

5. Economic efficiency impacts

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INTRODUCTION

In the previous chapter, the financial impacts of the introduction of the Conversion of Cropland to Forest and Grassland Program (CCFGP) on farmer livelihoods were analysed through the examination of survey data collected from 400 farm households across four counties in two of China's Northwest Provinces, Qinghai and Shaanxi. The aim of this chapter is to convert that analysis to one that investigates the economic benefits and costs associated with the changes in agricultural production induced by the implementation of the Program.

Whilst the goal of Chapter 4 was to gain an understanding of the incentives for farmers to continue their involvement in the Program, the focus here shifts to a consideration of the economic efficiency of the Chinese investment in the Program. Hence, the first key element of the research reported in this chapter is the conversion of on-farm financial impacts to the effects of the Program on wider social welfare. The principles of cost-benefit analysis are therefore invoked. The second key element is the extrapolation of the estimates of benefits and costs derived from the survey data to the population of farm households in the study region.

This chapter is made up of four further parts. In Section 2, the methodology used for converting the financial impacts estimated for the sample of farm households to economic benefits and costs is detailed. This is followed by a description of the process employed to extrapolate those estimates to the population of the study region. In Section 3, the results of the analysis are detailed and this is followed in Section 4 with a brief sensitivity analysis of the results. Finally, some conclusions are outlined in Section 5.

METHODOLOGY

Converting the Financial Analysis to an Economic Analysis

Binxian and Ansai Counties in Shaanxi Province, and Minhe and Gonghe Counties in Qinghai Province, were selected to act as representative counties for the extrapolation of the survey results to the wider study area. They provide variation in biophysical and socioeconomic conditions that reflects the broad differences across all counties in the Northwest. In Chapter 4, financial impacts of the CCFGP on livelihoods were calculated for 400 surveyed farm households in the four counties. These impacts are summarized in Table 5.1.

Table 5.1 Financial impacts of the CCFGP on livelihoods per household (CNY)

NPV	Binxian	Ansai	Gonghe	Minhe
NPV of net revenue difference	32 059.44	63 389.32	63 537.32	59 824.58
NPV of net costs difference	755.25	35 179.73	15 011.28	4 200.91
NPV of net profits difference	31 304.19	28 209.59	48 526.04	55 623.67

Note: NPV is calculated at 3 per cent discount rate.

In order to convert these per household financial impacts to per household economic impacts, that is, impacts per household on overall social welfare, a number of adjustments were carried out:

1. Grain prices received by farmers for soybeans, maize and wheat were re-placed by shadow prices.
2. Payments made to farmers under the CCFGP were deducted from revenues and instead counted as a cost of the Program.
3. Government administration costs associated with the operation of the CCFGP and expenses related to the production of seedlings supplied to farmers were added as costs.

The shadow prices of grains were taken to be the average of prices across those recorded in 1998 and 2003 as determined in the Chicago Grain Exchange. The prices, which were originally in the form of US cents per bushel,¹ have been converted into CNY per kg and are displayed in Table 5.2.

Table 5.2 Shadow prices of grains (CNY/kg)

	Wheat	Maize	Soybeans
1998	0.88	0.72	1.64
2003	1.02	0.72	1.92

Source: China Grain and Oil Information Centre (2006).

Seedling costs include those borne by the government in raising seedlings distributed to farmers under the Program and those paid by farmers who raised their own seedlings. The seedling costs per household are set out in Table 5.3.

Table 5.3 Seedling costs (CNY/per household)

	Farmer	Government*	Total
Binxian	1.19	118.90	120.08
Ansai	0.00	966.82	966.82
Gonghe	2.39	2,556.77	2,559.16
Minhe	6.38	408.42	414.80

Note: *Seedling costs borne by the government were estimated based on the land area under CCFGP and a government subsidy of CNY50 per mu of land.²

Source: 400 household survey.

To estimate the government's operational costs for the Program on a per mu basis to be consistent with the livelihood analysis, the annual national CCFGP operational costs from 1999 to 2004 were divided by the corresponding areas of land falling under the CCFGP. This yields the average annual CCFGP operational costs per mu from 1999 to 2004. For 2005 and following years, operational costs are assumed to remain constant at the average level for 1999 to 2004. These cost calculations are shown in Table 5.4. The operational costs were then scaled up to the per household level by multiplying the per mu estimates by the average farm size.

Table 5.4 Government's operational costs of CCFGP per mu

	1999	2000	2001	2002	2003	2004
Total operational costs (10 000 CNY)	12,429.9	21,570.5	43,281	144,614	291,139	298,000
Total CCFGP area (ha)	394,600	683,599	890,292	4,423,607	6,196,128	3,214,209
Operational costs (CNY/mu)	21	21	32	22	31	62

Source: China Forestry Statistical Yearbook, 1999–2004.

Finally, the payments of subsidies and grain to farmers were removed as revenues from the livelihood analysis and included as costs in the economic analysis.

