A Socio-Economic Study of Kelang Village in Yunnan Province in relation to Uptake by Farmers of Improved Management Practices on Red Soils in China

Michael P. Cuddy[*], Hongmei Liu[**] and Scott Steele[***]

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Department of Economics
National University of Ireland, Galway

http://www.economics.nuigalway.ie/index/html

• Department of Economics, National University of Ireland, Galway, Ireland

** Yunnan Agricultural University, People's Republic of China

*** Berea College, Berea, KY, USA.

Abstract

This paper reports on the socio-economic outcome of a study of innovative, integrated, agricultural management practices in a catchment near Kelang village in Yunnan Province in south-west China. The focus of these practices, which included biological and engineering measures, was enhanced productivity in maize production and soil conservation on the Kelang uplands. Although these measures did enhance productivity and reduced soil erosion, there is strong evidence that the farmers are unlikely to implement these practices without significant support on the part of the authorities. In particular, investment measures, which have a medium to long-term payback period, will not be implemented without significant assistance from the public authorities. These outcomes follow from the fact that maize production is relatively marginal to the total integrated earning activities of the farm household, where 45% of income comes from off-farm activities, while rice, and particularly tobacco, give a much higher return per labour unit. The critical factor is the "opportunity cost" of labour. If significant off-farm employment exists at a wage above what can be earned from maize production with the new management practices, then the consequence will be that these new practices will not be embraced. The Kelang catchment area is dominated by red soils and has many of the erosion problems associated with these soils which occur extensively across southern China. However, because of their derivation from limestone, the Kelang soils are inherently more fertile. Nevertheless, the results from Kelang have implications concerning the utilization of Chinese red soils in general, particularly the likelihood of uptake by the Chinese farmer of novel and integrated management approaches on these soils based on scientific experimentation.

Keywords: red soils, integrated management practices, socio-economic outcome, opportunity cost

JEL Classification: O12, O13, O18, Q12, Q51, R20.

1. Introduction

Chinese agriculture is based upon the efforts of the 214.5 million rural households, 90% of which are engaged in agriculture (National Bureau of Statistics of China, 2002a). These households, through a system of "household responsibility", farm 95% of the 130 million hectares of cultivated land, giving an average cultivated area per farm of 0.636 ha. The cultivated land per capita in China is 0.107 ha which is less than half that of the mean value for the world. The level of mechanization is extremely low, influenced to a great degree by the size of cultivation unit. Whereas agriculture accounts for 50% of the total Chinese labour force, it produces only 15% of GDP. These few statistics convey a number of critical messages:

(i) China's dependence on her own food production can only be precarious;
(ii) Incomes in agriculture are less than 30% of the average across all sectors;
(iii) The contribution of agriculture to economic development will depend on the rise in the land/labour ratio and increased mechanization;
(iv) This in turn has implications for the surplus labour in agriculture – it must be absorbed into value added creating activity off-farm.

The process of movement out of agriculture and into alternative employment has been in train for some time. There are three main policy impacts on the absorption of surplus agricultural labour (Cui, 1998):

(i) The relaxation of government control on labour movement through the 1980's;
(ii) The support of town and village enterprises (TVE) and private enterprises through tax privileges and technical support which developed through the 1980's and were increasingly privatized throughout the 1990s; and

(iii) Foreign direct investment (FDI), primarily in the coastal zones centered on large cities.

The much stronger development of enterprises in the East and Middle regions relative to the West (only 15% of total) and the inflow of FDI in the coastal zones have given rise to inter-regional labour movements of the surplus agricultural labour (Table 1). It is clear that these movements are dominated by the pull from the East where FDI is predominantly located and where TVEs are most active. Forty percent of migration from the West is out of province, in contrast to about half this in the East.

Table 1 : Geographical patterns of movement of rural migrants, 1993

Region of Origin	Region of destination		
	Same County	Same Province	Other Provinces
East	47.7	31.1	21.2
Middle	26.3	35.0	38.7
West	30.9	29.2	39.9

Source: Cui, 1998.

Agriculture is not homogeneous across China. Some indicators of development suggest that the East is more developed than the West or Middle. Although the average land area per worker is smaller in the East than the West or Middle, it has a much smaller share of the hill land, a much larger share of irrigated lands and a considerably larger share of motorized machinery (Table 2).

