Implications of CIP-Related Technologies for Poverty Reduction in Asia

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Poverty reduction is one of the three main goals of the Future Harvest Centers, the others being food security and sustainability of natural resources. The largest concentration of the world's poorest people is in rural Asia. Further, there is a strong correlation between where the rural poor live and where potato and sweetpotato are grown. Thus, it appears likely that a large share of the economic benefits from productivity improvements in CIP commodities may accrue to these rural poor.

Our objective in this paper is to review progress we are making in key technology areas for achieving poverty reduction in Asia. To examine the "poverty content" of CIP-related technologies in Asia, we draw heavily upon the research priority-setting exercise that was led by Tom Walker and Marie-Helene Collion in the mid 1990s (Walker and Collion). In that exercise, Walker and Collion surveyed the collective judgment of CIP scientists on the likely impacts of CIP technologies in various countries of the world and the likely research costs of achieving those impacts. That exercise was based heavily on income measures of impact, weighted by head-count measures of poverty. More recently, Walker (2000) developed a qualitative checklist for a broader set of poverty impacts. We will also use this checklist to make some preliminary assessments of a few key CIP technologies in Asia.

Income-based measures of poverty in Asia

Let us look briefly at some national-level indicators of poverty in countries in Asia where we are working. A common income-based measure to compare poverty is simply the average per capita income, measured in "purchasing-power-parity" (PPP) dollars. We all know that at market exchange rates, a dollar can buy far more in some countries than others. PPP exchange rates, on the other hand, are based on the cost of a common basket of goods, and therefore are better suited for comparing real income across countries. Of course, average per capita income is a limited measure since it does not take into account how evenly national income is distributed amongst the population. Another measure of poverty is the percentage of the population living in poverty. To compare amongst countries, a constant poverty level must be used – the poverty rates listed in table 1 are the percentage of the population living on less than $1/day at PPP exchange rates. But we could also examine other measures of poverty, such as the percentage of children that are malnourished, life expectancies, or other quality of life measures.

In the countries listed in table 1, the World Bank classifies China and the Philippines as low middle income countries while the rest are classified as low income countries. We've added a further division, listing Nepal and Bangladesh as

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very poor countries with average annual income in the late 1990s less than $1500 per person (PPP $). Note further that in these countries the poor are heavily concentrated in rural areas (thus the importance of agricultural growth for poverty reduction). In China, virtually all of those in absolute poverty live in rural areas. In South Asia and Vietnam, more than three-fourths of the very poor are rural. Urban poverty is a significant feature only in Indonesia and Philippines, but even here rural poverty accounts for most of the poor.

These poverty measures are sensitive to definitions. The poverty rates we've shown in the table are the percent of "absolute" poor, or those spending less than $1/day/capita. But even achieving this level of income may not be enough to provide an adequate standard of living. It may be enough for bare survival, but not enough for a decent quality of life. If we use a standard of poverty of $2/day, these poverty rates rise dramatically. It is fair to say that in Asia (as is the case with many developing countries), poverty remains pervasive.

We can also make the mistake of thinking of those in poverty as a rather well defined group, whereas in fact poverty is a very dynamic process. In studies where a group of households were tracked for an extended period of time, we find that rural households of poor and near poor are frequently getting out of poverty and falling back into poverty. Crop failures, family illnesses, general macroeconomic conditions, and other factors cause household incomes to fluctuate from year to year and month to month. Therefore, when we talk of a poverty rate, or percent of people living in poverty, it only gives us a picture of poverty at a snapshot in time. Over a longer period, the share of the population that experience absolute poverty can be much greater. This can be clearly seen from the ICRISAT village survey that tracked about 100 households in south India over a nine-year period (Walker and Ryan 1990). While the poverty rate over the period ranged between 60 and 40 percent, nearly 90 percent of households experienced poverty at least one year out of the nine (table 2). Thus, poverty can be very pervasive in rural communities even if the poverty rate appears to be relatively low. What this seems to imply for agricultural research is that we should not be too concerned about trying to develop technology specifically for the "poor" within an area (because they are a very fluid group) but rather we should be trying to develop technology for poor areas.