Through these adjustments, household economic benefits and costs tables were constructed for each of the four counties.³ These tables, hereafter referred to as the baseline tables, are set out as Tables 5.5 to 5.8.

Identifying the Boundary for Extrapolation

The extrapolation process involves the net benefit estimates derived from the sample of farm households in the previous sub-section being used to 'represent' a wider population. That population is taken to be farm households across the Loess Plateau. That region covers 327 counties across Qinghai, Gansu, Ningxia, Shaanxi, Shanxi and Inner Mongolia Provinces and autonomous regions. In 2002, 198 of those 327 counties were engaged in the CCFGP. Hence, this research uses farm households in those 198 counties as the extent of the population for extrapolation.

Grouping Counties for Extrapolation

Each of the four counties involved in the farm livelihood survey was chosen because of its representative socioeconomic and biophysical conditions. The extrapolation process took advantage of those differences by establishing groupings of the counties making up the overall population according to how closely they match the conditions in the survey counties.

Pasture-based counties

Of the four survey counties, Gonghe is predominantly a pasture-based economy and so was used to represent other pasture-dominated CCFGP counties on the Loess Plateau. On the basis of each county government's website, 24 of the 198 counties were identified as pasture-based.

Table 5.5 Economic benefits and costs (Binxian) (CNY/ household)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2011	2014	2017
<i>Without CCFGP</i>													
Costs	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4	1485.4
1. Hired labour	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.4
2. Material	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5	1455.5
3. Land rent	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6
Benefits	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7	3658.7
1. Crop	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5	1302.5
2. Livestock	255.5	255.5	255.5	255.5	255.5	255.5	255.5	255.5	255.5	255.5	255.5	255.5	255.5
3. Others	847.3	847.3	847.3	847.3	847.3	847.3	847.3	847.3	847.3	847.3	847.3	847.3	847.3
4. Off-farm labour	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5	1253.5
5. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net benefit	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3	2173.3

Table 5.5 continued

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2011	2014	2017
<i>With CCFGP</i>													
Costs	2299.1	2183.0	2213.2	2188.9	2214.2	2295.3	2241.6	2211.0	1872.1	1876.0	1902.8	1876.0	1902.8
1. Hired labour	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7	18.7
2. Material	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0	1401.0
3. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. CCFGP costs	823.5	707.3	707.3	711.2	711.2	711.2	738.0	707.3	368.5	372.3	399.1	372.3	399.1
5. Operational	55.9	56.0	86.2	58.0	83.3	164.4	84.0	84.0	84.0	84.0	84.0	84.0	84.0
Benefits	5155.2	5166.1	5313.1	5367.5	5367.5	5983.0	5550.2	5916.2	5658.9	5713.2	5648.0	5713.2	5648.0
1. Crop	1201.8	1201.8	1201.8	1201.8	1201.8	1229.2	1229.2	1229.2	1229.2	1229.2	1229.2	1229.2	1229.2
2. Livestock	444.4	444.4	444.4	444.4	444.4	444.4	444.4	444.4	444.4	444.4	444.4	444.4	444.4
3. Others	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4	1070.4
4. Off-farm labour	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6	2438.6
5. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Forest/grass	0.0	10.9	157.9	212.2	212.2	800.4	367.6	733.6	476.3	530.6	465.4	530.6	465.4
Net benefit	2856.2	2983.1	3099.9	3178.6	3153.3	3687.7	3308.6	3705.2	3786.8	3837.2	3745.2	3837.2	3745.2
Net benefit difference	682.8	809.8	926.6	1005.3	979.9	1514.4	1135.2	1531.9	1613.5	1663.9	1571.9	1663.9	1571.9

Notes:

- a. CCFGP costs include farmers' seedlings, CCFGP subsidies (cash, grain and seedlings), planting and management inputs.
 b. Benefits and costs in years 2007/2012/2013/2018, years 2008/2009/2010 and years 2014/2015/2016 are the same.

Table 5.6 Economic benefits and costs (Ansai) (CNY/ household)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2013	2016	2018
<i>Without CCFGP</i>													
Costs	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0	1488.0
1. Hired labour	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
2. Material	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1	1444.1
3. Land rent	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7
Benefits	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8	5084.8
1. Crop	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1	1651.1
2. Livestock	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7	2232.7
3. Others	275.1	275.1	275.1	275.1	275.1	275.1	275.1	275.1	275.1	275.1	275.1	275.1	275.1
4. Off-farm labour	920.2	920.2	920.2	920.2	920.2	920.2	920.2	920.2	920.2	920.2	920.2	920.2	920.2
5. Land rent	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
Net benefit	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8	3596.8