Table 2: Indicators of relative development by region

Region	Share of agricultural work force	Share of cultivated land	Share of hill land > 25% slope	Share of irrigated lands	Share of Motorized Machinery
East	35.1	28.4	6.4	41.2	51.4
Middle	36.6	43.2	17.1	35.7	37.7
West	28.3	28.4	76.5	23.1	10.9

Source: Derived from National Bureau of Statistics of China (2002,a and b)

In addition, as one moves form West to East there is a much lower dependence on agriculture as a source of income (Table 3). Thus, 96% of rural households in the West are at least partly dependent on agriculture (AHH) compared with 85% in the East. Four percent and 15 percent respectively are not dependent on agriculture (NAHH). In the West 70% of agricultural households are "pure" agricultural households (PAHH), while the rest are either partly (HHANAA) (26%) or mainly (HHNAAA) (4%) dependent on non-farm income; in contrast, in the East, only 53% of "agricultural" households are "pure" agricultural households, while the remainder are partly (43%) or mainly (5%) dependent on non-farm income.

Table 3: Industrial structure of rural household operation in the east, middle and west parts

Region	Rural households as 100 (%)		Agricultural households as 100 (%)		
	Proportion of AHHs	Proportion of NAHHs	Proportion of PAHHs	Proportion of HHANAA	Proportion of HHNAAA
East	84.71	15.29	52.75	42.51	4.74
Middle	94.71	5.47	66.70	23.44	9.86
West	95.8	4.20	70.27	26.01	3.72

Source: Derived from National Bureau of Statistics of China (2002,c)

Against the background of this national picture in agriculture, we have been investigating the development level and adjustment process in the village of Kelang in the West of China, Yunnan Province. The context is the collaboration with colleagues in a multi-disciplinary team analysing and proposing catchment management practices which enhance productivity and lead to more sustainable agriculture through the reduction of soil erosion. More specifically we were charged with carrying out a cost benefit analysis of the alternative practices proposed. However, we took advantage of the project to widen the focus of our research and to place the cost/benefit analysis against a broader canvas of economic development, not only of Kelang village but also in relation to those extensive areas of southern China where there are

similar soils. The soils of the study catchment, the Wang Jia catchment, which lies immediately adjacent to Kelang village, have been classified as “red soils” under the Chinese system of soil taxonomy. Red soils are widely distributed over southern China and are generally regarded as problem soils. They are highly susceptible to soil erosion, their inherent fertility is usually low and they are subject to a wide range of constraints on crop production. In this study, we regard the utilization of the red soils of the upland Wang Jia catchment by the Kelang village farmers as a microcosm of rural China involved in farming similar soil types. This leads to implications concerning the potential utilization of Chinese red soils in general, particularly the likelihood of uptake by the Chinese farmer of novel and integrated management approaches on these soils based upon scientific experimentation.

2. Kelang Village in Kedu Township, Yunnan Province

Kelang village is located in Kedu Township in Yunnan Province, ~67 km north-east of Kunming and ~12 km from Kedu Town. Kelang administrative village area comprises eight natural villages, covering 8 sq. km.(Kelang Government, 1999) and is at an altitude ranging from 1716-2163 m. According to the village statistics (Kelang Government,1999), the population of the Kelang administrative village is 3,510, with 839 households (average 4.2 persons per household) in 1998.

Yunnan has a high proportion of upland (84%) and is particularly subject to soil erosion, with consequent soil loss and crop yield reduction. Kelang has a total arable land area of 2430 mu (162 ha), including paddy fields, 942 mu, and upland, 1488 mu. The average amount of arable land per household is 2.9 mu or 0.1933 ha.

The number of households in Kelang village with government land rental contracts increased between 1983 and 1998 (Table 4). Consequently, there was a decrease in the average farm size. Some land changed from being used

as paddy land in 1983, to upland in 1998, due primarily to a shortage of irrigation water. The amount of upland increased, because some unallocated land cultivated by private individuals was taken back into the collective and reallocated.

Table 4: Number of households in Kelang with registered contracts and type of land rented from government, 1983 and 1998.

	1983	1998
Number of households with land rental contracts with the government	745	823
Area of Paddy field (mu)	950.86	942
Area of Upland (mu)	1364.65	1488

Source: (Kelang Government, 1983,1998).

The main crops are rice, tobacco and maize, with lesser amounts of wheat, beans, soybean, vegetables and fruit. Cultivated lands in upland areas have major problems, which include lack of water, poor water retention and soil erosion.

2.1 Employment

According to official Kelang village statistics (Kelang Government,1999), 1,698 people are classified as working; 1620 work in Kelang and 78 work in other locations. Of the 1620 people working, 65% are engaged for at least eight months of the year in agriculture. About half of these work approximately 3-5 months of the year in non-agricultural activity. The principal off-farm employment sectors are transport, construction, commerce, other services and manufacturing (Table 5). The average number of employees per enterprise is 2.3 and if construction is removed then the average size falls to 1.4.

2.2 Income

The average household income is 5,895 Yuan (1 euro = 7.35 Yuan) per annum or 1.409 Yuan per capita. This is 53% below the rural area average for all of China, but 1.57% and 40.34% above the average for Yunnan Province and Kedu Township respectively. Having increased significantly between 1994 and 1997, agricultural incomes declined sharply in 1998 and 1999, due primarily to a drop in tobacco and non-tobacco crop incomes (Figure 1). Tobacco was the most important single component of farm income prior to 1997. However, due to a government policy aimed at curtailing tobacco production, it lost its previous status.

