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## Chapter 8

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### Micro-level Evidence of Impacts on Agrobiodiversity Caused by the Change from Subsistence to Cash Crop Farming in the Hills

H. R. Sharma

#### Introduction

Agricultural development in Himachal Pradesh (HP) provides us with a number of useful lessons for other mountain areas to follow. HP's success lay primarily in the ability of its planners to consider the specific attributes of mountains in development approaches. By reducing inaccessibility, the process of agricultural transformation from traditional cereal crops to commercial cash crops was expedited and resulted in remarkable improvements in the socioeconomic status of the farmers in the state.

The objective of the present study was to understand the process of agricultural transformation in one of the agriculturally developed areas and discover how it has affected crop diversity. The study was also intended to examine the implications of any changes in crop diversity for the sustainability of mountain agriculture in terms of the natural resource base, the quality of life, and equity. The case studies were carried out in two villages in Kullu district of Himachal Pradesh, Naggar (Katrain) and Banjar (Plach), which were selected to represent the transformed area (TA) and non-transformed area (NTA) scenarios, respectively (Table 8.1).

#### Material and Methods

The Kullu district of Himachal Pradesh was chosen for the study because the level of crop diversity in this district was higher than in other transformed districts. At the first stage of sampling, two development blocks (groups of villages), Naggar and Banjar, were selected to represent transformed and non-transformed areas

	Transformed Area	Non-Transformed Area
Elevation	1000 to 1500 masl	2000 to 2500 masl
Mean annual rainfall	50-75 cm. Some rainfall throughout the year, but mostly during the monsoon	103 cm, mostly during the monsoon.
Temperature	0.6°C to 27.3°C	0.3°C in December to 20.8°C in August.
Soils	Sandy loam to clay loam	Clay loam
Irrigation	100 % (rice farming)	Rainfed
Dominant Cereal Crops	Paddy and wheat	Maize and wheat
Horticultural Crops	Apples, plums, and peaches	Apples, apricots, and plums
Average size of cultivated landholding	0.97 hectares	0.88 hectares
Source : Field Survey 1995		

respectively. Two panchayats (clusters of a few villages) were then selected, again to represent the two levels of agricultural development. The selected panchayats were Katrain from the Naggar block and Plaich from the Banjar block. Finally, a total sample of 125 households, 62 from the transformed areas and 63 from the non-transformed areas, were selected randomly using the method of proportional allocation. In addition, 35 key informants, 20 from the transformed area and 15 from the non-transformed area, were also interviewed to assess changes in the natural resource base, quality of life, and equity at the community level based on their perceptions.

The salient agroclimatic features of the selected *panchayat(s)* are given in Table 8.1.

### Changes in Crop Diversity and Yields

The process of agricultural transformation in the study area has led to significant changes in crop diversity during the past two decades, in both the transformed and non-transformed areas. Traditional crops, such as *Setaria italica*, millets, grain chenopod, and amaranth, are no longer cultivated in either area (Table 8.2). Hog millet (*Setaria italica*) is no longer cultivated in the transformed area and only to a very small extent in the non-transformed area. These crops have been completely replaced, mainly with fruit crops. Similarly, local varieties of wheat and maize crops have been substituted by exotic varieties, particularly in the transformed area. In both areas, there has been a complete substitution of local wheat with high-yielding cultivars. Similar trends are discernible in respect of other crops such as barley, potato, and oilseeds. The main additions to crop diversity have been kidney beans; different vegetables such as cabbages, cauliflowers, radishes, and tomatoes; and fruit crops. The area under fruit crops

Table 8.2: Changes in Crops between 1975 and 1995 (% of area under crops)

Crop	Transformed Area		Non-Transformed Area	
	1975	1995	1975	1995
<i>Setaria italica</i>	1.75	-	4.17	0.22
Millet	1.50	-	4.71	-
Grain chenopod	1.00	-	2.60	-
Amaranth	1.50	-	5.50	-
Kidney beans	-	4.02	-	2.55
Barley	7.25	1.08	25.75	4.29
Oilseeds	1.50	0.31	1.04	0.18
Vegetables	2.75	2.79	-	-
Potatoes	2.00	-	6.75	0.40
Orchards	28.33	59.87	7.25	20.82
All crops + wheat & rice	100.00	100.00	100.00	100.00

Source: Field survey 1995

has nearly doubled in the transformed area and has increased from seven to 21 per cent in the non-transformed area. These changes in the pattern of crops are usually leading to cash crop driven loss of agrobiodiversity.