120

Table 5.6 continued

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2013	2016	2018
<i>With CCFGP</i>													
Costs	8 120.6	7 128.9	7 385.2	7 150.8	7 366.3	8 037.4	7 369.6	7 398.4	4 808.8	4 806.8	4 803.7	4 818.2	4 811.0
1. Hired labour	230.9	230.9	230.9	230.9	230.9	230.9	230.9	230.9	230.9	230.9	230.9	230.9	230.9
2. Material	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1	3 170.1
3. Land rent	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
4. CCFGP costs	4 250.8	3 258.3	3 263.4	3 263.4	3 268.6	3 266.5	3 266.5	3 295.4	705.8	703.8	700.7	715.1	707.9
5. Operational	463.7	464.5	715.6	481.2	691.7	1 364.7	696.9	696.9	696.9	696.9	696.9	696.9	696.9
Benefits	4 049.3	4 056.9	4 196.0	5 010.1	5 411.3	6 672.7	6 841.9	7 878.8	7 871.2	10 349.1	11 128.2	12 343.8	9 176.3
1. Crop	703.5	703.5	703.5	703.5	703.5	719.5	719.5	719.5	719.5	719.5	719.5	719.5	719.5
2. Livestock	938.4	938.4	938.4	938.4	938.4	938.4	938.4	938.4	938.4	938.4	938.4	938.4	938.4
3. Others	643.3	643.3	643.3	643.3	643.3	643.3	643.3	643.3	643.3	643.3	643.3	643.3	643.3
4. Off-farm labour	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2	1 741.2
5. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Forest/grass	23.0	30.6	169.7	983.8	1 385.0	2 630.4	2 799.6	3 836.4	3 828.8	6 306.8	7 085.9	8 301.4	5 134.0
Net benefit	-4 071.3	-3 072.0	-3 189.2	-2 140.7	-1 955.0	-1 364.7	-527.7	480.4	3 062.4	5 542.3	6 324.5	7 525.6	4 365.4
Net benefit difference	-7 668.0	-6 668.7	-6 785.9	-5 737.5	-5 551.8	-4 961.5	-4 124.4	-3 116.4	-534.4	1 945.6	2 727.8	3 928.8	768.6

121

Notes:

a. CCFGP costs include farmers' seedlings, CCFGP subsidies (cash, grain and seedlings), planting and management inputs.

b. Benefits and costs in years 2008/2009/2010 and years 2014/2017 are the same, and are almost the same for years 2008/2011/2012/2014/2015.

Table 5.7 Economic benefits and costs (Gonghe) (CNY/ household)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015
<i>Without CCFGP</i>													
Costs	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0	7303.0
1. Hired labour	378.8	378.8	378.8	378.8	378.8	378.8	378.8	378.8	378.8	378.8	378.8	378.8	378.8
2. Material	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2	6413.2
3. Land rent	511.0	511.0	511.0	511.0	511.0	511.0	511.0	511.0	511.0	511.0	511.0	511.0	511.0
Benefits	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6	23266.6
1. Crop	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0	10087.0
2. Livestock	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0	11021.0
3. Others	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
4. Off-farm labour	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5	1053.5
5. Land rent	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6	1102.6
Net benefit	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6	15963.6

Table 5.7 continued

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2015
<i>With CCFGP</i>													
Costs	19496.0	16938.9	10639.3	10096.5	10583.9	13199.2	10842.0	10846.5	10050.5	10050.5	11106.7	10050.5	9804.5
1. Hired labour	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9	73.9
2. Material	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1	4639.1
3. Land rent	352.1	352.1	352.1	352.1	352.1	352.1	352.1	352.1	352.1	352.1	352.1	352.1	352.1
4. CCFGP costs	13357.0	10798.0	3916.8	3916.8	3916.8	4973.2	4162.8	4167.3	3371.3	3371.3	4427.5	3371.3	3125.3
5. Operational	1073.9	1075.8	1657.4	1114.6	1602.0	3160.9	1614.1	1614.1	1614.1	1614.1	1614.1	1614.1	1614.1
Benefits	23380.1	23381.7	26649.9	26652.6	27372.8	24261.7	24949.4	29414.9	29414.9	27926.5	24658.3	24658.3	23967.2
1. Crop	6765.7	6765.7	6765.7	6765.7	6765.7	6920.0	6920.0	6920.0	6920.0	6920.0	6920.0	6920.0	6920.0
2. Livestock	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0	13681.0
3. Others	78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9	78.9
4. Off-farm labour	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6	1257.6
5. Land rent	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8	48.8
6. Forest/grass	1548.1	1549.7	4817.9	4820.6	5540.8	2275.4	2963.6	7428.6	7428.6	5940.2	2672.0	2672.0	1980.9
Net benefit	3884.1	6442.8	16010.6	16556.1	16788.9	11062.5	14107.4	18568.4	19364.4	17876.0	13551.6	14607.8	14162.7
Net benefit difference	-12079.5	-9520.8	47.0	592.5	825.3	-4901.1	-1856.2	2604.8	3400.8	1912.4	-2412.0	-1355.8	-1800.9

Notes:

a. CCFGP costs include farmers' seedlings, CCFGP subsidies (cash, grain and seedlings), planting and management inputs.

b. Benefits and costs for years 2008/2011/2012/2013 and years 2016/2017/2018 are the same; and are almost the same for years 2008/2016 and years 2010/2014.