Table 5: Off-farm activities in Kelang

The item of sideline	The number of Non-farm enterprises	The number of employees
Processing	18	18
Woodwork	4	4
Petrol station	1	1
Commerce	50	89
Catering trade	4	8
Other services	16	37
Construction	12	203
Transportation	94	98
Total	199	458

Source: Kelang Government,1999

Agriculture is no longer the primary source of farm household income, with the share having declined from over 70% in 1995 to less than 30% in 1999 (Figure 2). This is partly due to the significant drop in agriculture incomes, but also to an increase in off-farm incomes. The growth in off-farm income is led by transport and manufacturing industry, followed by commercial services and construction, all of which have grown significantly in absolute terms since 1996 (Figure 3).

2.3 Household characteristics (Survey results)

2.3.1 Sample

A sample of 100 households provided detailed information on a number of parameters and attitudes of Kelang households. The sample comprised 65

farmers from among those who had plots in the target catchment, and a further 35, selected from the rest of the village in order to get a statistically representative sample, in terms of household mix according to income level.

2.3.2 Household size

The average household size in the sample is 4.56 and most households (63%) have either four or five members, with a further 26% having either three or six members (Table 6).

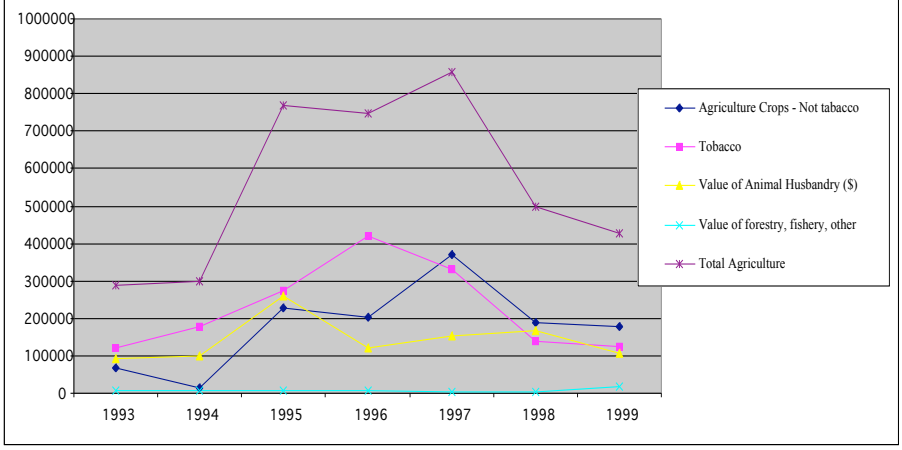
Table 6: Household size

Household size	1	2	3	4	5	6	7	8
% of sample	0	3	13	41	22	13	5	3

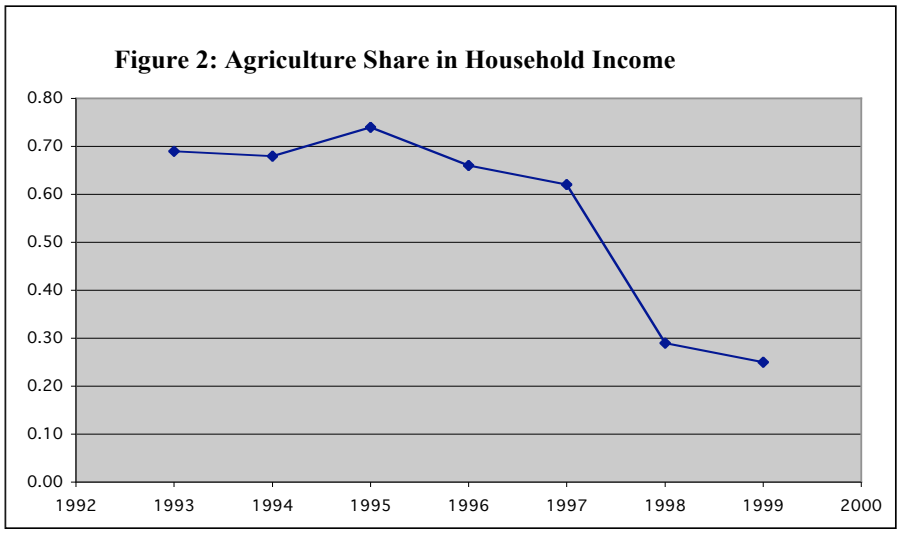
Source: Based on household sample survey, covering 100 households.