Anticipated economic and poverty impacts of CIP-related technologies in Asia

Let's now turn to look at the potential poverty impacts of CIP-related technologies in Asia. As mentioned earlier, this analysis takes as its starting point the priority-setting exercise conducted at CIP in the mid 1990s (Walker and Collion). In that exercise, CIP scientists used their collective judgment to estimate area and yield impacts of various technologies in various countries, or in the case of China and India, in various provinces or states. To determine how much of the anticipated impact would likely benefit poor people, Walker and Collion looked at the incidence of poverty in each region where impact was anticipated (table 3). This approach largely considers the direct benefits of new technology on poor farmers, and does not take into account effects on poor consumers (through lower food prices) or multiplier effects on rural economies.

What Walker and Collion found was that in general we could anticipate a high poverty content to the impact of CIP-related technologies. In other words, a large share of the economic benefits would accrue to poor people. The reason for this is simply that in Asia, most potatoes are sweetpotatoes are grown by poor households. In South Asia, for example, the highest concentration of poor resides in the lower part of the Ganges River Valley (Uttar Pradesh, Bihar, West Bengal states of India, Bangladesh). In this area, potato is widely grown as a winter crop. In China, potato is grown primarily in interior provinces such as Sichuan and Yunnan in the southwest and Inner Mongolia in the north, areas that have not enjoyed nearly the growth as the coastal provinces and where poverty in rural areas remains high. An overlay of potato- and sweetpotato-growing areas and provincial per capita income is shown for China in figure 1.

Of the CIP-related technologies expected to have significant impact in Asia, research on potato late blight and sweetpotato high dry-matter varieties are expected to have the greatest overall impact. The expected net present value for Asia of each of these technologies is over $200 million (table 4). Research on potato virus resistance, True Potato Seed (TPS), and sweet potato post-harvest utilization are expected to have impacts of around $100 million in net present value terms. The estimated poverty content of these technologies is based on the percent of rural poor in the areas where diffusion of these technologies is expected. It is a rough measure of the share of these impacts we expect will accrue to poor people. While sweetpotato high dry matter varieties are expected to have the largest economic impact, when weighted for poverty content potato late blight scores the highest. This is because a larger share of the anticipated benefits of improved varieties resistant to late blight are expected to benefit South Asia, an area with a higher incidence of poverty than China, which reaps most of the benefits from improved sweetpotato varieties.

Figure 2 shows the regions in Asia where CIP-related potato and sweetpotato technology are anticipated to have the largest impact for each technology. We expect other areas will also benefit from these technologies – the figure only shows the regions where economic benefits are expected to be most concentrated. China looms largest as the country expected to benefit most from CIP's work (not only in Asia, but globally). This is largely because China is the largest producer of both potato and sweetpotato in the world, with more than 45% of the developing world's potato production and 90% of its sweetpotato production.

Technologies were also weighted for their potential positive impacts on health and the environment, mainly through lower pesticide use. Technologies that have alternative sources of supply to CIP were weighted downward. These include the private sector in the case of potato varieties resistant to viruses and late blight and potato seed systems. Another alternative source of supply of new technology is the strong Chinese national program in the case of high dry matter yielding sweetpotato varieties.

Progress to date in technology diffusion and impact

Since the time these estimates were made, CIP has reduced its investment in some of these technologies, so some of these impacts are unlikely to be achieved, at least not in the original time frame. Post-harvest utilization research on potato has been eliminated. Research on sweetpotato utilization, potato TPS and bacterial wilt has been cut back. Research on potato seed systems should probably be considered as a service project rather than a stand-alone project, given the central role of this work on helping to diffuse new potato varieties resistant to pests and diseases. We might also discount the impact of utilization research as well, given that the private sector is active in supplying innovations in this area. There are also technologies where we probably underestimated economic impact, such as virus-free sweetpotato planting material.

These estimates of impact are projected to 2015 (estimated area impacts are shown in table 5). To see how far we have come, we have put together a list of achievements we have made so far and compare them with where we hope to be by 2015 (table 6). The single largest impact achieved so far has been with virus-free sweetpotato planting material in China. By 2000, this technology had spread to an estimated 800,000 hectares in three provinces of China and had already far exceeded our expected impact of 573,000 hectares by 2015. Another area we have achieved significant impact is with the diffusion of a new potato variety that has some resistance to late blight – Cooperation 88 has spread to around 200,000 hectares in Yunnan Province in southwest China. Walker and Collion projected that the predominate area of late blight impact would be South Asia, although our experience since then suggests that the more immediate impacts will occur in southwest China. There have also been important impacts with virus resistant varieties (CIP-24 in China) and TPS in Vietnam and South Asia. So far we have not released new varieties with high sweetpotato dry matter yield, although we have projected large impacts with this technology.