Table 5.8 Economic benefits and costs (Minhe) (CNY/ household)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2014	2015	2017	2018
<i>Without CCFGP</i>													
Costs	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3	1605.3
1. Hired labour	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9	31.9
2. Material	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8	1561.8
3. Land rent	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
Benefits	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8	5468.8
1. Crop	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8	1932.8
2. Livestock	978.9	978.9	978.9	978.9	978.9	978.9	978.9	978.9	978.9	978.9	978.9	978.9	978.9
3. Others	841.5	841.5	841.5	841.5	841.5	841.5	841.5	841.5	841.5	841.5	841.5	841.5	841.5
4. Off-farm labour	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6	1715.6
5. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net benefit	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6	3863.6

Table 5.8 continued

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2014	2015	2017	2018
<i>With CCFGP</i>													
Costs	3530.8 ^a	3116.3	3235.5	3148.7	3226.6	3532.4	3285.3	3259.0	2292.2	2235.5	2235.5	2235.5	2244.6
1. Hired labour	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
2. Material	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0	1331.0
3. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. CCFGP costs	2016.0	1601.2	1627.5	1627.5	1627.5	1684.2	1684.2	1658.0	691.1	634.4	634.4	634.4	643.5
5. Operational	171.6	171.9	264.8	178.1	255.9	505.0	257.9	257.9	257.9	257.9	257.9	257.9	257.9
Benefits	5641.9	5641.9	6271.5	9099.0	10231.9	10669.3	10669.3	9976.7	9976.7	9563.6	8856.7	8556.8	9032.1
1. Crop	1063.8	1063.8	1063.8	1063.8	1063.8	1088.0	1088.0	1088.0	1088.0	1088.0	1088.0	1088.0	1088.0
2. Livestock	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1	1153.1
3. Others	891.6	891.6	891.6	891.6	891.6	891.6	891.6	891.6	891.6	891.6	891.6	891.6	891.6
4. Off-farm labour	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3	1916.3
5. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Forest/grass	617.1	617.1	1246.6	4074.2	5207.0	5620.2	5620.2	4927.6	4927.6	4514.5	3807.6	3507.7	3983.0
Net benefit	2111.1	2525.6	3036.0	5950.3	7005.3	7136.9	7384.0	6717.7	7684.6	7328.1	6621.2	6321.4	6787.5
Net benefit difference	-1752.5	-1338.0	-827.6	2086.7	3141.7	3273.3	3520.4	2854.1	3821.0	3464.5	2757.7	2457.8	2923.9

Notes:

- a. CCFGP costs include farmers' seedlings, CCFGP subsidies (cash, grain and seedlings), planting and management inputs.
 b. Benefits and costs for years 2007/2008/2009/2010/2011/2012/2013 and years 2015/2016 are the same.

Selecting other grouping criteria

The remaining 174 counties differ in their social economic conditions. The livelihood survey results showed that the proportion of CCFGP land in total cropland is a key indicator of the mix between farm and non-farm activities undertaken by rural households. Hence, this proportion was used as the primary criterion for grouping counties. In addition, crop yield as an indicator of land productivity was taken as a secondary criterion to achieve finer differentiation.

Classifying counties

The ratios of CCFGP land area⁴ (total from 2002 to 2005)⁵ to total cropland were calculated for each of the 174 non-pasture-dominated counties. Three intervals (less than 14 per cent, 14–30 per cent, large than 30 per cent) were set with reference to the proportions observed in Binxian, Ansai and Minhe respectively. The 174 counties were classified according to their proportions into the three intervals:

1. The Binxian group comprised 76 counties (Binxian has a CCFGP ratio of 13.43 per cent and a crop yield of 148.53 kg per mu).
2. The Minhe group of 59 counties (Minhe has a CCFGP ratio of 20.18 per cent and a crop yield of 140.16 kg per mu).
3. The Ansai group of 39 counties (Ansai has a CCFGP ratio large than 60 per cent and 114.48 kg crop yield per mu).

Extrapolation Values

One further step is required prior to the extrapolation of the economic impact values. The four per household-based economic impact tables (Tables 5.5 to 5.8) must be converted from a household basis to an area basis because data on CCFGP implementation across counties is collected on an area rather than household basis. This requires the net benefits for each survey county to be divided by the area of the household farm under CCFGP. The per mu economic impacts of the CCFGP are presented as Tables 5.9 to 5.12.