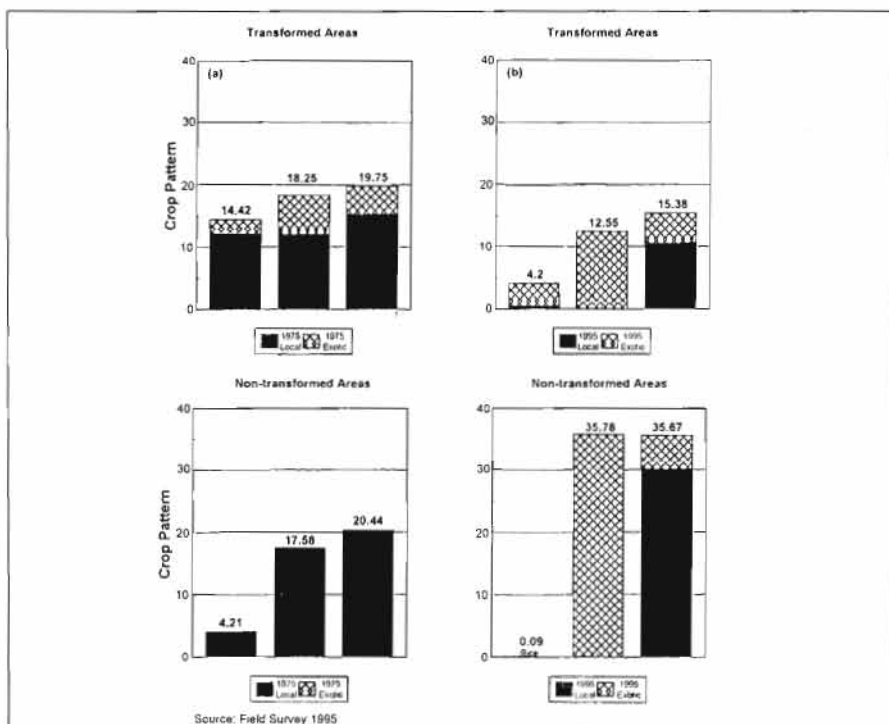


Figure 8.1: Comparative changes (1975-1995) in percentage area under local and exotic cultivars of major crops in the transformed and non-transformed villages of Himachal Pradesh, India.

The process of agricultural transformation has also led to the substitution of local breeds of livestock for hybrid breeds. In both areas, the number of livestock per household has gone down drastically; the most conspicuous changes being in the numbers of cows, sheep, and goats. The number of local cows per household has declined from 2.5 to 0.02 and from 3 to 1.05; and the number of sheep from 4.00 to 1.24 and from 10 to 1.44 in the transformed and non-transformed areas respectively. These changes can be explained primarily in terms of changes in crops. The spread of fruit crops, particularly apples, to marginal and fragile lands has led to a reduction in the area under pasture, forcing households to reduce the number of animals. Similarly, the replacement of local crop varieties that yielded more fodder with high-yielding cultivars has also resulted in a reduction in the amount of fodder available.

The changes in crop yields over time are shown in Table 8.3. The yields of all crops have increased to varying degrees, both in the transformed and non-transformed areas. This is attributed to such factors as the adoption of high-yielding varieties and the availability of inputs such as fertilizers. The evidence in Table 8.3 is in sharp contrast to that of declining crop yields in mountainous regions documented by the MFS Division of ICIMOD. It is clear, however, that crop yields in the non-transformed areas are still lower than those in the transformed areas, mainly because of low use of inputs such as fertilizers.