Approximately three-fifths of households have two parents with two children. This accords with the general profile of families in rural China and reflects the two-child policy that applies in rural areas where agriculture is the predominant means of livelihood. There is a considerable amount of inter-generational co-residence, with many families having either parents or grandchildren of the basic stem family living together in one household.

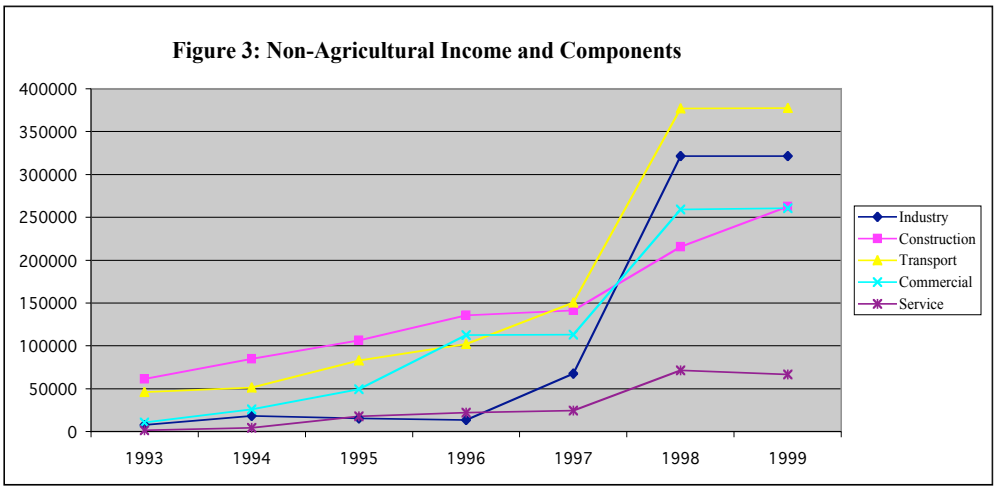
Figure 1.Total Agriculture Income and Components in Yuan



Source:Kelang Government ,1992-2000



Source:Kelang Government ,1992-2000



Source:Kelang Government ,1993-2000

2.3.3 Characteristics of the head and second member of the household

In most cases (92%), the head of the household is male. The average age of the head is 41.7 years. The level of education attained by almost half of the heads of household (49%) was a few years of primary school and many of the heads were unable to read or write, or had a limited ability to do so. A further 29% had completed primary school, 17% had completed junior school, 3% had completed senior school and only 1 had post-secondary education.

The second member of the household is usually female (90%) and 88% are listed as the wife of the head. The education level is lower in the second member of household, with 65% having received a few years of primary school only. A further 30% had completed primary school; 4% had completed senior school and again, 1% had post-secondary education. This pattern of relatively lower education levels for females reflects findings in the literature on education levels and gender in China.

2.4 Socio-economic status

2.4.1 Household income source

The household sample was stratified according to three income levels, low, middle and high, in proportion to their occurrence in the village[*]. The average income of the richest category was over seven times that of the poorest (Table 7). The results show an inverse relationship between income level and reliance on agriculture. The poorest category derived 67% of its income from agriculture, whereas the richest category derived only 16%.

Table 7: Household income (Yuan per year)

Economic Status	Average Household Income by source (Yuan)			Agriculture Share . (%)
	Agriculture	Non-agriculture	Total	
Low income	1617	811	2428	67
Middle income	3151	3903	7054	45
High Income	2824	15100	17924	16

2.4.2 Perception of most important factors for economic well-being

When asked to rank the factors, which most influence their level of well-being, respondents ranked training in non-agricultural activities highest,

[*] Low income: Household income is less than 1000 Yuan per person per year (11% of all households).
Middle income: 1,000-2000 Yuan per person, per year (80% of households).
High income: Over 2000 Yuan per person, per year (9% of households).

followed by the provision of better health care, control over more agricultural land and better agricultural machinery.

2.5 Time preference of farmers

An experiment carried out, as part of the household survey, to measure farmers time preference (rate of return implied by foregoing a present given income in favour of a larger future income), suggests that, whereas farmers, in general, have a high time preference, poorer farmers have a much higher time preference than richer farmers. Consequently, from a policy point of view, farmers and in particular poorer farmers require a high level of inducement to undertake environmentally sustainable agricultural practices, which yield long-term benefits.

2.6 Land Use and Agricultural Production

Results from the household survey indicate that the average size of paddy holdings for each household is 1.25 mu (10% above the village average) and the average size of upland area holdings is 2.11 mu (15% above the village average). However, the latter includes unofficial land, which is brought into use by farmers. In addition, there is an active unofficial rental market. Among the households surveyed, 11% rented on average an extra 1.3 mu of paddy land and 35% of households rented on average an extra 2 mu of upland. Only 14% of upland is irrigated.

The average household income from farming is 2894 Yuan, 83% of which is derived from crop production.

