteristic of developed-country agriculture for a century or more).

4.2.2 The ideas that simple measurements, of erosion and sedimentation or of on-farm cost/benefit analysis of specific interventions, can and should be done with farmers is quite new. For example, farmers are perfectly capable, if literate, of measuring erosion and sedimentation by the erosion pin method. Even the notion that technical information should circulate freely is not always accepted. The development of a 'professional culture' in which farmers' interests, not professionals' interests, are central is an intangible but potentially positive benefit of the proposed project. Most professionals in the field have never taken part in a multi-

disciplinary, practically-oriented project such as is outlined here. Consequently personnel development feeds into institutional development.

4.2.3 It is proposed that the Guizhou Agricultural Regionalization Commission be the prime contractor on the Chinese side. It would provide organizational backup and be responsible for project administration locally and for engaging specialists from other provincial government organs, G.N.U., G.A.U. and the G.F.R.I. In addition it would liaise with the Qingzhen County administration. At this juncture the capabilities of the G.A.R.C. are largely unknown and it would be desirable, as a formal proposal is prepared to provide for an early review of these capabilities and to have a fall-back position in the event that G.A.R.C. proves to be administratively weak. It cannot be too strongly emphasised that the project is likely to stand or fall on the quality of its administration. To this my report now turns.

#### 4.3 Administration and Financial Control

4.3.1 Experience thus far has not been particularly encouraging in this area with letters not replied to in good time nor queries answered. This situation may reflect the difficulties of handling two languages, obtaining satisfactory translation and interpretation facilities and possibly a 'culture of communication' in which everything is confidential unless it is specifically stated to be for general distribution. (It is a matter for concern that, apparently, some members of the provisional GUICEP committee had not, in February 1992, seen Watters' and Hill's visit report, sent for distribution many months earlier).

4.3.2 Interpretation and translation are particular skills and scientific professionals should not be expected to act in those capacities on a regular basis. There is a difficulty with the technical vocabulary but that can be acquired fairly quickly provided that a high level of general competence in English exists. Bilingual secretarial assistance is essential and it may be necessary to employ relatively high-level personnel, e.g. from G.N.U., in order to facilitate adequate communication.

4.3.3 It will be essential to employ a skilled administrator from the outset, to set up clear lines of communication and procedures. In general, the bulk of project files will need to be open and accessible to all professional staff concerned and certainly not tucked away in the private residence of any member.

4.3.4 On the financial side the setting up of appropriate controls on the authorization of expenditure and the determination of who will carry out audits and when will be important desiderata. Sanctions for failure to follow procedures and to account properly for expenditures need to be known and spelt out beforehand. Projects are not cows for milking.

4.3.5 Given that G.A.R.C. is something of an unknown quantity administratively, early consideration should be given to the identification and formal training in project administration of an appropriate person from the Commission. Such training should be

given during the early phase of the Qingzhen County Project. It is now to phasing that the Report turns.

#### 4.4 Phasing

4.4.1 The precise detail of phasing in Qingzhen County will, on the technical side, depend upon the availability of planting material. Although Associate Professor Chen was asked in September 1991 to obtain a small quantity of Vetiver for multiplication by February 1992 nothing had been done, possibly as a result of his convalescence following a motor accident. The Guizhou Academy of Science has a small planting and it is now, with the approach of the growing season, a matter of urgency that a start be made if multiplication is to be done in Guizhou for planting out in the 1993 growing season. Alternatively it may be possible to contract with a supplier (e.g. S. China Botanical Institute near Guangzhou) in an area with a longer growing season. The use of plantlets (e.g. from U.K.) is not recommended unless sufficient heated greenhouse space can be made available at G.A.U. for initial growth and multiplication.

4.4.2 The supply of other planting material is also somewhat problematic and it will be an early task to establish suitable sources. For some species the Dushan Seed Farm may be able to assist.

4.4.3 As a broad strategy it is particularly recommended that contracts for multiplication, beyond the initial round or two, be given to farmers, not only as a means of putting some money in their pockets but also as a means of developing interest and skills amongst their number. It has long been a serious weakness of Chinese research institutes that techniques are developed 'in house', rather than through active experimentation on farms. It will be important to involve farmers virtually from the outset even though administrative and supervision costs in producing planting material may be higher than using in-house facilities.