A big unknown in our impact assessment is sweetpotato post-harvest utilization research. We have apparently achieved some important gains in diffusing improved technology for starch and noodle processing in Sichuan, China. But the extent to which this can be credited to CIP or our NARS partners, or was mainly a private sector activity, is not clear. Getting a better understanding of the impact of sweetpotato postharvest processing research is a priority for our impact assessment series. Another question mark in our impact assessment concerns the prospects for success in information-intensive technologies such as integrated pest management and integrated bacterial wilt management. The approach we have been taking is a participatory needs assessment followed by the development of protocols for Farmer Field Schools. The widespread extension of this approach to farmers requires a significant and sustained commitment on the part of national research and extension systems to provide the resources for this knowledge-intensive approach. So far this impact has been limited.

We clearly have a long way to go to reach our goals by 2015. But we also shouldn't expect to achieve these targets for each technology. There is a degree of risk and luck involved in all of these efforts – some will fall short of expectations and some, as we have already seen with virus-free sweetpotato planting material, will exceed them.

A broader assessment of poverty implications of new technology

Our impact assessments to date have taken a rather narrow view of poverty impact. In addition to these gross impacts, we can use Walker's (2000) qualitative checklist to make some preliminary assessments of other kinds of poverty impacts of these technologies. We should emphasis that the scores we have given here (table 7) are subjective as in many cases we lack solid data with which to make these judgments. A score of +1 means that the technology is expected to have an especially favorable impact, a score of 0 implies a neutral impact and a score of –1 implies a negative impact in this aspect. For the technologies, we have scored them for the countries or regions where they are anticipated to have the greatest impact; for example, South Asia in the case of potato late blight and southwest China in the case of sweetpotato high dry matter.

In terms of country poverty, potato LB gets a +1 because India and Bangladesh have an exceptionally high incidence of poverty while sweetpotato high DM gets a –1 because China as a whole is relatively well off. Spatial poverty looks at those particular areas within the country and compares the incidence of poverty incident in the impact areas to the country average. Both potato late blight and sweetpotato high DM are scored +1 on spatial poverty because the Ganges River basin and southwest China are relatively poor regions within their respective countries. For poverty and gender, we scored sweetpotato high DM with +1 because of the increasing proportion of women farmers and female-headed rural households found in rural China. As more and more young men migrate to coastal provinces and cities in search of work, technology that improves farm productivity in rural China is likely to be of particular benefit to women. Potato in India receives a negative score on consumption because it is not a staple of the poor but rather a vegetable predominantly consumed by the urban middle class. However, this is changing. Over the long run the price of potato in South Asia has fallen relative to other foods and to income (Horton 1987), and it is slowly becoming an important food for rural poor, especially in the months immediately following harvest. Potato late blight management also scores well on a number of other aspects: increasing potato productivity in South Asia is likely to provide more employment for landless labor, reducing losses from disease will reduce yield fluctuation and risk, and reducing reliance on chemical means of control has benefits for the health of farmers and the environment.

In table 7 we present some tentative povery scores for the other technologies as well. We emphasize that at this point these scoring exercises are highly subjective. But the checklist does provide a guide for data collection for future impact studies to help assess a wider range of poverty impacts than we have considered previously.

New challenges for CIP in Asia

We close this presentation by listing a few new challenges – regions or issues that were not addressed in the last priority setting exercise. One challenge is how we extend technology to "left-behind" countries – countries with substantial poverty and food security problems but because of political and funding constraints we have been unable to make a sustained effort at introducing new technology. Top on this list in Asia are North Korea, Burma, and Laos. Our strategy to address this challenge is to seek special project support in the case of a large producer (North Korea) and link up with other centers such as CIAT in the case of small producers (Laos) to extend technologies.

A second challenge is a more complete coverage of natural resource management (NRM). CIP has a significant NRM program, which includes not only soil conservation in the Andes mountain zone but also long-term sustainability in intensive cereal-potato Asian cropping systems. So far though we have not done much to address long-run sustainability of highland vegetable production systems in Southeast Asia, where one faces the combined problems of soil erosion on mountain slopes and resource degradation from intensive multiple cropping and pesticide use.

With the expanding use of potato and sweetpotato in starch and food processing, we are also faced with growing waste management concerns.

A third challenge is urban and peri-urban poverty. Urban populations are projected to grow very rapidly in Asia over the next couple of decades. Recently CIP was designated as the lead CG Center for the new System-wide initiative on urban and peri-urban agriculture (SUIPA). However, as we have seen extreme poverty in Asia is largely rural. We need to clearly identify the potential poverty content of work we do on urban and peri-urban agriculture.