Table 5.9 Economic benefits and costs (Binxian) (CNY/mu)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2011	2014	2017
<i>Without CCFGP</i>													
Costs	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4	558.4
1. Hired labour	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8
2. Material	547.2	547.2	547.2	547.2	547.2	547.2	547.2	547.2	547.2	547.2	547.2	547.2	547.2
3. Land rent	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Benefits	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5	1375.5
1. Crop	489.7	489.7	489.7	489.7	489.7	489.7	489.7	489.7	489.7	489.7	489.7	489.7	489.7
2. Livestock	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1	96.1
3. Others	318.5	318.5	318.5	318.5	318.5	318.5	318.5	318.5	318.5	318.5	318.5	318.5	318.5
4. Off-farm labour	471.2	471.2	471.2	471.2	471.2	471.2	471.2	471.2	471.2	471.2	471.2	471.2	471.2
5. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net benefit	817.0	817.0	817.0	817.0	817.0	817.0	817.0	817.0	817.0	817.0	817.0	817.0	817.0

EXTRAPOLATION OF ECONOMIC COST-BENEFIT ANALYSIS

The estimates of per mu benefits and costs presented in Tables 5.9 to 5.12 form the basis of the extrapolation process. For each of the county groupings, these per mu values are multiplied by the total area of land under the CCFGP in each year of the analysis. The extrapolated net benefit difference (NBD) of the CCFGP across the four county groups and for the whole group during the 20-year period is demonstrated in Table 5.13. In the following four sub-sections, the results of the extrapolations are presented.

Table 5.13 Extrapolated net benefit difference (CNY million)

County Group	Binxian	Ansai	Gonghe	Minhe	All groups
1999	1 002.94	-3 459.36	-576.29	-1 508.24	-4 540.96
2000	1 191.24	-3 008.53	-444.45	-1 153.84	-3 415.61
2001	1 364.45	-3 061.40	48.49	-717.43	-2 365.91
2002	1 481.14	-2 588.40	76.6	1 774.19	743.54
2003	1 443.55	-2 504.64	88.59	2 676.19	1 703.69
2004	2 236.12	-2 238.30	-206.43	2 788.74	2 580.14
2005	1 673.85	-1 860.66	-49.53	3 000.02	2 763.67
2006	2 262.14	-1 405.89	180.27	2 430.33	3 466.85
2007	2 383.09	-2 41.03	221.27	3 256.98	5 620.30
2008	2 457.91	877.8	144.59	3 256.98	6 737.29
2009	2 457.91	877.8	-78.19	3 256.98	6 514.49
2010	2 457.91	877.8	-23.78	3 256.98	6 568.91
2011	2 321.49	873.47	144.59	3 256.98	6 596.54
2012	2 383.09	978.06	144.59	3 256.98	6 762.71
2013	2 383.09	1 230.70	144.59	3 256.98	7 015.34
2014	2 457.91	668.97	-27.34	2 952.23	6 051.77
2015	2 457.91	664.64	-46.71	2 347.86	5 423.70
2016	2 457.91	1 772.55	121.67	2 347.86	6 699.98
2017	2 321.49	668.97	121.67	2 091.47	5 203.60
2018	2 383.09	346.81	121.67	2 490.01	5 341.57

Binxian Group

The annual NBD with and without CCFGP across the Binxian group counties through time are graphed in Figure 5.1. From 1999, annual NBD begins to increase with some fluctuations in 2004 and 2005 before remaining relatively constant from 2007 to 2018. The annual NBD is always positive across the 20 years of prediction.

Table 5.12 continued

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2014	2015	2017	2018
<i>With CCFGP</i>													
Costs	432.1	381.4	396.0	385.4	394.9	432.3	402.1	398.9	280.6	273.6	273.6	273.6	274.7
1. Hired labour	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
2. Material	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9	162.9
3. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. CCFGP costs	246.8	196.0	199.2	199.2	199.2	206.1	206.1	202.9	84.6	77.6	77.6	77.6	78.8
5. Operational	21.0	21.0	32.4	21.8	31.3	61.8	31.6	31.6	31.6	31.6	31.6	31.6	31.6
Benefits	690.6	690.6	767.6	1 113.7	1 252.4	1 305.9	1 305.9	1 221.1	1 221.1	1 170.6	1 084.1	1 047.3	1 105.5
1. Crop	130.2	130.2	130.2	130.2	130.2	133.2	133.2	133.2	133.2	133.2	133.2	133.2	133.2
2. Livestock	141.1	141.1	141.1	141.1	141.1	141.1	141.1	141.1	141.1	141.1	141.1	141.1	141.1
3. Others	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1	109.1
4. Off-farm labour	234.6	234.6	234.6	234.6	234.6	234.6	234.6	234.6	234.6	234.6	234.6	234.6	234.6
5. Land rent	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. Forest/grass	75.5	75.5	152.6	498.7	637.3	687.9	687.9	603.1	603.1	552.6	466.0	429.3	487.5
Net benefit	258.5	309.2	371.6	728.3	857.5	873.6	903.8	822.2	940.6	897.0	810.4	773.7	830.8
Net benefit difference	-7 668.0	-6 668.7	-6 785.9	-5 737.5	-5 551.8	-4 961.5	-4 124.4	-3 116.4	-534.4	1 945.6	2 727.8	3 928.8	768.6

Notes:

- CCFGP costs include farmers' seedlings, CCFGP subsidies (cash, grain and seedlings), planting and management inputs.
- Benefits and costs are the same for years 2007/2008/2009/2010/2011/2012/2013 and years 2015/2016.