Table 8.3 : Changes in Crop Yields Over Time 1975 to 1995 (t/ha)					
Particulars		Transformed Area		Non-Transformed Area	
		1975	1995	1975	1995
Corn – black gram	Local	1.6	2.1	0.9	1.3
	HYV*	1.7	2.6	-	2.0
Paddy	Local	1.7	2.0	0.6	0.9
	HYV*	2.0	2.7	-	-
<i>Setaria italica</i>		1.3	-	0.8	0.2
Millet		1.4	-	0.8	-
Grain chenopod		0.7	-	0.5	-
Amaranth		0.9	-	0.8	-
Kidney beans		1.6	0.5	-	0.5
Wheat	Local	1.3	-	0.7	-
	HYV*	1.5	2.2	-	1.1
Barley		1.6	1.5	0.9	1.0
Oilseeds		0.4	0.5	0.5	0.6
Peas		2.5	-	-	-
Potatoes		3.0	-	2.5	3.5
Cabbages		-	5.6	-	-
Cauliflower		-	6.3	-	-
Radishes		-	2.5	-	-
Tomatoes		-	8.3	-	-

HYV=high yielding varieties  
Source : Field survey, 1995

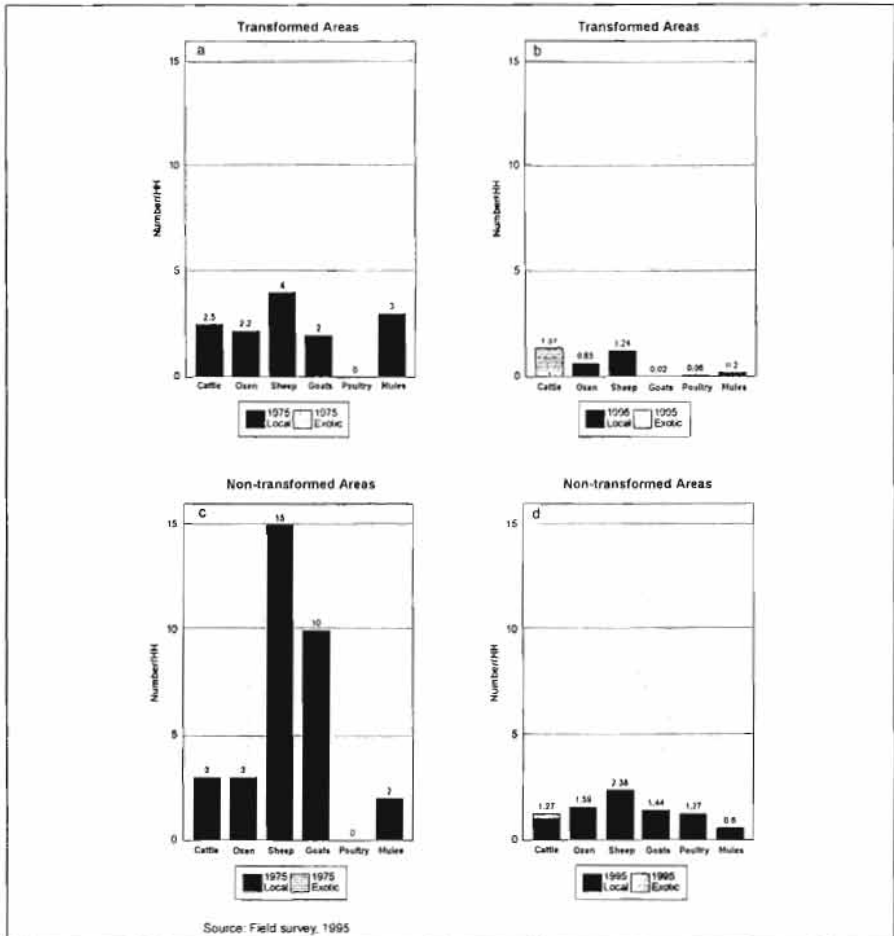


Figure 8.2: Comparative (1975/95) Changes in Number of Local and Exotic Livestock in the Transformed and Non-transformed Villages of Himachal Pradesh, India

### Changes in Crop Diversity: Impact on Income and Employment

The process of transformation from traditional subsistence agriculture to commercial agriculture based on high-value cash crops has led to significant changes in household income (Table 8.4). There is a small difference in the number of household livelihood options between the transformed and the non-transformed areas; although around 80 per cent of the total households in both areas are engaged in three to four livelihood options. The clearest difference, however, is seen in the level of income; both the household and per capita incomes are nearly twice as much in the transformed areas as in the non-transformed areas. The contribution of different production/livelihood options towards total household

Range of Options	Transformed Areas			Non-Transformed Areas		
	% of HHs	HH income	Per capita income	% of HHs	HH income	Per capita income
Up to 2	9.68	82,498	13,026	3.17	8,309	1,846
3-4	85.48	67,423	9,684	79.37	33,574	5,134
5-6	4.84	88,135	15,553	17.46	48,089	5,750
All households	100.00	69,884	10,219	100.00	35,305	5,197

Note: Household and per capita incomes are net income figures. In June 1995, 35 Indian Rupees were equal to 1 US\$.