Approximately 90% of the total crop production value comes from summer crops (rice, tobacco and maize). Four-fifths of labour days are spent on summer crops and 20% on autumn crops (wheat, peas, beans and barley). Tobacco is the principal crop in terms of returns to labour. It accounts for 57% of the total value of crops, uses 45% and 40% of fertilizer and other materials,

respectively, and uses 46 of labour (Table 8). It provides 60% of the net return to labour. Rice is the second most important crop in contributing to returns to labour, followed by broad beans and barley.

Table 8: Distribution (%) of the value of output, inputs and returns by crop

	Rice	Wheat	Maize	Tobacco	Peas	Beans	Barley
Output Value	19	4	13	57	3	2	3
Fertiliser	9	4	38	45	-	-	4
Other Material	18	7	13	40	12	5	5
Net return	20	3	8	60	3	2	3
Labour	19	7	16	46	6	2	4

The average return to labour per manday is 20.57 Yuan; the highest return is from tobacco, followed by rice and broad beans (Table 9). The lowest return is from wheat.

Some conclusions can be drawn from these results. If the farmers can earn 20 Yuan per day on off-farm employment, then only tobacco and rice are worth growing. If the off-farm wage is 10 Yuan per day then only wheat and peas are not worth producing. Probably the most striking conclusion is that there is a huge under-employment in agriculture and the principal constraint is the lack of land. The average annual utilization of labour for cropping is 116.2 man days, where the average household size is 4.56 or a minimum of two adults, who have, approximately, 600 man days available per annum. Thus crops take up less than 20% of available household labour.

Table 9: Value of output, costs, labour input and returns to labour by crop (for 100 households)

	Rice	Wheat	Maize	Tobacco	Pea	Bean	Barl.	Tot.
Value of Output	57258	11916	38824	174040	9499	5930	10479	307946
Fertiliser cost	3789	1719	16254	19381	70	181	1847	43241
Other material	4663	1911	3218	10310	3067	1286	1181	25635
Net Returns	48806	8286	19352	144349	6362	4463	7451	239070
Labour man days	2177	862	1901	5304	648	229	499	11620
Return/	22.42	9.61	10.18	27.22	9.82	19.49	14.93	20.57

man day

2.7 Attitudes toward off-farm employment

A very strong preference was expressed for off-farm employment, where the choice existed (Table 10). Only 42% preferred on-farm employment in Kelang, while 58% preferred off-farm employment and 29% would prefer employment outside Kelang village.

Table 10: Preferred type and location of work

Location of work	Number	%
On-farm in Kelang	92	42
Off-farm in Kelang	64	29
Off-farm in Kedu	8	4
Off-farm in Yunnan	48	22
Off-farm outside Yunnan	6	3
Total	218	100

In response to the question, "Do you anticipate that your children will be cultivating the same plots you are in, in years to come?" a large majority of respondents (69%) did not wish to see their children cultivate the plots (Table 11).

Table 11: Farmers' preferences regarding their children's future participation in farming

Preference	Unwilling	No choice	Willing
Percentage	69	16	15

Many respondents rank training in non-agricultural activities and the provision of better health care as of more importance to the economic well-being of their family than having more agricultural land and/or better agricultural machinery.

These results lend further support to the increasing importance of non-agricultural activity in rural China, which has been highlighted in the literature.

3. New Catchment Management Practices

3.1 Measures introduced

The Project team, in conjunction with Kelang villagers, devised an integrated plan of measures for catchment management, which included both biological and engineering elements. These measures were implemented in a catchment, of 40.1ha, which included arable plots belonging to 163 households.

3.1.1 Biological measures

The broad objectives of the biological intervention were to curb environmental degradation of the catchment and improve the income of the local farmers. The specific objectives of the biological intervention were:

(i) Enhance soil fertility while curbing soil erosion on slopes < 25 degrees;
(ii) Reduce soil erosion on slopes > 25 degrees; and
(iii) Generate alternative output on the slopes > 25 degrees (sweet chestnuts, fruits of prickly ash (for medicinal purposes) and pine (wood)

In the upper part of the catchment, pine trees were planted on the barren hills and in gaps in the forest; Chinese prickly ash tree were planted on sloping arable land and barren hills. In the middle and lower part of the catchment, sweet chestnut trees were planted on barren hills and on cultivated land with slopes >25 degrees.

Fields with a slope <25 degrees will continue to be used for cultivation. Experimentation was carried out on five different types of cultivation practices, in order to evaluate the impact on productivity and soil conservation of each:

D	*Traditional cultivation with downslope planting, without mulch*
C	*Traditional cultivation with contour planting, without mulch*
C+P	*Traditional cultivation and contour planting, with polythene mulch*
C+P+S	*Traditional cultivation of maize + contour planting, with wheat straw and polythene mulch*
C+P+IS	*Traditional cultivation of maize + contour planting, wide and narrow row spacing, with polythene mulch and intercropping with soybean in wide row spacing*.