A critical issue in achieving poverty impact of CIP related technology is to keep our resources focused on those areas where success is most likely to be achieved and where the poverty content is high. This is especially important as our staffing resources in Asia are reduced.

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Table 1. Income and poverty in selected Asian countries in late 1990s

Country	Population 1999 (million)	Income/capita 1999 (PPP US$)	Children malnourished (%)	Poverty rate (% of pop)		Rural share of poor (%)
				(< $1/day)	(< $2/day)	
Nepal	23	1219	57	37.7	82.5	92.2
Laos & Cambodia	17	1415				91.9
Bangladesh	128	1475	56	29.1	77.8	85.0
Vietnam	78	1755	46			89.9
Pakistan	135	1757	38	31.0	84.7	69.5
India	998	2149		44.2	86.2	75.5
Indonesia	207	2439	34	23.3	66.1	65.0
Sri Lanka	19	3056	38	6.6	45.4	83.1
China	1250	3291	16	18.5	53.7	99.0
Philippines	77	3815	30			53.0

Sources: World Bank Development Report 2000/2001, except for Indonesia, which is from Frankenberg, Thomas, and Beegle (1999) to include effects of the Asian economic crisis.

Table 2. Poverty dynamics in India: ICRISAT panel survey of households

Years in poverty (out of nine)	Percent of families	Cumulative percent of families
Never poor	13	100
1-2 years	19	87
3-6 years	32	68
7-8 years	14	36
Always poor	22	22
Average poverty rate	50	

Source: Walker and Ryan (1990).

Table 3. Poverty weights assigned to impact assessment in ESEAP and SWA

Country or province		Poverty weight (TAC revised)
Northern China	Inner Mongolia	0.906
	Heilongjiang	0.706
Southwest China	Yunnan	0.733
	Sichuan	0.432
East & central China	Anhui	0.297
	Shandong	0.262
	Hunan	0.239
Southeast Asia	Vietnam	0.673
	Philippines	0.530
	Burma	0.499
	PNG	0.444
	Indonesia	0.334
	Thailand	0.000
India	Bihar	0.800
	West Bengal	0.800
	Uttar Pradesh	0.760
	Other	0.720
Other south Asia	Bhutan	0.884
	Nepal	0.757
	Bangladesh	0.732
	Pakistan	0.481
	Sri Lanka	0.276

The poverty weight is a rough measure of the share of benefits from improved potato and sweetpotato technology that accrue to poor households.

Source: Walker and Collion.

Table 4. Unweighted and weighted benefits of CIP-related technologies in Asia

	Technology *	Benefits in ESEAP + SWA (Net Present Value)					Rank	
		Total (million $)	To poor (million $)	Health (%)	Alternative supplier (%)	Weighted benefits (million $)	Un-weighted	Weighted
P	Late blight	226.5	148.7	0.10	-0.05	156.1	2	1
SP	High dry matter	277.5	139.7		-0.05	132.7	1	2
P	Virus	102.4	82.7		-0.05	78.5	5	3
P	TPS	113.2	73.1	0.05		76.8	4	4
SP	Utilization	117.5	54.1			54.1	3	5
SP	IPM	54.5	30.3			30.3	8	6
P	Bacterial wilt	61.6	27.9	0.05		29.3	7	7
SP	Virus-free planting material	82.0	28.7			28.7	6	8
P	IPM	40.3	23.0	0.10		25.3	9	9
P	Cropping systems	19.0	15.0			15.0	10	10
P	Utilization	11.8	8.7			8.7	11	11
P	Seed systems	5.3	2.9		-0.05	2.7	12	12
ARTC	Utilization	2.6	1.4			1.4	13	13

* P = potato, SP = sweetpotato, ARTC = Andean root & tuber crops (especially Canna).

Source: Walker and Collion.

Table 5. Projected diffusion area and annual benefits of CIP-related technologies in Asia by 2015

Technology *		Area (000 ha)			Benefits/year	
		Total	Target	Spillover	$/ha	million $
P	Late blight	644	410	234	530	341
SP	High dry matter	1,633	1,619	14	325	531
P	Virus	345	213	132	243	84
P	TPS	135	135	0	299	40
SP	Utilization	844	814	30	307	259
SP	IPM	373	359	14	135	50
P	Bacterial wilt	125	119	6	484	61
SP	Virus-free planting material	573	493	80	200	115
P	IPM	143	124	19	243	35
P	Cropping systems	39	28	11	500	20
P	Utilization	135	135	0	299	40
P	Seed systems	45	45	0	327	15
ARTC	Utilization	9	0	9	245	2

* P = potato, SP = sweetpotato, ARTC = Andean root & tuber crops (especially Canna).