Source : Sharma 1996

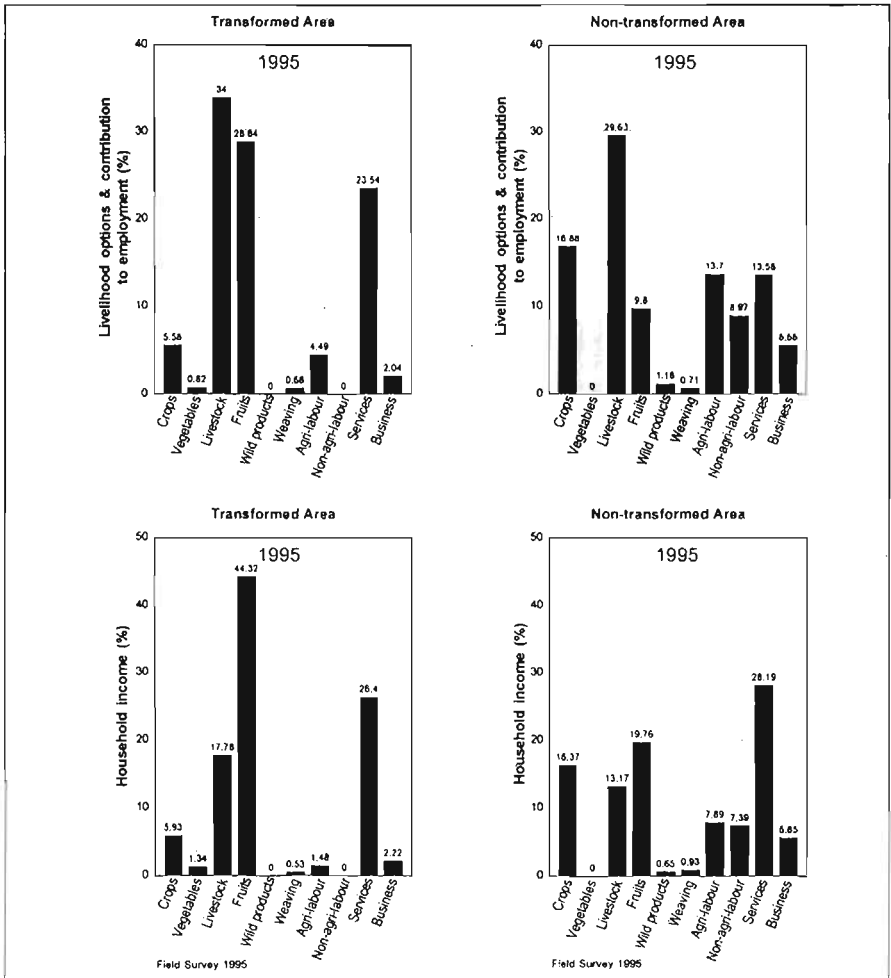


Figure 8.3: Livelihood Options and Their Contribution to Employment

employment and level of income are shown in Fig 8.3. A few significant features that emerge from Table 8.3 and Figure 8.3 need to be underlined. First, agriculture, defined broadly to include food grains, fruit, vegetables, and livestock continues to be the major source of livelihood in both areas. For example, in the transformed areas, fruit crops and livestock are the major production activities accounting for as much as 70 per cent of total employment days. In the non-transformed areas, crop production, livestock, and agricultural labour are the most important sources of household employment, accounting for nearly two-thirds of total employment days. Second, agriculture-related activities contribute two-thirds of the total household income in the transformed areas, with fruit production alone accounting for two-fifths of the total income. In contrast, in the non-transformed areas, the contribution of agriculture to the total household income is nearly one-half with fruit production contributing about the one-fifth, followed by crop production and livestock. Among the non-farm activities, service activities contribute more than one-fourth, followed by business and non-agricultural labour. Average per worker per day earnings, which take into account both amount of employment and level of income, are substantially higher in the agriculturally transformed areas than in the non-transformed areas. In brief, the process of substitution, replacement, and addition to the diversity of crops and animals in the agriculturally transformed areas has led to a significant increase in household income and, in the ultimate analysis, in the economic status of the local people.