Grass strips between rows was also introduced in the catchment.

3.1.2 Engineering measures.

Five water storage ponds and a water supply pipe system were constructed to provide irrigation water for crops planted in the catchment, while three check dams have been built close to the village at the lower part of the catchment. A division ditch was built to divert runoff and prevent gully enlargement at the top of the newly formed gully in the upper part of the catchment. A meteorological observatory was established near the experimental plots to record rainfall, temperature, humidity, wind velocity and direction and solar radiation

3.2 Impact evaluation

3.2.1 Method of evaluation

Cost-benefit analysis (CBA) is the conventional method of analysing the effects of such projects. The Net Present Value (NPV) and Internal Rate of

Return (IRR) are the discounting techniques used to evaluate costs and benefits over a given time horizon. Sensitivity analysis is normally adopted to define the change range of the effect. CBA incorporates economic, ecological and social sustainability criteria at the project level. The economic evaluation focuses on the direct value brought about by the project, such as the increased yield of crops and fruit trees; the social evaluation measures of farmers' willingness to accept (WTA) and willingness to pay (WTP) to assess farmers' attitudes to the project. The WTA is estimated by asking farmers whether they would be willing to adopt tillage practices which conserve soil. WTP is measured directly by asking farmers how much they would be willing to pay for the irrigation pond. The ecological evaluation uses shadow prices to evaluate the change in soil nutrition after the adoption of new tillage practices. This requires information on the different values of the nitrogen (N), potassium (K) and phosphorus (P) content in the soil arising from the introduction of new tillage practices. Relative market prices are used to measure the ecological impact. The framework used to carryout a CBA of the Catchment Management measures is set out in Table 12.

3.2.2 Alternative cultivation methods.

Scientific experimental plots were set up in the catchment to test the effect of the different "treatments" or cultivation methods. In parallel with this 100 plots were selected from the lands of 65 farmers who farm in the catchment. The farmers were encouraged to cultivate these 100 plots ("experimentally") using one or other of the suggested methods. Results are available for the scientific experimental and farmers experimental plots for 1999 (Table 13) and 2000 (Table 14).

The "Contour and polythene" method is the superior method in terms of return per labour unit in the scientific experimentation. However, it is clear that all agricultural practices give a superior return to labour than can be earned off-farm, even "D" the down slope traditional cultivation method. It is interesting to note that the return per manday from cultivation method "D" on the scientific experimental plots is over twice the average obtained by the 100

households from maize production over all land plots cultivated (see Table 11).

The farmers in cultivating the 100 plots in the catchment showed a strong preference to stay with the "down-slope" traditional method. Although 42 farmers did take on the "contour" method in 1999, this declined to 27 in 2000. The sample sizes are too small to place much confidence in the results of any of the alternative practices.

Table 12: Framework for the Cost Benefit Analysis

Measure	Costs			Benefit	
	Capital	Maintenance	Opport-unity	Direct	Indirect
Alternative cultivation practices	-	Material and labour input	Off-farm employment	Increased output	Soil conservation, water retention
Grass strip	-	Material and labour input	Alternative crop use	Increased crop yield	Soil conservation Nutrition and water retention
Cash tree planting	Planting cost	Management cost	Alternative crop use	Fruit crop yield	Soil conservation
Forestry	Planting cost	Management cost	Alternative crop use	Value of tree	Soil conservation, Environmental Enhancement
Irrigation pond	Building	Maintenance	Crop cultivation	Increased crop yield	Reduced run-off.
Dam	Building	Maintenance		Reduced run -off and soil loss	Farm less vulnerable to flooding

Table 13: Results from various practices in maize cultivation with experimentation and farmers plots (1999)

Cultivation Method .	Number of Farmers	Value Output (Yuan)	Material Costs (Yuan)	Return to Labour	Required Labour Units	Yuan Per Labour Unit (a)	Yuan Per Labour Unit (b)	Marginal Return to Labour
			Experimental plots					
D		5810.4	1417.3	4393.1	203	21.64		
C		6462.4	1417.3	5045.1	225	22.42		29.64
C+P		8949.6	1953.3	6996.3	223	31.37		infinite
C+P+S		8641.6	1953.3	6688.3	229	29.21		negative
C+P+IS		9092.8	1953.3	7139.5	229	31.18		infinite
			Farmers Plots					
No Irrigation								
D	34	4206.4	2820.44	1385.96	319	4.34	6.82	
D+P	4	5880	3373.13	2506.87	306	8.19		infinite
C	42	4659.2	2604.03	2055.17	329	6.25	9.13	67.00
C+P	4	5169.6	3049.56	2120.04	429	4.94	9.51	
Irrigation								
D	4	5888.8	2798.93	3089.87	241	12.82		
C	6	5188	3798.45	1389.55	455	3.05		
D+P	3	5995.2	5330.84	664.36	267	2.49		