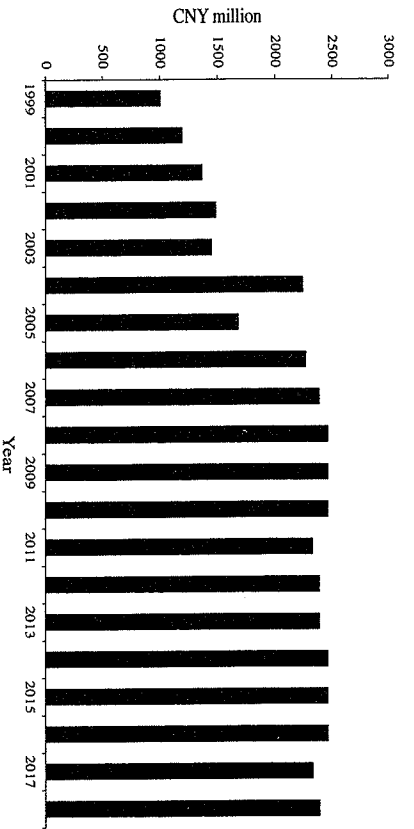


Figure 5.1 Net benefit difference with and without CCFGP of Binxian group

Using a discount rate of 3 per cent, the net present value (NPV) of NBD under the CCFGP at year 2006 level in the Binxian group of counties across the 20 years is CNY36.74 billion. If the discount rate rises to 10 per cent or 20 per cent, the NPV falls to CNY30.55 billion and CNY28.60 billion respectively.

Ansai Group

For farmer households in the Ansai group of counties, the predicted differences between net benefits with and without CCFGP from 1999 to 2007 were all negative. Following the constant increase of revenue from grass and forest products, the difference after 2008 becomes positive.

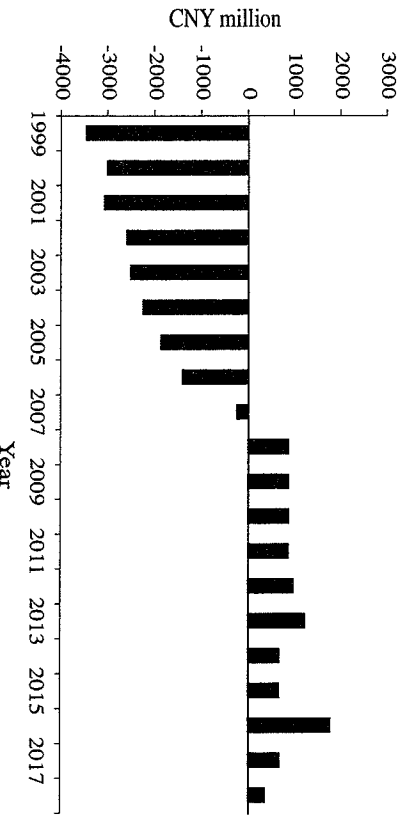


Figure 5.2 Net benefit difference with and without CCFGP of Ansai group

At a 3 per cent discount rate, the NPV of Ansai group's NBD across 20 years is -CNY14.48 billion. At 10 per cent and 20 per cent discount rate, the corresponding NPVs are -CNY22.88 billion and -35.41 billion respectively.

The above result shows that from national point of view, the costs of the CCFGP in these areas are higher than the on-farm benefits.

Gonghe Group

For farmer households in the Gonghe group of counties, the net profit difference with and without CCFGP from 1999 to 2018 fluctuates. The difference in 1999, -CNY576.29 million is the lowest, and then the difference alters four times between positive and negative values following fluctuation of grass and forest revenues.

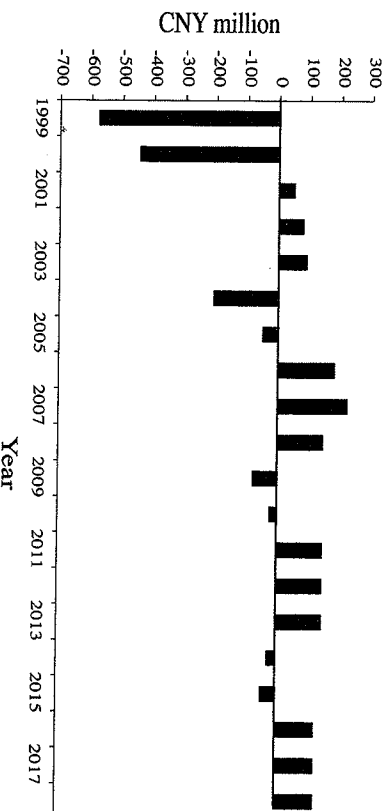


Figure 5.3 Net benefit difference with and without CCFGP of Gonghe group

At a 3 per cent discount rate, the NPV of Gonghe group's NBD across 20 years is -CNY0.25 billion. At 10 per cent and 20 per cent discount rate, cost is also higher than the benefit and the corresponding NPVs are -CNY1.0 billion and -CNY2.3 billion respectively.