Source: Walker and Collion.

Table 6. Progress on diffusion of CIP-related technologies in Asia by 2000

Technology *		Successes so far	Estimated area in 2000 ('000 ha)	Area projected for 2015 (‘000 ha)
P	Late blight	Cooperation 88 : SW China	200	644
		BSU-PO3 : Philippines	3	
SP	High dry matter			1,633
P	Virus	CIP-24 : N China	40	345
P	TPS	2/67 & 7/67 : Vietnam, SW Asia	10-20	135
SP	Utilization	Starch/noodle processing : SW China	??	844
SP	IPM	FFS ICM : Indonesia	1	373
P	Bacterial wilt			125
SP	Virus	Virus-free planting material : China	800	573
P	IPM			143
P	Cropping systems			39
P	Utilization			135
P	Seed systems	Tissue culture : Vietnam	0.4	45
ARTC	Utilization			9
Total			1,100	5,043

* P = potato, SP = sweetpotato, ARTC = Andean root & tuber crops (especially Canna).

Sources: Walker and Crissman (1996); Chilver *et al*. (1997); Fuglie *et al*., (1999), Fuglie *et al*. (2001), and authors’ estimates.

Table 7. Qualitative checklist of technology impacts on poverty in Asia

	P LB	SP HDM	P Virus	P TPS	SP Util.	SP IPM	P BW	SP Virus	P IPM
Dominant area of impact (share of projected poverty benefits) Poverty aspect *	SW Asia (61%)	SW China (48%)	N China (84%)	SW Asia (74%)	SW China (67%)	SE Asia (78%)	SW China (79%)	China (64%)	SW Asia (76%)
Production and poverty									
Country poverty	+1	-1	-1	+1	-1	0	-1	-1	+1
Spatial commodity poverty	+1	+1	+1	+1	+1	0	+1	0	+1
Poverty of the recommendation domain	0	0	0	0	0	0	0	-1	0
Poverty and adoption	0	0	0	+1	-1	0	0	+1	0
Poverty and gender	0	+1	+1	0	+1	0	+1	0	0
Growing season poverty	0	0	0	0	0	0	0	0	0
Consumption and poverty									
Poverty and commodity consumption	-1	0	0	-1	0	0	0	0	-1
Poverty and rural consumption	-1	0	0	-1	0	+1	0	0	-1
Other aspects of poverty									
Poverty and landless labor	+1	0	0	+1	0	0	0	0	+1
Stochastic poverty	+1	0	+1	0	0	+1	+1	0	+1
Poverty and linkages	0	+1	0	0	+1	0	0	0	0
Poverty and health	+1	0	0	+1	0	0	0	0	+1
Losers versus gainers	0	0	0	0	0	0	0	0	0
Total score	3	2	2	3	1	2	2	-1	3

* For explanations of the poverty aspects, see next page.
Scores: +1 = positive differential impact of technology on poverty of specified group
0 = no differential impact
-1 = negative differential impact

P LB = Potato late blight management
P Virus = Potato virus-resistance
P TPS = True Potato Seed
P BW = Potato bacterial wilt management
P IPM = Potato integrated Pest management

SP HDM = Sweetpotato high dry matter varieties
SP Util. = Sweetpotato utilization/new markets
SP IPM = Sweetpotato integrated pest management
SP Virus = Sweetpotato virus-free planting material

Producer poverty & rural equity:

Country poverty: Does the developing country rank in lower, middle, or higher tercile on a head-count poverty index?

Spatial poverty: Are producers of the crop poorer, same, or richer than average farmers in country?

Poverty in the recommendation domain: will the technology benefit a greater proportion of poorer or richer regions where the crop is grown within the country or region?

Poverty and adoption: Are poorer rather than richer farmers likely to benefit within the same region?

Poverty and gender: Is the technology especially attractive to women farmers?

Growing season poverty: Is the crop harvested during a "hunger" season?

Consumer effects:

Poverty and commodity consumption: Is the crop consumed as a staple food or does it enter the diet as a higher price vegetable in urban consumption?

Poverty and rural consumption: Are poorer rural households net consumers of the crop?