4.4.4 Given that there are likely to be severe constraints on the availability of planting material, it will be important to decide upon an optimal planting strategy. Obviously the more 'rounds' of multiplication (wherever they are done) the longer it will be before actual plantings on farms begins and the longer it will take for results from the monitoring of erosion and sedimentation to emerge. Given that erosion rates are highly variable through time it is desirable that on-farm plantings, other than simply for multiplication, begin at an early stage, even if the spread of planting material is somewhat slower as a result. In this connection it will be important to establish at an early date the time taken for successive rounds of multiplication. For Vetiver these data may already be available from the Academy of Sciences' plantings. It will also be vital to ensure that on farms where erosion rates are being monitored, plantings are not uprooted for multiplication. Local advice as to how to minimize this will need to be taken. (For example, if farmers are paid to monitor erosion they would receive no further payments if the plantings were disturbed).

4.4.5 Phasing is set out schematically below but no timings are available since the time taken for successive 'rounds' of multiplication for Vetiver and other planting material are unknown. For Vetiver a 'guesstimate' of three months per round, if plots are fertilized, seems reasonable to give a maximum of three rounds per growing-season though it may be safer to reckon on only two.

<u>Phase</u>	<u>Technical</u>	<u>Administrative etc.</u>
1	G.N.U./G.A.U. obtain Vetiver motherstock & information on other planting material G.F.R.I. obtain small quantity of material for terrace risers	
2	Expansion of 'in-house' plant multiplication, G.A.U./F.R.I. Purchase seed +/-or multiplication	Obtain funding, set up secretariat (at G.A.R.C.?). Set up administrative & financial procedures Train project admin. staff Engage professional staff from G.N.U.; G.A.U., F.R.I., Purchase vehicle(s)
3	On-farm multiplication esp. Vetiver. Plant cover-crops on unvegetated areas with soil cover	Training professional staff including county extension workers on construction, installation and maintenance of erosion monitoring equipment. Training G.A.U. economists in economic analysis of environmental projects
4	Plant out Vetiver etc. on terrace edges on farms, some monitored, some not	Install erosion monitors & train farmers in use & recording Set up and maintain planting records
5	Plant trees on terrace risers on farms. Plant cover crops on partly-eroded 'pocket' areas	County agricultural extension workers to assist
6	Plant trees on areas previously stabilized using cover-crops	

4.4.6 The phasing described in para. 4.3.5 is obviously very tentative and must be adjusted according to the availability of planting material and to farmers' reactions. If, for

example, a strong demand for material arises to the extent that it is stolen from bare places then more emphasis would have to be placed on multiplication, and on protection of existing plantings. Local advice on the likelihood of such a scenario developing will need to be taken at an early stage in project planning.

4.4.7 Phase 1, which need be only in a small way, is proposed to be scheduled before project funding is committed since it is felt that G.A.R.C. and the other institutions need to demonstrate in a practical way their commitment to the project. Thus far there has been a good deal of talk, most of it fruitful, and many assurances, but on the ground there is nothing though a course of initial action (planting Vetiver for multiplication) was suggested in September 1991.

## 5.0 Conclusion

5.1.1 An erosion-control project for Qingzhen County is likely to be feasible, accessible to both farmers and professionals. The County administration is reputedly strong and supportive. A major task will be to set up appropriate administrative and support structures since the concept of drawing upon professionals trained in various disciplines and employed by various institutions and employing them full-or, in most cases, part-time, is entirely new. There is great potential for split loyalties and conflicts of interest. There is also great potential for real co-operative working, not only amongst professionals but with farmers. This kind of approach, coupled with simple but many-times-replicated experimentation, has worked well in both developed and many developing countries. It will be an important achievement if professionals and farmers together experiment with and develop appropriate interventions.

## Appendix

### List of Plants for Trial - compiled by Mr Xie Jishi (with comments by R.D. Hill & Mr Xie)

#### Grasses, Herbs

1. *Cynodon* spp. esp. *C. dactylon* (Bermuda grass) 狗牙根  
Widespread in province, spreading habit, good fodder, spreads freely into places where it is not wanted, consequently not suited to terrace-edge planting. Many cultivars.
2. *Hemarthia compressa* var. *fasciculata* 牛鞭草  
Rhizomous, spreading habit
3. *Imperata cylindrica* var. *major* 白茅

Good cover, fair fodder after burning, liable to fire. Extremely persistent spreading both vegetatively and, being light-seeded, by wind. Very difficult to remove from cropland once established. Definitely not recommended.

4. *Paspalum thunbergii* (Buffalo grass) 雀稗

Cultivars highly variable so need for strict selection. Good fodder but not erect and stiff enough to trap moving sediment. Suits Qingzhen. Grown for seed at Dushan but seed supply difficult.