The result shows that from a national economic perspective, the costs of the CCFGP in these areas are higher than the on-farm benefits.

Minhe Group

For Minhe group, NBD with and without CCFGP from 1999 to 2001 were all negative. The difference in 2002 and following years becomes positive. The change of difference with and without CCFGP is mainly caused by the change of grass and forest product revenue.

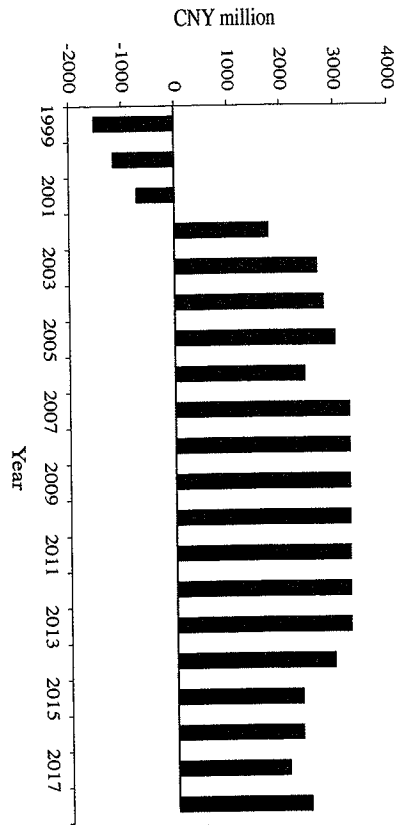


Figure 5.4 Net benefit difference with and without CCFGP of Minhe group

At a 3 per cent discount rate, NPV of Minhe group's NBD across 20 years is CNY37.63 billion. The benefit is far beyond cost. At 10 per cent and 20 per cent discount rate, NPV's decreases to CNY27.08 billion and 17.95 billion respectively.

The result shows that from a national economic perspective, the on-farm benefits of the CCFGP in these regions are higher than costs.

All Counties

Although the NBDs with and without CCFGP of 198 counties between 1999 and 2001 are negative, they become positive in the rest of the period under consideration. This shows that overall, the total on-farm benefits from the CCFGP are higher than its costs.

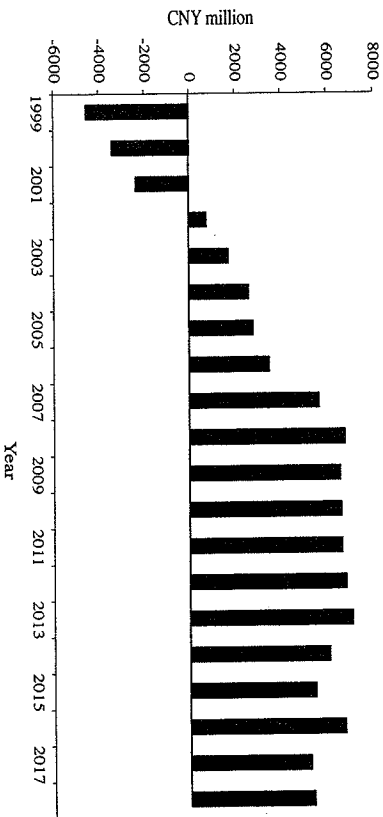


Figure 5.5 Net benefit difference of all counties with and without CCFGP

At a 3 per cent discount rate, the NPV of NBD in all 198 counties is CNY59.64 billion. At 10 per cent and 20 per cent discount rate, the NPV is still positive. Therefore, CCFGP is economically feasible in the Loess Plateau regions (Table 5.14).

Table 5.14 NPV of NBD with and without CCFGP (CNY million)

County Group	Discount Rate		
	3%	10%	20%
Binxian group	36 739.62	30 548.80	28 603.15
Ansai group	-14 475.96	-22 883.76	-35 410.13
Gonghe group	-254.15	-1 035.65	-2 272.24
Minhe group	37 633.02	27 078.74	17 946.98
All Loess Plateau counties	59 642.43	33 708.02	8 867.62

SENSITIVITY ANALYSIS

It has been found that forest and grass income, operational costs as well as off-farm labour income are the key factors affecting the extrapolation results when analysing each group revenue and costs. Hence, sensitivity analyses are conducted on these three factors. The sensitivity analysis results are shown in Table 5.15.