Other effects:

Poverty and landless labor: Will the technology increase or reduce employment of rural landless labor?

Stochastic poverty: Will the technology reduce or increase crop yield or price risk?

Poverty and linkages: Does the technology have strong or weak multiplier effects in the rural economy?

Poverty and health: Does the technology improve or worsen farmer or consumer health?

Losers versus gainers: Are there any groups that will be made worse off by the technology ("left behind" areas)?

Figure 1. Poverty and potato/sweetpotato production in China

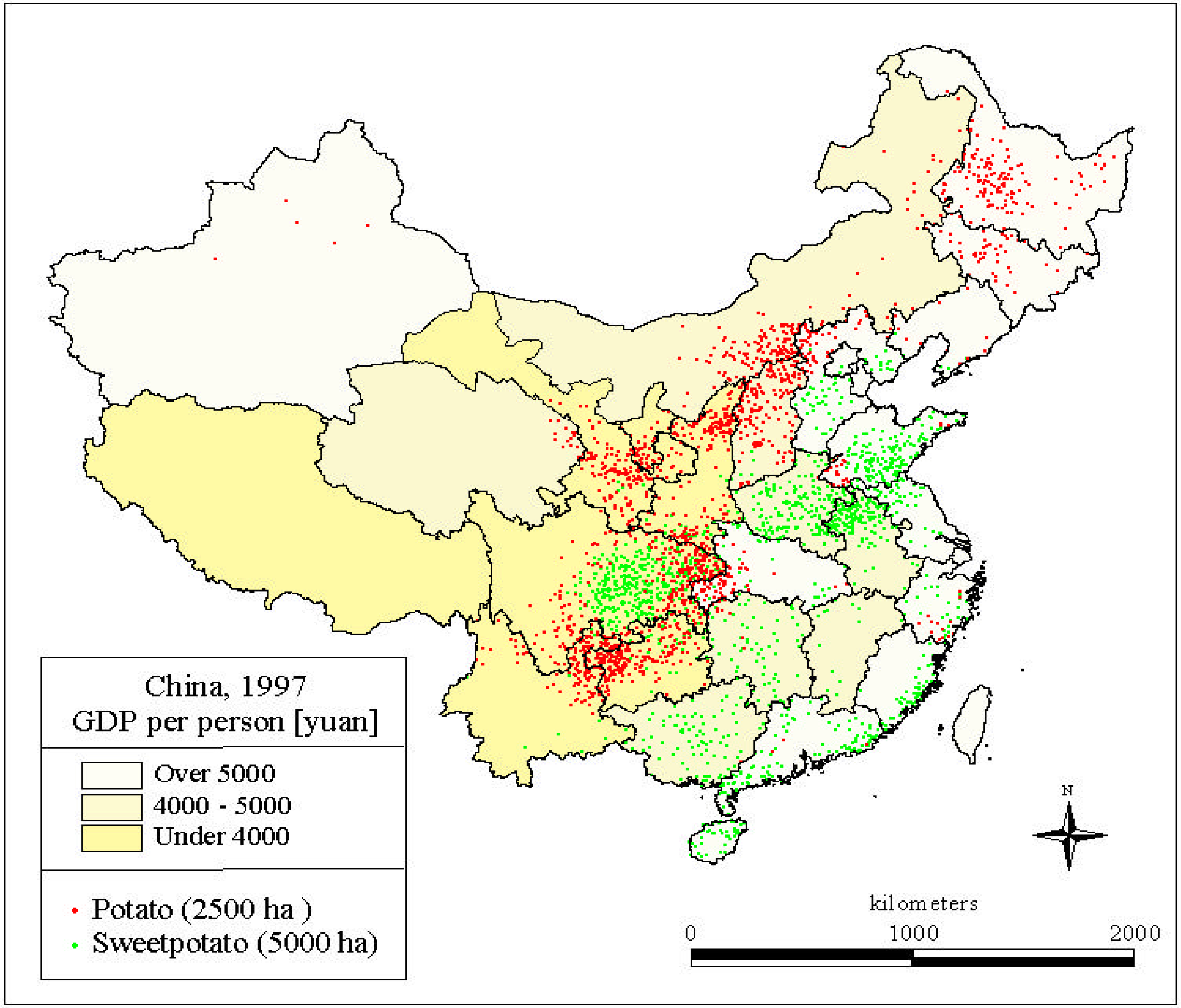

Figure 2. Major potato and sweetpotato production constraints in Asia