\*5. *Pueraria lobata* & *P. thomsonii* 野葛

Legume. Used for erosion control along railways, spreads rapidly. Several cultivars with different performance. Suited to earth dams and road cuttings. Good fodder. *P. thomsonii*: Grows wild in Vietnam to 1,500 m.

\*6. *Coronella varia* (Crown vetch) 小冠花

Legume. Good erosion control not wide-spreading so suitable for terrace-edge planting. Leaves for fodder. Naturalized in N.Z.

7. *Trifolium repens* (White clover) 白三叶

Legume. Not erect and sediment-trapping ability doubtful. Excellent, high-protein fodder. Unlikely to persist if not given fertilizer but may be worth a small trial.

\*8\* *Vetiveria zizanioides* (Vetiver)

Stiff, erect grass of very moderate value as fodder (which is advantageous in that animals are unlikely to eat it out). Non-spreading, forms hedge, deep-rooted, good control of sediment movement. Value as fuel and fish-feed being tested. Widely recommended by World Bank.

## 2 Bushes

\*1. *Lespedeza bicolor* 胡枝子

Legume. Various cultivars available to suit Guizhou conditions. Grows wild so may be assumed to be hardy. Grows to 1.5 m and provides good fodder.

\*2. *Amorpha fruticosa* (Bastard indigo) 紫穗槐

Legume. Said to be superior to *Desmodium*. Good fodder, fruits also edible. Seed available from Dushan. Originally North American.

3. *Desmodium racemosum* (syn. *D. podocarpum*) 山蚂蝗

Legume. Seed from Dushan. Indigenous. 60-120 cm high.

### 3 Trees

1. *Pinus massoniana* 马尾松

Widely used in Province. Both roots & crown too widespreading for planting on terrace risers. Not suitable for planting on bare soil - grows too slowly, but may be suitable following establishment of a cover. Known to be susceptible to pine wilt disease (in H.K., Japan) but this disease, a very serious one, not so far reported in Guizhou. Good market for timber, fast-growing.

2. *Cunninghamia lanceolata* 杉树

Used already, including terrace-riser planting but has fairly spreading habit & probably depresses yields of crops planted nearby. Best for land after stabilization. Good market.

3. *Cupressaceae* 木白树

The following have narrow crowns and narrow root zones and thus appear structurally suitable for terrace-riser planting, but are untested as timber. Their likely effects on near-adjacent crops (like all trees listed) are unknown. No significant market exists but probably useful as fuel and village timber

*Sabina sinensis*  
*Juniperus virginiana*

*Cupressus funebris*  
*C. torulosa* (though rather slow-growing)

*Chamaecyparis lawsoniana*  
(also rather slow-growing)

4. *Fagaceae* 壳斗科

Said to be generally suitable but specific spp. & cvs. need to be identified.

5. *Quercus fabri* 青杠

Seeds vigorously. Seeds edible after boiling. Spreading habit. May be suitable for erosion control after initial establishment of a cover. Grows to 20 m?

6. *Betula luminifera* 桦木

Common in Province & grows on any soil. Said to control erosion but habit not known. Tree growing to 25 m.

7. *Robinia pseudoacacia* (False acacia) 刺槐

Legume. Grows well in Qingzhen, some existing plantings. Roots very ramifying so not suitable for terrace-riser planting. Deciduous. Good timber. Good bee-forage.



8. *Sinarundinaria nitida* 箭竹  
A rapidly-spreading small bamboo. Dangerous to crops. Shoots edible by man & leaves may be used as fodder. Stems used for baskets and temporary fencing (not lasting). May be suitable for severely-deteriorated land where little else will grow.
9. *Locusta* spp.  
Said to be cheap and effective in stabilizing bare land but a pernicious weed in higher economic value tree plantations. Provides summer fodder and firewood. Suckers freely from stumps.
10. *Paulownia fortunei* 泡桐  
Very high-value tree (US\$1000 m<sup>3</sup>) with good market. Deciduous and widely-ramifying, soil requirements unclear. Not suitable for terrace-riser planting but probably worth a trial on areas with fair soil depth following stabilization.
11. *Eucommia ulmoides*  
Medicinal tree, quick-growing, deciduous. Performs well on limestone & is drought-resistant. Good market for bark & leaves (for extraction). Moderately-narrow crown & roots (2 x 2 m).

Notes:

- (1) The seasonal production curves for these plants are not known, nor, for the most part, are sources of planting material.
- (2) Timber value of most trees is unknown as is the extent to which shed leaves may be toxic to adjoining crops. While trees recommended for trial for terrace-riser planting are said to have narrow, deep roots, no field trial has been made.

# Qingzhen County