### **Changes in Crop Diversity: Implications for Sustainability**

The effect of changes in crop and animal diversity on sustainability has been examined in terms of changes in the quality of life, equity, and the natural resource base. Some quantitative aspects of sustainability are presented and discussed in this section. Some indicators of the quality of life are shown in Table 8.5. Expenditure on food, clothing, shelter, health, and education, amongst others, reflects the quality of life of the people. Expenditure on food items such as meat, eggs, milk products, and fruit could simply indicate the result of these households no longer having their own livestock or food crops. Similarly, the availability and use of facilities like telephones, liquid petroleum gas (LPG), and television, and the very high value of residential houses in the transformed areas, say a lot about the quality of life being enjoyed by the people. In comparison, people in the non-transformed areas are just surviving; not only is the expenditure on basic necessities such as food, clothing, and education very low, some households remain perpetually in debt.

Equity, both intra- and inter-generational, is one of the most important prerequisites to ensure sustainable development. A process of economic transformation accompanied by widening inequalities is inherently unstable. Agricultural development that dispossesses a large number of marginal and small farmers and makes income more inequitable cannot be sustained in the long run.

**Table 8.5: Impact of Agricultural Transformation by Producing Cash Crops on the Quality of Life of Farm Families**

Indicator	Transformed Areas	Non-Transformed Areas
1 Expenditure on superior grains in IRs	5124 (10.49)	3461 (13.40)
2 Access to food (% of HHs)	100.00	100.00
3 Expenditure on clothing	4765 (9.75)	3040 (11.76)
4 Expenditure on milk & milk products.	11,771 (24.09)	2774 (8.80)
5 Expenditure on meat, fish and eggs	2344 (4.81)	893 (3.46)
6 Expenditure on fruit and vegetable	2378 (4.87)	697 (2.70)
7 Expenditure on education	5174 (10.59)	1826 (7.07)
8 Expenditure on health	1174 (2.40)	1594 (6.17)
9 Value of residential houses (Per household, Rs)	113,839	56,762
10 Percentage of households using LPG	43.33	-
11 % of households having telephone connection	21.67	-
12 % of households having television	100.00	20.00
13 Literacy level ( percent)	52.19	35.00
14 % of households in debt	5.00	35.00
15 % of households without electricity	-	11.67
16 % of households below poverty line (official)	-	30.00

Source: *Sharma 1996*  
Expenditure in Indian Rupees (Rs)

In fact, some scholars have argued that the ideal solution to the problem of making development sustainable lies in ensuring the equability of a system even at the cost of sacrificing some productivity and conservation (Conway 1985; Redcliff 1987). Various indicators of equity in the transformed and non-transformed areas are shown in Table 8.6. It is clear from this table that the process of agricultural transformation has not exacerbated intra-household inequalities. On the contrary, the extent of inequality is somewhat less in the transformed areas than in the non-transformed areas. For example, in the transformed areas both income and land distribution, as measured by the Gini ratio, are less skewed, male-female differentials are less pronounced, female literacy is significantly higher, and sexual division of work is less rigid.

Some quantitative evidence related to the health of the natural resource base is shown in Table 8.7. The replacement of traditional crops such as millet and *Setria*



Table 8.6: Agricultural Transformation and Implications for Equity

Indicator	Transformed Areas	Non-Transformed Areas
1 Male wage rates (agricultural)	IRs. 30.00	IRs. 25.00
2 Female daily wage rates	IRs. 25.00	IRs. 20.00
3 Income distribution (Gini ratio)	0.37	0.40
4 Land distribution (Gini Ratio)	0.58	0.62
5 Female literacy	42.62	34.18
6 Male literacy	60.09	53.48
7 % of female participation in household decisions	90.00	40.00
8 Sexual division of work	Fewer activities exclusively performed by males; females are often seen managing shops, etc	Rigid, less flexible sexual division of work.
9 Female employment	The introduction of new cash crops has opened up opportunities for female employment. For example, many women earn a good amount of income by working in apple orchards.	Such changes are discernible in the non-transformed area as well, but the impact is much less pronounced.
10 % of females with secondary or higher level of education.	41.34	12.96
11 % of children going to school		
Male	100.00	100.00
Female	100.00	100.00