(a) On the basis of actual labour declared

(b) On the basis of labour used in experiment

There is a clear discrepancy between what can be achieved in controlled scientific experiments and what farmers can achieve, even on an experimental basis. It is clear overall that there is a much higher use of labour per hectare on the farmers plots, which is partly explained by the fact that the farmers counted in the travel time to and from the fields. Also, the output obtained is much lower and material inputs were considerably higher. So, all cultivation methods gave a very low average return to labour. Even if the labour input used in scientific experiments is applied to the net returns achieved from the farmers plots, the average return per labour unit is extremely low compared to the experimental results, but not too dissimilar from the village average. However, the marginal return to the additional labour required for the

"contour" method over the "down slope" method is significantly higher than the average return per labour unit.

Table 14: Results from various practices in maize cultivation with experimentation and farmers plots (2000)

Cultivation Method .	Number of Farmers	Value Output (Yuan)	Material Costs (Yuan)	Return to Labour	Required Labour Units	Yuan Per Labour Unit (a)	Yuan Per Labour Unit(b)	Marginal Return to Labour
			Experimental plots					
D		6256	1417.3	4838.7	203	23.84		
C		7051.2	1417.3	5633.9	225	25.04		36.15
C+P		7594.4	1953.3	5641.1	223	25.3		infinite
C+P+S		7760	1953.3	5806.7	229	25.36		27.67
C+P+IS		7417.6	1953.3	5464.3	229	23.86		negative
			Farmers Plots					
No Irrigation								
D	46	4932.36	3072	1860.36	348	5.35	9.16	
D+P	1	2988.51	3794	-805	497			
C	27	4584.43	3277	1307.43	364	3.59	5.86	negative
C+P	1	4074.07	1146	2928.07	347	8.44	12.79	
Irrigation								
D	6	6644.52	3940	2704.52	444	6.09	9.05	
C	4	4092.81	4431	-338.19	458			negative

(a) On the basis of actual labour declared
(b) On the basis of labour used in scientific experiment

A number of conclusions can be drawn from the foregoing results:

(i) The Contour cultivation method with polythene is the superior method, on the basis of returns to labour (although scientists recommend the addition of straw mulch for soil conservation);

(ii) Increase the know-how of farmers is necessary in order to close the gap between what can be achieved in experimentation and what can be currently achieved in practice.

(iii) If farmers can get off-farm employment, at 10 Yuan per day or more, it is more remunerative than working the marginal hill land for maize

cultivation. However, if a farmer must engage in farming the hill land, then it is best to incur the extra labour cost to engage in the more advanced but more environmentally friendly cultivation methods.

3.2.3 Irrigation.

The cost of the irrigation pond consists of the capital cost, running cost and opportunity cost of labour. Benefits come from the increased yields of crops and fruit due to irrigation. The yield of crops is calculated to be 30% higher and fruit yields ~20% higher than cultivation without irrigation. Labour costs are ~10% higher with irrigation. For the first five years, the net present value from irrigation (NPV) is negative, because the capital investment is very high but, after several years, the capital investment will be repaid and the NPV will increase. If the irrigation system is used in conjunction with new cultivation practices, the investment will be repaid in at least five years.

3.2.4 Tree planting

The benefits of tree-planting will be realised in the long-run. During the first five years, there is no benefit from trees in terms of cash crops e.g. sweet chestnut and prickly ash. From the 6th year to the 10th year, there is little benefit from fruit. After 10 years, maximum yield of fruit will be obtained, leading to higher benefits. So, tree-planting is a long-term project. According to calculations of the net present value, in 10 years time, the investment will not have been repaid, but in the longer term (after 15 years) the benefit from tree-planting will be high. Tree planting is beneficial for the environment and to help conserve soil. However, actual measurements were not made in this study.

3.3 Attitude of farmers to catchment management practices

3.3.1 New cultivation practices

Just over 76% of respondents said they would be willing to adopt the new techniques, while 24% were unwilling to do so. Nevertheless, although 63%

of the farmers plots were cultivated according to new methods in 1999, this dropped to 39% in 2000.

3.2.3 Tree planting

Less than half of those who had chestnut trees planted on their land thought the effect would be positive, while one-third thought it would have no effect and less than one-fifth thought it would have a negative impact. Only seven farmers had prickly ash trees on their land. Three of these thought the effect would be positive, while the same number expected no effect and one expected a negative effect.

All of the 46 farmers who had pine trees on their land saw this as beneficial and cited environmental reasons, such as "soil conservation" for their attitude.