Table 5.15 Economic sensitivity analysis results (CNY million)

Sensitivity Factor	Discount rate		
	3%	10%	20%
Halve forest and grass revenues	4 844.03	-9 560.82	-27 642.40
Halve off-farm income	3 786.36	-16 937.47	-44 397.26
Halve revenues and off-farm income	-51 012.00	-60 206.30	-80 907.20

When forests and grass revenues were halved, the NPV of the NBD is positive at the 3 per cent discount rate, but negative at the 10 per cent and 20 per cent discount rates. This result demonstrates that in the Loess Plateau region, the economic efficiency of the CCFGP investment is sensitive to the tree crop and grass outputs and prices. Hence, if because of a natural risk factor (such as drought or disease reducing yields) or a market risk factor (oversupply of the

market causing price reductions) there were reduced forest and grass revenue, the CCFGP would not be economically feasible across the Loess Plateau region at all but the lowest discount rate.

Another possibility is that off-farm incomes are lower than predicted. If the Chinese workforce is otherwise fully employed, the labour freed from farm work for other occupations by the CCFGP would involve a positive opportunity cost. Hence, off-farm incomes currently recorded as a benefit of the CCFGP become costs. To reflect this possibility, off-farm incomes were halved as one sensitivity analysis exercise. In that case, the net present value of the net benefit difference is positive at the 3 per cent discount rate, but negative at the 10 per cent and 20 per cent discount rates. This result shows that off-farm income prospects have the potential to make the CCFGP uneconomic.

If both revenues and off-farm incomes fall simultaneously, the results show that the costs of implementing the CCFGP would outweigh the on-farm benefits at all discount rates.

CONCLUSION

The extrapolation of the household agricultural production impact of the CCFGP across the 198 counties on the Loess shows that, in general, the CCFGP is economically feasible in the Loess Plateau region but the situation differs across the four groups of counties. The net present values of all 198 counties are all positive at 3 per cent, 10 per cent and 20 per cent discount rates, indicating the economic feasibility of CCFGP in the region. The 35 counties of the Ansai group and 24 pasture counties of the Gonghe group have negative NPVs at all three discount rates, suggesting that the CCFGP brings losses for counties with larger CCFGP land ratios and that the CCFGP is not economically feasible for those counties. With relatively small proportions of CCFGP land ratio, both the Binxian and Minhe groups have positive NPVs at all the three discount rates. This shows that the CCFGP is economically feasible in these districts.

The sensitivity analysis conducted demonstrates that the concerns regarding the economic viability of the Program in some counties can be extended to the whole Loess Plateau region if prices for or yields of the products of the land conversion fall and/or off-farm incomes fall. The conclusion to be drawn is that careful monitoring of these factors will need to be a feature of any continuation of the CCFGP. Government may in particular take measures to facilitate the marketing of land conversion products through the development of transportation networks and the lowering of any artificial barriers to their trade.

For counties with larger land conversion rates, the land-use change under the CCFGP changes the rural economic structure and this has negative impacts on the feasibility of the Program. Measures to offset the negative impacts of the

CCFGP may be introduced in these areas. These may involve the closer targeting of areas to be involved in the Program so that conversion is limited to areas where ecological risks are highest and the costs of conversion are lowest.

It is important to note that the study reported in this chapter is a partial cost-benefit analysis. Specifically it has not incorporated any of the benefits of environmental improvements that the CCFGP has been primarily aimed to achieve. Hence any negative net present values of the net benefit difference with and without the Program need to be considered relative to these (largely unmarketed) environmental benefits. For instance, the county groups showing negative economic impacts of the CCFGP are also the most ecologically fragile and the land conversion impacts on environmental benefits are likely to be the greatest in those counties. The extent of these environmental benefits will therefore play a key role in determining the overall social impact of the CCFGP. The negative NPVs of the NBD of the CCFGP reported here could thus be viewed as the thresholds that the environmental benefits of the Program would need to exceed in order for it to be socially welfare enhancing.

NOTES

1. One ton equals 36,7437 bushels.
2. One mu equals 1/15 hectare.
3. Note that income arising because farm labour has been freed to earn income away from the farm has been included as a benefit of the CCFGP. This is based on the assumption that such labour has a zero opportunity cost in the Chinese economy. The importance of this assumption is tested in the sensitivity analyses conducted in Section 4.
4. Data of CCFGP land area of 198 counties comes from the CCFGP Management Office of the State Forestry Administration (SFA) and the Statistics Division of the SFA.
5. Data for CCFGP area prior to 2002 were not available at county level, but since the CCFGP was officially launched in 2002 and most CCFGP activity has occurred since then, the data from 2002 to 2005 are regarded as sufficient.

REFERENCE

China Grain and Oil Information Centre (2006), *Grain Price in the Chicago Grain Exchange*, Beijing: Government Document.