Source : Sharma 1996

*italica* with high-value cash crops such as apples, for which the area has a comparative advantage, has led to a decline in the cropping intensity, which in this mountainous region augurs well for the maintenance of soils. Likewise, the process of transformation has been accompanied by a significant decline in the number of livestock per household and a complete switch from grazing to stall feeding, which has positive implications for the maintenance and conservation of the natural resource base. There is also no evidence of land degradation in terms of such factors as an increase in the intensity and frequency of landslides, an increase in soil erosion, or a decline in the water level in natural water sources. All is not well, however. Shrinking agrobiodiversity (crop and animal diversity), a decline in the amount of support land, and disruption of social values are the emerging problems.

### Changes in Crop Diversity: Factors and Process

The process of substitution, replacement, and addition in the diversity of crops and animals is caused by a number of factors — both exogenous and endogenous.

**Table 8.7: Agricultural Transformation and Implications for the Natural Resource Base**

Indicator	Transformed Areas	Non-Transformed Areas
Cropping intensity	128	167
% of area under fruit crops	75	24
Livestock (No./HH)	5	10
Use of fertilizer	Balanced	Unbalanced
Fuelwood	Use of LPG, kerosene, coal and less dependence on fuelwood	Total dependence on forests
Packing boxes	Substitution with cardboard boxes, recycling of boxes, and imports of timber from neighbouring states.	Similar trends
Livestock rearing	Stall feeding	5-6 hrs grazing
Land degradation	No evidence	No evidence
Awareness about natural resources	Very high	Very high
Natural water sources	No change	No change
Support land	0.11 ha per ha of crop land	0.45 ha per ha of crop land
Agrobiodiversity	<ul style="list-style-type: none"> <li>• Reduction in the number of crops</li> <li>• Destruction of predators and useful insects</li> </ul>	Problem is less acute, though the number of crops grown has declined
Investment in agriculture	30-40 per cent of total household income	10-15 per cent of total household income

Source : Sharma 1996

It is well known that farmers steeped in poverty with an extremely low standard of living are quick to seize any opportunity that might afford them a better livelihood. The experience of the transformed areas shows that the process of change has been caused primarily by exogenous factors. For example, wider promotion of apple farming and potatoes and the provision of infrastructural facilities such as roads set the whole process of change into motion. These new crops were not grown earlier because of lack of infrastructure and marketing facilities. Another factor that has played an important role in the wider adoption of fruit and other new cash crops is political patronage. A vast research and development network has been created to provide technical know-how to farmers. Support prices have been introduced to safeguard the farmers from extreme price fluctuations; institutional arrangements have been made to procure fruit in the event of prices falling to a very low level.

### Summing up

In summary, the agricultural transformation experienced in our study areas has led to a substantial improvement in the quality of life of the people in terms of

access to food and expenditure on clothing, health, superior grains, and so on. An improved level of welfare is also evident from the increase in the level of literacy in general and in female literacy in particular, the disappearance of poverty, and the decrease in the number of land and water disputes. The equity aspect is also positive; the Gini coefficient of income distribution is 0.37 in the transformed areas compared with 0.40 in the non-transformed areas. The evidence related to the impact on natural resources is also positive. In the process of transformation, factors and processes have been generated on both the demand and supply side that have lessened the burden on natural resources. These include the decline in cropping intensity, the decrease in the number of livestock per household, and the complete change over to stall feeding.

Another aspect of this change relates to the experiences of the transformed and non-transformed areas in the conflict between the maintenance of biodiversity and the level of development. Local agrobiodiversity is the first casualty of the onset of the process of transformation and integration of remote mountain areas with the mainstream: old crops are replaced with new crops; traditional varieties are substituted with high-yielding varieties; new crops are introduced; indigenous and local animals are replaced with crossbred and improved animals; traditional social and cultural values give way to new ways of life; and so on. The conflicts tend to increase with the increase in population pressure and spread of urbanisation. Farmers, who want to exploit any opportunity offered to improve their standard of living, cannot be expected to preserve the rich agrobiodiversity on their own. The solution for conserving species of crops and animals that are endangered and on the verge of extinction lies in combining their conservation with agricultural development.

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