3.2.4 Irrigation ponds

An evaluation of the overall effects of the irrigation scheme suggests that, while benefits less costs are negative in the short run, they are positive in the long run. The project needs to run for at least five years before the amount invested in the irrigation scheme is recovered.

In the course of the household survey, willingness-to-pay for irrigation was tested. The results show that 85 households would be willing to pay for an irrigation pond, with only 15 refusing to pay (Table 15). However, the amounts that households stated they would be willing to pay were relatively low.

Table 15: Willingness to pay for irrigation pond

Payment Amount	0 Yuan	10 Yuan	50 Yuan	100 Yuan	150 Yuan	200 Yuan
No. of Households	15	32	30	17	4	2

4. Conclusions

China has a very low level of arable land per capita so that self-sufficiency in agriculture is at the least very challenging. However, allied to this is low productivity in agriculture due to extremely small farm size and low level of mechanization. There is also a very large surplus labour in agriculture. The process of development is moving rapidly and with it increasing outflows from agriculture. The process intensifies as you move from West to East. The absorption capacity into alternative employment of the surplus from agriculture is greater as you move from West to East. So there is labour migration from West to East.

Kelang is a microcosm of the national rural situation. The primary constraint is arable land area, absorbing less than 20% of the available labour. The average return to farm labour was considerably above that available from off-farm employment, although this was heavily influenced by returns from tobacco growing. Although living standards are well above the poverty level, generally, there is a close relationship between poverty and dependence on agriculture or between income levels and off-farm employment. For some families (11%) agriculture is the main source of income. There is a keen awareness of the lack of opportunity on the land and overwhelming preference is for off farm employment both for the present adults themselves and their wishes for their children. If this means leaving Kelang, they are willing to do so. Indeed, 25% expressed a wish to move out of the Kedu Township. The level of education is extremely low. This is perceived as a disadvantage and in terms of priorities, training in off-farm activity is ranked ahead of medical services, increased land area and machinery in order of preference. However, the predominant view was that they themselves had little or no influence on the decisions affecting their lives.

The central focus of the Kelang project was to improve productivity and sustainability of farming through improved catchment management. The essence of this was improved cultivation methods, tree planting and irrigation. A framework for assessing the costs and benefits shows a considerable requirement for information. Much of this information can only be obtained from

experimentation and over a long period of time, particularly with respect to the impact of tree planting. The most concrete information obtained has been from the alternative crop cultivation methods. The views and preferences of the farmers were also obtained.

The alternative cultivation methods on the basis of scientific experiments show very significant gains. These gains are less evident from the experience of farmers. Whereas, the gains in 1999 were clearcut, the results in 2000 were ambiguous. Also, the income obtained by farmers per manday on these hill plots was less than could be obtained in off farm activity. Nevertheless, it was clear that the marginal return (return to the additional labour required for the cultivation method) from the alternative cultivation methods were high. So, if farmers were going to cultivate the hill lands, then it was more financially rewarding to use the alternative methods. It is clear form the project that greater precision in measurements and quantification is required. Nevertheless, there is an enormous discrepancy between what can be achieved through scientific experimentation and what can be achieved in practice by the farmer, whatever the cultivation method.

Although there was a strong preference expressed in interview toward the new cultivation methods, the reality was that over the period 1999 – 2000, there was a significant reduction in the actual use of new methods, in favour of the traditional one.

The scientific information on the tree planting shows clear long term benefits, particularly with regard to the sustainability of the catchment farming. The irrigation results were also very positive and profitable in the long term. However, it is clear that, given the high time preference of farmers and the relatively long payback period, that farmers would not undergo this investment of their own accord, despite again expressing a willingness in interview to undergo such investments.

Although the benefits of catchment management to the productivity and sustainability of the catchment and thus to the short and long term benefits of the farmers have been established, it is not clear that the farmers are willing or capable of implementing such a system. Particularly, in the context of the integrated system of farming and off-farm engagement which is the norm, household behaviour does not focus on just one element, like improved hill farming practice, but on the totality of the integrated system and the impact that change in some elements of the system might have on its overall wellbeing. Movement away from a well established historical orientation of the integrated system is unlikely to arise in the absence of significant and obvious benefit. Such significant benefits are more likely to come from more holistic approaches to improve farm incomes, particularly those who see farming as their main occupation, such as alternative high income crops and flexibility in the land use legislation which would give legal access to land to the more productive farmers. It would appear that the state must make most of the capital investment in regard to soil erosion prevention. However, the wider impact of stabilising the catchment and preventing soil erosion on downstream flooding would reinforce the social justification for such investment.

This study has made it clear that public policy toward rural regions will play a critical part in its future development. It will include improved education and training with regard to both on and off-farm activity, investment in erosion prevention measures as well as the creation of off-farm activity to absorb the surplus labour.

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MAP 1:

Wang Jia and Tree Planting